

Broads Annual Water Plant Monitoring Report 2024



January 2025

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Broads water plant survey: 2024 Annual Report

Executive Summary

The Broads Authority have surveyed the water plant communities within the Broads since 1983. The Broads Annual Water Plant Survey 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 (previously 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.

Water plants (also known as 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 2024, which covered 19 broads, with a total of 517 survey points.

- Most of the broads connected to the Bure River recorded lower in abundance scores than 2023, including Cockshoot, Hoveton Little Broad, Hoveton Great Broad and Hudson's Bay, Pound End and Wroxham Broad.
- The Ant and Yare catchments recorded varying results across the waterbodies surveyed.
- The Thurne waterbodies mainly recorded positive results with high abundance scores with Horsey Mere being the exception.
- Stonewort's were dominant in Hickling Broad, Martham North and Martham South and were also present at low abundance in Alderfen Broad, Cromes Broad, Cockshoot Broad, Heigham Sound, Hoveton Great Broad, Rockland Broad, Upton Great Broad, and Wroxham Broad. Vascular macrophytes were dominant in 10/19 sites this year including Cockshoot Broad, Decoy Broad, Heigham Sound, Hoveton Great Broad, Hoveton Little Broad, Hudsons Bay, Pound End, Upton Broad and Wroxham Broad. Macro algae and mosses feature in the majority of broads with Strumpshaw having the greatest abundance in 2024 of all the broads. Free-floating or round floating leaved macrophytes were recorded i in 74% (9/19) of the broadss

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 survey 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 have contributed 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, the 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 purpose 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 Survey 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. River stretches are also surveyed annually, focusing on the upper reaches where plant growth is concentrated.

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, which are 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 (used at Hickling Broad).

The purpose of this report is to present the results of the 2024 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 Hollyleaved 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 ($y = 4.6242 \ln(x) + 17.149$) 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



Area of Open Water (ha)

Figure 2 Map showing the sample points of 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 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 2024 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 2022.

| Broad | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|
| Alderfen Broad | х | х | х | х | х | Х | х | х | х | х | Х |
| Bargate Broad | Х | | | Х | | | х | | | Х | |
| Barnby Broad | | х | | | | | | | | | |
| Barton Broad | Х | х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| Belaugh Broad | | | | Х | | | | | Х | | |
| Blackfleet broad | | | Х | | | | | | | | |
| Bridge Broad | | х | | | | | х | | | Х | |
| Buckenham Broad | | x | | х | | | | | | х | |
| Burntfen Broad | | | Х | | | | | | Х | | |
| Buttle Pools | l | | | | | | l | | U | Х | l |
| Calthorpe Broad | Х | | | | | | | Х | | | |
| Catfield Broad | | х | | | | | | | | | |
| Cockshoot Broad | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| Cromes Broad | х | х | х | х | х | Х | х | х | х | х | х |
| Decoy Broad | х | | Х | | Х | | х | | х | | Х |
| Hassingham Broad | | x | | х | | | | | | х | |
| Heigham Sound | Х | х | Х | Х | Х | Х | х | Х | Х | Х | Х |
| Hickling Broad | Х | х | х | Х | х | Х | х | Х | Х | Х | Х |
| Horsey Mere | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| Hoveton Great Broad | x | x | x | x | х | х | x | х | x | х | x |
| Hoveton Little Broad | x | | | х | | | x | | x | | x |
| Hudson's Bay | | х | | | Х | | Х | Х | Х | Х | Х |
| Little Broad | | | х | | | | | | х | | |
| Malthouse Broad | | | | | | | х | | | | |
| Martham Broad North | х | x | x | х | х | Х | х | х | x | Х | x |

| Broad | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|------------------------------|------|------|------|------|------|------|------|------|------|------|------|
| Martham Broad South | х | х | х | х | х | х | х | х | х | х | x |
| Mautby Decoy | | | Х | | | | | | | | |
| Norton's Broad | | | Х | | | | | | Х | | |
| Oulton Broad | | | х | | | | | | | | |
| Pound End | | х | | | | | Х | | х | | Х |
| Ranworth Broad | х | х | | х | | Х | х | х | | | |
| Reedham Water | | | | | | | | | | Х | |
| Rockland Broad | х | х | х | х | Х | Х | х | х | х | Х | Х |
| Round Water Broad | | | х | | | | | | x | | |
| Salhouse Great Broad | | | | | | | | | х | | |
| Sotshole Broad | | | Х | | | | | | | | |
| South Walsham Broad | | | | | | | | | | х | |
| Sprat's Water | | | Х | | | | | | Х | | |
| Strumpshaw broad | | х | | | х | | | х | | | x |
| Upton Broad | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| Upton Little Broad | х | | х | | х | | | | х | | |
| Wheatfen Broad & Channels | | х | | | х | | | х | | | х |
| Whitlingham Great Broad | х | х | х | х | х | | | | | | |
| Whitlingham Little Broad | | х | х | х | х | х | | | | | |
| Woolner's Carr | | | Х | | | | | | Х | | |
| Wroxham Broad | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |

Data processing

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

(Score from north + Score from south)

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 summary 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" are those covered under Section 41 (England) of the NERC Act (2006). These species 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 in 2024.

| Species | Broads |
|--|--|
| Holly-leaved naiad - <i>Najas marina</i> | Alderfen Broad, Cockshoot Broad, Heigham Sound, Hickling Broad, Martham South, Pound End, Strumpshaw, Upton Great Broad |
| Baltic stonewort - Chara baltica | Heigham Sound, Hickling Broad, Martham North, Martham South |
| Intermediate stonewort - <i>Chara intermedia</i> | Heigham Sound, Hickling Broad, Martham North, Martham South, Upton Great Broad |
| Convergent stonewort - Chara connivens | Heigham Sound, Hickling Broad, Martham South |
| Starry stonewort - Nitellopsis obtusa | Heigham Sound, Hickling Broad, Martham North, Martham South |

As can be seen from this table, the broads in the Thurne are an important site for Section 41 species, with most sites showing increases in abundance recorded . Holly-leaved naiad was also recorded in Strumpshaw not seen since 2015.

Graph 1

2024 abundance scores for Broads with Section 41 species (combined abundance scores for all Section 41 species present)



NB: Summary abundance axis usually sees ranges up to 10 in score, but to show the lower values for section 41 species the axis has been reduced for this graph.





The graph shows the combined abundance of all five section 41 species in each broad.

Graph 3

This graph shows the percentage of survey points where Holly-leaved naiad was recorded for those broads which are surveyed every year.



Predominantly found in the Norfolk Broads this species is of interest to monitor each year. The broads not connected to a river directly had a higher incidence of Holly-leaved naiad this year.

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 open water 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, including 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 along with Intermediate stonewort, Baltic stonewort, Convergent stonewort and Starry stonewort, as well as more common vascular plants such as Spiked water milfoil and Mare's tail.

2024 Summary

This year there has been an assortment of results with increases and decreases recorded in various waterbodies. Hickling, Martham North, Martham South and Heigham Sound increased in their overall abundances compared with 2023, whereas Horsey Mere has slightly decreased in abundance levels. 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 3

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------------|----------------------------|----------------------|----------------------------|
| Intermediate stonewort | Chara intermedia | 1.453 | 17 |
| Zygnematales | Zygnematales | 1.422 | 29 |
| Rigid hornwort | Ceratophyllum demersum | 0.844 | 37 |
| Starwort species | Callitriche sp | 0.719 | 23 |
| Starry stonewort | Nitellopsis obtusa | 0.688 | 8 |
| Bristly stonewort | Chara hispida | 0.594 | 9 |
| Shining pondweed | Potamogeton lucens | 0.484 | 10 |
| Spiked water milfoil | Myriophyllum spicatum | 0.469 | 26 |
| Nuttall's waterweed | Elodea nuttallii | 0.313 | 17 |
| Canadian waterweed | Elodea canadensis | 0.281 | 11 |
| Baltic stonewort | Chara baltica | 0.250 | 12 |
| Mare's tail | Hippuris vulgaris | 0.219 | 9 |
| Fan-leaved water crowfoot | Ranunculus circinatus | 0.125 | 8 |
| Enteromorpha | Enteromorpha | 0.109 | 7 |
| Convergent stonewort | Chara connivens | 0.109 | 2 |
| Perfoliate pondweed | Potamogeton perfoliatus | 0.109 | 5 |
| Whorled water milfoil | Myriophyllum verticillatum | 0.031 | 2 |
| Curled pondweed | Potamogeton crispus | 0.031 | 2 |
| Willow-leaved pondweed | Potamogeton x salicifolius | 0.031 | 1 |
| Common duckweed | Lemna minor | 0.016 | 1 |
| Ivy-leaved duckweed | Lemna trisulca | 0.016 | 1 |
| Intermediate water-starwort | Callitriche stagnalis | 0.016 | 1 |
| Holly-leaved naiad | Najas marina | 0.016 | 1 |
| No plants | No plants | 0.000 | 2 |
| Total number of species reco | rded | 23 | Total samples taken: 66 |

This year has seen a large increase for Heigham Sound, with the summary abundance increasing to the highest level seen at 8.344. However, species numbers decreased slightly from 25 to 23. The top seven species in order of abundance have all increased from last year and all the Chara species increased in their abundance levels and most in their occurrence as well. Starry stonewort also increased in abundance from 0.439 to 0.688 and was seen in large beds whilst travelling between the points. Spiked water milfoil decreased from 1.062 to 0.469.

Graph 4

Heigham Sound summary abundance shown in plant groups (see Appendix 1 for more detail)



Heigham Sound summary abundance shown in plant groups separately (see Appendix 1 for more detail)



Hickling Broad Table 4

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------------|-------------------------------|----------------------|-------------|
| Intermediate stonewort | Chara intermedia | 4.813 | 60 |
| Baltic stonewort | Chara baltica | 0.864 | 31 |
| Spiked water milfoil | Myriophyllum spicatum | 0.401 | 23 |
| Holly-leaved naiad | Najas marina | 0.300 | 6 |
| Mare's tail | Hippuris vulgaris | 0.238 | 2 |
| Convergent stonewort | Chara connivens | 0.213 | 4 |
| Starry stonewort | Nitellopsis obtusa | 0.200 | 2 |
| Zygnematales | Zygnematales | 0.188 | 15 |
| Hedgehog stonewort | Chara aculeolata | 0.163 | 2 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 0.163 | 7 |
| Bristly stonewort | Chara hispida | 0.150 | 5 |
| Rigid hornwort | Ceratophyllum demersum | 0.138 | 10 |
| Fragile/convergent stonewort | Chara globularis/connivens | 0.125 | 4 |

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|--------------------------------|---------------------|----------------------|----------------------------|
| Rough stonewort | Chara aspera | 0.113 | 4 |
| Lesser bearded stonewort | Chara curta | 0.038 | 2 |
| Canadian waterweed | Elodea canadensis | 0.025 | 2 |
| Curled pondweed | Potamogeton crispus | 0.013 | 1 |
| No plants | No plants | 0.000 | 4 |
| Total number of species record | ed | 17 | Total samples taken: 80 |

This year the summary abundance within Hickling increased slightly from 8.001 to 8.140 and there were three dominant species compared with four in 2023. Intermediate stonewort and Baltic stonewort are the two most dominant stoneworts with other Stonewort (*Chara*) species this year having less dominance. There were similar number of species this year. The vascular macrophytes decreased this year with macro algae & mosses increasing slightly.

Graph 6

Hickling Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Hickling Broad summary abundance trends shown by plant groupings s (see Appendix 1 for more detail)



Horsey Table 5

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------------|------------------------|----------------------|----------------------------|
| Mares Tail | Hippuris Vulgarus | 0.439 | 12 |
| Spiked water milfoil | Myriophyllum spicatum | 0.395 | 21 |
| Perfoliat pondweed | Potmageton Perfoliatus | 0.242 | 5 |
| Fennel-leaved pondweed | Potmageton Pectinatus | 0.152 | 1 |
| Zygematales | Zygematales | 0.030 | 2 |
| No plants | No plants | 0.000 | 40 |
| Total number of species reco | orded | | Total samples taken: 66 |

Species number stayed the same this year. Mare's tail increased in abundance from 0.394 to 0.439. Spiked water milfoil decreased in abundance from 1.412 to 0.395 and from 38 to 21 occurrences. The number of sample points with no plant records increased from 28 to 40 in 2024.

Graph 8

Horsey Mere summary abundance shown in plant groups (see Appendix 1 for more detail)



Martham North Table 6

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|----------------------------|----------------------|----------------------------|
| Bristly stonewort | Chara hispida | 4.854 | 38 |
| Filamentous algae | Zygnematales | 2.146 | 15 |
| Intermediate stonewort | Chara intermedia | 1.500 | 23 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 1.021 | 14 |
| Baltic stonewort | Chara baltica | 0.438 | 8 |
| Common water moss | Fontinalis antipyretica | 0.354 | 4 |
| lvy-leaved duckweed | Lemna trisulca | 0.167 | 8 |
| Willow-leaved pondweed | Potamogeton x salicifolius | 0.065 | 4 |
| Perfoliate pondweed | Potamogeton perfoliatus | 0.042 | 2 |
| Canadian waterweed | Elodea canadensis | 0.021 | 1 |
| Starwort species | Callitriche sp | 0.021 | 1 |
| Spiked water milfoil | Myriophyllum spicatum | 0.021 | 1 |
| Starry stonewort | Nitellopsis obtusa | 0.021 | 1 |
| Yellow water lily | Nuphar lutea | 0.002 | 1 |
| Total number of species recorded | | 13 | Total samples taken: 52 |

Overall abundance has increased from 8.696 to 10.671. The top five species in the table have not changed since last year. Decreases were seen in the abundance of Filamentous algae and Intermediate stonewort. Bristly stonewort saw an increase from 2.769 to 4.854. The southern end of the broad was difficult to access due to the large amount of Filamentous algae which was not located at the sample points and thus is not reflected in the abundance score 2.146 (down from last year, 2.692). Fennel-leaved pondweed with Baltic stonewort also record slight increases. Although there was a decreases in Macro-algae & Mosses, Common water moss increased from 0.231 to 0.354.

Martham North Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Graph 10

Martham North summary abundance shown in plant groups separetly (see Appendix 1 for more detail)



Martham South Table 7

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|----------------------------|----------------------|----------------------------|
| Bristly stonewort | Chara hispida | 5.481 | 40 |
| Intermediate stonewort | Chara intermedia | 1.788 | 32 |
| Zygnematales | Zygnematales | 0.692 | 7 |
| Baltic stonewort | Chara baltica | 0.692 | 17 |
| Starry stonewort | Nitellopsis obtusa | 0.346 | 8 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 0.250 | 8 |
| Holly-leaved naiad | Najas marina | 0.192 | 7 |
| Hedgehog stonewort | Chara aculeolata | 0.135 | 2 |
| Common water moss | Fontinalis antipyretica | 0.115 | 6 |
| Spiked water milfoil | Myriophyllum spicatum | 0.058 | 3 |
| Rough stonewort | Chara aspera | 0.038 | 2 |
| Convergent stonewort | Chara connivens | 0.038 | 1 |
| Fragile/convergent stonewort | Chara globularis/connivens | 0.038 | 2 |
| Ivy-leaved duckweed | Lemna trisulca | 0.021 | 2 |
| Canadian waterweed | Elodea canadensis | 0.019 | 1 |
| Delicate stonewort | Chara virgata | 0.019 | 1 |
| Rigid hornwort | Ceratophyllum demersum | 0.019 | 1 |
| Mare's tail | Hippuris vulgaris | 0.019 | 1 |
| Total number of species recorded | | 18 | Total samples taken: 52 |

Bristly stonewort and Baltic stonewort recorded increases in abundance. Overall, the proportion of vascular macrophytes stayed the same while stoneworts and macro-algae & mosses increased in the summary abundance score. Decreases were seen in Stary stonewort, Hedgehog stonewort, Rough stonewort, Fragile/convergent stonewort, Intermediate stonewort, Holly-leaved naiad, Spiked water milfoil and Common water moss.

Martham South Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Graph 12

Martham South summary abundance shown in plant groups separetly (see Appendix 1 for more detail)



Ant Valley

In the Ant Valley, Alderfen, Barton Broad and Cromes 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 have all experienced improvements to water quality.

2024 Summary

2024 recorded an increase in overall abundance for Cromes, whereas Alderfen and Barton Broad recorded decreases in overall abundance.

Alderfen

Table 8

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|--------------------------------|------------------------|----------------------------|-------------|
| Rigid Hornwort | Ceratophyllum demersum | 4.167 | 48 |
| Ivy leaved Duckweed | Lemna trisulca | 0.979 | 40 |
| Holly-leaved naiad | Najas Marina | 0.917 | 30 |
| Zygnematales | Filamentous Algae | 0.313 | 10 |
| Fragile/Convergent Stonewort | C.Globularis/connivens | 0.042 | 2 |
| Lesser Pondweed | Potmageton Pussilus | 0.021 | 1 |
| Total number of species record | 6 | Total samples taken: 48 | |

Alderfen has seen an overall decrease in summary abundance. Rigid Hornwort increased (0.896 to 4.167) along with Ivy-leaved duckweed and Holly-leaved naiad. Filamentous algae and Stoneworts have decreased. Macro-algae and mosses have also seen a decrease this year whereas free floating or round floating leaved plants have kept a similar level of summary abundance. The overall species count stayed the same at 6 this year with Jelly algae, Freshwater sponge and a Swan mussel being found.



Alderfen Broad summary abundance shown in plant groups (see Appendix 1 for more detail)

Graph 14

Alderfen Broad summary abundance shown in plant groups separetly (see Appendix 1 for more detail)



Barton Broad Table 9

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------|------------------------|----------------------|---|
| Yellow water lily | Nuphar lutea | 0.389 | 7 |
| White water lily | Nymphaea alba | 0.292 | 3 |
| Rigid hornwort | Ceratophyllum demersum | 0.208 | 13 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 0.208 | 15 |
| No plants | No plants | 0.000 | 48 |
| Total number of species ro | ecorded | 4 | Total samples taken: With Barriers : 92 Without Barriers:72 |

Barton Broad has seen a decrease this year and only two plant groups were recorded, those being vascular macrophytes and free-floating or round floating plants. Four freshwater mussel species were observed again this year including Duck, Swan, Painters and Zebra mussels. The only increase this year has been seen in Free-floating or round floating leaved species, from 0.576 to 0.681. There was not much difference between the number of plants in or out of the fish barriers this year.





Barton Broad summary abundance shown in plant groups (see Appendix 1 for more detail)

Crome's Broad Table 10

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|--------------------------|----------------------|----------------------------|
| Zygnematales | Zygnematales | 3.477 | 35 |
| Fragile/Convergent Stonewort | C. Globularis/connivens | 1.659 | 12 |
| White water lilly | Nymphaea Alba | 1.409 | 10 |
| Rigid Hornwort | Ceratophyllum Demersum | 0.455 | 16 |
| lvy-leaved duckweed | Lemna trisulca | 0.318 | 14 |
| Entromorpha | entromorpha | 0.227 | 8 |
| Yellow water lilly | Nuphur Lutea | 0.182 | 2 |
| Least duckweed | Lemna Minuta | 0.114 | 5 |
| Common duckweed | Lemna Minor | 0.068 | 3 |
| Frogbit | Hydrocharis morsus-ranae | 0.045 | 1 |
| Nutall's waterweed | Elodea Nutallii | 0.023 | 1 |
| Total number of species recorded | | 11 | Total samples taken: 44 |

There was an increase in free-floating or round floating leaved species within Crome's Broad this year, mostly White water lily, Ivy-leaved duckweed and Yellow water lily. Rigid hornwort decreased in occurrences from 33 to 27, and, abundance reduced from 2.186 to 0.786. Holly-leaved naiad abundance decreased from 1.823 to 0.238. Filamentous algae increased substantially from 1.364 to 3.598 along with White water lily, 0.409 to 0.905 and Delicate stonewort from 0.482 to 1.214. Of particular note was the increase in Filamentous algae although the algae was mainly submerged rather than on the surface as in other years. Delicate stonewort was recorded this year with higher abundance but at lower occurrence. Bladderwort was also seen in six spots and a swan mussel was found during the survey.



Crome's Broad summary abundance shown in plant groups (see Appendix 1 for more detail)

Graph 17

Cromes Broad summary abundance shown in plant groups separately (see Appendix 1 for more detail)



Bure Valley

In recent years, Upton and Cockshoot Broads, both isolated from the river, have been a stronghold for the rare Holly-leaved naiad. Conversely, those broads directly connected to the river, such as Wroxham and Hoveton Great, have tended to have minimal plant diversity. This year, all the broads except Upton Great Broad have seen a decrease is in summary abundance.

Cockshoot

Table 11

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------------|------------------------|----------------------|----------------------------|
| Holly-leaved naiad | Najas marina | 2.752 | 37 |
| Rigid hornwort | Ceratophyllum demersum | 2.125 | 37 |
| Zygnematales | Zygnematales | 1.463 | 40 |
| Canadian waterweed | Elodea canadensis | 0.104 | 5 |
| Enteromorpha | Enteromorpha | 0.104 | 5 |
| Common stonewort | Chara vulgaris | 0.021 | 1 |
| Nuttall's waterweed | Elodea nuttallii | 0.021 | 1 |
| Horned pondweed | Zannichellia palustris | 0.021 | 1 |
| Total number of species reco | orded | 8 | Total samples taken: 48 |

This year, Cockshoot has seen a decrease in vascular macrophytes and stoneworts. Rigid hornwort increased from 1.604 to 2.125 and Filamentous algae from 0.940 to 1.463. Holly-leaved naiad decreased from 3.646 to 2.752 which is the lowest figure seen in the last 7 years. Common stonewort decreased from 7 to 1 occurrence. The water lilies (white and yellow) are in the broad however they are not near a set point so do not get recorded on the survey.

Cockshoot Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Graph 19

Cockshoot Broad summary abundance shown in plant groups separetly (see Appendix 1 for more detail)



Decoy Broad Table 12

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|--------------------------------|------------------------|----------------------|----------------------------|
| Rigid hornwort | Ceratophyllum demersum | 1.500 | 25 |
| Yellow water lily | Nuphar lutea | 1.148 | 17 |
| Unbranched bur-reed | Sparganium emersum | 0.093 | 2 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 0.037 | 2 |
| Nuttall's waterweed | Elodea nuttallii | 0.037 | 1 |
| Zygnematales | Zygnematales | 0.019 | 1 |
| No plants | No plants | 0.000 | 23 |
| Total number of species record | ed | 6 | Total samples taken: 54 |

A decrease has been seen in overall summary abundance in Decoy this year. The three highest abundance species from 2023, Rigid hornwort (1.648 to 1.500), Yellow water lily (1.167 to 1.148) and Nuttall's waterweed (0.356 to 0.037) have all decreased this year. 'No plant' scores were similar this year to last (21 to 23).





Hoveton Great Broad

Table 13

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------|------------------------|----------------------|-------------|
| Rigid hornwort | Ceratophyllum demersum | 1.800 | 44 |
| Fennel-leaved pondweed | P. pectinatus | 0.833 | 24 |
| Nuttall's waterweed | Elodea nuttallii | 0.550 | 32 |
| Yellow water lily | Nuphar lutea | 0.350 | 3 |
| Zygnematales | Filamentous algae | 0.205 | 13 |
| Canadian waterweed | Elodea canadensis | 0.100 | 6 |
| grass-wrack pondweed | P. compressus | 0.100 | 5 |
| Curled pondweed | P. crispus | 0.100 | 6 |
| Fragile stonewort | C. globularis | 0.017 | 1 |
| Enteromorpha | Enteromorpha | 0.017 | 1 |
| Unbranched bur-reed | Sparganium emersum | 0.017 | 1 |
| No plants | No plants | 0.000 | 4 |

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|-----------------|----------------------|----------------------------|
| Total number of species recorded | | 11 | Total samples taken: 60 |

There has been a slight decrease in overall summary abundance this year even with more species recorded (7 to 11). Rigid hornwort (1.034 to 1.800), Yellow water lily (0.258 to 0.350) and Filamentous algae (0.066 to 0.205) increased this year however Fennel-leaved pondweed (1.694 to 0.833) and Nuttall's water weed (0.984 to 0.550) saw a decrease. Three mussel species were found including Duck, Painters and Zebra throughout the survey and an Asiatic clam. There are a few key places such as the eastern edge of the Broad near the new reedbed installations which continue to show encouraging signs of plants establishing in the area. Plants were seen at the surface of the water which is not usual for the broad (also seen last year), although the edges of the broad are still where the plants are found the vast majority of the time, with the centre points remaining largely plant free, although 'no plant' scores have reduced from 16 to 4. Long-stalked Pondweed (Potamogeton praelongus) was observed on the eastern end of the broad.

Graph 21

Hoveton Great Broad summary abundance shown in plant groups (see Appendix 1 for more detail)


Hoveton Little Broad

Table 14

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|---------------------------|---------------------------|-------------------|----------------------------|
| Fennel-leaved pondweed | P. pectinatus | 1.070 | 41 |
| Rigid hornwort | Ceratophyllum demersum | 0.452 | 15 |
| Yellow water lily | Nuphar lutea | 0.200 | 5 |
| No plants | No plants | 0.000 | 13 |
| Total number of spec | cies recorded | 3 | Total samples taken: 60 |

Overall summary abundance has decreased this year from 3.725 to 1.722. Rigid hornwort (2.083 to 0.452) has seen a large decrease whereas Fennel-leaved pondweed (0.952 to 1.070) and Yellow water lily (0.100 to 0.200) had increases. There were more 'no plant' scores this year compared to 2023 (5 to 13).

Graph 22

Hoveton Little Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Hudson's Bay Table 15

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|------------------------|----------------------|----------------------------|
| Rigid hornwort | Ceratophyllum demersum | 2.350 | 23 |
| Yellow water lily | Nuphar lutea | 1.008 | 15 |
| Zygnematales | Filamentous algae | 0.998 | 33 |
| White water lily | Nymphaea alba | 0.875 | 6 |
| Horned pondweed | Zannichellia palustris | 0.128 | 6 |
| Water net | Hydrodictyon | 0.075 | 3 |
| Nuttall's waterweed | Elodea nuttallii | 0.050 | 2 |
| Jelly algae | Nostoc | 0.050 | 2 |
| Starwort species | Callitriche sp | 0.025 | 1 |
| Canadian waterweed | Elodea canadensis | 0.025 | 1 |
| Enteromorpha | Enteromorpha | 0.010 | 4 |
| Total number of species recorded | | 11 | Total samples taken: 40 |

Hudson's Bay has recorded a decrease this year from 7.663 to 5.543 in overall summary abundance. The largest drop was seen in Rigid hornwort decreasing from 4.228 to 2.350. Yellow water lily (0.425 to 1.008) Filamentous algae (0.700 to 0.998) and White water lily (0.550 to 0.875) all increased. Three species of mussels (Duck, Zebra and Painters mussel) were present in the survey. Observations of Long-stalked Pondweed (Potamogeton praelongus) Fennel-leaved pondweed (P. pectinatus) and Freshwater sponge were also made. There were plants at every survey point.



Hudson's Bay summary abundance shown in plant groups (see Appendix 1 for more detail)

Pound End Table 16

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------|-------------------------|----------------------|----------------------------|
| Rigid hornwort | Ceratophyllum demersum | 0.775 | 15 |
| Holly-leaved naiad | Najas marina | 0.605 | 24 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 0.352 | 20 |
| Zygnematales | Zygnematales | 0.095 | 6 |
| Common water moss | Fontinalis antipyretica | 0.023 | 1 |
| No plants | No plants | 0.000 | 5 |
| Total number of species re | corded | 6 | Total samples taken: 48 |

The broad has seen an overall decrease in summary abundance from 2.525 to 1.850. Fennelleaved pondweed has seen a decrease from 1.023 to 0.352 which makes up the main reason for the decrease seen this year however the occurrence only went from 21 to 20. Hollyleaved naiad (0.545 to 0.605) increased and went from 8 occurrences to 24. Filamentous algae also decreased (0.184 to 0.095).



Pound End summary abundance shown in plant groups (see Appendix 1 for more detail)

Upton Great Broad Table 17

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------------|------------------|----------------------|-------------------------|
| Holly-leaved naiad | Najas marina | 5.500 | 34 |
| Bristly stonewort | Chara hispida | 0.854 | 5 |
| Zygnematales | Zygnematales | 0.483 | 23 |
| Intermediate stonewort | Chara intermedia | 0.021 | 1 |
| Total number of species reco | orded | 4 | Total samples taken: 48 |

This year saw the overall summary abundance increase from 5.233 to 6.858. Holly-leaved naiad increased from 4.208 to 5.500. Bristly stonewort also increased from 0.521 to 0.852. Filamentous algae increased from 0.294 to 0.483 and 'no plants' occurrences went from 1 to 0.

Upton Great Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Graph 26

Upton Great Broad summary abundance shown in plant groups separetly (see Appendix 1 for more detail)



Wroxham Broad Table 18

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|-------------------------------|----------------------|----------------------------|
| Rigid hornwort | Ceratophyllum demersum | 1.397 | 52 |
| Zygnematales | Filamentous algae | 0.540 | 21 |
| Fennel-leaved pondweed | P. pectinatus | 0.531 | 29 |
| Yellow water lily | Nuphar lutea | 0.281 | 11 |
| Nuttall's waterweed | Elodea nuttallii | 0.221 | 15 |
| Pointed stonewort | Nitella mucronata | 0.147 | 10 |
| Unbranched bur-reed | Sparganium emersum | 0.134 | 9 |
| Common water moss | Fontinalis antipyretica | 0.044 | 3 |
| Whorled water milfoil | Myriophyllum verticillatum | 0.029 | 2 |
| Spiked water milfoil | Myriophyllum spicatum | 0.015 | 1 |
| No plants | No plants | 0 | 5 |
| Total number of species recorded | | 10 | Total samples taken: 68 |

There was a decrease recorded in the overall abundance this year from 4.050 to 3.338. Rigid hornwort (1.547 to 1.397), Filamentous algae (0.849 to 0.540) Nuttall's waterweed (0.932 to 0.221) and Pointed stonewort (0.191 to 0.147) all recorded decreases this year. Occurrences for Filamentous algae (61 to 21) and Nuttall's waterweed (45 to 15) also dropped. Fennel-leaved pondweed (0.310 to 0.531) and Yellow water lily (0.088 to 0.281) saw increases in summary abundance and occurrence scores. Three mussels were found including Duck, Painters, Zebra and Jelly algae was noted.

Wroxham Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Graph 28

Wroxham Broad summary abundance shown in plant groups separately (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;' a manmade lake created from flooded peat diggings, or 'decoy', a lake created for wildfowl shooting.

2024 Summary

There were three broads surveyed this year in this river valley, they are Rockland Broad, Strumpshaw and Wheatfen. Decreases have been recorded in Rockland and Wheatfen this year and Strumpshaw has seen an increase.

Rockland Broad Table 19

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|---------------------------------|-------------------------------|----------------------------|-------------|
| Yellow water lily | Nuphar lutea | 3.229 | 41 |
| Zygnematales | Zygnematales | 1.406 | 32 |
| Nuttall's waterweed | Elodea nuttallii | 1.290 | 48 |
| Common water moss | Fontinalis antipyretica | 0.694 | 26 |
| Unbranched bur-reed | Sparganium emersum | 0.566 | 22 |
| Spiked water milfoil | Myriophyllum spicatum | 0.406 | 21 |
| Starwort species | Callitriche sp | 0.390 | 24 |
| Rigid hornwort | Ceratophyllum demersum | 0.198 | 15 |
| Whorled water milfoil | Myriophyllum verticillatum | 0.129 | 6 |
| Common duckweed | Lemna minor | 0.113 | 8 |
| Greater duckweed | Spirodela polyrhiza | 0.081 | 5 |
| Water-soldier | Stratiotes aloides | 0.081 | 1 |
| Least duckweed | Lemna minuta | 0.065 | 4 |
| Pointed stonewort | Nitella mucronata | 0.065 | 4 |
| Fennel-leaved pondweed | Potamogeton pectinatus | 0.048 | 3 |
| Frogbit | Hydrocharis morsus- ranae | 0.048 | 3 |
| Inflated duckweed | Lemna gibba | 0.048 | 4 |
| Arrowhead | Saggitaria sagittifolia | 0.032 | 2 |
| Enteromorpha | Enteromorpha | 0.018 | 2 |
| Ivy-leaved duckweed | Lemna trisulca | 0.016 | 1 |
| Crowfoot species | Ranunculus sp. | 0.016 | 1 |
| Fan-leaved water crowfoot | Ranunculus circinatus | 0.002 | 1 |
| Total number of species recorde | 22 | Total samples taken: 62 | |

Rockland Broad has seen a decrease this year from 10.776 to 8.942 in overall summary abundance. Vascular plants, floating leaved or round floating and macro-algae and mosses

have all decreased in abundance this year. Yellow water lily (3.274 to 3.229), Filamentous algae (1.598 to 1.406) and Spiked water milfoil (0.645 to 0.406) recorded decreases. Increases were seen in Nuttall's waterweed (1.032 to 1.290) and Common water moss (0.452 to 0.694). A Painters mussel was found.

Graph 29

Rockland Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Rockland Broad summary abundance shown in plant groups seperately (see Appendix 1 for more detail)



Strumpshaw

Table 20

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|------------------------------|------------------------------|----------------------|----------------------------|
| Zygnematales | Filamentous algae | 5.976 | 37 |
| Rigid hornwort | Ceratophyllum demersum | 0.895 | 8 |
| Ivy-leaved duckweed | Lemna trisulca | 0.763 | 23 |
| Holly-leaved naiad | Najas marina | 0.079 | 2 |
| Frogbit | Hydrocharis morsus- ranae | 0.026 | 1 |
| Least duckweed | Lemna minuta | 0.026 | 1 |
| No plants | No plants | 0.000 | 1 |
| Total number of species reco | orded | 6 | Total samples taken: 38 |

Strumpshaw has seen an increase this year along with some new species appearing since the last survey. Filamentous algae (5.100 to 5.976) and Ivy-leaved duckweed (0.067 to

0.763) have increased and three species have reappeared after a long absence, Rigid hornwort and Holly-leaved naiad have not been recorded since 2015 and Frogbit not recorded since 2011. Least duckweed (0.067 to 0.026) recorded a decrease.

Graph 31

Strumpshaw Broad summary abundance shown in plant groups (see Appendix 1 for more detail)



Wheatfen Broad and Channels Table 21

| Common Name | Scientific Name | Summary Abundance | Occurrences |
|----------------------------------|----------------------------|----------------------|----------------------------|
| Nuttall's waterweed | Elodea nuttallii | 2.000 | 26 |
| Frogbit | Hydrocharis morsus-ranae | 1.853 | 8 |
| Yellow water lily | Nuphar lutea | 0.882 | 9 |
| Unbranched bur-reed | Sparganium emersum | 0.794 | 12 |
| Zygnematales | Filamentous algae | 0.447 | 14 |
| Common duckweed | Lemna minor | 0.388 | 14 |
| Enteromorpha | Enteromorpha | 0.235 | 7 |
| Greater duckweed | Spirodela polyrhiza | 0.212 | 9 |
| Least duckweed | Lemna minuta | 0.209 | 8 |
| Arrowhead | Saggitaria sagittifolia | 0.206 | 3 |
| Ivy-leaved duckweed | Lemna trisulca | 0.147 | 5 |
| Whorled water milfoil | Myriophyllum verticillatum | 0.088 | 1 |
| Inflated duckweed | Lemna gibba | 0.065 | 4 |
| Starwort species | Callitriche sp | 0.032 | 2 |
| Rigid hornwort | Ceratophyllum demersum | 0.029 | 1 |
| Total number of species recorded | | 15 | Total samples taken: 34 |

A decrease has been seen in overall summary abundance from 8.919 to 7.588 this year. Nuttall's (3.750 to 2.000), Yellow water lily (1.222 to 0.882) and Filamentous algae (0.447 to 0.278) have seen decreases. Increases have been seen in Frogbit (0.778 to 1.853) and Unbranched bur-reed (0.639 to 0.794). Painters mussels were also observed.

Wheatfen Broad and Channels summary abundance shown in plant groups (see Appendix 1 for more detail)



Graph 33

Wheatfen summary abundance shown in plant groups seperately (see Appendix 1 for more detail)



River Plant Survey Methodology

Point sample survey technique

The new survey design has developed upon groundwork laid by earlier surveys of the Broads' river systems. Stretches where routine water plant cutting takes place annually were identified and the surveys have focused exclusively on these reaches (see Appendix 1).

Survey points were placed in a diamond formation along the reach to be surveyed, to account for differing plant communities at the margins compared to the centre of the channel (see figure 3). A sampling point was taken in the middle of the channel and then 100m downstream two sampling points were taken at the true left and true right banks. The maps and sample point co-ordinates were loaded onto a Samsung tablet for the survey teams to use.

Along each reach to be surveyed, the survey team used the maps and grid references, loaded onto the Samsung tablet, and GPS to navigate by boat to each sample point. Once within 5m of the plotted grid reference, mud weights were deployed to keep the boat in the correct location. At the sample point a double headed survey rake is thrown at a distance of 5m from the edge of the boat. In contrast to the broads' water plant survey, only one downstream throw is made at each point to mitigate against downstream drift of plant material. The rake is left for 10 seconds to allow it to sink to the bottom, after which it is pulled steadily back towards the boat.

Figure 3



Diagram illustrating river survey methodology

The plants accumulated on the rake head are collected in a white survey tray and washed to remove any excess sediment, as required. All live plant material is identified to species level wherever possible. However, some particularly difficult groups, such as the non-flowering starworts *Callitriche sp.*, can only be identified to genus level. Specimens that remain unidentified in the field, or where identification was uncertain, are collected in labelled plastic bags and taken for closer inspection under a microscope or sent for expert

identification. Specimens of interest are pressed and dried using standard herbarium techniques.

A level of abundance for each species is assigned based on the total volume of live water plant material, accounting for maximum trap-ability on the rake. Scores give each species present a range from 10% (low abundance) to 100% (the maximum trappable) in increments of 10%, with scores of 1% given to trace, or very small amounts, of identifiable plant material. A score of 100% represents the maximum amount trappable on the rake, to control for the 'trap-ability' of a given species. For instance, fine leaved species such as unbranched bur-reed, *Sparganium emersum*, are not as trappable with the rake as more structured species such as spiked water milfoil, *Myriophyllum spicatum*. This has the potential to result in under-recording of high abundances of less readily trapped species. Consequently, surveyor experience and judgement are important for scoring these less trappable species, such as duckweeds, *Lemna sp.* and water lilies. Scoring should consider the likelihood of a given species being retrieved on the rake and other visual indications of abundance.

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.

On the Thurne, a preliminary survey is undertaken in April/May, before the water plant harvester is mobilised, and where prioritised, a secondary survey is undertaken later in the season, in June or July. Due to the constraints introduced by the coronavirus pandemic in 2020, the river survey was confined to the River Thurne. In 2021, lifting restrictions allowed the survey to be extended to the other Broads' river systems. However, in 2021 the River Ant was excluded from the survey programme due to an infestation of floating pennywort which is currently under management. In 2022 the river plant survey was extended to all survey reaches of all river systems in the Broads for the first time since 2014 and this has continued into 2024. However, due to time and resource constraints, a single survey is completed in the middle of the growing season on all river systems, except the Thurne where an early and late survey is still undertaken annually.

River Plant 2024 Survey Results

The data collected from each river transect is presented as abundance (the amounts of each species recorded) based on the Braun-Blanquet Scale, as outlined in the river survey methodology. The results tables illustrate the number of points at which each species was recorded to indicate frequency of occurrence. Historical records from past surveys are not presented here, different survey methodologies were used and therefore the results are not directly comparable.

Summary

Vascular plants were the most common group of plants recorded on most river systems, followed by floating plants, whereas on the Ant there were greater abundances of floating than vascular plants in 2024. Stonewort species were completely absent in this year's survey, continuing the pattern of decline seen in the preceding years. Also not recorded was the Section 41 priority species Holly-leaved naiad *Najas marina*, which has been present on

the Thurne since 2021 albeit in low abundance. The Thurne and the Ant were the most species rich river systems, surpassed in plant abundance only by the Yare, in which a considerable proportion of the total plants recorded was represented by vascular macrophytes. Greater levels of macro-algae and mosses were recorded on the Thurne compared to the other river systems.

Plant life was least abundant on the Bure, and only 8 species were recorded there. The Wensum had the lowest species richness, however the abundance of the most dominant species, arrowhead *Sagittaria sagittifolia*, had increased compared to 2023.

Graph 33

Relative abundance of each plant type, and species richness, across the Broads rivers (see Appendix 1 for more detail)



Ant

Table 22

| Common Name | Scientific Name | Abundance | Occurrence |
|---------------------|--------------------------|-----------|------------|
| Frogbit | Hydrocharis morsus-ranae | 0.22 | 4 |
| Common duckweed | Lemna minor | 0.03 | 1 |
| Least duckweed | Lemna minuta | 0.03 | 1 |
| Ivy-leaved duckweed | Lemna trisulca | 0.05 | 2 |
| Yellow water lily | Nuphar lutea | 3.43 | 29 |
| Greater duckweed | Spirodela polyrhiza | 0.03 | 1 |
| Zygnematales | Filamentous algae | 0.08 | 4 |
| No plants | No plants | 0.00 | 1 |
| Starwort species | Callitriche sp | 0.05 | 2 |

| Total number of species recorded: 19 | | Total number o | f samples taken: 37 |
|--------------------------------------|----------------------------|----------------|---------------------|
| Water violet | Hottonia palustris | 0.03 | 1 |
| Lesser water parsnip | Berula erecta | 0.03 | 1 |
| Bladderwort | Utricularia vulgaris | 0.03 | 1 |
| Water Soldier | Stratiotes aloides | 0.03 | 1 |
| Unbranched bur-reed | Sparganium emersum | 0.65 | 14 |
| Arrowhead | Saggitaria sagittifolia | 0.97 | 24 |
| Whorled water milfoil | Myriophyllum verticillatum | 0.03 | 1 |
| Nuttall's waterweed | Elodea nuttallii | 0.27 | 10 |
| Canadian waterweed | Elodea canadensis | 0.03 | 1 |
| Rigid hornwort | Ceratophyllum demersum | 0.19 | 7 |

The Ant had the second highest abundance of aquatic plants of all the river systems and species richness was also high, with 19 species recorded over 37 survey points. The most dominant species was yellow water lily *Nuphar lutea*. Arrowhead *Saggitaria sagittifolia* was the second most recorded species, followed by Unbranched bur-reed *Sparganium emersum*. Nuttall's waterweed *Elodia nuttallii* decreased in abundance on the Ant from 2023. At one survey point there were no recorded species. Water soldier *Statiotes aloides* was recorded for the second consecutive year on the Ant.



Graph 34

Bure

Table 23

| Common Name | Scientific Name | Abundance | Occurrence |
|-------------------------------------|-------------------------|------------|---------------------------|
| Yellow water lily | Nuphar lutea | 0.84 | 24 |
| No plants | No plants | 0.01 | 27 |
| Long-stalked Pondweed | Potamogeton praelongus | 0.02 | 2 |
| Starwort species | Callitriche sp | 0.07 | 8 |
| Nuttall's waterweed | Elodea nuttallii | 0.22 | 24 |
| Arrowhead | Saggitaria sagittifolia | 0.37 | 31 |
| Unbranched bur-reed | Sparganium emersum | 0.82 | 49 |
| Lesser water parsnip | Berula erecta | 0.03 | 3 |
| Total number of species recorded: 8 | | Total numb | per of samples taken: 108 |

The Bure had the lowest abundance of aquatic plants; there were no plants recorded at 27 sample points, representing 25% of the total number of samples taken. Yellow water lily *Nuphar lutea* and Unbranched bur-reed *Sparganium emersum* were the most recorded species, followed by Arrowhead *Saggitaria sagittifolia*. As was also the case on the Ant, Nuttall's waterweed *Elodia nuttallii* was less abundant on the Bure than in 2023. It is worth noting that dredging operations for navigation were ongoing from the mid-Bure through Coltishall and up to Horstead Mill during the time of the survey. Species richness in the Bure was among the lowest of all the river systems, with 8 species recorded compared with 24 species on the Thurne. Among the species absent from this year's survey but previously recorded were the water crowfoot species, genus *Ranunculus*.



Graph 35

Pie chart showing Bure species diversity

Thurne

| Common Name | Scientific Name | Abundance | Occurrence |
|----------------------------------|----------------------------|----------------------|------------|
| Least duckweed | Lemna minuta | 0.01 | 1 |
| lvy-leaved duckweed | Lemna trisulca | 0.06 | 5 |
| Yellow water lily | Nuphar lutea | 2.00 | 29 |
| White water lily | Nymphaea alba | 0.01 | 1 |
| Enteromorpha | Enteromorpha | 0.06 | 5 |
| Zygnematales | Filamentous algae | 0.96 | 19 |
| Common water moss | Fontinalis antipyretica | 0.38 | 12 |
| No plants | No plants | 0.00 | 1 |
| Long-stalked Pondweed | Potamogeton praelongus | 0.10 | 4 |
| Starwort species | Callitriche sp | 0.44 | 12 |
| Rigid hornwort | Ceratophyllum demersum | 0.06 | 5 |
| Canadian waterweed | Elodea canadensis | 0.35 | 22 |
| Nuttall's waterweed | Elodea nuttallii | 0.23 | 13 |
| Mare's tail | Hippuris vulgaris | 0.24 | 15 |
| Spiked water milfoil | Myriophyllum spicatum | 0.11 | 8 |
| Whorled water milfoil | Myriophyllum verticillatum | 0.34 | 8 |
| Curled pondweed | P. crispus | 0.04 | 3 |
| Shining pondweed | P. lucens | 0.01 | 1 |
| Perfoliate pondweed | P. perfoliatus | 0.05 | 4 |
| Willow-leaved pondweed | P. x salicifolius | 0.33 | 14 |
| Pondweed species | Potamogeton sp. | 0.01 | 1 |
| Fan-leaved water crowfoot | Ranunculus circinatus | 0.01 | 1 |
| Arrowhead | Saggitaria sagittifolia | 0.16 | 9 |
| Unbranched bur-reed | Sparganium emersum | 0.01 | 1 |
| Total number of species recorded | Total number | of samples taken: 40 | |

Yellow water lily, *Nuphar lutea*, was the most dominant species on the Thurne system followed filamentous algae, *Zygnematales*. Filamentous algae, *Zygnematales*, was abundant on the Thurne compared to the other river systems. There was greater species richness recorded on the Thurne than on any of the other surveyed river systems. There were 24 species recorded, and only one point was recorded as having no plants. Significantly higher abundance was recorded in the August survey compared with the April survey, accounted for by increased abundance of yellow water lily *Nuphar lutea*. There were also increases in abundance of *Myriophyllum* and *Callitriche* sp from April to August. Holly-leaved naiad *Najas marina* was not recorded on the Thurne this year. This Section 41 species has been found in the Thurne since 2021, reaching peak abundance in 2022 when it was recorded at 3 points at both early and late surveys. In 2023 it was recorded at only one point in each survey at a lower relative abundance.





Graph 37







Waveney

Table 25

| Common Name | Scientific Name | Abundance | Occurrence |
|------------------------------------|-------------------------|-----------------------------------|------------|
| Yellow water lily | Nuphar lutea | 0.33 | 8 |
| Common water moss | Fontinalis antipyretica | 0.04 | 3 |
| No plants | No plants | 0.05 | 20 |
| Rigid hornwort | Ceratophyllum demersum | 0.04 | 3 |
| Nuttall's waterweed | Elodea nuttallii | 0.03 | 2 |
| Arrowhead | Saggitaria sagittifolia | 3.24 | 52 |
| Unbranched bur-reed | Sparganium emersum | 0.33 | 15 |
| otal number of species recorded: 7 | | Total number of samples taken: 76 | |

The number of species recorded on the Waveney halved from 2023 to 2024, with just 7 species recorded, the lowest of all the river systems. Total abundance was also down on last year, but to a minor degree; Arrowhead *Saggitaria sagittifolia* remained the most recorded species. There were no plants recorded at 20 sample points, accounting for 26% of the points.

Graph 39

Pie chart showing Waveney species diversity



Wensum

| Table 26 | | | | |
|-------------------------------------|-------------------------|-----------------------------------|------------|--|
| Common Name | Scientific Name | | Occurrence | |
| Yellow water lily | Nuphar lutea | 0.38 | 3 | |
| Common water moss | Fontinalis antipyretica | 0.02 | 1 | |
| No plants | No plants | 0.00 | 17 | |
| Starwort species | Callitriche sp | 0.02 | 1 | |
| Spiked water milfoil | Myriophyllum spicatum | 0.02 | 1 | |
| Fennel-leaved pondweed | P. pectinatus | 0.02 | 1 | |
| Perfoliate pondweed | P. perfoliatus | 0.02 | 1 | |
| Arrowhead | Saggitaria sagittifolia | 1.88 | 22 | |
| Unbranched bur-reed | Sparganium emersum | 0.24 | 9 | |
| Total number of species recorded: 9 | | Total number of samples taken: 42 | | |

Arrowhead *Saggitaria sagittifolia* dominated the Wensum survey this year; its abundance increased on 2023 data, accounting for the overall increase in plant abundance this year. Despite this, the Wensum had low abundance and low species richness in comparison with the Yare and Thurne respectively; only the river Bure was lower in abundance. No plants were recorded at 17 points, accounting for 40% of the total number of points sampled.

Graph 39

Pie chart showing Wensum species diversity



Yare

Table 27

| Scientific Name | Common Name | Abundance | Occurrence |
|--------------------------------------|-------------------------|------------|--------------------------|
| Yellow water lily | Nuphar lutea | 0.2 | 1 |
| Zygnematales | Filamentous algae | 0.2 | 3 |
| No plants | No plants | 0 | 3 |
| Starwort species | Callitriche sp | 0.16 | 4 |
| Rigid hornwort | Ceratophyllum demersum | 0.28 | 3 |
| Nuttall's waterweed | Elodea nuttallii | 0.12 | 3 |
| Sharp-leaved pondweed | P. acutifolius | 0.04 | 1 |
| Flat-stalked pondweed | P. friesii | 0.24 | 6 |
| Fennel-leaved pondweed | P. pectinatus | 0.04 | 1 |
| Arrowhead | Saggitaria sagittifolia | 2.4 | 20 |
| Unbranched bur-reed | Sparganium emersum | 2.92 | 21 |
| Lesser water parsnip | Berula erecta | 0.08 | |
| Total number of species recorded: 12 | | Total numb | er of points sampled: 25 |

Unbranched bur-reed *Sparganium emersum* was the most dominant species on the section of the Yare surveyed, followed by Arrowhead, *Saggitaria sagittifolia*. There was good species richness in the stretch surveyed, with a total of 12 separate species recorded. Only three points had no plants recorded.

Graph 40

Pie chart showing Yare species diversity



Variation in centre and margin points

Whilst routine maintenance of navigation channels is one of the Broads Authority's statutory obligations, it is important to leave an unmanaged margin of at least 3 meters from the riverbank not only to consolidate the bank structure and buffer surrounding habitat but also to provide a connection through the riverine landscape. A diversity of riparian vegetation is fundamental to supporting populations of invertebrates, mammals, birds, and fish, by oxygenating the water and providing shelter and food at different life cycle stages.

It was hypothesised that plants would have a greater abundance at the river channel margins than in the centre. In 2024 this was true for three of the six river systems, the Ant, Thurne and Waveney. The greatest difference was seen on the Thurne between centre and margin points.

Graph 41



Relative abundance of plants between centre and margin survey points

Across all river systems species richness was higher at the margins than in the centre of the river channel. The Thurne had the greatest species richness overall, and a small difference in number of species observed between centre and margin. The greatest difference was observed on the Ant (7 species in the centre, compared with 16 in the margins). There was double the number of species in the margins of the Waveney and Wensum than in the centre. Survey point position in the river made the least difference to species richness on the river Bure.



Species count comparison between centre and margin survey points

Annual comparison across all surveyed stretches

There was a decrease in the abundance of vascular plants recorded in 2024 compared with 2023, but abundance remained similar to 2021 levels. There was also a decrease in the abundance of macro-algae and mosses, resulting in a 4-year low for this plant type. The abundance of free-floating or round-floating plants decreased markedly from 2023 levels in this year's survey, but did not decrease beyond 2022 or 2021 levels. None of the stonewort species were recorded in this year's survey, continuing the pattern of decline seen in the preceding years.

Graph 43 Relative abundance across plant families 2021-2024



Despite an overall decrease in the abundance of plants retrieved in 2024 compared to the 2023 survey, and the absence of some rarities and priority species previously observed, the species richness of plant communities in the Thurne and the Ant saw an increase this year. Note there was no data collected on the Ant in 2021.

Graph 44





Hydroacoustic surveys of Hickling Broad: 2024 Annual Report

Figure 1

Hydroacoustic echogram of Hickling Broad



Background Information

Hickling Broad

Hickling Broad (Figure 2) is the largest body of water within the Norfolk & Suffolk Broads, comprising 128 hectares (ha) of open water. The broad has an average depth of between 0.68m to 1.86m and the bed is mostly comprised of soft mud with a layer of fluidised sediment on top. Hickling Broad contains species and habitats of high conservation importance and is also a key navigation waterbody within the Broads executive area.

Figure 2

Aerial image of Hickling Broad from 2022



distribute or sell any of this data to third parties in any form.Bluesky International Ltd. / Getmapping PLC

As the navigation authority, the Broads Authority (BA hereafter) is obliged to maintain navigable access within the Broads Executive Area. Water plants, especially during the summer when growth can be prolific, can reduce accessibility for boats. For Hickling Broad, <u>waterways specifications</u> are assessed with consideration to the presence of protected water plant communities. Given the good water plant growth in Hickling Broad and the importance of the broad to navigation and recreation in the Norfolk Broads, the main channel has undergone management in the form of dredging during the winter months that were completed in February 2021 and water plant cutting in the summer (assent from Natural England is currently in place) to cut the submerged water plants within the marked channel to enable boat access to continue.

Hydroacoustic Survey

Hickling Broad is monitored by the BA to assess the condition and status of the water plant community and provide useful information to inform management decisions. Two complimentary survey techniques are conducted at Hickling Broad.

Hydroacoustic surveys, which have been undertaken annually at Hickling since 2012, provide a measure of the height, cover and volume of water plants across the broad (see Table 1, Appendix 2 for historical information.)

Standard water plant surveys identify the species present at 39 sampling points and provide a score of their abundance. The purpose of this report is to present the findings of the hydroacoustic surveys of Hickling Broad.

Survey equipment

Hydroacoustic survey equipment, utilising sonar technology, is commonly used for detection, assessment, and monitoring of underwater physical and biological objects. Boat-mounted hydro-acoustic 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.

The surveys were completed with updated hardware (BioSonics DT-X scientific echosounder) and software which was first used in the August 2021 survey. The older equipment (DTX biosonics) was replaced as the software was no longer being supported.

Survey design & timings

Since 2018, 19 transects across the Broad are surveyed (see Figure 2.) The length of the programmed transects are between 150 to 1020m and the survey consists of ten transects on an east – west axis and nine on a north – south axis. These parallel transects are 177 m apart and the location where transects intersect corresponds to the sample points for the annual water plant survey.

Three surveys were conducted by trained BA staff on 02 May, 07 August and 08 October 2024.

Figure 3 Location of the 19 hydroacoustic survey transects (A-S) covering Hickling Broad



Survey methodology

The hydroacoustic surveys were conducted by navigating a survey boat along the transects (see Figure 3), maintaining a constant speed of approximately 5 miles per hour (mph). The equipment used in this survey included a BioSonics DT-X, single beam (10°), 420 KHz transducer, with an on-board control unit and operating laptop. All data recorded was geo-referenced through connection to an internal GPS receiver. This allowed subsequent quantitative analysis of the data using Visual Aquatic post-processing software, developed specifically with a vegetation analysis component (see below).

Table 1 presents the total length of transects surveyed in each of the surveys conducted in 2024.

Table 1

Sampling details

| Survey | Dates | Number of transects | Distance surveyed (m) |
|---------|----------|---------------------|-----------------------|
| May | 2nd 2024 | 19 | 11,939 |
| August | 7th 2024 | 19 | 11,671 |
| October | 8th 2024 | 19 | 11,973 |

Data analysis & results

Using the Visual Aquatic 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. The sonar produces 5 pings per second and the transects were analysed every 10 pings. The programme produces a report on those 10 pings to get an average on depth, plant height and percentage cover.

The results derived from the processing of the hydroacoustic data were then used to calculate:

- Maximum and mean plant height
- Mean percentage of lake bed covered by water plants (PAI)
- Mean percentage volume of the water column inhabited by water plants (PVI).

Overall means were calculated for each survey for the entire broad and the individual transects (A to S). Water depth on the date of the survey is recorded and variability between surveys should be considered when interpreting results. Water depths are noted with the result tables and accompanying maps.

The results of the three surveys of Hickling Broad undertaken in 2024 are summarized in Table 2.

Table 2

Results of the hydroacoustic surveys of Hickling Broad in 2024

| Metric | May 2024 | August 2024 | October 2024 |
|------------------------------|----------|-------------|--------------|
| Mean Low Water (metres Above | | | |
| Ordnance Datum) | 0.50m | 0.50m | 0.61m |
| Maximum water depth (m) | 1.99m | 1.95m | 2.01m |
| Mean water depth (m) | 1.36 m | 1.33m | 1.45m |
| Maximum plant height (m) | 1.13m | 1.06m | 1.31m |
| Mean plant height (m) | 0.41m | 0.43m | 0.42m |
| PAI (%) | 85.67 | 80.98 | 82.07 |
| PVI (%) | 28.60 | 31.68 | 27.67 |

Plant volume

Figure 4

Mean PVI (plants in water column as %) from all transects (May, Aug & Oct), 2013 – current year



(NB the dashed vertical line shows change of sonar equipment in August 2021 – comparison of results before and after this date may be unreliable)

As Figure 4 illustrates, PVI often peaks in August and then drops dramatically in October. By August, plant density will be high following the main growing period, but water levels often low due to summer evaporation; this means the proportion of plants in the water column will be relatively high. By October, plants are starting to die-back and with increasing autumn water levels, the percentage of plants occupying the water column diminishes.

In 2024, mean PVI showed much less seasonal variation than in previous years, ranging from 28.6% in May, rising to 31.68% in August and dropping to 27.67% in October. This small range is primarily due to much lower percentages in May and August compared to 2022 and 2023. This could be partly accounted for by the high water levels at these times. The annual mean water level for Hickling Broad is 0.35m metres Above Ordnance Datum (mAOD). Apart from an exceptionally high water level of 0.66m in October 2023, levels have been steadily increasing since 2021 and remained over 0.50m during all three surveys in 2024 (see Table 2.)
Plant heights

Figure 5

Mean plant height (m) from all transects (May, Aug & Oct), 2013 – current year (NB the dashed vertical line shows change of sonar equipment in August 2021 – comparison of results before and after this date may be unreliable)



Figure 5 shows that mean plant heights have decreased slightly each season since 2022, with August peaks dropping from 57cm in 2022 to 43cm this year. Seasonal variation is also less compared to previous years with average plant height being maintained at approximately 41cm throughout the growing season.

Figure 6

Plant heights (m) across the transects in 2024



Figure 6 illustrates plant heights across the Broad during each survey. The darker the colour, the taller the plant. Deep red indicates plants taller than 1m tall. The marked channel appears as white or pale yellow, with minimal plant growth. The white ovals on Figure 6 outline the areas of the Broad consistently showing the greatest plant heights, peaking in

August at above 90cm. These areas represent some of the most sheltered or undisturbed areas of the broad.

Plant cover

Figure 7



Mean PAI (plant cover across bed as %) from all transects (May, Aug & Oct), 2013 – current year

(NB the dashed vertical line shows change of sonar equipment in August 2021 – comparison of results before and after this date may be unreliable)

Figure 7 shows that the mean area of the Broad bed covered with plants ranged from 82% to 86% this year, with the peak in May. These percentages are slightly lower than peak coverage of 89% in August 2023.

Figure 8

Plant cover as % of the Broad bed in 2024



Figure 8 shows percentage plant cover across the Broad during the three survey periods. The yellow lines show areas of the Broad with less than 10% plant cover and represent the marked channel (9% of surveyed area.)

Based on the August results, 54% of the transect points had 100% cover, 69% more than 90% cover and 76% more than 80% cover.

The white ovals indicate the areas with highest percentage mean cover.

Water depths Figure 9 Water depths (m) 2024



The maps in Figure 9 show the **water depths** of Hickling along the transects during the survey. The marked channel (running SE to NW across the Broad) and the channel to Catfield Dyke can be identified from the dark blue points.

Maximum water depths of 1.95m – 2.0m were maintained in these channels across all three surveys. Mean water depths across the main Broad were slightly lower in August (1.33m) compared to May (1.35m), with mean water depths highest in October (1.45m). Outside of the main channels, the Broad shows little variation in water depth until the shallower fringes are met, particularly to the south.

Key findings & Recommendations

- Mean PVI and plant height are lower in each season this year compared to the previous two years, with less variation between months.
- Higher water levels may account for the lower PVI in May and August this year, compared to previous years.
- Plant heights peaked in August, with a maximum height of 1.31m recorded.
- 76% of survey points had more than 80% vegetation cover, with peak coverage in May.
- Heigham Corner, the southern bay between Swim Coots and Rush Hill, and the western fringe of the Broad display some of the highest plant growth and % coverage.
- The dredged channels show the greatest water depths of 1.95 2m with only 0 10% plant coverage on the bed.

Acknowledgements

The Broads Authority would like to thank all those individuals and organisations who assisted during the 2024 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, the Horsey Estate and the National Trust and the RSPB.

In addition, many thanks to those individuals who facilitated access to the broads this year; John Blackburn, Steve Collin, Adam Houlgate, Howard Jones, Robin Buxton, Richard Starling, Simon Partridge and Chris Tubby from How Hill Trust, Tim Strudwick and Will Fitch.

Most of all many thanks to all those who gave up their time to collect and assist with analysing the water plant data; Ben Shaw, Abigail Leach, Wyn Purdy, Merlyn Purdy, Kylie Moos, Georgina Lake, Elaine Green, Howard Jones, Marc Jimson, Sam Elliot, Ian Walker, Nathan Betts, Alyssa Osben, Rebbecca Carver, Jeremy Halls, Matt Magson, Jonathan Cook, Bethan Edmunds and Sue Stephenson.

A special thanks to Ben Shaw for help with the analysis and presentation of the results, Vicky Short for all the GIS work involved and Tom Waterfall for formatting and publishing the report.

Appendix I: Common water plants in the Broads

Table 1

Details of Broads water plants

| Group | Scientific name | Common name | Section 41 |
|-------------|------------------------------|---------------------------|------------|
| Stoneworts | Chara aspera | Rough stonewort | |
| | C. baltica | Baltic stonewort | Υ |
| | 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 | Acorus calamus | Sweet flag | |
| macrophytes | 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 | Hydrocharis morsus-ranae | Frogbit |
| Round floating | Lemna gibba | Inflated duckweed |
| leaved | L. minor | Common duckweed |
| macrophytes | 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 & | Enteromorpha | |
| Mosses | Fontinalis antipyretica | Common water moss |
| | Hydrodictyon | Water net |
| | Leptodictyum riparium | Stringy moss |
| | Zygnematales | Filamentous algae |

For more information about Stoneworts please see

https://www.yumpu.com/en/document/view/31414379/important-stonewort-areas-plantlife

Appendix 2: details of hydroacoustic surveys from 2013 – current year

Hydroacoustic surveys have been conducted annually at Hickling Broad since 2012. In 2016, the survey design was updated to incorporate the water plant survey points with the frequency of surveys also increased. In 2017, an additional 18 transects, running parallel to the main transects were surveyed in June, August and October, to increase the coverage of the western section of the broad. The increased survey effort was in response to the expansion of water plants in 2016 with the aim of monitoring the growth of plants over the growing season. The schedule returned to the original number of surveys and transects in 2018.

| Year | Survey date | No. of transects | Distance surveyed (m) |
|------|-------------|------------------|-----------------------|
| 2013 | October | 14 | 4,746 |
| 2014 | August | 26 | 8,120 |
| 2015 | August | 18 | 6,585 |
| 2016 | June | 19 | 12,468 |
| | October | 19 | 10,565 |
| | Мау | 19 | 12,204 |
| 2017 | June | 37 | 21,238 |
| | August | 37 | 22,148 |
| | October | 37 | 22,673 |
| | Мау | 19 | 11,943 |
| 2018 | August | 19 | 11,761 |
| | October | 19 | 11,975 |
| 2019 | Мау | 19 | 11,704 |

Table 1

| Year | Survey date | No. of transects | Distance surveyed (m) |
|------|-------------|------------------|-----------------------|
| | August | 19 | 11,981 |
| | October | 19 | 12,242 |
| | June | 19 | 10,092 |
| 2020 | August | 19 | 11,796 |
| | October | 19 | 11,964 |
| | Мау | 19 | 11,897 |
| 2021 | August | 19 | 11,717 |
| | October | 19 | 11,692 |
| | Мау | 19 | 11,496 |
| 2022 | August | 19 | 10,799 |
| | October | 19 | 11,290 |
| | Мау | 19 | 11,981 |
| 2023 | August | 19 | 11,823 |
| | October | 19 | 12,970 |