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29 September 2017 Our Ref: **L**/EDP3861/EW/fj

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Dear Sarah

Cosmeston Lakes, Penarth

Further to the recent pre-application consultation for the proposed development at Cosmeston Lakes, Penarth, comprising a new wakeboarding sporting facility, a formal response from Natural Resources Wales (NRW) via letter issued on 13 June 2017 (NRW reference CAS-34101-H3D1) was received. It is understood that significant concerns have been raised over the proposed scheme as submitted, specifically with respect to the potential for adverse impacts to arise upon key ecological features onsite, including the status of Cosmeston Lakes Site of Special Scientific Interest (SSSI) and qualifying populations of starry stonewort (*Nitellopsis obtusa*) and an ongoing programme for the reintroduction of water vole (*Arvicola amphibicus*) to Cosmeston Lakes Country Park.

With reference to the findings of the Ecological Baseline Report previously prepared by EDP and submitted in support of the planning application (C_EDP3861_01a Ecological Baseline Report) in addition to consultation with third parties and review of additional ecological information subsequently circulated where this is available, I address the most pertinent points raised by NRW with respect to ecological matters for your detailed consideration below.

Designated Sites

The wakeboarding park is located entirely within the boundaries of the Cosmeston Lakes SSSI notified for its population of starry stonewort, a species which usually grows in calcareous lakes of between 1m and 6m in depth. However, although the SSSI encompasses both the eastern and western lake, only the western lake is considered of special interest for this species and has thus been established as a conservation area, with large areas of woodland and swamp habitat fenced off from public access given its potential as a haven for wildlife. As such, there appear to be marked differences between the condition of the two lakes, with the western lake considered to be of greater nature

conservation value when compared to the eastern lake, which is otherwise highly accessible to the public and thus functions as an area of open green space for amenity and recreational use. Consequently, the eastern lake is characterised by trampled and eroded banks with little to no marginal aquatic vegetation visible. As such, the proposed development has sought to avoid and/or minimise impacts to the SSSI through siting the proposed development across the publicly accessible eastern lake, a waterbody of less conservation interest when compared to the western lake.

In addition, the Ecological Baseline Line report has sought to provide appropriate avoidance, protection and mitigation measures considered necessary to ensure the maintenance of the favourable condition of this SSSI during both construction and operational phases. To inform a planning submission, such measures haven been provided, in brief, within the Ecological Baseline Report and were considered sufficient at this stage, with a detailed Ecological Construction Method Statement (ECMS)/Environmental Management Plan (EMP) to be provided as a condition of planning consent.

It is understood that NRW require provision of the ECMS/EMP prior to any planning permission being granted and that this document should include *"detailed baseline regarding the current size and state of the starry stonewort population in order to determine whether any changes have occurred to the starry stonewort post-construction".*

Upon review of existing baseline information compiled on behalf of NRW (then Countryside Council for Wales), to deliver on their obligation to monitor and report to the Joint Nature Conservation Committee (JNCC) the conservation condition of all designated features (provided as **Enclosure EDP 1** attached to this letter), SCUBA diving surveys, despite their limitations, were recommended as the most appropriate means for the non-destructive monitoring of starry stonewort. Upon review of the consultation response and existing ecological baseline information for starry stonewort however, we do not consider the methodology proposed as a comprehensive means of monitoring the condition of the SSSI in direct relation to potential development impacts and feel that NRW's response has not considered the complexity of factors (unrelated to development proposals) that are having an existing negative effect on the current status of the SSSI.

It has been recognised within supporting information that the biggest threat to starry stonewort is pollution and nutrient enrichment of the lakes arising from agricultural run-off and the use of the lakes by excessive numbers of waterfowl (**Enclosure EDP 2**). Indeed, the results of the SCUBA diving surveys undertaken to record the presence of this species within the western lake during 2011 suggested that Cosmeston Lakes currently have a nutrient enrichment problem, as evidenced by the extent and intensity of algal cover (filamentous algae, algal mats and amorphous algal masses) and *Potamogeton pectinatus*, a variety of pondweed. This, in addition to the presence of invasive, non-native fauna and flora, has resulted in the current **Unfavourable** status of the SSSI reported.

Due to the inherent level of pollution and nutrient enrichment already present in the lake, it is considered that a monitoring regime, following the diving methodology previously established in 2011, would be extremely limited in the amount of valuable information that can be delivered in relation to proposed development. Although it is recognised that such a monitoring regime could confirm presence/infer absence of starry stonewort within the lake, in addition to detecting any changes to its distribution and density that have occurred post construction, such changes could never be confidently attributed to

impacts arising from any future proposed wake park activities, given the existence of other pollution and nutrient enrichment pathways that could otherwise confound the results. Any attempt of development to implement remedial measures to arrest the decline of a starry stonewort population may, therefore, be ineffective and/or beyond their development boundaries or even environmental responsibilities.

As an alternative to directly monitoring populations of starry stonewort using diving methodology, which are also considered disproportionality expensive when considering: the small scale and extent of development; the inherent limitations of the survey methodology; in addition to health and safety risk and the limited beneficial outcomes; it is instead recommended that a monitoring regime be based on assessing those parameters which have a direct influence on the reproductive success of starry stonewort and which would potentially be influenced by wakeboard activities; i.e.

"Starry stonewort is regarded as a summer annual which reproduces by the release of spores into the water column from July to September under suitable light levels. The species favours deep, clear, unpolluted waterbodies relatively rich in nutrients and with high alkalinity. Though light is a trigger for its reproduction, it is able to withstand low light conditions but is less tolerant of turbulence".

Monitoring of the following, physical and chemical parameters is therefore suggested to potentially include water quality and nutrient enrichment, turbidity, suspended solids, turbulence and ph. Monitoring is to be undertaken bi-annually and to include monitoring both outside of the active season (i.e. November to early March) and during the months that the wake park is active (i.e. late March to end October).

This would be combined with the adoption of best practice methodologies (to be detailed within the ECMS/EMP) to ensure all activities are undertaken with due diligence to ensure the protection of sensitive ecological receptors and with regard to biosecurity.

To address NRW's concerns regarding the status of the SSSI and with reference to the above, it is therefore suggested that a draft ECMS/EMP is submitted in support of the planning application with all future monitoring to be undertaken as a condition of planning. In summary, the ECMS/EMP will:

- Summarise existing baseline ecological information for the Site with reference to existing habitat and protected species survey reports where these are available and provide a description of the key ecological features within the proposed development have been retained and safeguarded;

- Identify ecological trends and constraints onsite that could influence management;

- Sets out the appropriate working practices and safeguards to be deployed the during all phases of development, in order to protect the ecological interests of the Site;

- Details the monitoring and management mechanisms which will be undertaken with respect to features of the SSSI over a 5-year period as well as any appropriate remedial actions to be undertaken to ensure the biodiversity interest of the Site is maintained over the long-term;

- Provide an appropriate schedule of works for a 5-year period post-construction;
- Provide details of the body/organisation responsible for implementation of the plan and its review at five yearly intervals over the lifetime of the development; and
- Identifies the funding resources and mechanisms to ensure the long-term delivery of the plan over the lifetime of the development.

Ecology

With respect to concerns regarding the potential for adverse impacts to the water vole population currently being re-introduced to Cosmeston Lakes over the course of 2017, we provide the following additional information set out below.

It is understood that as part of a joint project between the Vale of Glamorgan County Council (VoGCC) and NRW, water vole is currently being re-introduced to Cosmeston Lakes over the course of 2017. As such the VoGCC Cosmeston Lakes Park Ranger was consulted by EDP on 27 July 2017 regarding these re-introduction proposals. It is understood that, to date, 140 individuals have been released within the grounds of Cosmeston Lakes Country Park, with a further 60 re-introductions proposed over the remainder of 2017 and a further 200 re-introductions proposed during 2018. The exact number of re-introductions may vary, dependent on their breeding success within captivity.

Illustrated maps (provided at **Enclosure EDP 3**) detail the proposed released locations. It is noted that release pens will largely be distributed around the western lake, specifically the reed beds and island. Water vole will, additionally, be released at locations around Sully Brook, west of the Country Park, and along reed beds, ponds and drainage system located around the Visitor Centre.

No release pens are proposed adjacent to the eastern lake. In addition, no further habitat enhancements specifically for water vole are proposed around the eastern lake such that this lake and the proposed construction footprint would not be rendered any more suitable for a water vole population in the long term. As per EDP's Ecological Appraisal Report, the eastern lake is considered to offer limited opportunities for a water vole population. Comprising a former quarry, the banks are very stony and, therefore of limited suitability for burrowing water vole. The banks are, furthermore, heavily trampled and eroded by the public, with waterfowl further deterring establishment of a water vole colony within the lake itself. Illustrative photographs are provided at **Table EDP 1.1**.

Table EDP 1.1: Cosmeston Lakes Wake Park Illustrative Photographs.

	
Photo EDP 1: Public access to the eastern lake from visitor carpark	**Photo EDP 2**: Side view of the southern half of the proposed wake park location on the southern bank of the eastern lake.
	
Photo EDP 3: View of the proposed wake park footprint from the southern bank of the eastern lake.	**Photo EDP 4**: Southern extent of the proposed development footprint adjacent to eroded and trampled banks of the eastern lake.

With reference to the above, it is therefore considered that the assessment provided within EDP's Ecological Appraisal Report submitted alongside the application is sufficiently detailed with respect to determining the potential for water vole to occur within the proposed development footprint. Consultation with the Cosmeston Lakes Park Ranger has further confirmed the assessment of the proposed development footprint to be of negligible value to this species.

I trust that the foregoing provides all the information you require at this stage to further inform your position with respect to proposed development and alleviate your concerns with respect to ecology matters. I would, however, suggest a site meeting between ourselves, the client and NRW, if deemed beneficial, to address any outstanding concerns relating to ecological maters, whilst allowing the opportunity to appraise the site first-hand.

In the meantime, please do not hesitate to contact me should you have any comments or queries.

Yours sincerely

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Consultant Ecologist
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Enc: **Enclosure EDP 1**: Monitoring of Starry stonewort at the Cosmeston Lakes SSSI

Enclosure EDP 2: Llynnoed Cosmeston/Cosmeston Lakes Site of Special Scientific Interest

Enclosure EDP 3: Water Vole release 20, 22 June and 11, 26 July 2017

Cosmeston Lakes, Penarth
L/EDP3861/EW/fj
29 September 2017

Enclosure EDP 1
Monitoring of Starry stonewort at the Cosmeston Lakes SSSI

Llywodraeth Cymru
Welsh Government

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

Monitoring of Starry stonewort *Nitellopsis obtusa* at the Llynnoedd Cosmeston / Cosmeston Lakes SSSI

S. Otto, J. Jones and A. Mildren

[enter series title] No. [enter number in series]

Report series:	[Enter name of series here]
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Publication date:	March 2012
Contract number:	WDM051
Contractor:	**Freshwater Diving Services**
Contract Manager:	A. Lucas
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Restrictions:	None

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Andrew Lucas, CCW (PDF)	Individual, Organisation
Nick Stewart, National Stonewort Recorder (PDF)	Individual, Organisation

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EXECUTIVE SUMMARY

This report documents work undertaken by *Freshwater Diving Services*, an independent freshwater diving consultancy, on behalf of the Countryside Council for Wales (CCW). The report details the results of a 2-day dive survey to confirm the continued presence of Starry stonewort *Nitellopsis obtusa* at its only known location in Wales and to establish a surveillance and monitoring programme. *N. obtusa* was first found in the Cosmeston Lakes Site of Special Scientific Interest (SSSI) in July 2007 and is currently the only feature of the SSSI.

Given limitations on time and funding, the CCW is required, as a minimum, to monitor and report to Joint Nature Conservation Committee (JNCC) on the conservation condition of all designated features using Common Standards Monitoring, against which the condition of a habitat or species is being assessed.

- The dive survey established the continued presence of *Nitellopsis obtusa* in the Cosmeston Lakes SSSI. A continuous recording of accurate positions of surveyed transects was achieved by using a float-mounted GPS tethered to a diver with a lanyard.
- *N. obtusa* was found to occupy at varying extent and density three locations in the Lakes, but in considerably deeper depths of water than in the 2007 survey, although lake levels only vary by a maximum of 15 cm over the year.
- Based on observations and data gathered during the dives there is sufficient circumstantial evidence to suggest that Cosmeston Lakes have currently a nutrient enrichment problem.
- A preliminary feature condition assesses *N. obtusa* to be of unfavourable conservation condition.
- Recommendations for the future non-destructive monitoring of *Nitellopsis obtusa*, and its associated native and non-native species by a combined method of simultaneous drop-down video and SCUBA-diving surveys are being made.
- Proposals of how to eradicate current non-natives and how to improve management of the site, foremost of the implementation of biosecurity measures have been put forward.
- Alternative solutions of how to ensure the continued presence of the species in Wales, chiefly by translocation to other named site(s), are being suggested.
- All field data have been converted to MapInfo files and are held by the CCW and relevant species information has been entered into the NBN Gateway database.

1 INTRODUCTION

1.1 Monitoring of Sites of Special Scientific Interest

One of the key responsibilities of the statutory nature conservation agencies in the UK is the identification and protection of a series of sites intended to conserve important wildlife and earth science features.

Under the Environmental Protection Act, 1990, the country agencies and the Joint Nature Conservation Committee (JNCC) are required to establish common standards throughout Great Britain for the monitoring of nature conservation, thus enabling consistent reporting to Government (JNCC, 2005).

Under the JNCC framework the procedure for monitoring is as follows:

- Identify each notified interest feature on the site.
- For each notified feature set a conservation objective, thus providing a 'formulated standard' for monitoring.
- Assess each feature condition against its conservation objective. If the objective has been achieved, the feature condition will be described as 'favourable'.
- Assess whether management activities on the site will enable the feature to attain or retain 'favourable condition'.
- Report the condition of all notified interests to JNCC within each reporting cycle.

The Wales Environment Strategy - Outcome 21 - requires CCW to bring 95 % of all Welsh SSSIs into favourable conservation condition by 2015 (WAG, 2010).

1.2 Llynnoedd Cosmeston / Cosmeston Lakes Site of Special Scientific Interest

The Cosmeston Lakes are part of the Cosmeston Lakes Country Park located near Penarth in the Vale of Glamorgan, SE Wales (Figure 1). It has a variety of habitats and covers over 100 ha, about a quarter of which is designated a SSSI (Figure 2). The lake has its origins with the advent of limestone quarrying in the early 1890s. Quarrying ceased in 1970 and underground springs flooded parts of the quarried area creating one lake, but separated by a causeway, thus giving rise to the Eastern Lake and the Western Conservation Lake, referred to collectively as 'Cosmeston Lakes'. Relevant SSSI information can be found in Appendix I.

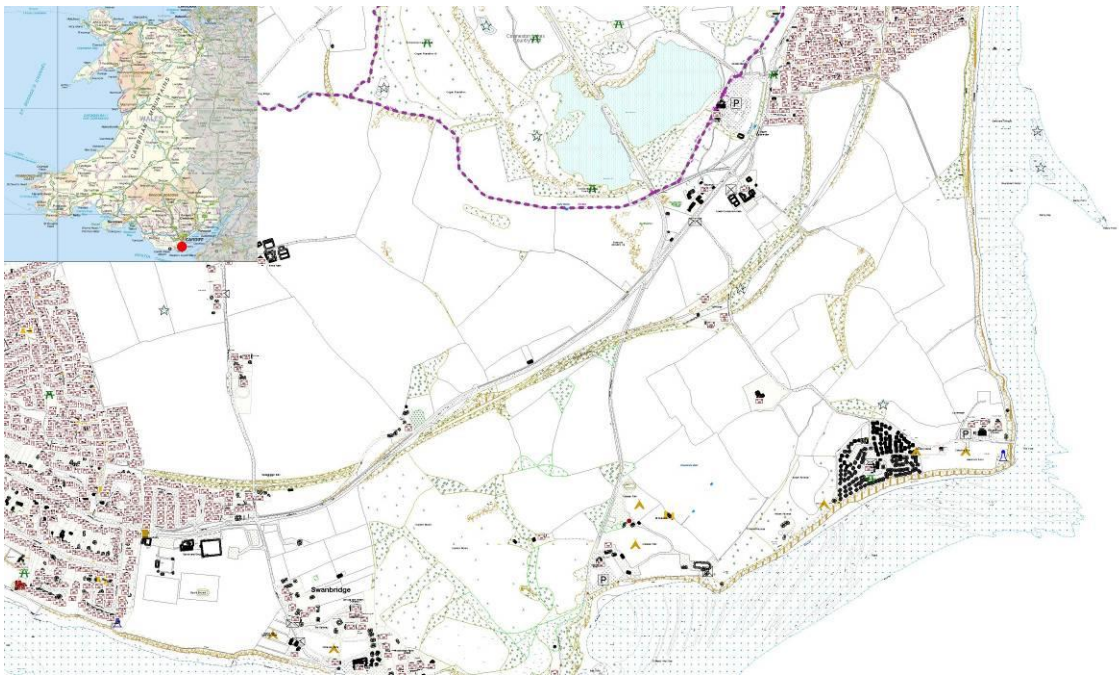


Figure 1 Location map and setting of Cosmeston Lakes

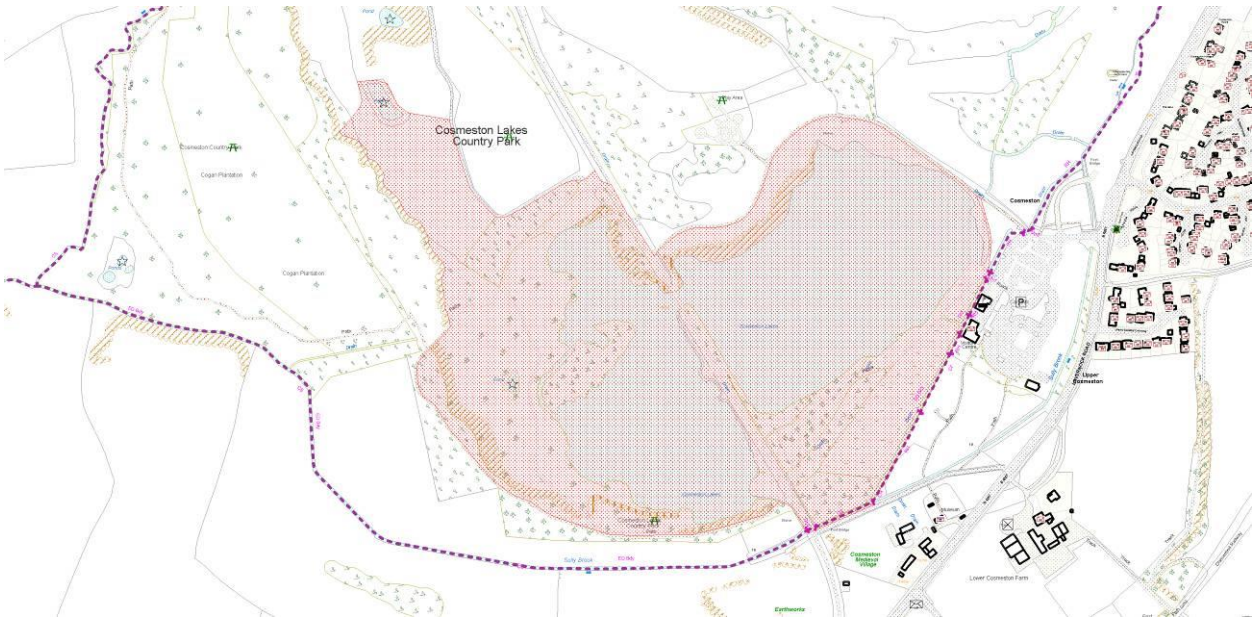


Figure 2 Map of Llynnoedd Cosmeston / Cosmeston Lakes SSSI

The Western Conservation Lake is very shallow (max. 6 m water depth) and its southern part has a maximum length and width of 230 m and 200 m respectively. The Eastern Lake is larger, up to 10 m deep and connected with the Western Lake at its north-western corner. The mean depth of the lakes is 5.4 m and the estimated lake volume is 334,800 m^3 (Burgess *et al*., 2009). The Eastern Lake is located approximately 800 m west of the Severn Estuary, while the Western Lake lies 1,200 m north of the Bristol Channel (Figure 1).

1.3 Starry Stonewort *Nitellopsis obtusa*

Nitellopsis obtusa is an aquatic charophyte of deep lakes and slow-running water at low altitudes (JNCC, 1999). The species requires clear, unpolluted water. It generally grows at depths of between 1 and 6 m and is very rarely found in shallow water. Most of its sites occur in calcareous water and are usually near to the coast which suggests that it may prefer slightly saline conditions. It seems to be capable of surviving in low light intensities, but is less tolerant of turbulent conditions. Observations suggest that it is generally a summer annual, but in favourable conditions and mild winters it may not die back completely (Stewart & Church, 1992).

Starry stonewort is relatively easy to identify (Figures 9 to 14): a freshwater macroalga with smooth, irregular branches and root-like rhizoids. It forms dense mats that cover lake bottoms. The stems may reach 80 cm in length, with 5-8 whorls of fine, uneven-length branches that arise at an acute angle from nodes. The branchlets are pinnately divided and have typical convexly pointed branchlet tips (as opposed to usually acuminate pointed ones in *Nitella opaca*). The content of the branchlets can be squeezed out of the tube-like cell wall when cut, but the alga does not float when cut. It has distinctive star-like bulbils; dark reddish gametangia. It feels gelatinous, unlike *Chara* spp. which feel brittle and scaly. It appears in June and increases through September.

The main centre for this species has always been the Norfolk Broads, where it has been recorded from about six sites (historic records are difficult to localise). However, recent surveys have confirmed its presence in only two of these. There is also a recent record from a gravel pit in Gloucestershire. Other areas where it has been recorded in the past include Devon, Hampshire and Surrey, but it is doubtful whether it still occurs at any sites in these areas. Records from Perthshire and Dorset are likely to be erroneous. *N. obtusa* is scarce throughout Europe. In Great Britain this species is classified as *Endangered*. It receives general protection under the

Wildlife and Countryside Act 1981 (as amended; most recently by the Countryside and Rights of Way Act 2000). *N. obtusa* is a species 'of principal importance for the purpose of conserving biodiversity', covered under Section 42 (Wales) of the Natural Environment and Rural Communities Act 2006, and therefore needs to be taken into consideration by a public body when performing any of its functions with a view to conserving biodiversity. The species is listed on the 2007 Biodiversity Action Plan UK list of priority species.

Current factors causing loss or decline include water pollution, particularly from phosphates and nitrates. The most significant sources of this pollution include effluent from sewage treatment works (especially in the Norfolk Broads where phosphates have also become concentrated in the mud) and also run-off of agricultural chemicals.

It is thought that the following factors may also be involved at some sites:

- Disturbance from boat traffic may be a threat at the Norfolk Broads sites. Waste water from boats may also be contributing to the pollution problem here.
- Algal blooms may be a threat to some populations. These blooms are generally a consequence of the pollution problems mentioned above.
- The Norfolk Broads sites may be at risk from an increase in salinity levels, as influxes by sea water become more common due to sea-level rise. Although Starry stonewort appears to tolerate slightly saline conditions, its performance may decline if salinity levels increase.
- The large numbers of waterfowl at the Gloucestershire site may threaten the habitat with eutrophication.

Furthermore, the rhizoids, which are colourless, hair-like filaments that anchor *N. obtusa* to its substrate, can be easily disturbed. Disturbance by the behaviour of certain species of bottom feeding fish could cause damage.

1.4 Selected results of the 2007 Survey

Nitellopsis obtusa was recovered by double-headed rake from boat (used in deeper water or where poor water clarity restricted visibility) from the Western Conservation Lake (Figure 3) in the July 2007 survey (Burgess *et al.*, 2009) – the first and only Welsh record to date. The ID was confirmed by Nick Stewart (National Stonewort Recorder).

Amy Burgess (ENSIS Ltd, pers. comm.) provided additional information to that presented in the original survey report (Burgess *et al.*, 2009), as the raw survey data had not been submitted to the CCW. *Nitellopsis obtusa* was found growing in Cosmeston Western Lake at low abundance (score = 1) on a silty substrate in the boat transect of Section 1 only (Figure 3), at points 11-14 inclusive, at water depths of 125 cm, 140 cm, 160 cm and 180 cm. The actual coordinates of points 11-14 where *N. obtusa* was found, however, could not be provided by ENSIS Ltd, but the two locations where *N. obtusa* was found were subsequently plotted in the final report (Burgess *et al*., 2009) as shown in Figure 3. The boat transect start and end coordinates were ST 17443 68986 (80 cm water depth) and ST 17495 69079 (340 cm water depth) respectively and the boat transect followed a compass bearing of 030^{o} N (Figure 3). Other species found growing alongside *N. obtusa* were *Potamogeton pectinatus* (abundance = 3) and *Chara contraria* (abundance = 1).

In addition to *N. obtusa*, *Nitella flexilis* agg. was identified in one wader / boat survey sample in 2007 (Burgess *et al.*, 2009; Appendix II), although information on its location was not provided in the report. *N. flexilis* agg. consists of two species that can only be distinguished by examining fertile material, the common *N. opaca* and the Nationally Scarce *N. flexilis*. The report recommended further investigation of fertile material from the site.

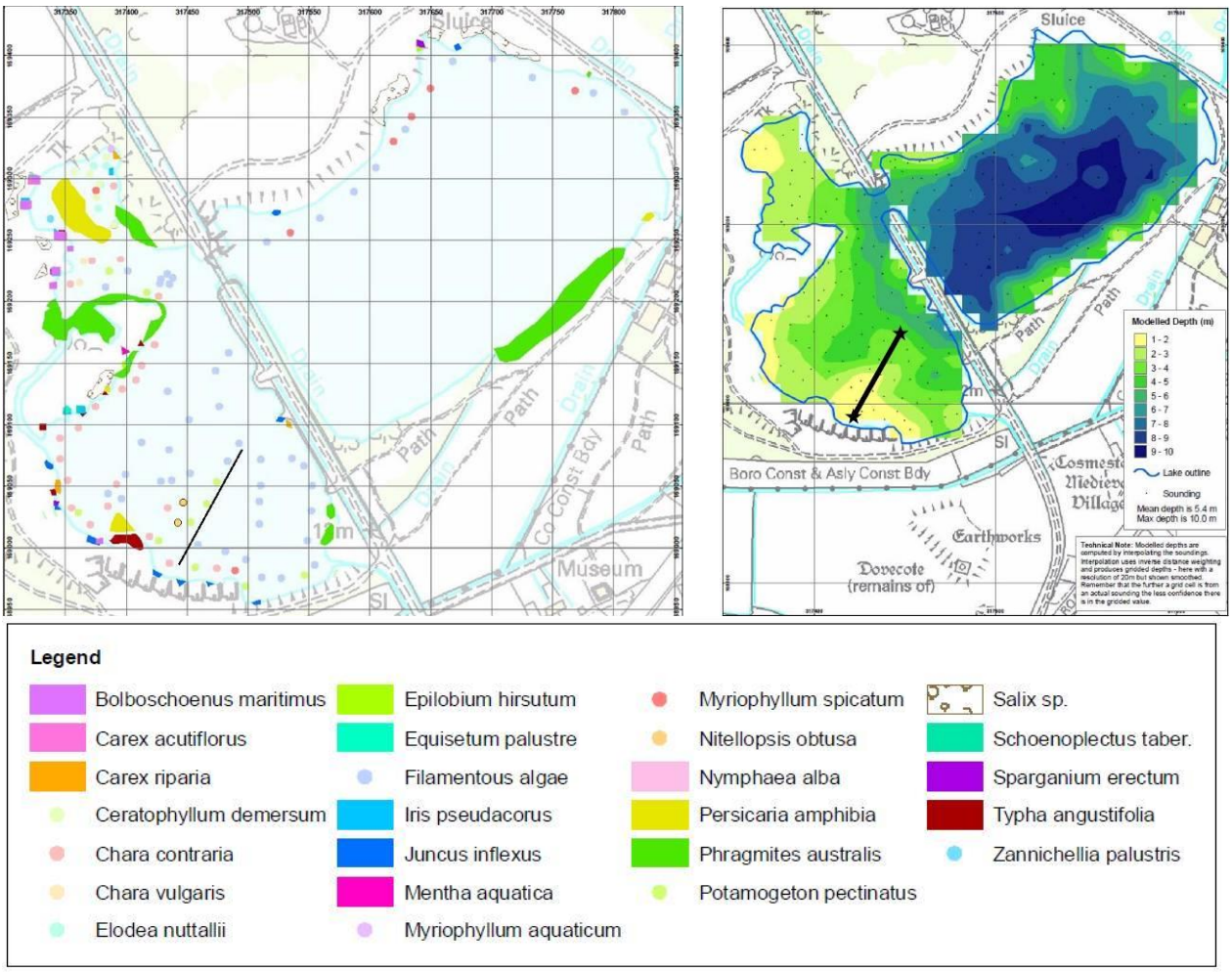


Figure 3 **Left:** map of macrophyte locations from 2007 survey (from: Burgess *et al.* 2009; Figure 3.7.5) with Boat Transect 1 superimposed (Amy Burgess, pers. comm.). ○ = locations of *Nitellopsis obtusa*. **Right:** Boat Transect 1 in relation to modelled bathymetry (from: Burgess *et al.* 2009; Figure 3.7.3).

In respect of water quality, the Dissolved Oxygen (DO) profile (Figure 4) showed a rapid decline in DO below 5 m and the water column was devoid of DO below 8 m in July 2007. There was an abundance of filamentous algae (Burgess *et al.*, 2009; Figure 3.7.5: in 44 % of wader / boat survey samples from the Western Lake), as well as an abundance of *Zannichellia palustris* and *Potamogeton pectinatus* (in 42 and 38 % of all wader / boat survey samples respectively) (Burgess *et al.* 2009; Appendix II), both of which are indicators of nutrient enrichment and / or 'hard', possibly brackish, waters (T. Hatton-Ellis, CCW, pers. comm.).

Conversely, the lake recorded relatively low nutrient concentrations in the 2007/08 survey; mean annual TP was 15.5 µg l^{-1}, indicating 'good' ecological status with regard to the EA WFD criteria and fulfilling the CSM favourable condition criteria for TP (although the annual mean TP value was based only on 2 samples from January and April 2008 due to data reliability issues with the 2007 data; Burgess *et al.*, 2009).

The report expressed serious concerns over the presence of two invasive, non-native species (INNS), *i.e. Myriophyllum aquaticum* and *Elodea nuttallii*, and assessed the lakes accordingly as being in **unfavourable** condition.

Overall, the report concluded that Cosmeston Lakes were in "near favourable" condition in "other respects", that a BAP Priority Species, *Nitellopsis obtusa*, was present and that removal of *E. nuttallii* and *M. aquaticum* would return the lake to favourable condition (Table 1).

Finally, the 2009 Report recommended the renotification of the SSSI to take account of the presence of *N. obtusa.*

Dissolved Oxygen Profile

GPS Location	ST1770369215
Maximum Depth (m)	10 m
Secchi Depth (cm)	-
Notes:	

Depth (m)	DO (mg/l)	Temp (°C)
0	8.97	19.4
0.5	8.85	19.3
1	8.75	19.3
1.5	8.63	19.2
2	8.7	19.1
3	8.81	19
4	8.47	18.8
5	7.95	18.5
6	5.79	17.5
7	1.47	16.4
8	0.2	14
9	0.18	12.8
10	0.11	12

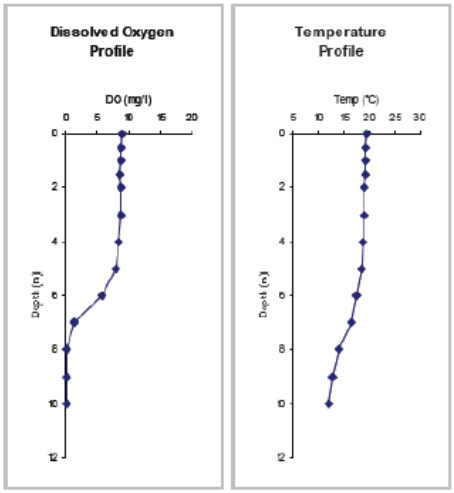


Figure 4

Dissolved oxygen and temperature profiles for Cosmeston Eastern Lake (17/07/2007) (from: Burgess *et al.* 2009; Figure 3.7.4).

Table 1 Summary table for Cosmeston Lakes illustrating the site condition assessment outcome (from: Burgess *et al*., 2009; Table 4.1).

Lake Name	WFD Typology	Site condition assessment outcome	LEAFPACS analysis outcome	Key reasons for failure to meet favourable condition targets and/or reasons for attaining favourable condition
Cosmeston Lakes	Marl, S	Unfavourable	Moderate	• Presence of invasive / non-native macrophytes (*M. aquaticum* & *E. nuttalli*). • Abundance of *Z. palustris* & *P. pectinatus* (enrichment indicators). • Filamentous algae locally abundant. N.B. Near favourable in other respects & BAP Priority Species *Nitellopsis obtusa* present.

1.5 Project Objectives

The main objective of this project was to establish the distribution of Starry stonewort *Nitellopsis obtusa* in Cosmeston Lakes. Priority was given to the Western Lake, with additional work in the Eastern Lake if time allowed. This information was then to be used to formulate a conservation objective for monitoring this feature in future years.

A secondary objective was to establish a monitoring protocol that is simple and replicable, that can be used in future years.

1.6 Format of this Report

This report has been presented in a format primarily aimed at informing future management and monitoring exercises. The Feature Condition Assessment contained in this report and undertaken in accordance with the CSM Methodology, is also fit for purpose to be used by the CCW to report on the condition of the notified special interest feature of the Llynnoed Cosmeston / Cosmeston Lakes SSSI to JNCC.

2 METHODOLOGY

As the current population extent of this rare species in Cosmeston Lakes was still unknown, an appropriate baseline needed to be established. Considering that Cosmeston Lakes is home to the only known Welsh population of Starry stonewort, any further survey, surveillance or monitoring methods to be deployed had to be non-destructive and benign. Consequently monitoring by SCUBA-diving was proposed.

There are many advantages of using SCUBA-diving for the surveillance and monitoring of freshwater habitats and species (Otto, 2009). The following is a non-exhaustive list of why to include SCUBA-diving as a technique in surveillance, survey and monitoring programmes:

- Accurate and precise *in-situ* recording of species (SMB / float with mounted GPS)
- Non-destructive and benign
- Fixed-point still photography
- Rapid, regular video transects to establish seasonal, annual and long-term changes
- Rapid, therefore cost-effective
- Can be used in highly turbid and deeper waters
- Lower risk of false negatives in the examination of deeper water species
- Targeted spot sampling of species, sediments and water (*e.g.* underwater springs)
- Better repeatability of sampling
- Targeted removal of non-native species (if possible and desirable)
- Instantaneous assessment of underwater damage (*e.g.* from pollution incident)

A team of four staff (2 divers, 1 supervisor, plus 1 surface support) was required to comply with The Diving at Works Regulations 1997 (HSE, 1997). A Diving Risk Assessment (Appendix II) was produced prior to the dive operations in accordance with the Scientific and Archaeological Approved Code of Practice (HSE, 1998).

The two divers, Jennifer Jones (Scientific Diver) and Alan Mildren (Underwater Videographer), worked as a buddy pair. Entry into the lake was from the shore.

The buddy pair was equipped with a float containing the GPS within a watertight, transparent plastic sample bag (Figure 5). The GPS was synchronised to ± 10 seconds with the HD Video camera (Figure 6). The time and water depth of each Starry stonewort encounter was written down and a small voucher specimen of the plant was taken to confirm identification. Water depth was recorded with a Cressi Sub Nitrox Dive Computer.

Figure 5 Scientific Diver Jennifer Jones with 'float' and mounted GPS used for deeper water surveys.

Figure 6 Cameraman Alan Mildren with the Sony HD Z1 Camera in a Light & Motion Housing.

Visibility was good and the divers were able to survey a swath of 4 m width along the dive routes. The dive survey of the Western Lake took two days (2 July and 12 August 2011). It was intentional that these were non-consecutive days to allow for preliminary data evaluation and possible changes to survey methodology (if required). Following the two days of survey of the Western Lake there was no opportunity left to continue work on the Eastern Lake, due to resource limitations by the CCW.

The divers spent a total of 5 hours 40 minutes in the water (2 hours 54 minutes and 2 hours 46 minutes on the first and second day respectively), covering a total distance of in excess of 2.8 km (1.23 km and 1.61 km on the first and second day respectively; Figure 7). A total of almost 2 hours of video footage was recorded (21 minutes and 96 minutes on the first and second day respectively; Appendix III), including the one transect and three stations identified for the future monitoring of *N. obtusa*, plus three additional transects, recommended for the monitoring of macrophyte community composition, zonation, *etc*. and invasive non-native fauna and flora.

The dive search pattern adopted for the first day was pre-determined by the locations and water depths where *N. obtusa* was found in the 2007 survey (Figure 3; *cf*. Figure 7). After an unsuccessful first day, for reasons explained in section 1.4 above, further information from the 2007 survey was obtained (Amy Burgess, ENSIS Ltd, pers. comm.) and Transect 1 from 2007 was consequently resurveyed by SCUBA–diving on the second day. After having found three locations with *N. obtusa*, the objective was then to cover as much of the remainder of the Western Lake as possible, given the time constraints and size of the lake.

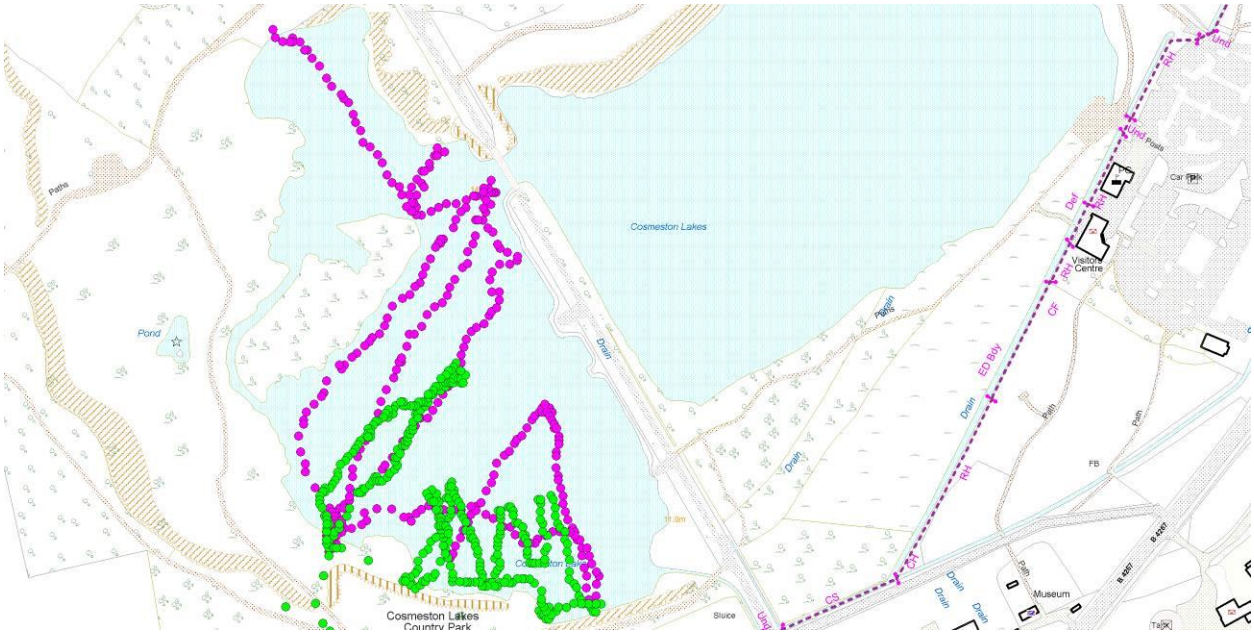


Figure 7 GPS positions of the survey dives (**green** = 2 July 2011; **purple** = 12 August 2011)

Two water samples were taken at ST 17500 69087 in the Western Lake; one at the bottom, the other at the surface. Salinity was measured with a visual, hand-held Refractometer (Index Instruments Ltd, Model REF 201) and the approximate pH was established with Litmus paper.

The dive survey was followed by data processing and report writing, including production of MapInfo files and NBN Access Database ('zipped') file in accordance with CCW specifications, production of Metadata in CCW standard format and archiving of video files.

The data collected during the dives, plus some desktop evaluation of additional data, allowed for an almost complete CSM feature condition assessment. The authors were able to assess most 16 of the 21 sub-attributes, plus one additional, non-CSM one (*i.e.* salinity).

3 RESULTS

3.1 Starry Stonewort *Nitellopsis obtusa*

Starry stonewort was found at three locations on 12 August 2011 (Table 2 and Figure 8). A small colony was found at Location L1, just beyond the end of Boat Transect 1 of the 2007 survey, in 3.6 m water depth. The largest colony was found at L2 in 3 m water depth, followed by a smaller colony at L3 in 2.2 m water depth. The relative extent of *N. obtusa* at these locations was L1 < L3 < L2. Figures 9 to 14 provide details of the three locations and samples[1].

Table 2 Details of *N. obtusa* locations.

Location No	Coordinates	Water Depth	Approx. Extent	Location No	Coordinates	Water Depth	Approx. Extent
L1	ST 17500 69084	3.6 m	<1 m^2	**L3**	ST 17496 69006	2.2 m	<1 m^2
L2	ST 17506 69075	3.0 m	>2 m^2				

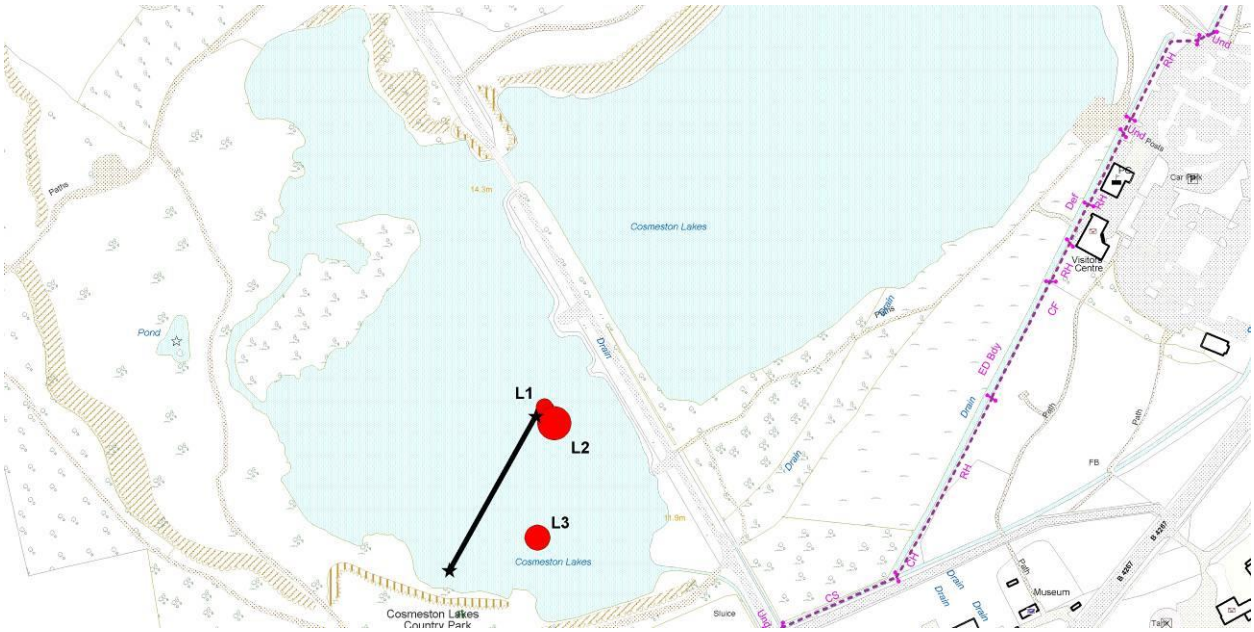


Figure 8 Locations and relative / proportional representation of extent of *Nitellopsis obtusa* (12 August 2011) with Boat Transect 1 from 2007 survey superimposed.

Figure 9 Sparse occurrence of *Nitellopsis obtusa* at L1.

Figure 10 Close-up of *Nitellopsis obtusa* (magnification x10) from L1.

[1] The initial identification of *N. obtusa* specimens made by *Freshwater Diving Services* was subsequently confirmed by Nick Stewart (National Stonewort Recorder).

Figure 11 Dense stand of *Nitellopsis obtusa* at L2. Note the dark 'spots' on the algae, *i.e.* juvenile Zebra mussels.

Figure 12 Close-up of *Nitellopsis obtusa* (magnification x60) from L2 (pressed and dried specimen).

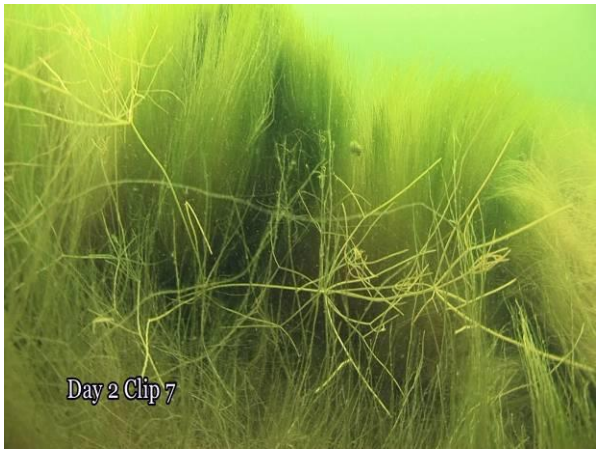


Figure 13 Minor stand of *Nitellopsis obtusa* at L3.

Figure 14 Close-up of *Nitellopsis obtusa* (magnification x10) from L3.

Underwater video footage of *N. obtusa* in Cosmeston Western Lake can be viewed on *You Tube* at http://www.youtube.com/watch?v=7SPpruosxYk&feature=related

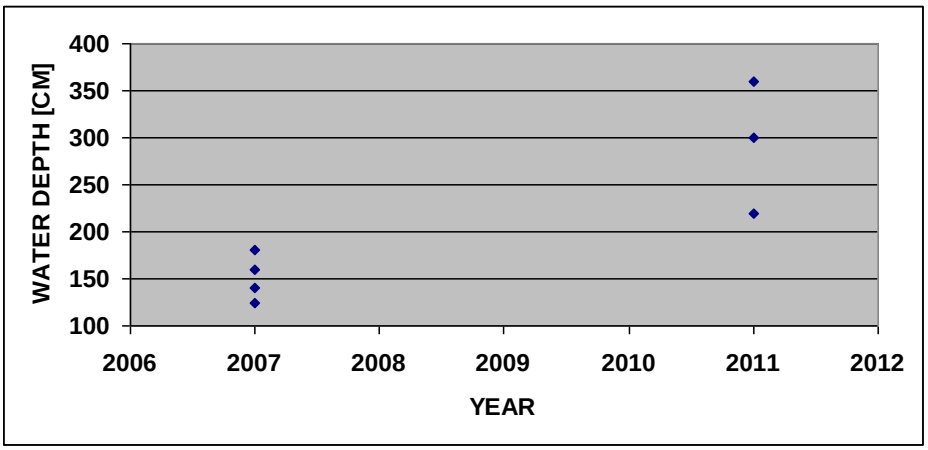


Figure 15

Occurrence of *Nitellopsis obtusa* in relation to water depth (17 July 2007 vs 12 August 2011).

3.2 Miscellaneous Selected Macrophytes

The distribution of selected macrophytes can be readily established from the HD Video footage. This information can then be used to inform the Feature Condition Assessment in Section 5.

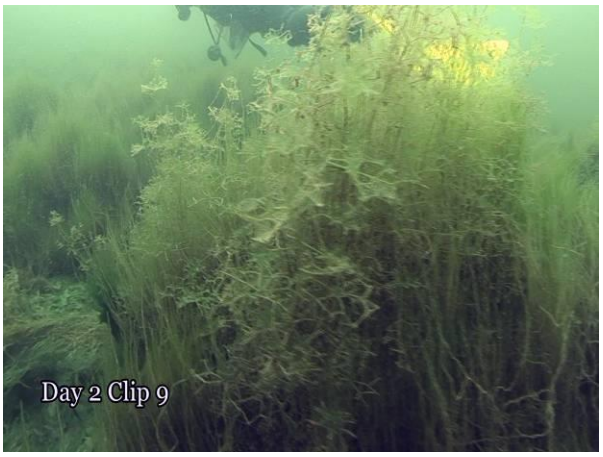


Figure 16 Stand of *Chara contraria* within a dense bed of filamentous algae.

Figure 17 Dense bed of *Potamogeton pectinatus*.

Chara contraria (Figure 16) and *Chara vulgaris* were identified in the 2007 survey as typical charophyte species of conservation value present in Cosmeston Western Lake. The abundance of the easily recognisable *Potamogeton pectinatus* (Figure 17), a nutrient enrichment indicator species, has been used as an additional proxy for any potential nutrient enrichment of the lakes. The distributions of both *Chara* spp. and *P. pectinatus*, based on a rapid assessment of the video footage, are shown in Figure 18.

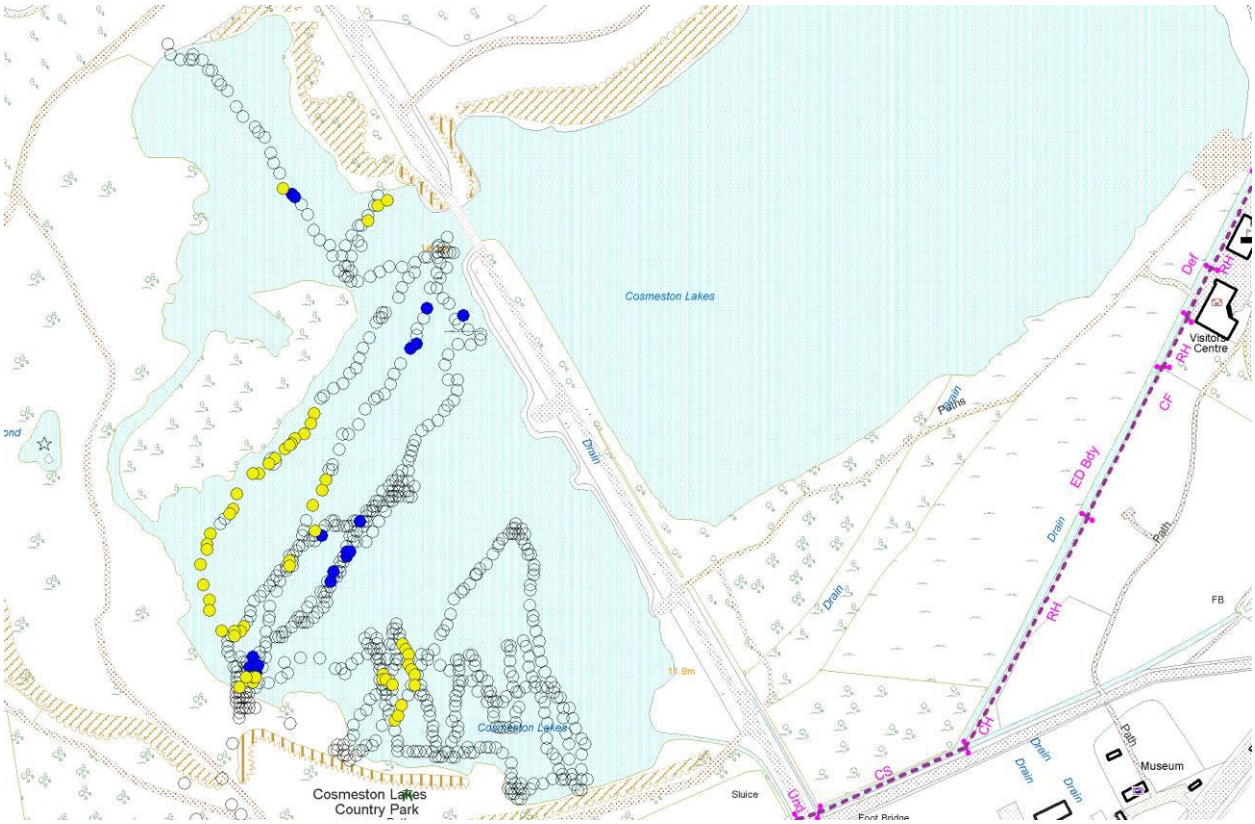


Figure 18 Locations where stands of *Chara* spp. (●) and dense beds of *Potamogeton pectinatus* (●) were identified on the HD Video footage recorded during the dives.

Locations of *Chara* spp. are evidently rare, whilst there are extensive, dense beds of *P. pectinatus*.

There are discontinuous stretches of fringing and emergent vegetation along the Western Lake with mixed macrophyte communities (Figure 19). Changes to the distribution and extent of floating vegetation (*Persicaria amphibia*) was also possible to ascertain, based on the comparison of air photographs (Figure 33), supported by some ground-truthing.

Figure 19

Fringing and emergent vegetation of lake margin (incl. *Phragmites australis, Typha* spp., *Iris pseudacorus, Carex* spp. and *Juncus* spp.), with floating vegetation (*Persicaria amphibia*) in the background.

3.3 Invasive Non-Native Macrophytes

The 2007 macrophyte survey established the presence of two invasive, non-native aquatic plants, *i.e.* Parrotts' feather *Myriophyllum aquaticum* and Nuttall's waterweed *Elodea nuttallii*. In the Western Lake these species were found confined to the NW corner (Figures 3 & 35). Further information on invasive, non-native macrophytes can be found in Appendix III.

An i*n-situ* example of *Elodea nuttallii* is shown in Figure 20.

Figure 20

Stand of *Elodea nuttallii* with (native) M*yriophyllum spicatum* in the foreground.

The current distribution of *E. nuttallii* (and of the native *M. spicatum*) is shown in Figure 21 and is based on a rapid assessment of the video footage. It is difficult to distinguish between the two *Elodea* species, *i.e. Elodea nuttallii* and *E. canadensis*, but it may be assumed that the *Elodea* spp. present are all *E. nuttalli*, as there is no record yet of *E. canadensis* from Cosmeston lakes.

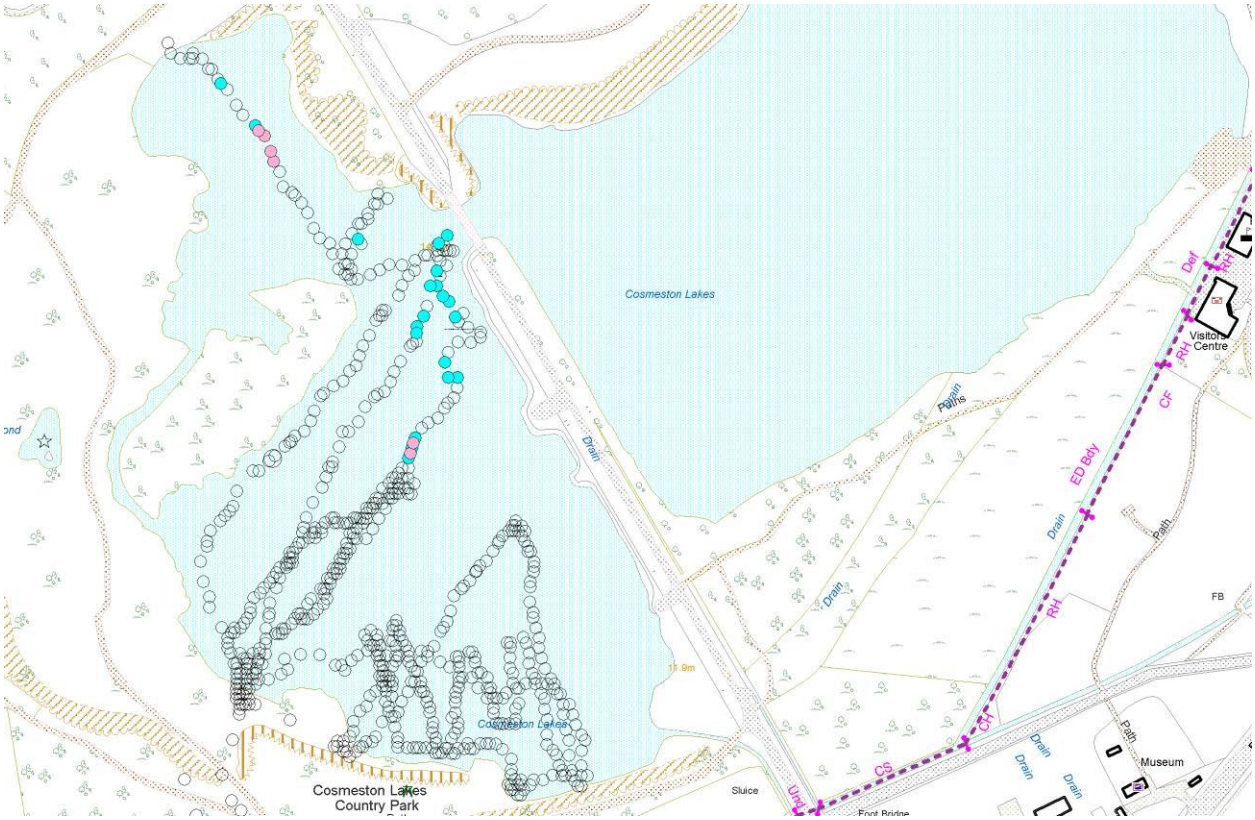


Figure 21 Locations where *Elodea* spp. (●) and (the native) *Myriophyllum spicatum* (●) were encountered during the survey dives.

3.4 Filamentous Algae, Algal Mats and Amorphous Algal Masses

The Western Lake is dominated by filamentous algae, algal mats and amorphous algal masses (Figures 22 & 23). The filamentous algae form dense carpets surrounding otherwise rare macrophytes of conservation value. The algal mats cover either bare substrate or macrophytes and appear to be the result of algal blooms that sunk to the bottom of the lake. Amorphous algal masses are also very common and found frequently associated with and covering *P. pectinatus* beds. Locations dominated by the presence of filamentous algae, algal mats and amorphous algal masses are shown in Figure 24.

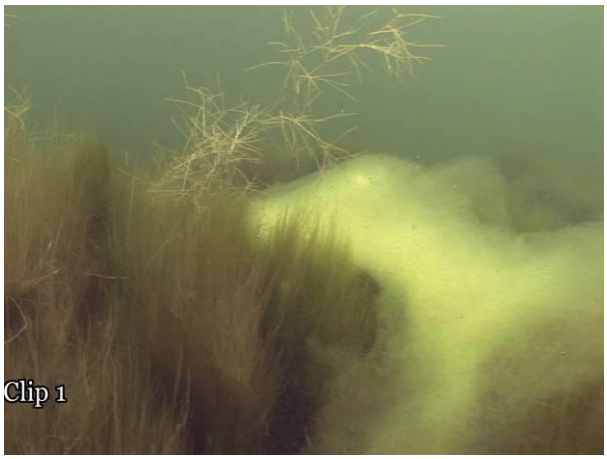


Figure 22 Filamentous algae and amorphous algal mass with *Potamogeton pectinatus*.

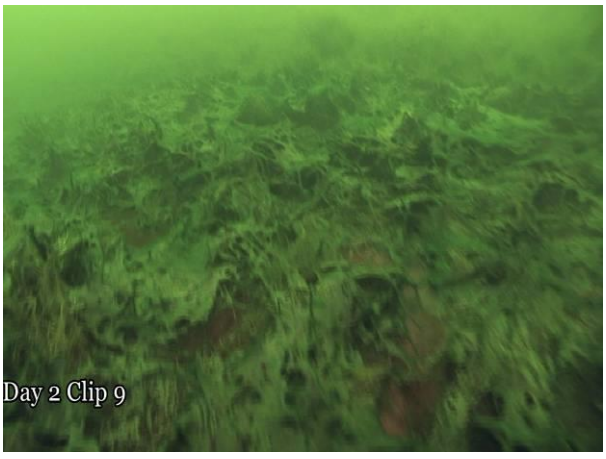


Figure 23 Algal mats draped over and smothering erect macrophytes.

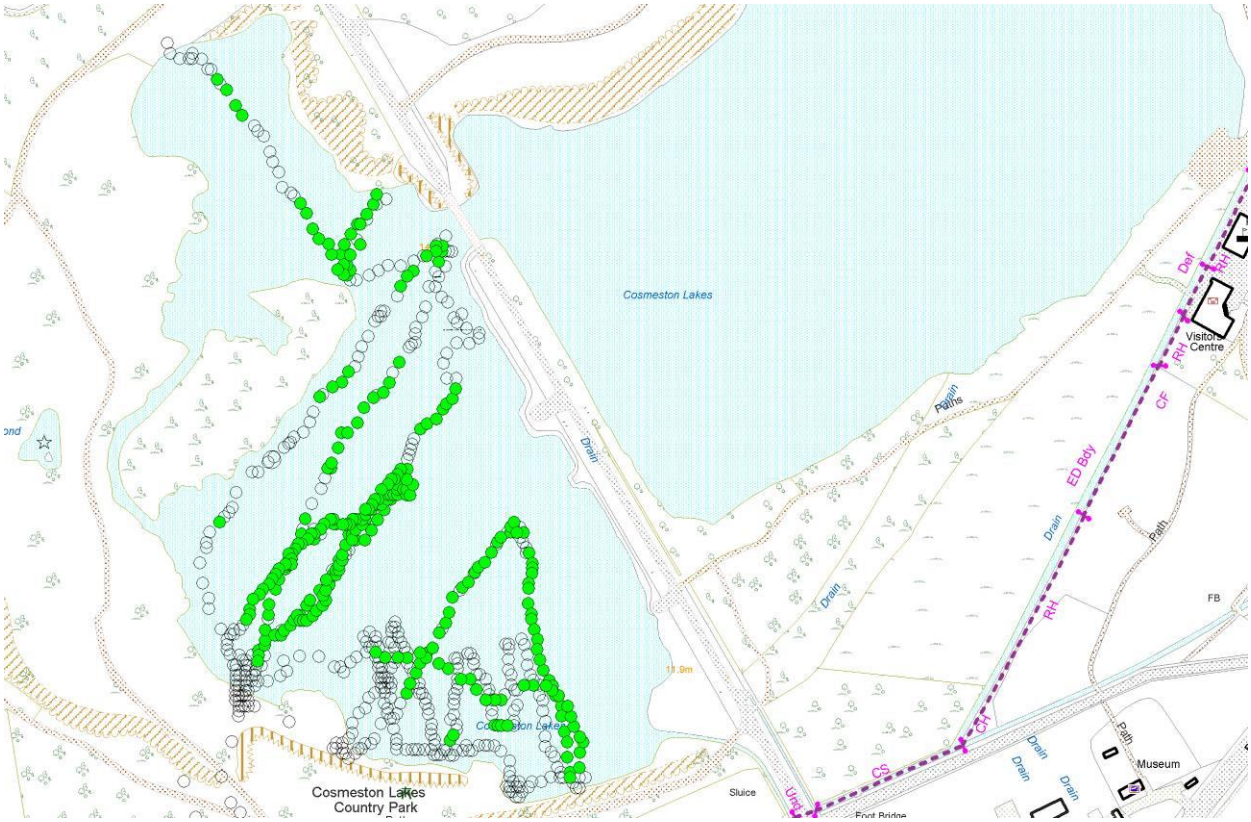


Figure 24 Locations of filamentous algae, algal mats and amorphous algal masses.

3.5 Anoxic Mud Exposures

Black, anoxic mud exposures are frequent occurrences and are generally found within dense carpets of filamentous algae (Figures 25 & 26). Figure 27 presents a map of where some of these black, anoxic mud exposures were found during the dives. Understandably, their locations will most probably not be the same next year, following possible colonisation of the substrate by filamentous algae in spring/early summer. Anoxic mud ranges from thin veneers to deep deposits in both shallow and deep water. Stirring up these muds near the shore when the divers entered the lake released a penetrating stench of hydrogen sulphide (the result of anaerobic ingestion in the muds).

Figure 25 Black, anoxic mud exposure.

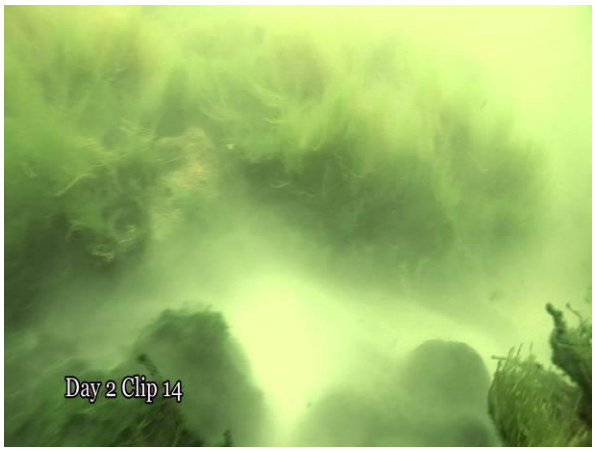


Figure 26 Very fine-grained, calcareous(?) 'mist' suspended over black, anoxic mud pool.

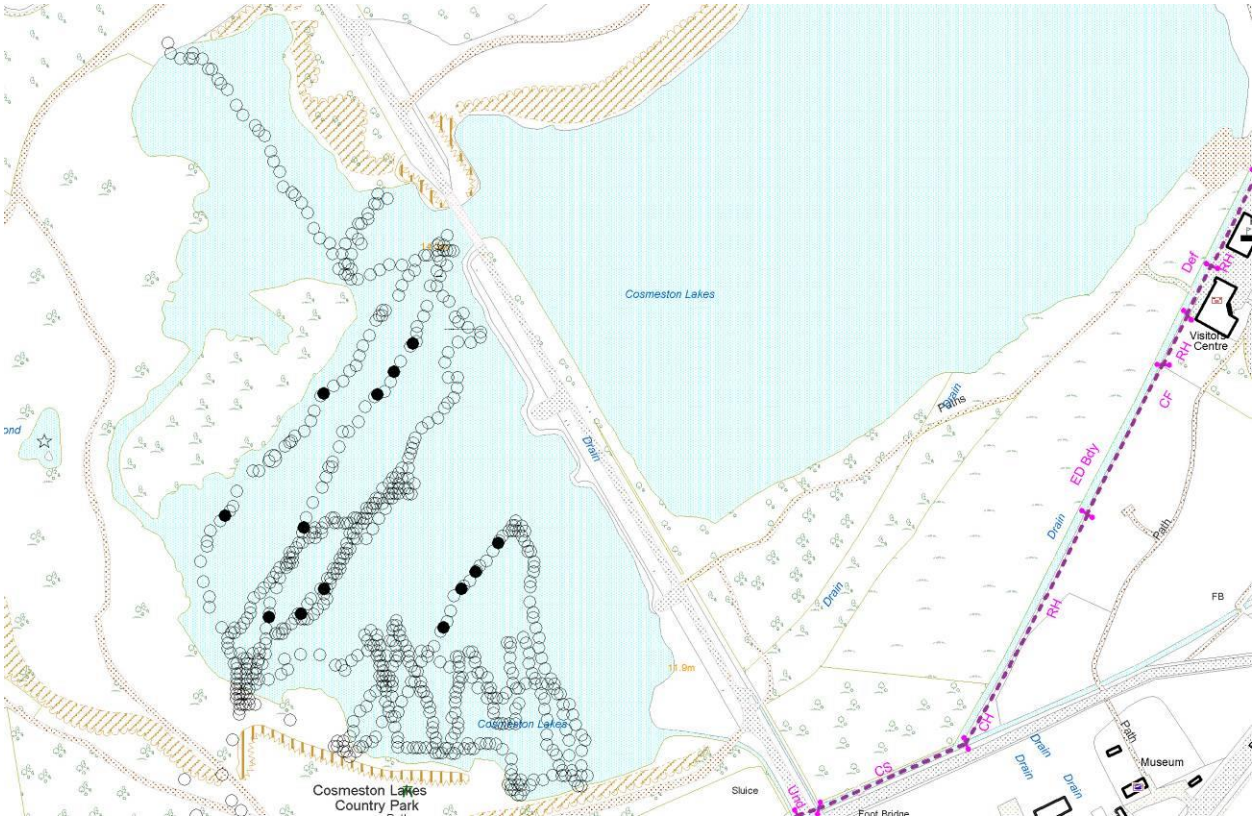


Figure 27 Locations of black, anoxic mud exposures.

3.6 Zebra Mussel *Dreissena polymorpha*

Zebra mussels are very abundant in the Western Lake, although they decrease in abundance and density away from the conduit between the Eastern and Western Lake in a southeasterly direction. This is evidence that the Zebra mussel was first introduced to the Eastern Lake and has now spread to the Western Lake via the conduit between the two lakes. This highly invasive, non-native species (*or* INNS) was first discovered in the Eastern Lake in 2010, is omnipresent now and covers - by way of a very dense carpet - many hard surfaces, ranging from bridge supports, via rocky substrata (Figure 28) and tree branches hanging in the water, even attaching itself to plants and algae (*e.g.* Figure 11). The Duck mussel *Anodonta anatina*, common in Cosmeston Lakes, has also been found covered in Zebra mussels (Richard Facey, pers. comm.).

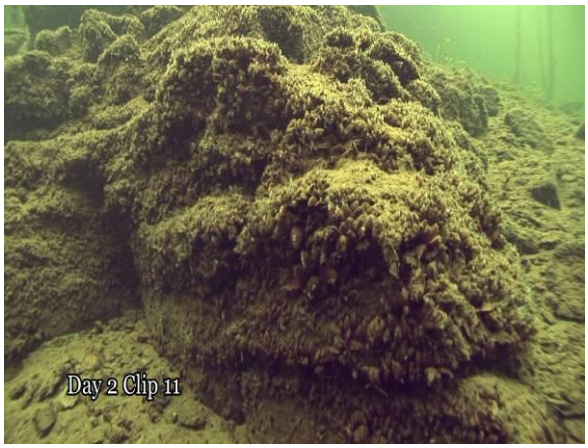


Figure 28 Adult Zebra mussels *Dreissena polymorpha* covering rock exposures in the flooded quarry.

Figure 29 Juvenile Zebra mussel *Dreissena polymorpha* (magnification x60) from L2, found attached to a sample of *N. obtusa*. Note that the characteristic 'zebra pattern' is not yet discernible.

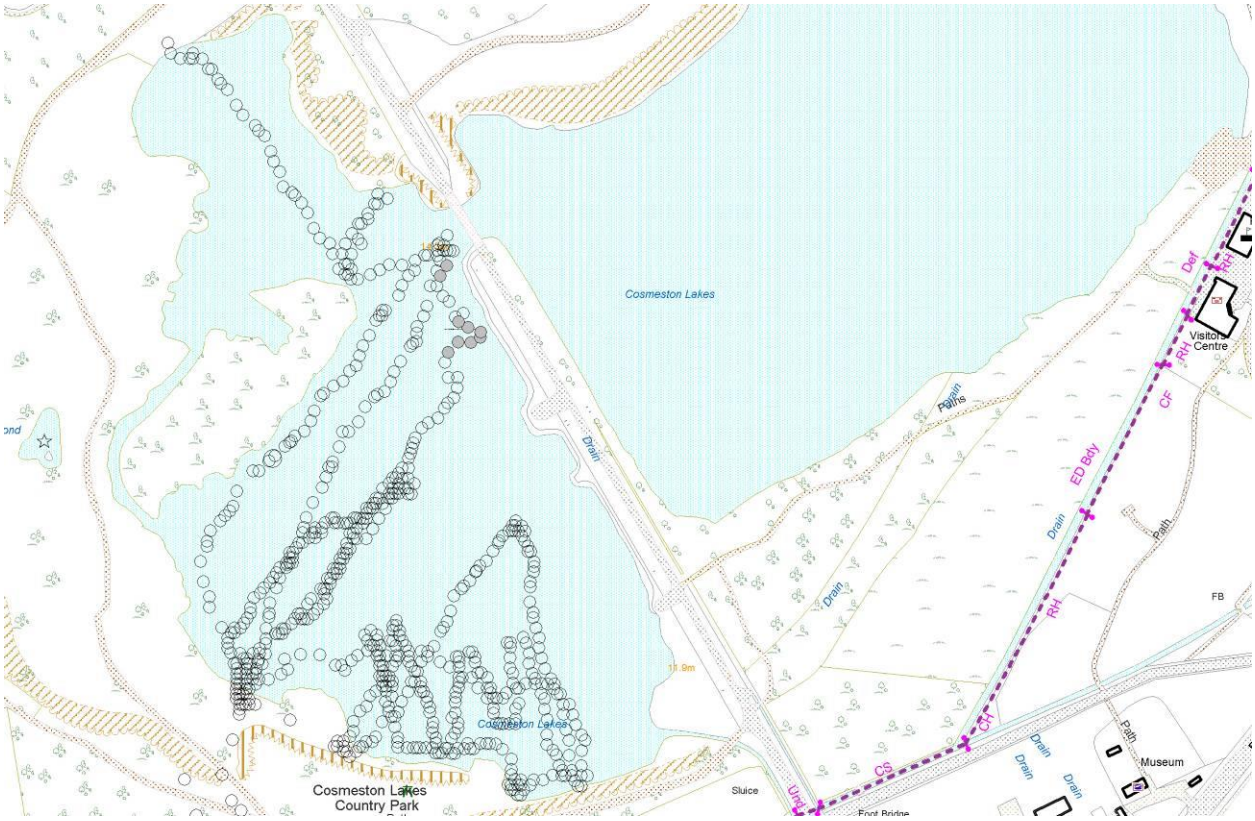


Figure 30 Locations of rock outcrops with Zebra mussels encountered during the survey dives.

Further information on invasive, non-native species can be found in Appendix III.

3.7 Fish Assemblage

No fish were encountered by the divers, but shoals of juvenile roach and rudd were observed in very shallow water amongst protective, marginal, emergent vegetation around the Western Lake. A list of fish species found in Cosmeston Lakes was supplied by the Vale of Glamorgan Council (Steve Latham, pers. comm.). These include Bream *Abramis brama*, Carp *Cyprinus carpio*, Eel *Anguilla Anguilla*, Pike *Esox lucius*, Roach *Rutilus rutilus*, Rudd *Scardinius erythrophthalmus*, Tench *Tinca tinca* and Three-spined Stickleback *Gasterosteus aculeatus*

3.8 Red-eared slider *Trachemys scripta elegans*

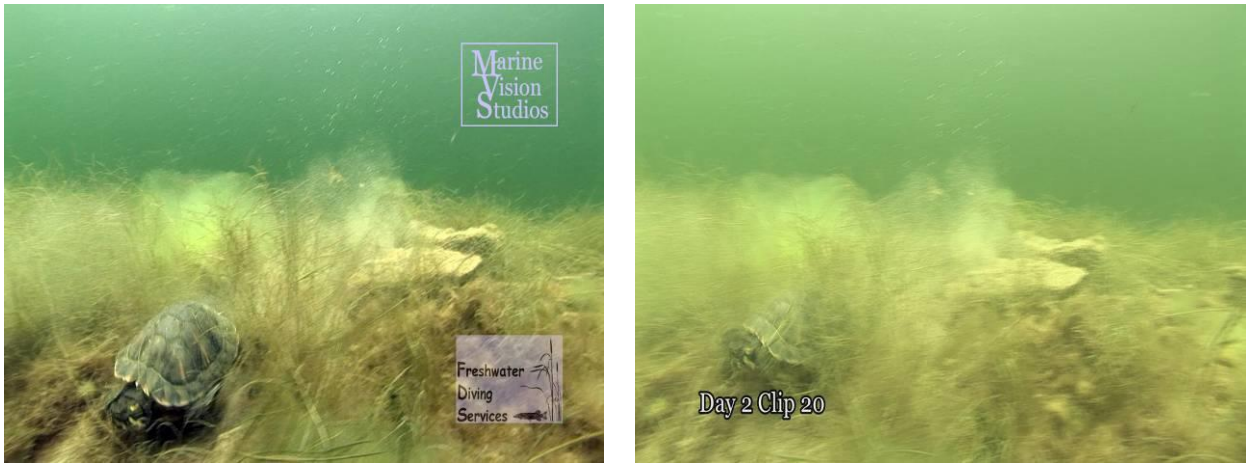


Figure 31 Red-eared slider *Trachemys scripta elegans* found at ST 17386 69116. The speed of the terrapin can be appreciated in the right photograph, as the HD Video camera takes 25 frames per second.

One Red-eared slider was encountered on the dives (location marked with a '★' in Figure 34) and captured on video (Figure 32). Country Park staff remove at least six terrapins a year, however, due to the depth of the lake it is very hard to catch them once they have warmed up during the spring months (Stephen Pickering, pers. comm.). Underwater video footage of the terrapin can be viewed on *You Tube* at http://www.youtube.com/watch?v=owGGD5hQ0Rg

3.9 Selected physico-chemical parameters

The bottom and surface water samples, taken at ST 17500 69087 in the Western Lake, both returned salinity readings of 2 $^{o}/_{oo}$, *i.e.* pure freshwater without any brackish influence, although the lakes are situated in relatively close proximity to the Bristol Channel and Severn Estuary. The pH value for both samples was 8+.

Comparison of air photographs from 2006 and 2010 (Figure 33) does not show any changes to extent of water surface or modifications of shoreline. Small changes to the distribution and extent of floating vegetation, however, are discernible, but not considered to be significant.

Figure 32 Air Photographs of Cosmeston Lakes from 2006 (top) and 2010 (bottom).

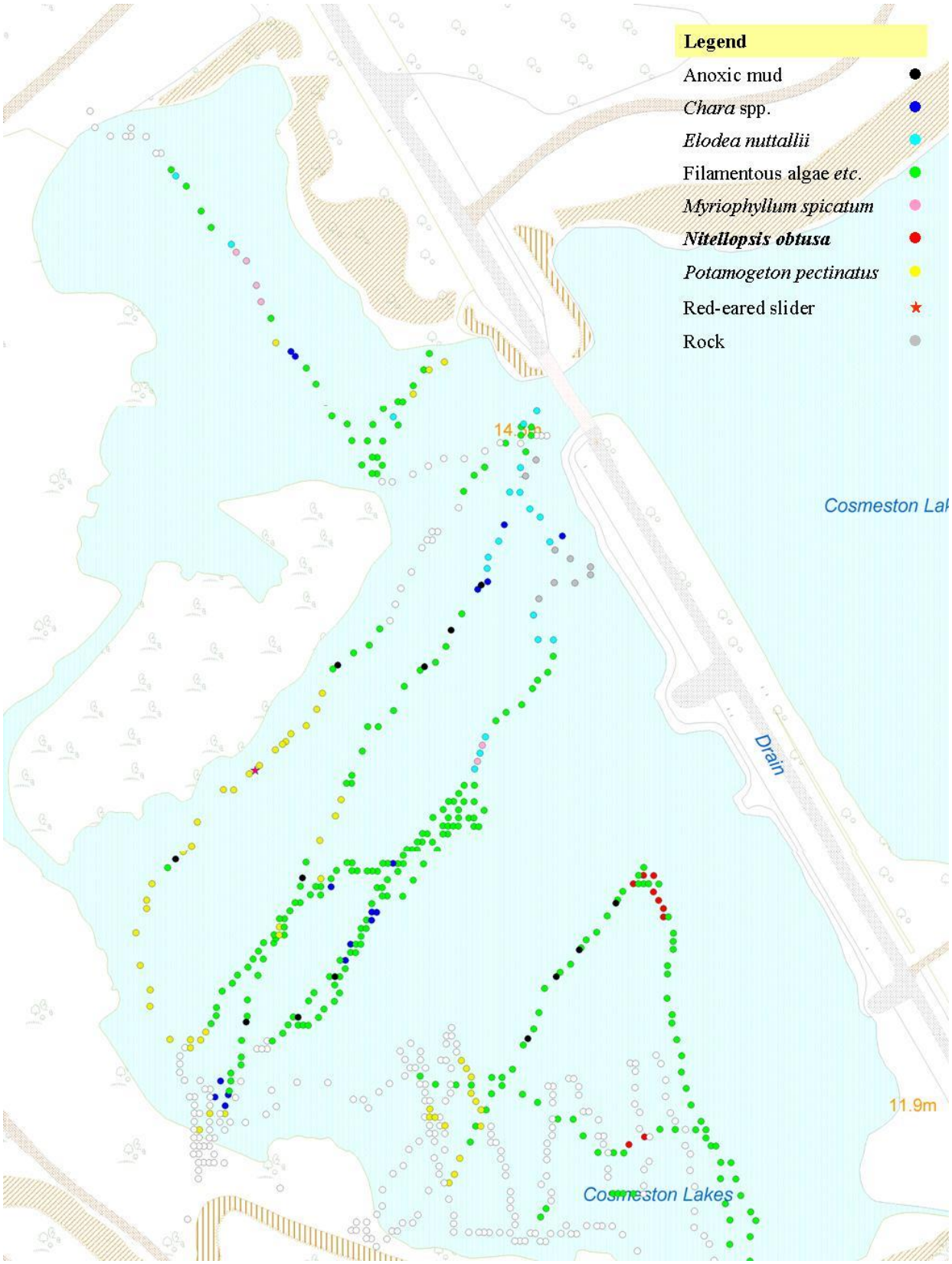


Figure 33 Summary map of all dive survey results.

4 DISCUSSION

Nitellopsis obtusa continues to be rare in Cosmeston Western Lake, although one dense bed of several square metres in extent was found at L2. The depth range at which *N. obtusa* was found in 2011 was 2.2 – 3.6 m compared with that of 1.25 – 1.80 m in 2007. Consequently, *N. obtusa* appears to occur now in significantly deeper water only, occupying a niche beyond the maximum foraging depth of swans and above water depths too deep for *N. obtusa* to flourish. Water levels, however, stay at the same level throughout the summer give or take 15 cm (Steven Pickering, pers. comm.).

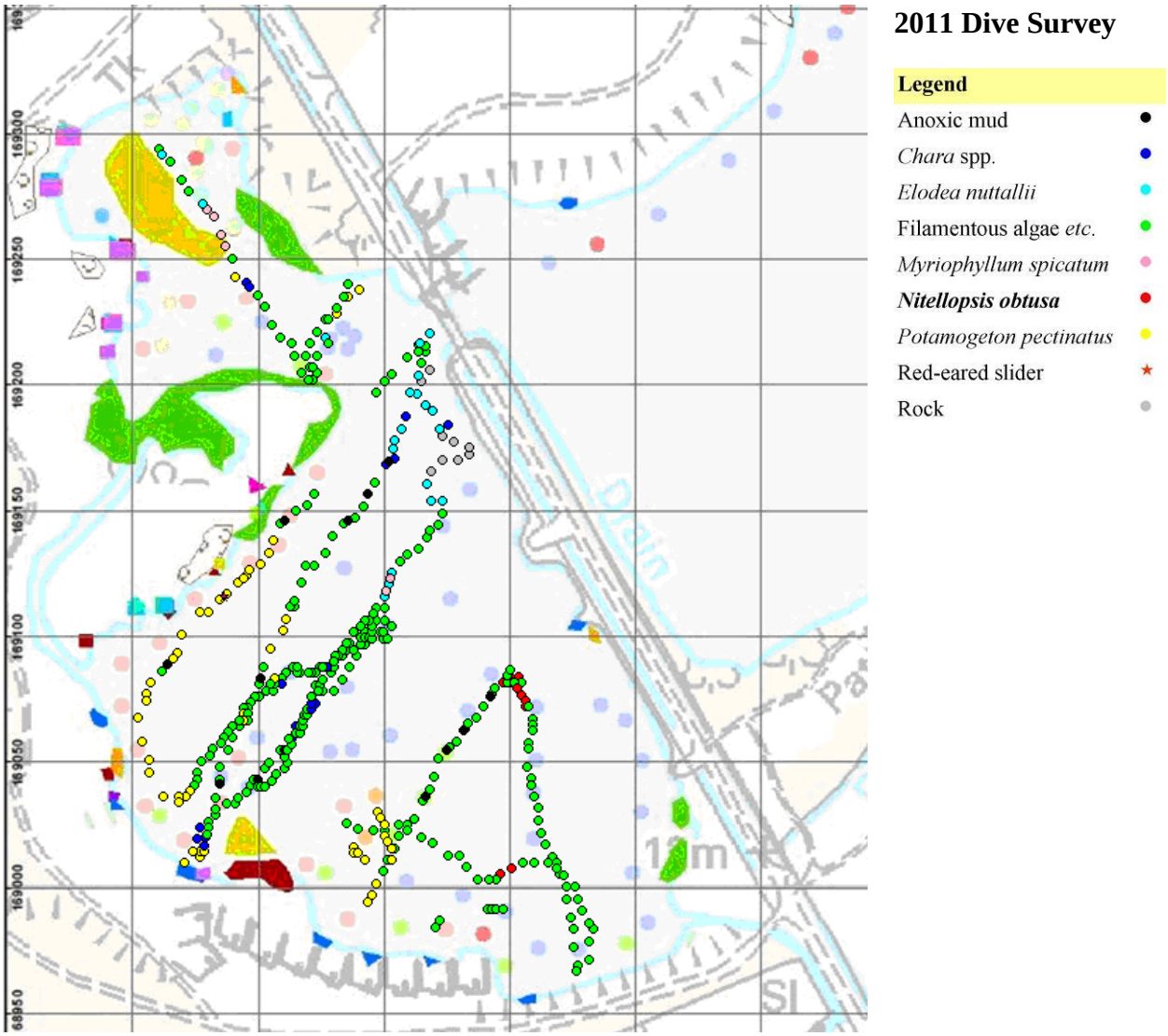
The explanation for this conundrum, however, could also be more simple (or complicated) than that. For instance, the 2007 transect (Transect 1) did not extend to the area where *N. obtusa* was found in 2011, and the divers could have missed the alga along the shallow depth of that transect. Conversely, other factors, such as dispersal of bulbils or preference / suitability of substrate, changes in light penetration and intensity, water temperature at time of germination, *etc*., could have played a role.

The spread of sites where *N. obtusa* was found is encouraging and – given the time and resource constraints of the 2-day dive survey - it is highly probable that there are more locations within the Western Conservation Lake where the species occurs.

Contrary, it is a source of concern that exposures of black anoxic mud are frequent and found in deep as well as in shallow water, ranging from thin veneers to deep pools. In view of other, plant-related evidence, there can be little doubt that Cosmeston Lakes have a (possibly serious) nutrient enrichment problem, possibly arising by way of run-off from the adjacent golf course where fertiliser application is frequent and generous (Country Park staff, pers. comm.).

Figure 34 superimposes the 2011 dive survey results on those of the 2007 macrophyte survey. Whilst a direct comparison cannot be made because of the very different survey methods used, a few tentative conclusions may be drawn however.

- The extent of cover by filamentous algae and that of *P. pectinatus* appears to have increased.
- There are fewer locations where *Cara* spp. are found.
- Elodea nuttallii has spread from the NW corner of the Western Lake where it was originally found.



2007 Macrophyte Survey

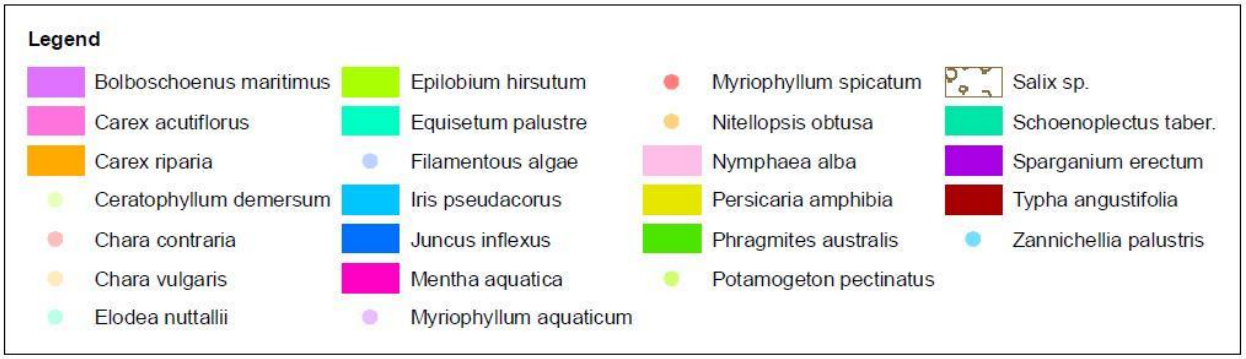


Figure 34 Comparison of the 2011 dive survey results with those of the 2007 macrophyte survey (Burgess *et al.*, 2009; Figure 3.7.5).

For the sake of comprehensiveness, the characteristics of fish that occur in Cosmeston Lakes are listed in Table 3. The fish species marked in red are of serious concern in respect of nutrient recycling and plant destruction, those of amber colour less so (but their presence is still not desirable) and those coloured green are of a benign nature.

Table 3 Summary of the characteristics of the fish species in Cosmeston Lakes in respect of their compatibility with shallow lakes restored to diverse plant communities (modified after Moss *et al*., 1996; Table 9.1).

	Bream	**Common carp**	**Eel**	**Pike**	**Roach**	**Rudd**	**Tench**	**Three-spined stickleback**
Native / Introduced	N	I	N	N	N	N	N	N
Breeds prolifically	+	-	++	++	++	++	+	-
Disturbs bottom	++	++	-	-	-	-	++	-
Pelagial zooplanktivore	++	+	-	-	++	+	-	-
Weed-bed zooplanktivore	-	-	-	-	-	+	-	+
Piscivorous	-	-	+	++	-	-	-	+
Intrusive angling	++	++	-	-	-	-	-	-
Usually abundant	+	++	++	++	++	+	+	±
Destroys plants	-	++	-	-	?+	-	?+*	-
Total score	**-7**	**-23**	**+28**	**+25**	**-3**	**+1**	**-4**	**+30**

Scoring system

Origin: N = 5, I = -5
for bottom disturbance: - = 5, + = 0, ++ = -5
for piscivory: ++ = 5, + = 3, - = -5
for abundance: ± = 0, + = -3, ++ = -5
for breeding: - = 5, + = 0, ++ = -5
for zooplanktivory: - = 5, + = -3, ++ = -5
for angling intrusion: - = 5, + = -3, ++ = -5
for plant destruction: - = 5, + = -3, ++ = -5

* because of predation on epiphyte eating snails

5 FEATURE CONDITION ASSESSMENT

The data gathered by the survey dives, plus additional information noted down during the site visits and some desktop analyses, provides for supporting information towards a Feature Condition Assessment for Cosmeston Lakes SSSI, as detailed in Table 4.

Table 4 Contributions towards a Feature Condition Assessment of Llynnoed Cosmeston / Cosmeston Lakes SSSI in respect of attributes mandatory for the feature assessment of *N. obtusa* (applicable for Cosmeston Western Lake only) (2007 vs 2011 Survey).

Attribute	Target	2007 Survey		2011 Survey	
		Status	Comment	Status	Comment
Water quality	Stable nutrients levels appropriate to lake type. TP target / limit = 20 µg P l^{-1}	✓	TP = 9 µg l^{-1} (range = <3 - 20) & TN = 0.55 mg l^{-1} (range = 0.41 – 0.74)	?	**N/A**, but possible indicators of nutrient enrichment (*e.g.* extent of filamentous algae, *P. pectinatus* and anoxic sediment substrata throughout the Western Lake in shallow and deep water.
	Stable pH / ANC values: pH >7.00 to 8.50.	✓	pH = 7.8 (range = 7.5 – 8.9) ANC = 3,500 µeq l^{-1}	✓?	**N/A**, only assessed semi-quantitatively with Litmus paper: pH = 8+ for both bottom and surface sample at ST 17500 69087.
	Adequate dissolved O_2 for health of characteristic fauna	✓	~ 8-9 mg l^{-1} from 0 – 5 m, decreasing to ~ 0 mg l^{-1} by 8 m.	?	**N/A**, but divers did not encounter any fish during their dives. Juvenile fish only observed in very shallow water. Anoxic sediment substrata throughout the Western Lake (near-shore to deep water).
	No excessive growth of cyanobacteria or green algae	✓	No blooms noted	?	**N/A**, but a conservative estimate suggests that >50 % of the lake is occupied by filamentous algae and algal mats.
Hydrology	Natural hydrological regime	✓	Appears natural – fed by underground springs	✓?	**N/A**, but hydrological regime assessed in 2007 appears to have been maintained, *i.e.* no surface water course enters the Lakes.
Lake substrate	Natural shoreline maintained	✓?	'Natural' shoreline maintained as far as possible - lake lies within a country park, with visitor access.	✓	Shoreline is man-made. There is no change discernible based on comparison of air photographs from 2006 and 2010.
	Natural and characteristic substrate maintained	✓	No evidence of change since quarry filled with water.	X	All sediment substrata – from thin veneers to deep mud pools – are currently anoxic, whether in shallow or deep water.
Sediment load	Natural sediment load maintained	✓	No evidence of increased sediment loads[2].	?	**N/A**
Indicators of local distinctiveness	Distinctive elements maintained at current extent /	✓[2]	*Nitellopsis obtusa* (Starry stonewort) recorded in 2007 – UK BAP Priority Species and only Welsh	X?	*N. obtusa* colonies present, but impossible to compare any change in abundance because of different survey

[2] There were no previous records for comparison.

Attribute	Target	2007 Survey		2011 Survey	
		Status	Comment	Status	Comment
	levels / locations		record. *Chara contraria* – one of only three sites in Glamorgan.		methods. Possible reduction in the abundance of *Chara* spp.
Status: ✓ **= favourable; X = unfavourable; ? / ? = reduced confidence level; N/A / ? = not assessed.**					

6 CONSIDERATION OF POSSIBLE MANAGEMENT OPTIONS

In order to achieve and maintain good ecological status for the man-made lakes in the Cosmeston Lakes Country Park, the following management and remediation measures could be considered. Some of these will probably not yield the required or desirable outcomes and / or will be too expensive and not cost-effective. These are nevertheless included here for an overall more holistic evaluation. Final recommendations are listed in Section 7, and it is those that should be taken forward and implemented.

6.1 Eradication of Invasive Non-Native Fauna

The initial method of controlling Zebra mussels, involved the use of chlorine in infested water. However zebra mussels can detect chlorine and in response can close their shells for up to three weeks, therefore chlorine would need to be continually dosed for that period. This would have serious environmental repercussions.

Dr David Aldridge of Cambridge University has developed a solution to overcome rejection and valve closing, in the form of the 'biobullet'. The biobullet is a 100 micron wide, lipid coated capsule containing a toxic potassium chloride core (Figure 36). The biobullet is consumed as the Zebra mussels filter feed, the edible coating then dissolves to release the lethal dose of potassium chloride. The capsules have been engineered to break down after a couple of hours and are only toxic to freshwater bivalves because of their low body fluid concentrations. Biobullets are also effective with the Asian Clam (*Corbicula fluminea)*, another invasive, non-native species.

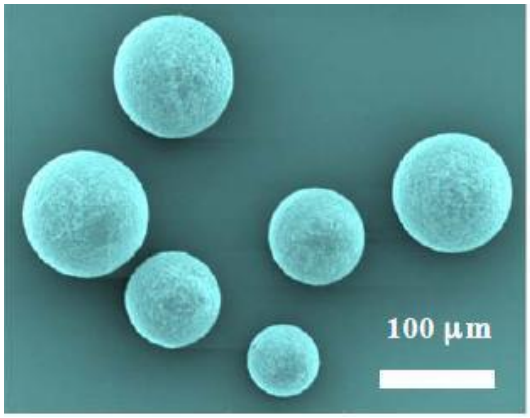


Figure 35 Electron microscope image of 'Biobullets'.

Figure 36 Shells of predated Duck mussel *Anodonta anatina.*

Understandably, the Biobullets will also kill off the resident Duck mussel *Anodonta anatina* population in the Cosmeston Lakes, which appears to be of significance to predators, such as otter (and possibly heron?), as evidenced by notched shells along the lake margin (Figure 37).

Biobullet trials are planned in a Welsh reservoir (David Aldridge, pers. comm.). The results of these trials should be carefully evaluated in view of the conservation interests of Welsh freshwater SSSIs in general. Strict biosecurity measures will need to be in place, should the Biobullet be deployed at Cosmeston Lakes, and a SSSI Assent will be required from the CCW.

In respect of Red-eared sliders, efforts should be made to trap the terrapins and remove them from the lakes. There are many effective traps to use – baited, as well was un-baited ones (http://www.turtle-trap.com/).

6.2 Eradication of Invasive Non-Native Flora

Elodea spp. and *Myriophyllum aquaticum*, both reproduce vegetatively in this country, including by vegetative fragmentation. M. aquaticum should be eradicated by way of spraying it with

glyphosphate. For *E. nuttalli*, the only realistic and practicable solution is the physical removal of these plants, in particular around locations where *N. obtusa* occurs (filamentous algae to be cleared there at the same time). As every bit of the plant will need to be removed very carefully, this should be undertaken by experienced divers and should not form part of any training exercise of inexperienced divers or dive novices. Strict biosecurity measures need to be in place and a SSSI Assent / Consent is required from the CCW.

6.3 Amelioration of Impacts of Nutrient Loading

For shallow lakes, the best strategy for improving their environmental state is external nutrient loading reduction. Control of filamentous algae or algal blooms through nutrient-input reduction alone, however, is a slow, long-term process. For instance, in agricultural areas, every effort should be made to manage runoff from livestock production areas under grazing and pasture along the feeder streams of the lakes to minimize off-farm transport of nutrients and sediment.

Removal of filamentous algae, and dead and decaying plant material with a rake undertaken on an annual basis is one option, but the size of the Lakes makes this an unrealistic option. Any non-native plants would need to be removed as well during this process. Removal of anoxic mud in areas without desirable macrophytes from the Western Conservation Lake by suction-dredging could also be considered, but is prohibitively expensive and would require a suitable disposal site.

The deployment of subsurface diffused aeration systems could be considered rather than the setting up of fountains which are considerably less effective and would have an adverse impact on landscape and the semi-natural character of the lakes.

Barley straw bales in netting could be deployed in the Western Conservation Lake and away / out of sight from the footpath along the lake. The application of barley straw to water has proved to be very successful in most situations with no known undesirable side-effects. It offers a cheap, environmentally acceptable way of controlling algae in water bodies ranging in size from garden ponds to large reservoirs, streams, rivers and lakes.

An increase of water surface covered with floating plants, such as pondweeds and water-lilies, should be encouraged.

Finally, monitoring of nutrient levels should be introduced as soon as practicable.

6.4 Management of Fish Assemblage

The fish community should be restructured to favour the dominance of piscivorous fish instead of planktivorous and benthivorous ones. If possible, all planktivorous and benthivorous fish species (*e.g.* carp, bream, roach, tench, *etc*.) that either recycle nutrients or resuspend nutrients from bottom sediments should be eliminated. A combination of electro-fishing and netting is the recommended method to attempt and achieve this as illustrated in Moss *et al*., 1996 for the North Norfolk Broads. The removed fish should not be transported and transferred to another site, unless all Zebra mussels have been eradicated prior to the capture of the fish. Introduction of non-native fish species that feed on algae or assist in algal management, such as sterile Asian grass carp, should not be considered.

6.5 Management of Waterfowl

The number of resident waterfowl in summer, foremost to mention that of Mute swans, appears to be excessive and could be reduced, as it may be a contributor to the nutrient problems of the Lakes in the form of faeces and unconsumed food fed by visitors. One pair of Mute swans succeeded in raising nine signets in 2011, whilst the Great-crested grebe managed to raise only one chick. Swans also feed on aquatic plants and can reach to a considerable depth, including

the depth *N. obtusa* was found in 2007. It is not inconceivable that the reason why *N. obtusa* is nowadays found in considerably deeper water only, may be related to the maximum depth swans can forage to. On the other hand, waterfowl, and in particular the swans, are a major attraction of the Country Park.

6.6 Biosecurity

Biosecurity means taking steps to make sure that good hygiene practices are in place to reduce and minimise the risk of introducing and spreading disease and invasive non-native species (INNS). A good biosecurity routine is always essential, even if invasive non-native species are not always apparent. Some biosecurity measures can be as simple and as quick as making sure footwear and equipment is clean. However, we must also be mindful of the fact that INNS are already prevalent in Cosmeston Lakes and that certain species require considerable more effort than others.

To ensure good Biosecurity is in place will require the Vale of Glamorgan Council, the Environment Agency Wales and the CCW jointly to:

- Communicate the history of INNS in the Lakes to all participants of leisure and other activities in the Country Park by way of an information leaflet, detailing recommended biosecurity measures; and
- Inform visitors to the Country Park by way of signs and posters at popular points around the Lakes about the potential risk of introducing and / or spreading INNS to other freshwater sites.

Detailed Biosecurity measures (effective for invasive, non-native plants only, but **NOT** Zebra mussel or 'Killer shrimp'!):

- ✓ No boating or SCUBA-diving activities to take place on or in Cosmeston Western Lake.
- ✓ Boats used on Cosmeston Eastern Lake must be power-washed prior to launching to prevent introduction of new / additional pathogens and INNS. Boats will also require power-washing immediately after having been removed from the water to prevent the further spread of INNS from Cosmeston Lakes to other sites.
- ✓ All equipment associated with SCUBA-diving should be thoroughly cleaned, disinfected, rinsed and dried prior to and after use within the SSSI.
- ✓ Alternatively: SCUBA-diving gear should be emerged in saltwater of normal salinity (33 $^{o}/_{oo}$) for at least 20 minutes. This is easiest achieved by following the freshwater dive with a marine one. The SCUBA-diving gear should never be used in consecutive dives at different freshwater sites, but dives should ideally be separated by a marine dive.

These biosecurity measures, however, are **ineffective** in respect of Zebra mussel and 'Killer shrimp', as the former can close its shells for up to 3 weeks and the latter have a very high tolerance to disinfectants. Both species can survive for extended periods in concealed, damp spaces associated with and common to both boating and SCUBA-diving activities!

6.7 CCW's SSSI Assents and Consents Procedure

As a Section 28G Authority under the Wildlife & Countryside Act 1981 (as amended; most recently by the Countryside & Rights of Way Act 2000), it is imperative that the Vale of Glamorgan Council notifies the CCW prior to the authorization of any activities within the SSSI or adjacent to it and which may impact on the SSSI (these are listed on the OLDSI list; see Appendix I). The recommended Biosecurity measures listed in Section 6.6 must be included on any SSSI Consent / Assent to be issued to the Vale of Glamorgan Council for water-based activities in the Country Park (should the Vale of Glamorgan Council be minded to continue to allow these).

6.8 Translocation of Starry Stonewort *Nitellopsis obtusa*

As Starry stonewort occurs currently at only one site in Wales, which is of very poor environmental quality and at risk of further deterioration, translocation of a few specimens or bulbils to another suitable site should be considered in order to ensure its continued presence in Wales. One should not be perturbed by the traditional view that *N. obtusa* is a deep water species only, as it was found to occur exclusively in water depths of 1.25 - 1.8 m in the 2007 Survey of Cosmeston Lakes.

The following Special Areas of Conservation (SACs) with 'hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.' feature could be assessed as potential receptor sites:

(1) ***Llyn Yr Wyth Eidion***, within Anglesey Fens SAC is a small, active, marl-producing lake in north Wales and is an example of a lake on limestone with water of high quality, in particular in respect of nutrients. Hedgehog stonewort *Chara pedunculata* and the rare Rugged stonewort *C. rudis* have been recorded at this site.

(2) ***Kenfig Pool*** is a shallow lake system within the extensive sand dune system of Kenfig, SAC alongside Swansea Bay in south Wales. The lake contains abundant Hairlike pondweed *P. trichoides*, Rigid hornwort *Ceratophyllum demersum*, Canadian waterweed *Elodea canadensis*, Fan-leaved water-crowfoot *Ranunculus circinatus*, Spiked water-milfoil *Myriophyllum spicatum* and the charophytes *Chara aspera* and *Nitella flexilis*.

(3) ***Bosherston Lakes*** are a shallow marl lake system within the Pembrokeshire Bat Sites and Bosherston Lakes SAC. They are fed in part by a series of calcium-rich springs and are isolated from the sea by a small sand dune ridge. Charophytes are represented by Bristly stonewort *Chara hispida* and by variable quantities of *C. globularis*, *C. virgata* and *C. vulgaris*. Extensive White water lily *Nymphaea alba* beds also occur, mainly in the western and central arms. In contrast, the eastern arm is characterised by variably dense stands of Curled pondweed *Potamogeton crispus*, Fennel pondweed *Potamogeton pectinatus*, Spiked water-milfoil *Myriophyllum spicatum* and Canadian waterweed *Elodea canadensis*. Part of the Lakes have currently nutrient enrichment problems.

In addition to the above SAC designated lakes, there may also be merit (if not even more so), to investigate the suitability of disused, flooded limestone quarries at Ludchurch (SN 144105) and the Caled Quarry at Bosherston (SR 959951). The main Ludchurch Lake, however, is home to a privately-owned coarse fishery for Rudd, Perch, Tench and Carp, whilst the Caled Quarry, owned by the National Trust, is hydrologically linked with (the also man-made) Bosherston Lakes, thereby giving rise to fluctuating water levels.

Any translocation (or re-introduction) should follow the guidelines produced by the International Union for Conservation of Nature (IUCN)[3]. Furthermore, any introduction of *Nitellopsis obtusa* to any one the SACs listed above would need to be reconciled with the Conservation Objectives for that site, *i.e.* the CCW's advice provided under Regulation 35 of *The Conservation of Habitats and Species Regulations 2010* (as amended). Introduction to any one of these sites would need to be treated as a 'plan' or 'project' under Regulation 61 of the aforementioned Regulations and a full Habitats Regulations Assessment (HRA) would need to be undertaken.

6.9 Establishing a new Conservation Pond or Lake

As it will be very difficult and take a long time to remedy the ailments of the Lakes (if at all possible), consideration could be given to the improvement / reinstatement or even creation of a new pond or small lake within the boundary of the current SSSI (Figure 38), so as to avoid yet another SSSI renotification of the site, bearing in mind that *N. obtusa* is currently the only 'legal

[3] IUCN (1998) *Guidelines for Re-introductions*. Prepared by the IUCN/SSC Re-Introduction Specialist Group, Gland, Switzerland and Cambridge, UK. 10pp. http://www.iucnsscrsg.org/download/English.pdf

feature' of the Cosmeston Lakes SSSI. This new freshwater body should be fenced in and made save from waterfowl (in particular swans) and dogs, and should then be seeded with *N. obtusa* bulbils. A trial of deploying bird scares (*e.g.* hawks and owls) and establishing their effectiveness could also be conducted. A potential candidate site is a pond found at ST 17276 69124 and the feasibility to prepare this pond to receive *N. obtusa* bulbils should be investigated.

Advice and guidance for reinstating or creating ponds can be found at http://www.pondconservation.org.uk/millionponds/pondcreationtoolkit[4].

Some projects can also be eligible for grant aid. For funding opportunities in Wales see: http://www.pondconservation.org.uk/Resources/Pond%20Conservation/Documents/PDF/Grants%20for%20Ponds%20in%20Wales_web.pdf.

6.10 *Ex-situ* Conservation

Ex-situ conservation means literally, 'off-site conservation'. It is the process of protecting an endangered species of plant or animal outside of its natural habitat; for example, by removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans. While ex-situ conservation comprises some of the oldest and best known conservation methods, it also involves newer, sometimes controversial laboratory methods.

The best method of maximizing a species' chance of survival (when ex-situ methods are required) is by relocating part of the population to a less threatened location. It is extremely difficult to mimic the environment of the original colony location given the large number of variables defining the original colony (microclimate, soils, symbiotic species, absence of severe predation, *etc.*). It is also technically challenging to uproot (in the case of plants) or trap (in the case of animals) the required organisms without undue harm.

Characaeae survive 'out of season' by means of spores (and bulbils) mostly and these can survive for many years (few decades at least) in soil[5]. Ex-situ conservation of charophytes has already been discussed between Kew Gardens and Nick Stewart (National Stonewort Recorder)[6].

[4] The Pond Creation Toolkit includes:
Core factsheets 1 to 8 with background information on the project and the best practice principles of clean water pond creation, such as location, design, project planning and implementation.
Habitat factsheets, which present detailed information on designing ponds in different land uses, *e.g.* woodland, grassland, *etc.*
Advice factsheets, which deal with issues such as birdstrike, planning permission, and ponds in public access areas.
Species dossiers with technical information on creating ponds specifically for over 40 pond-associated BAP species, based on their ecological requirements.
Aggregates factsheets specifically targeted at pond creation on mineral sites.
Case studies.

[5] Research in Australia: testing soil samples for viable charophyte spores; Dr Michele Casanova, Research Associate at Royal Botanic Gardens Melbourne; contact via the Charophyte website: http://www.charophytes.com

[6] Information provided by Margaret Ramsay, Conservation Biotechnology (Jodrell), Royal Botanic Gardens, Kew

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The current survey and assessment has established beyond reasonable scientific doubt that the Cosmeston Lakes SSSI is currently in **unfavourable** conservation condition. Reasons for this status are (a) nutrient enrichment, as evidenced by the extent and intensity of algal cover (filamentous algae, algal mats and amorphous algal masses) and *Potamogeton pectinatus*, and (b) presence of invasive, non-native fauna and flora (Zebra mussel and Nuttall's waterweed), introduced to the lakes because of lack of Biosecurity.

Starry stonewort continues to be rare in Cosmeston Western Lake, although one dense bed of several square metres in extent was found. Compared to the 2007 macrophyte survey, *Nitellopsis obtusa* now occurs in significantly deeper water only. This phenomenon, however, cannot be readily explained.

In contrast, the abundance of *P. pectinatus* appears to have increased since 2007, so has that of *E. nuttallii*; the latter occurs now also in the central part of the Western Lake and is not anymore confined to the NW corner. No attempt to eradicate the species has been made.

Zebra mussel was probably introduced to the Eastern Lake post-2007 and has spread rapidly, including to the Western Lake, and is nowadays very abundant.

7.2 Transects and Stations for Future Monitoring

Four transects for the future condition monitoring of the Western Lake are recommended. Only one transect (surveyed in both 2007 and 2011), however, relates currently to the presence of Starry stonewort, because of its rarity and all three locations where *N. obtusa* was found will ultimately be more easily surveyed by establishing monitoring stations. These should be marked with inconspicuous buoys (*e.g.* 5-litre water bottles) as soon as practicable. This would make use of the cumbersome float with mounted GPS redundant, would save time (as position fix would be 100 % accurate), and the locations could subsequently be monitored more readily with a drop-down video camera (but non-destructive ID by divers would still be required by divers). The additional three transects are optional, but would allow monitoring of the subjects listed in Table 4. To cut down on costs for all of the recommended actions, monitoring should ideally coincide with the time of year (*i.e.* autumn) when the annual extent of *N. obtusa* is arguably at its largest and bulbils could be collected for translocation.

Table 5 Details of recommended monitoring transects and stations.

Transect No	Coordinates		Transect Bearing [ºN]	Monitoring Purpose / Subjects
	Start	Finish		
T1	ST 17438 68977	ST 17521 69126	30º	*Nitellopsis obtusa*, *Potamogeton pectinatus*, filamentous algae, anoxic mud exposures, Zebra mussels
T2	ST 17380 69005	ST 17485 69183	30º	*Chara* spp., *Potamogeton pectinatus*, *Elodea nuttallii*, filamentous algae, anoxic mud exposures, Zebra mussels
T3	ST 17362 69014	ST 17475 69207	30º	*Chara* spp., *Potamogeton pectinatus*, *Elodea nuttallii*, filamentous algae, anoxic mud exposures, Zebra mussels
T4	ST 17354 69310	ST 17419 69199	150º	*Chara* spp., *Potamogeton pectinatus*, *Elodea nuttallii*, *Myriophyllum aquaticum*, filamentous algae
Station No	**Coordinates**	**Monitoring Purpose / Subjects**		
S1	ST 17500 69084	*Nitellopsis obtusa* and associated species and communities		
S2	ST 17506 69075	*Nitellopsis obtusa* and associated species and communities		
S3	ST 17496 69006	*Nitellopsis obtusa* and associated species and communities		

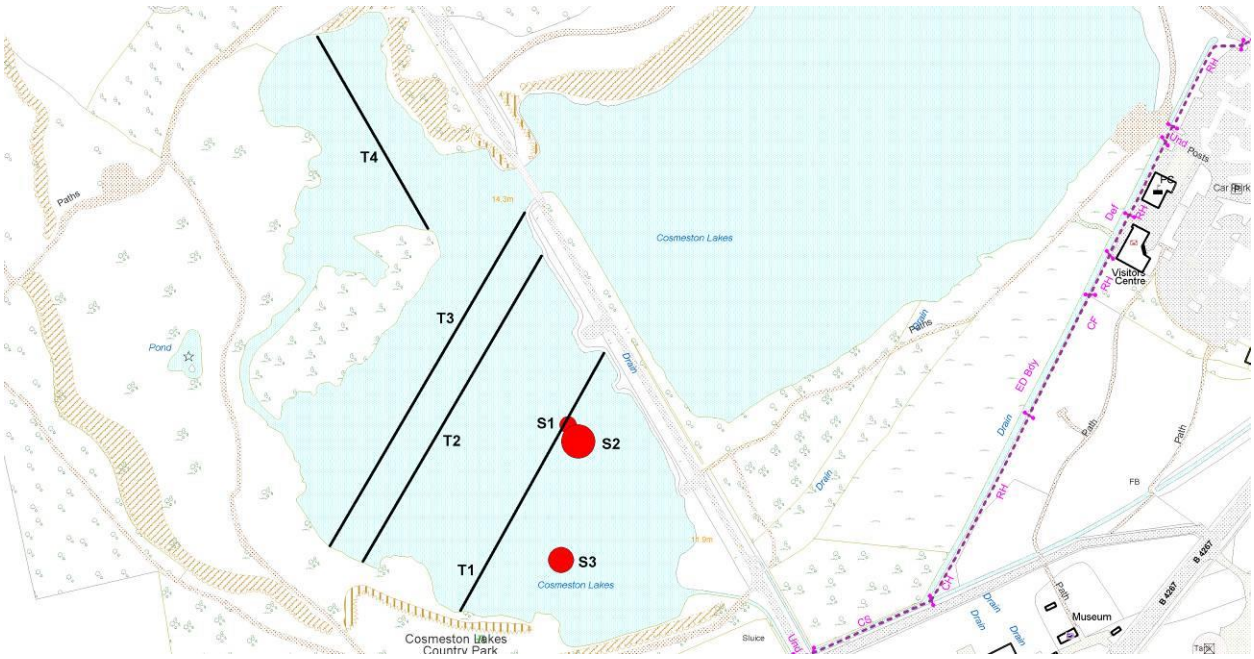


Figure 37 Locations of recommended monitoring transects and stations.

7.3 Recommended Biosecurity and Translocation

Appropriate biosecurity measures will need to be implemented and adhered to as a matter of priority and urgency. There is a high risk that installation of a boat wash on its own will not prevent the spread of Zebra mussel and other INNS (see Section 6.6 and Appendix III), nor will it prevent the introduction of the 'Killer shrimp' which is a very realistic and high risk of happening. Ideally, any boating and SCUBA-diving activities should cease immediately.

7.4 Recommended Conservation Objective for *Nitellopsis obtusa*

The recommended Conservation Objective in Table 5 is based (with modifications) on the Common Standards Monitoring Guidance for Standing Waters (JNCC, 2005). The Conservation Objective for *N. obtusa* should be formulated as if it was a higher, *i.e.* vascular, plant. As *N. obtusa* is an annual species, that will consequently exhibit a high variability in numbers, it should preferably be monitored and assessed on more than one occasion during each 6-year cycle.

Table 6 Recommended Conservation Objective (CO) for *Nitellopsis obtusa* in Cosmeston Western Lake and current Conservation Condition Assessment undertaken against the CO.

For *Nitellopsis obtusa* in Cosmeston Western Lake to achieve and maintain favourable conservation condition, all the following criteria need to be met:	**Does *Nitellopsis obtusa* and its supporting habitat in Cosmeston Western Lake currently meet these criteria? Give brief explanation / justification.**
HABITAT ATTRIBUTES	
Water quality [mandatory]	
Stable nutrient levels appropriate to lake type. TP target / limit = 20 µg P l^{-1}	**Unknown**; not assessed quantitatively, but Western Conservation Lake shows evidence of significant nutrient enrichment, based on cover by filamentous algae & algal mats, abundance of amorphous algal masses & *P. pectinatus*, and extent of anoxic sediment substrata in both shallow and deep water.
Stable pH/ANC values appropriate to lake type: pH >7.00 to 8.50.	**Yes**; only assessed semi-quantitatively with Litmus paper: pH = 8+ for both bottom and surface sample at ST 17500 69087.
Adequate dissolved oxygen levels for health of characteristic fauna.	**Unknown**; not assessed, but many juvenile roach and rudd observed in very shallow water from the shore amongst protective vegetation. Divers did not encounter any fish during their dives.
No excessive growth of cyanobacterial or green algae.	**No**; a conservative estimate suggests that >50 % of the lake is occupied by filamentous algae and algal mats.
Substrate [mandatory]	
Maintain natural shoreline.	**Yes**; shoreline is man-made. There is no change discernible based on comparison of air photographs from 2006 and 2010.
Maintain natural and characteristic substrate.	**No**; all sediment substrata – from thin veneers to deep mud pools – are currently anoxic in both shallow and deep water.
Hydrology [mandatory]	
There should be a natural hydrological regime.	**Yes**; hydrological regime assessed in 2007 appears to have been maintained, *i.e.* no surface water course enters the Lakes.
Sediment load [mandatory]	
Maintain natural sediment load.	**Unknown**
POPULATION ATTRIBUTES	
Presence / absence [mandatory]	
N. obtusa must be present.[7]	**Yes**; *N. obtusa* was present at three locations on 12 August 2011.
Population size / extent [discretionary]	
Two or more discrete populations must be present.[8] **[N.B. These discrete populations must be greater than 50 m apart.]**	**Yes**; L1 and L2 are 70+ m north of L3.
Successful regeneration [discretionary]	
N. obtusa must produce bulbils.	**Unknown**; bulbils were not observed on 12 August 2011, because it was possibly too early in the annual cycle of *N. obtusa* at this location and in this climate. Bulbils can survive in the substrate for many years.
Summary of Conservation Condition Assessment: Is *Nitellopsis obtusa* and its supporting habitat in Cosmeston Western Lake currently in Favourable Conservation Condition?	
No	

[7] **N.B.** Presence of one single specimen in whatever condition would meet this criterion.
[8] **N.B.** This is an arbitrary target that may not reflect what a favourable conservation condition for *N. obtusa* is or ought to be at this site and at this point in time.

8 ACKNOWLEDGEMENTS

Thanks are due to the following individuals:

Andrew Lucas (Contract Manager, CCW) who gave us the opportunity to demonstrate what SCUBA-diving can do for freshwater SSSI condition monitoring.

Steve Latham, Sharon Mullins, Stephen Pickering and Aaron Jones (Vale of Glamorgan Council) accommodated and assisted with access to the dive sites and for informative correspondence and chats concerning the site.

Sam Bosanquet and Dan Guest (CCW) assisted in species ID.

Richard Facey (CCW) provided additional information on the site.

Amy Burgess (ENSIS Ltd) provided additional information on the 2007 macrophyte survey.

Rohan Holt (CCW) reviewed the Diving Project Plan and Risk Assessment.

Tristan Hatton-Ellis (CCW) provided useful comments on the draft report.

Nick Stewart (National Stonewort Recorder) confirmed the Starry stonewort ID made by *Freshwater Diving Services*.

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APPENDIX I: SSSI INFORMATION

Cosmeston Park 1985 SSSI Citation:

Cosmeston Park supports a wide range of wildlife habitats including open water, fen, woodland and remnant limestone grassland.

Wetland habitats are of particular significance in supporting a regionally important Odonata *population. Thirteen species of dragonflies and damselflies are known to breed within the Park, making it one of the richest sites in South Wales for this group of insects. The Western Lake, the fen and a small isolated pool provide the necessary habitats for the bulk of these species with nine species alone confirmed breeding in the latter area.*

The wetland habitats also provide breeding sites for mute swan and great crested grebe. In addition to contributing towards an overall breeding population of some 45 different bird species, the wetland habitats of the Park attract numbers of spring and autumn passage migrants. Around 300 species of flowering plants have been recorded in the Park – a reflecting of its rich and diverse habitats. Everlasting pea (Lathyrus sylvestris), *Dyers' greenweed* (Genista tinctoria) *and bee orchid* (Ophrys apifera) *are among the most notable species present.*

Operations requiring consultation with the CCW (Appendix II) also included:
26. Use of vehicles, or craft likely to damage the qualifying features.
27. Recreational activities likely to damage the qualifying features.

The 1985 SSSI Citation does not list Bittern *Botaurus stellaris* that also winter at the site and are a Biodiversity Action Plan (BAP) Priority Species (JNCC, 1995).

During the 2007 survey of standing waters SSSIs (Burgess *et al.*, 2009), however, specimens of Starry stonewort *Nitellopsis obtusa* were found growing in the Western Conservation Lake. This was to date the first Welsh record and still remains the only one. Starry stonewort is a UK BAP Priority Species and its presence in Cosmeston Lake was considered a good indication that this site was worthy of conservation and should be re-notified (to include *N. obtusa*).

The SSSI was subsequently renotified on 4 March 2009 with an area of 25.6 ha (reduced from 46 ha in 1985).

Cosmeston Lakes 2009 SSSI Citation:

"*Llynnoedd Cosmeston / Cosmeston Lakes is situated 2 km south of Penarth. It includes two lakes, created from flooded limestone quarries, which are connected by a narrow channel. These are deep (up to 10 m) eutrophic water bodies, which support a range of submerged plants.*

One of the lakes is of special interest as the only known site in Wales for the presence of starry stonewort Nitellopsis obtusa. *This species usually grows in lakes of between 1 m and 6 m in depth. Elsewhere in Britain it occurs in the Norfolk Broads and in Gloucestershire, where it is found in calcareous lakes near the sea. This suggests that the species prefers slightly brackish conditions. The lakes at Cosmeston Park are less than 1.5 km from the Bristol Channel.*

The site also includes areas of swamp, ponds and grassland that form part of the water catchment area for the lake."

OLDSI LIST

CYNGOR CEFN GWLAD CYMRU
COUNTRYSIDE COUNCIL FOR WALES

SITE OF SPECIAL SCIENTIFIC INTEREST: OPERATIONS REQUIRING CONSULTATION WITH THE COUNTRYSIDE COUNCIL FOR WALES (CCW)

SITE NAME: **LLYNNOEDD COSMESTON/COSMESTON LAKES**

UNITARY AUTHORITY: **VALE OF GLAMORGAN**

DATE OF NOTIFICATION: **4 March 2009**

The operations listed below may damage the features of interest of Llynnoedd Cosmeston/Cosmeston Lakes SSSI. Before any of these operations are undertaken you must consult CCW, and may require our consent. **The list of operations is not a prohibited list.**

It is usually possible to carry out some of these operations in certain ways, or at specific times of year, or on certain parts of the SSSI, without damaging the features of interest. If you wish to carry out any of these activities please contact the local office of CCW. A Conservation Officer will give you advice and where appropriate issue a consent. Please help us by using the enclosed form to ask us for consent to carry out these operations.

In certain circumstances it will not be possible to consent these operations, because they would damage the features of interest. Where possible the Conservation Officer will suggest alternative ways in which you may proceed, which would enable a consent to be issued. To proceed without CCW's consent may constitute an offence. **If consent is refused, or conditions attached to it, which are not acceptable to you, you will be provided with details of how you may appeal to the National Assembly of Wales.**

Ref No	Type of operation
1.	Cultivation, including ploughing, rotovating, harrowing and re-seeding.
4.	Mowing or cutting vegetation.
5.	Application of manure, slurry, silage liquor, fertilisers and lime.
6.	Application of pesticides terrestrial and aquatic herbicides (weedkillers).
7.	Dumping, spreading or discharging of any materials.
9.	Release into the site of any wild, feral, captive-bred or domestic animal, plant, seed or micro-organism and any genetically modified organism.
11.	Destruction, displacement, removal or cutting of any plant or plant remains.
13b.	Modification to the structure of water courses including rivers, streams, springs, ditches, dykes, drains, including their banks and beds, as by re-alignment, regrading, damming or dredging.

13c. Management of aquatic and bank vegetation for drainage purposes

14. Alterations to water levels and tables and water utilisation including irrigation, storage and abstraction from existing water bodies and through boreholes. Also the modification of current drainage regime, (e.g. through the installation of new pumps).

15. Infilling or digging of ditches, dykes, drains, ponds, pools, marshes, quarries or pits.

16a. Freshwater fishery production and/or management, including sporting fishing and angling, the introduction of freshwater fishery production and/or management and alterations to freshwater fishery production and/or management.

20. Extraction of minerals including hard rock, sand and gravel, topsoil, subsoil and lime.

21. Destruction, construction, removal, rerouting, or regrading of roads, tracks, walls, fences, hardstands, banks, ditches or other earthworks, including soil and rock exposures.

22. Storage of materials.

23. Erection of permanent or temporary structures or the undertaking of engineering works, including drilling or the laying, maintenance or removal of pipelines and cables, above or below ground.

26. Use of vehicles, or craft likely to damage the qualifying features.

27. Recreational activities likely to damage the qualifying features.

Notes:

i. This is a list of operations appearing to the CCW to be likely to damage the special features of this SSSI, as required under section 28(4)(b) of the Wildlife and Countryside Act 1981 as substituted by Schedule 9 to the Countryside and Rights of Way Act 2000.

ii. Where an operation has been granted a consent, licence or permission from another authority separate consent will not normally be required from CCW, however you should always give notice to CCW prior to exercising such consent, licence or permission.

iii. Any reference to animal in this list shall be taken to include any mammal, reptile, amphibian, bird, fish or invertebrate (including honey bees).

APPENDIX II: DIVING RISK ASSESSMENT

DIVING RISK ASSESSMENT

The following is a standardised diving risk assessment (known as a diving project plan) in the format recommended by the HSE in the Scientific and Archaeological Approved Code of Practice (HSE, 1998). These are created by ourselves and are always updated for every new diving project. A diving project can be either a one-off visit to a particular site or a programme of dives over a number of years to revisit a location (*e.g.* for monitoring purposes). Changes in conditions and personnel are dealt with in the daily dive log and risk assessment which is completed just before and during the diving activities (appended to back of the project plan).

Diving Project Plan

To: Jennifer Jones (Scientific Diver), Alan Mildren (Underwater Videographer), Pamela Stockwell (Surface Support). **From:** Dr Siegbert Otto (Dive Supervisor).

Title of Project: **Starry Stonewort *Nitellopsis obtusa* Monitoring 2011 at Llynnoedd Cosmeston / Cosmeston Lakes SSSI**	
Date:	2 July & 12 August 2011
Location of diving operation:	Cosmeston Lakes (Vale of Glamorgan). Position of primary site (western lake): ST174690.
Diving Contractor:	Freshwater Diving Services
Diving Project Manager:	Dr Siegbert Otto
Names of Supervisors required (with Oxygen administration and 1st aid qualifications):	Dr Siegbert Otto
Names of Divers and qualifications:	Jennifer Jones (PADI Master Instructor & Oxygen Administration); Alan Mildren (BSAC Advanced Diver)
Names of other personnel required and their duties:	Pamela Stockwell (Surface Support)
Others:	N/A
Any other groups / persons to contact before diving ops take place.	Cosmeston Country Park
Decompression schedule	N/A
Equipment required:	Standard SCUBA; Polystyrene Float with mounted GPS (synchronised with video camera); underwater video camera; labelled sample bags; clipboard & pen
Emergency Oxygen equipment	An emergency O_2 kit is carried in the car. Both divers are familiar with its use.
Special kit requirements	No
Any special competencies required from any personnel:	No
Site specific details:	
Sea conditions anticipated:	N/A
Tidal conditions:	N/A
Transport to site:	By MPV

Anticipated minimum underwater visibility:	Unknown, but 4+ m anticipated as no pollution and / or algal blooms (lakes are fed by underwater springs).
Other hazards	Entanglement in macrophytes. **AVOID AREAS WITH ENTANGLEMENT HAZARDS!**
Pollution:	No
Depth:	≤ 6 m
Temperature:	Approximately 15+ ^{o}C
Access:	Entrance into water from shore; for western lake between ST17496897 and ST17326927.
Breathing gas:	Compressed Air (maximum 230 bar) from West Wales Diving School (Mathry)
In-water and surface communications requirements:	Standard dive sign language; oral communication also possible at surface, as very shallow depth.
Emergency Information	
Emergency procedures:	**ENSURE MOBILE PHONE COVERAGE!** Give immediate First Aid as required: *e.g*. resuscitation, oxygen, *etc*. **Contact emergency services on 999 or 112:** ➢ Give brief summary of the incident ➢ Give location and directions ➢ Stand-by for instructions
HM Coastguard No.	N/A
Chamber No.	London Diving Chamber (24-hour emergency) Tel: 07940 353 816 London Hyperbaric Medicine Ltd (24-hour emergency) Tel: 07740 251635 DDRC Plymouth, Plymouth Tel: 01752 209999
Duty Diving Medical Specialist HMS Nelson, Portsmouth	01705 818 888
Medical expertise:	Jennifer Jones, Alan Mildren and Siegbert Otto are all qualified as First Aiders.
Medical equipment:	First aid kit and O_2 kit in car.
Casualty evacuation plan:	Nearest ambulance pick up points on track surrounding all of the western lake. Evacuation to University Hospital of Wales, Heath Park, Cardiff CF14 4XN (Tel: 029 2074 7747); also possible by car (where appropriate).

DIVING OPERATIONS DAILY RISK ASSESSMENT & LOG

		Action required: Yes/no*
Geographical location		Date
Diving Project Manager / Contractor:	JNCC/EN/SNH/CCW/Other* Name:	
Shore/Vessel (name)*		Equipment used: SCUBA /Other*:
Breathing mixture: Air/Other*:		Stage decompression: Yes/no*
Decompression schedule used: Tables/Computers*(State types)		
Description of work / title of Diving Project		

Diving supervisors	Period of supervision	Signature(s)

Tidal information: (time of slack water/HW/LW etc.)

Special risks or changes to the Diving Project Plan which should be taken into account before diving ops take place (volunteer divers, personnel, qualifications, shipping movements etc.)		
Emergency Information		
Coastguard Area		
Coastguard telephone No.		
Nearest chamber checked operational?		
Diver first aid advice available from Duty Diving Medical Specialist, HMS Nelson, Portsmouth, Tel. 01705 818888		
Coastguard on Channel 16 or telephone 999		
Any emergency /incident: Yes/no*	Decompression sickness/illness/adverse effects: Yes/no*	Adverse environmental factors: Yes/no* / Equipment defects: Yes / no*
If 'yes' to any of the above, give details:		

Personnel			**Pre-dive checks**				**Dive times**			**Max depth**	**Decompression**
Divers / Standby	Boat	Super-visor	Air (wp/wc)	Equip. ok (✓)	Est. duration	Position	Leaving surface	Arrive surface	Total time		For (time) at (depth) Safety/Required (S or R) **Desaturation time**

APPENDIX III: INVASIVE NON-NATIVE SPECIES (INNS) INFORMATION

Brazilian watermilfoil *Myriophyllum aquaticum* is native to Central and South America and inhabits still or slowly flowing water. Emergent growth, blue-green colour and feather-like leaves make this a distinctive water plant. Present year round. Unlikely to be found in fast flowing water. Aquatic perennial, grows in emergent and submerged form. Both forms are similar in appearance. Most often found in nutrient rich waters. Grown in water gardens in UK since 1878, first recorded in the wild in 1960. Initial spread by improper disposal of garden and aquarium plants. Still found in some garden centres, often under one of its pseudonyms. Spreads by vegetative fragmentation, no seeds are produced in the UK. Causes flooding by blocking watercourses and drainage channels. Can rapidly dominate a water body displacing native species. Parrot's feather is listed under Schedule 9 to the Wildlife and Countryside Act 1981 (as amended) with respect to England, Wales and Scotland. As such, it is an offence to plant or otherwise allow this species to grow in the wild.

Elodea species are native to North America. They inhabit still or slow-flowing, shallow or deep water. There are two non-native species of Waterweed *Elodea* species in the UK, **Canadian waterweed *Elodea canadensis*** and **Nuttall's waterweed *Elodea nuttallii***. Both are aquatic, submerged (apart from tiny white flowers borne on very long threadlike stalks just above the water surface) growing up to 3 m in length, perennial and only reproduce vegetatively in the UK as all plants are female. Canadian waterweed, first recorded in Ireland in 1836 and in Britain in 1842, has subsequently spread rapidly and is now found commonly. It has disappeared from some areas, often being replaced by Nuttall's waterweed. Nuttall's waterweed is found in more nutrient-rich water than Canadian waterweed. First recorded as naturalised in Britain in 1966, it has since spread rapidly but is less common than Canadian waterweed in northern England, Scotland and Ireland. It is difficult to distinguish between these two species. Dense growth of these waterweeds in slow flowing rivers, drainage channels and canals can impede flow and exacerbate flooding. Replace native aquatic plant species and reduce biodiversity in lakes and ponds and interfere with recreational activities such as angling and boating. *Elodea* species are listed under Schedule 9 to the Wildlife and Countryside Act 1981 (as amended) with respect to England and Wales. As such, it is an offence to plant or otherwise allow these species to grow in the wild.

Zebra mussel *Dreissena polymorpha* is a freshwater mussel species with a distinctive striped colouration and shape. It is native to South-east Russia and is found almost everywhere, in slow rivers, canals, docks, lakes, reservoirs and sometimes water pipes and cooling systems. It inhabits a range of clean and well-oxygenated freshwaters but can tolerate weakly brackish waters. It attaches, usually in groups, by sticky threads known as byssus, to anything solid underwater such as masonry, stones, wooden posts, tree roots or shells. This attachment can block pipework, affect lock gates and other hard structures in the water. They can also significantly alter ecosystems by smothering native species and rapidly filtering out nutrients from the water. The growth of these colonies is similar to that of marine mussels. Zebra mussel is similar in shape to marine mussels but smaller in size (usually about 30 mm), has a distinctive 'D' shape and is ornamented with blue or brown and yellow-white alternating zig-zag or wavy bands. Its shell is asymmetrical, strong, thick and keeled. Its shell does not have teeth on its hinge. It can grow up to 50 mm long though much smaller specimens are often found (Figures 28). The Zebra mussel has a short-lived, free-living larval stage but it cannot easily be detected in the water and so only adult mussels can be used for identification.

The **Red-eared slider *Trachemys scripta elegans*** is a semi-aquatic turtle belonging to the family Emydidae. It is a subspecies of pond slider. It is the most popular pet turtle in the United States and also popular in the rest of the world since the 'Ninja' craze of the early 1990s. It is

native only to the southern United States, but has become established in other places because of pet releases and has become an invasive species in many introduced areas, like California, where it out-competes the native western pond turtle. Red-eared sliders get their name from the distinctive red patch of skin around their ears. The 'slider' part of its name comes from its ability to slide off rocks and logs and into the water quickly. Red-eared sliders are almost entirely aquatic, but leave the water to bask in the sun and lay eggs. These reptiles are deceptively fast and are also decent swimmers. They hunt for prey and will attempt to capture it when the opportunity presents itself. They are aware of predators and people, and generally shy away from them. The Red-eared slider is known to frantically slide off rocks and logs when approached. The female Red-eared slider grows to be 25–33 cm in length and males 20–25 cm. Contrary to popular misconception, Red-eared sliders do not have saliva. They, like most aquatic turtles, have fixed tongues, so they must eat their food in water. These terrapins have a very varied diet, including, not only fish, tadpoles, worms and insects, but also aquatic plants. They are also known to carry salmonella.

The **'Killer Shrimp'** ***Dikerogammarus villosus*** is a highly invasive shrimp, with only a few known populations in GB. It is native to South-east European and prefers still or flowing freshwater and brackish water, and is often found among hard surfaces or vegetation. A key ID feature is the presence of cone shaped protrusions on the tail. *D. villosus* is often larger than native freshwater shrimp species and sometimes with a striped appearance. It is a voracious predator, killing invertebrates and small fish. It quickly dominates habitats it invades and can significantly alter their ecology.

D. villosus is tolerant of poor water quality and can survive in damp conditions for up to five days. It could therefore be spread in ballast water and also by people on kit used in the water, including angling and SCUBA-diving gear, boats, kayaks and trailers. Of all the treatments tested by Stebbing *et al*. (2011), NaClO (at 50,000 ppm) was found to cause 100 % mortality within 4 minutes 20 seconds, FAM 30 (6 ml/l) within 3 minute and 10 seconds, Virkon S (1 % solution) within 7 minutes and 44 seconds and temperature (at 50°C) within less than 1 second. Carbonated water (saturated) caused narcosis in 100 % of animals within a few seconds of exposure. Due to various drawbacks in the use of NaClO, FAM 30 and Virkon S (*e.g*. health and safety, legal use) Cefas is unable to recommend these as treatments. Stebbing *et al.* (2011) make recommendations on the potential application of temperature and carbonated water as treatments, however, further research is required before these techniques can be fully realised as methods of control. Good biosecurity is essential and of utmost importance to reduce the risk of spread. As a non-resident species it could be an offence to release or allow the escape of this species into the wild.

APPENDIX IV: META DATA ARCHIVE

(a) HD Video Footage

DAY 1	02/07/11		DAY 2	12/08/11	
Video Clip Number	Time From	To	Video Clip Number	Time From	To
1	11:26:38	11:26:54	1	11:59:08	12:14:31
2	11:27:19	11:27:24	2	12:21:23	12:23:47
3	11:29:02	11:29:17	3	12:25:31	12:26:07
4	11:29:47	11:29:58	4	12:31:43	12:31:51
5	11:32:27	11:32:55	5	12:34:36	12:35:00
6	11:33:01	11:33:36	6	12:42:40	12:42:50
7	11:40:09	11:41:12	7	12:48:33	12:49:03
8	11:45:59	11:47:05	8	14:39:42	14:45:21
9	11:48:36	11:48:55	9	14:45:23	14:57:21
10	11:51:59	11:52:20	10	14:58:07	15:02:04
11	11:52:27	11:52:57	11	15:04:20	15:07:59
12	11:58:56	11:59:51	12	15:14:27	15:18:06
13	12:06:14	12:06:51	13	15:18:55	15:19:06
14	12:10:12	12:10:59	14	15:19:41	15:23:08
15	12:11:54	12:12:54	15	15:25:25	15:34:17
16	12:21:40	12:21:53	16	16:29:23	16:29:56
17	12:22:14	12:22:29	17	16:29:58	16:32:43
18	12:23:59	12:24:18	18	16:29:58	16:35:59
19	12:25:37	12:25:45	19	16:36:01	16:46:05
20	12:26:03	12:26:11	20	16:46:53	16:50:02
21	12:28:38	12:29:03	21	16:54:06	16:57:50
22	12:30:17	12:30:31	22	16:57:52	17:02:34
23	12:30:50	12:31:05	23	17:02:35	17:04:39
24	12:31:46	12:31:54	24	17:04:41	17:05:51
25	12:35:22	12:36:57		**TOTAL**	**01:36:22**
26	12:39:19	12:39:54			
27	12:42:43	12:43:43			
28	12:43:57	12:44:07			
29	12:44:19	12:44:45			
30	15:09:59	15:11:02			
31	15:11:37	15:12:21			
32	15:12:26	15:12:39			
33	15:12:53	15:13:11			
34	15:22:36	15:22:54			
35	15:35:33	15:35:59			
36	16:27:10	16:27:52			
37	16:28:26	16:28:36			
38	16:30:39	16:30:58			
	TOTAL	**00:21:14**			

(b) MapInfo Files

2011 SURVEY

DAY 1 (02/07/11)

2 July 11_Algae.DAT 2 July 11_Algae.ID 2 July 11_Algae.MAP 2 July 11_Algae.TAB	Locations of filamentous algae, algal mats and amorphous algal masses
2 July 11_Chara.DAT 2 July 11_Chara.ID 2 July 11_Chara.MAP 2 July 11_Chara.TAB	Locations of *Chara* spp.
2 July 11_Mud.DAT 2 July 11_Mud.ID 2 July 11_Mud.MAP 2 July 11_Mud.TAB	Locations of anoxic mud exposures
2 July 11_P pectinatus.DAT 2 July 11_P pectinatus.ID 2 July 11_P pectinatus.MAP 2 July 11_P pectinatus.TAB	Locations of *Potamogeton pectinatus*
GPS data 2 July 11.DAT GPS data 2 July 11.ID GPS data 2 July 11.MAP GPS data 2 July 11.TAB	All GPS positions

DAY 2 (12/08/11)

12 August 11_Algae.DAT 12 August 11_Algae.ID 12 August 11_Algae.MAP 12 August 11_Algae.TAB	Locations of filamentous algae, algal mats and amorphous algal masses
12 August 11_Chara.DAT 12 August 11_Chara.ID 12 August 11_Chara.MAP 12 August 11_Chara.TAB	Locations of *Chara* spp.
12 August 11_Elodea.DAT 12 August 11_Elodea.ID 12 August 11_Elodea.MAP 12 August 11_Elodea.TAB	Locations of *Elodea* spp.
12 August 11_M spicatum.DAT 12 August 11_M spicatum.ID 12 August 11_M spicatum.MAP 12 August 11_M spicatum.TAB	Locations of *Myriophyllum spicatum*
12 August 11_Mud.DAT 12 August 11_Mud.ID 12 August 11_Mud.MAP 12 August 11_Mud.TAB	Locations of anoxic mud exposures
12 August 11_N obtusa.DAT 12 August 11_N obtusa.ID 12 August 11_N obtusa.MAP 12 August 11_N obtusa.TAB	Locations of *Nitellopsis obtusa*
12 August 11_P pectinatus.DAT 12 August 11_P pectinatus.ID 12 August 11_P pectinatus.MAP 12 August 11_P pectinatus.TAB	Locations of *Potamogeton pectinatus*
GPS data 12 August 11.DAT GPS data 12 August 11.ID GPS data 12 August 11.MAP GPS data 12 August 11.TAB	All GPS positions

2007 SURVEY

Macrophyte map 2007.JPG Macrophyte map 2007.TAB	Geo-rectified map (Figure 3.7.5 from Burgess *et al*., 2009)
Bathymetry 2007.JPG Bathymetry 2007.TAB	Geo-rectified map (Figure 3.7.3 from Burgess *et al*., 2009)
2007_Transect 1.DAT 2007_Transect 1.ID 2007_Transect 1.MAP 2007_Transect 1.TAB	2007 Boat survey Transect 1 (Amy Burgess, ENSIS Ltd, pers. comm.)

Cosmeston Lakes, Penarth
L/EDP3861/EW/fj
29 September 2017

Enclosure EDP 2
Llynnoed Cosmeston/Cosmeston Lakes Site of Special Scientific Interest

LLYNNOEDD COSMESTON/COSMESTON LAKES
SITE OF SPECIAL SCIENTIFIC INTEREST

YOUR SPECIAL SITE AND ITS FUTURE

‘Your Special Site and its Future’ is part of our commitment to improve the way we work with SSSI owners and occupiers. In it, we try to explain what is special about the wildlife on your site, and what care is needed to look after it into the future.

All SSSI are considered to be of national importance and we recognise the crucial role that owners and occupiers play in their management and protection. We need you to share your views and knowledge of this site with us, to help safeguard it.

We hope that you will find ‘Your Special Site and its Future’ interesting and helpful. Please contact us if there is anything about the site and its management that you would like to discuss.

What is 'special' about the wildlife at Llynnoedd Cosmeston/Cosmeston Lakes SSSI?

In the course of its history, Cosmeston Park has been an industrial site as well as a dump for rubbish from nearby Cardiff. However, sensitive management of the site as a country park has transformed it into an oasis for wildlife, and parts of the park became a Site of Special Scientific Interest in 1985. It has one special feature:

- **Starry Stonewort**

The lakes at Cosmeston are the only place in Wales where starry stonewort is found. Stoneworts are green algae, although in structure they superficially resemble vascular plants. This particular species can grow up to 60cm long, and is usually found in clear, deep lakes with calcareous (chalky) waters, growing at depths of between 1 and 6 metres. The stonewort has whorls of narrow leaf-like branches along its length, and tiny starry bulbils, clusters of starch-filled cells, along the lower parts of the stem.

It is able to withstand low light conditions, but is less tolerant of turbulence. Generally, it is regarded as a summer annual, but in mild winters it may not fully die back. Spores are rarely produced, but where it does occur, spore production probably takes place from July to September and is controlled by light levels. Spread of the species is mainly through means of small, star-shaped bulbils occurring on the lower parts of the stem. These fall off and remain viable for several years, eventually growing into new stoneworts.

In the UK, starry stonewort has its stronghold in the Norfolk Broads, where it is present on two remaining sites. There are also a few records from southern England. Since most sites are close to the sea, it is possible that starry stonewort prefers slightly brackish (salty) water.

In addition, Llynnoedd Cosmeston/Cosmeston Lakes also has areas of grassland, ponds and swamp. Together with other habitats within the country park, they add to the interest of the SSSI and make Cosmeston Lakes Country Park one of the most ecologically diverse areas for its size in this part of Wales.

What do we want Llynnoedd Cosmeston/Cosmeston Lakes to look like?

The following is a description of how we would like to see the future of Llynnoedd Cosmeston/Cosmeston Lakes:

Llynnoedd Cosmeston/Cosmeston Lakes are very unusual water bodies: deep, with a high alkalinity, yet relatively rich in nutrients. The lakes support a range of plant species that specialise in this unusual habitat, including fennel pondweed, horned pondweed and lesser pondweed.

Llynnoedd Cosmeston/Cosmeston Lakes continue to support a thriving population of starry stonewort. This may be difficult to see without specialist survey effort, because the alga grows in deep water and does not float when cut.

There are no signs of pollution in the lakes or disturbance that might uproot the stonewort. The surrounding catchment area of grasslands, streams, ponds and swamp are unpolluted, ensuring that the water quality in the lakes remains suitable for starry stonewort and other freshwater plants.

What management is needed on Llynnoedd Cosmeston/Cosmeston Lakes SSSI and why?

The importance of Cosmeston as a resource for wildlife and as a site for recreation means that the competing needs of the park's users need to be carefully balanced against the importance of maintaining the special feature of the SSSI. This site will only remain in good condition if this balance can be maintained, and it is the CCW's priority to work with you to ensure that this happens.

What does this mean in practice?

These are the factors that we think are the most important:

- Pollution

Starry stonewort requires clear, unpolluted water. The biggest threat to starry stonewort at Cosmeston is likely to be pollution from within the park or agricultural run-off. An increase in phosphates and nitrates would be damaging to the plant in two ways. Firstly, the plant requires low nutrient calcareous water and secondly, high nutrients can encourage algal blooms that can make the water more turbid, and prevent the stonewort from photosynthesizing in deep water.

- Nutrient Enrichment

There is a potential threat from nutrient enrichment arising from use of the lakes by excessive numbers of waterfowl. Nutrient levels should be monitored.

- Disturbance

The rhizoids, which are colourless, hair-like filaments that anchor the starry stonewort to its substrate, can be easily disturbed. Disturbance by the behaviour of certain species of bottom feeding fish could cause damage.

Use of boats on the western lake could cause damage to the feature. Boating and other recreational use of the eastern lake will be allowed to continue under the carefully controlled conditions currently in place, but boating or recreational use of the western lake should be avoided.

Finally

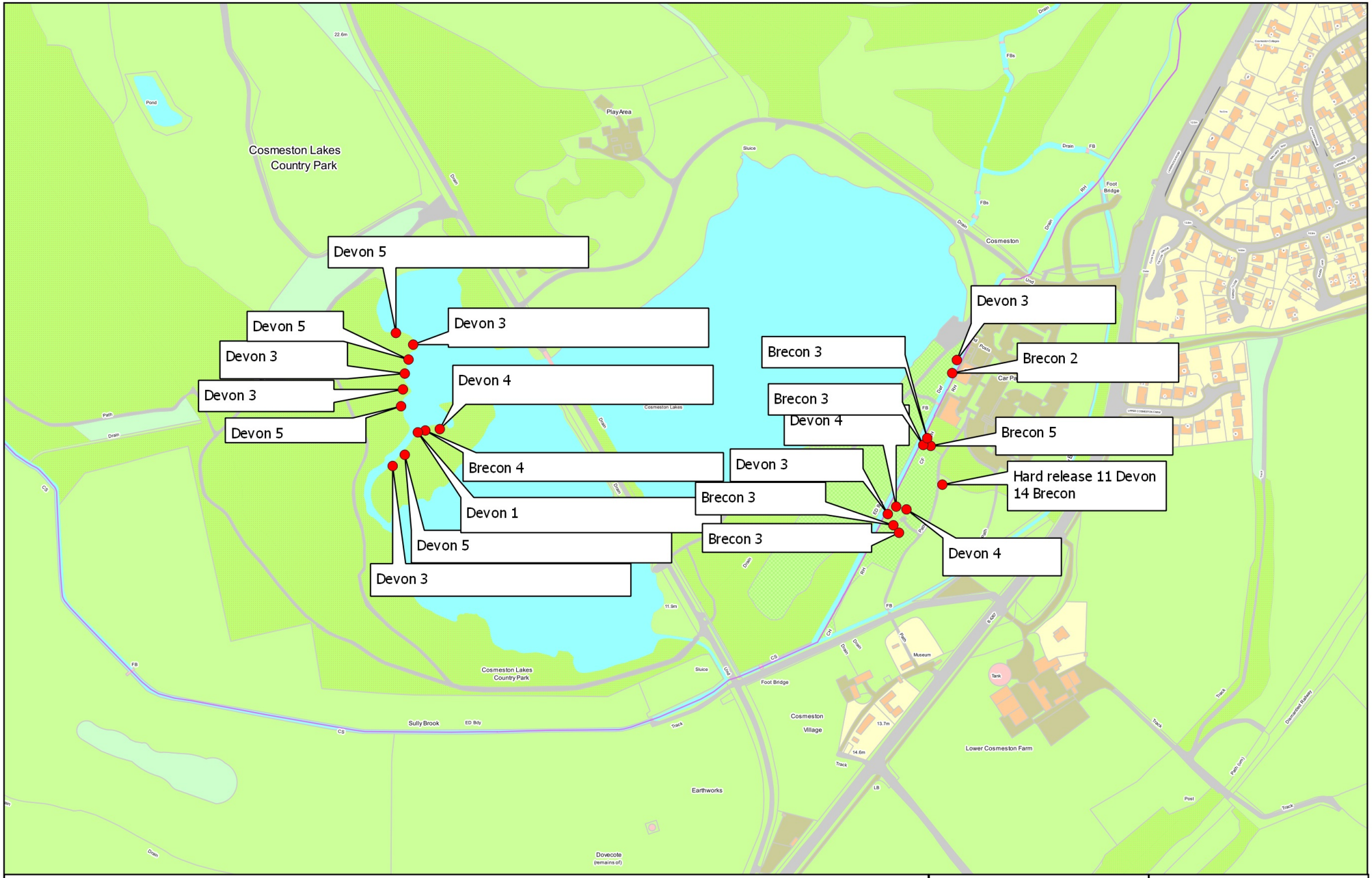
Our knowledge and understanding of wildlife is continually improving. It is possible that new issues may arise in the future, whilst other issues may disappear. This statement is written with the best information we have now, but may have to change in the future as our understanding improves. Any information you can provide on the wildlife of your site, its management and its conservation would be much appreciated.

If you would like to discuss any aspect of your SSSI, or have any concerns about your SSSI, please contact your local CCW office.

Your local office is:
Countryside Council for Wales,
Unit 7,
Castleton Court,
Fortran Road,
St Mellon's,
Cardiff,
CF3 0LT
Telephone: 029 2077 2400
Fax: 029 2077 2412

Cosmeston Lakes, Penarth
L/EDP3861/EW/fj
29 September 2017

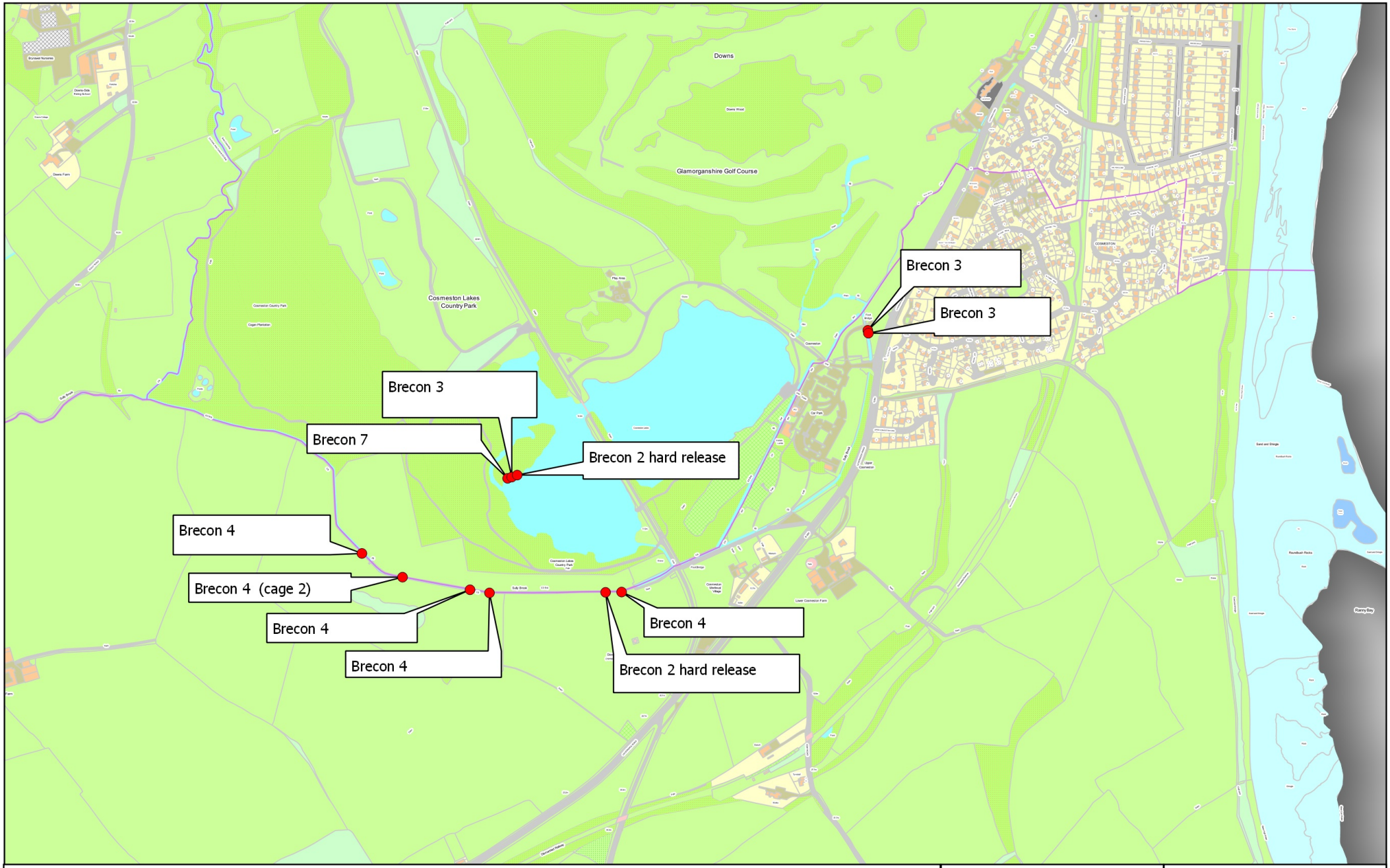
Enclosure EDP 3
Water Vole release 20, 22 June and 11, 26 July 2017



Water Vole Relaese June 20th, 22nd and July 11

11 July 2017

1:4,380



Water Vole release 26th July 2017

27 July 2017

1:8,761