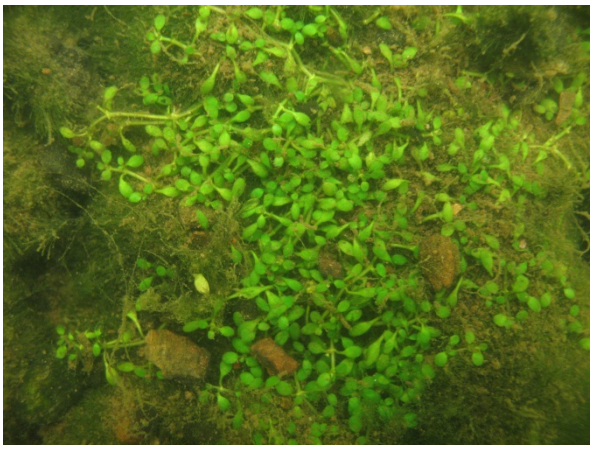
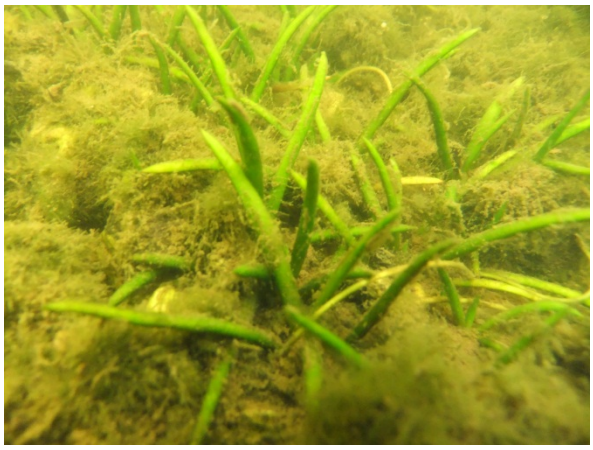
Loe Pool SSSI Macrophyte Monitoring 2014

Quantitative survey of four permanent transects


Report Date: November 2014
Author: Dr Jan Dinsdale

Survey Dates: 12 & 15 September 2014

Dive contractor: Kennack Diving

Ecologist: Dr Jan Dinsdale

NATURAL ENGLAND

National Trust

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Acknowledgements

Thanks to Rebecca Morton-Clarke for survey assistance;
David Roberts, Des Glover and Chris Cattlin of Kennack Diving who carried out scuba-dive survey work;
Rob Hunt, National Trust, for digital mapping;
Adrian Eggett of Time and Light Photography for images;
Nick Stewart, independent aquatic plant surveyor, for discussion and guidance on survey methodologies and long-term management aims to benefit Loe Pool macrophyte communities.

Executive Summary

This report details macrophyte survey work undertaken by Dr Jan Dinsdale, Independent Ecological Consultant, and Kennack Diving in September 2014. The work was carried out on behalf of the National Trust and funded by Natural England's Conservation Enhancement Scheme (CES).

Loe Pool Site of Special Scientific Interest (SSSI) in Southwest Cornwall, is currently eutrophic and in unfavourable condition. The Loe fails to meet Natural England's conservation objectives due to the Lake's elevated nutrient status and poor macrophyte community composition.

A boat-based grapnel survey along fourteen fixed-location transects has been undertaken on a regular basis in Loe Pool since 1998. This semi-quantitative method is effective for monitoring the abundance and distribution of large deep-water macrophytes but does not provide data on the population fluctuations of the inundation plant community, which currently comprises three diminutive species: Shoreweed *Littorella uniflora*, Needle Spike Rush *Eleocharis acicularis* and Six-stamened Waterwort *Elatine hexandra*.

In 2012, four new permanent transects were set-up on the lake's shallow-shelving shores in order to permit repeated quantitative recording of this inundation plant community at a more appropriate scale. A baseline survey of these four transects was undertaken in 2012 using a bathyscope to survey to 1.0m water depth. This 2014 survey is the first repeat of the 2012 survey; on this occasion we surveyed to 1.2m water depth, using scuba-divers in the deeper water quadrats.
In both 2012 and 2014, the macrophyte abundance data showed a distinct community zonation, with Shoreweed more frequent in the shallows to a depth of 0.3m and Six-stamened Waterwort found in deeper water, 0.5m-0.6m. Needle Spike Rush, occurs across the full range of both other species. The abundance of Shoreweed, Needle Spike Rush and Six-stamened Waterwort declined across all four transects in 2014 when compared to 2012. In 2014, Cladophora type algae was very abundant across all four transects on both sandy and stony substrates.

This non-destructive, quantitative surveying of the four permanent transects is to be undertaken biannually, with the next survey in 2016. Scuba-diving is not recommended in 2016, due to the habitat disturbance caused along the permanent transect by this method. Use of the bathyscope alone will be sufficient; trial snorkelling is also recommended in order to confirm plant abundance at depths greater than 1.0m while keeping habitat disturbance to a minimum.

Successful lake rehabilitation from a eutrophic algal dominated condition relies heavily upon the re-establishment of submerged vegetation. It is critical that the Loe Pool Forum continues to take a collaborative multi-agency approach to addressing external sources of nutrients and sediment to the Lake. Alongside this catchment approach, in-lake management options may be required to help 'kick-start' the growth of macrophytes within Loe Pool. Further assessment of these potential management options is required; the 2014 CES-funded fish survey (ECON Ltd, in prep) and the fish management plan proposed for 2015 will provide information on the suitability of fish biomanipulation options for Loe Pool. The adoption of a water level management regime that provides an extensive seasonal drawdown zone around the margins of the Pool and control of Willow *Salix* scrub along southern shores of the lake's Carminowe Creek are recommended.

1. Introduction

1.1 Loe Pool Site of Special Scientific Interest

Loe Pool is located within the National Trust's Penrose Estate near Helston, Southwest Cornwall SW649247. The Loe is the largest natural freshwater lagoon in Cornwall. The Site of Special Scientific Interest (SSSI) extends over 122 ha, and includes: The lake with an area of 56 ha, a coastal shingle bar and other associated wetland and coastal habitats. The Loe provides a winter refuge for nearly 80 species of wildfowl including high counts of Shoveler *Anas clypeata*, Pochard *Aythya farina* and Tufted Duck *Aythya fuligula*. The coastal shingle bar that separates the Loe from the sea is of importance for geomorphology, flora and fauna; it is the only known British site for the Cornish subspecies of the Sandhill Rustic Moth *Luperina nickerlii leechi*.

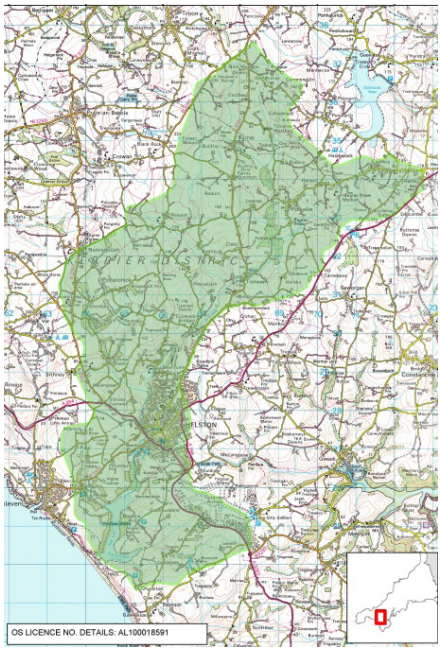
The condition of the standing open water habitat at Loe Pool SSSI is currently defined as unfavourable (no change) with targets not met for, amongst other things, macrophyte community composition and structure (Natural England, 2010; see *Appendix 1* for further information). Other relevant SSSI information is provided in *Appendix 1* of this report.

Photo 1: The Loe (National Trust)

1.2 Addressing water quality at the catchment scale

Loe Pool has suffered from the effects of elevated nutrient levels, eutrophication, and excess silt deposition over many decades (Wilson and Dinsdale, 1998; Dinsdale 2003; Dinsdale, 2009). The Loe Pool Forum continues to take a collaborative multi-agency approach to addressing external sources of nutrients and sediment to the Lake. The Forum's Catchment Group (which includes representatives from Natural England, the Environment Agency, South West Water, Cornwall

Wildlife Trust and the Rural Payments Agency) is working to deliver an integrated programme of regulation, advice and capital grant incentives, at the catchment scale, in order to bring about the necessary improvements in water quality for the Lake (Clitherow and Dinsdale, 2014).



The SSSI target condition is for a mean annual total phosphorus concentration less than 20µg P l^{-1} (*Appendix 1*). In-lake total phosphorus concentrations have reduced by 75% since 2000 (Dinsdale, 2009). This huge improvement in water quality can largely be attributed to the installation of tertiary phosphorus stripping at South West Water's Helston Waste Water Treatment Works. With current in-lake phosphorus levels stabilised at around 80µg P l^{-1} (EA unpublished data), the Loe Pool Forum continue to work towards further reductions in nutrient inputs from both point and diffuse sources, including: phosphorus stripping at RNAS Culdrose Waste Water Treatment Works which was installed in October 2014; and a South West Water Upstream Thinking catchment intervention project programmed for April 2015-March 2020.

1.3 Aim of the survey

The aim of this survey is to continue to build a long-term record of the changes to the distribution and abundance of the Lake's inundation community with water depth and over time.

2. Methodology

A quantitative macrophyte monitoring programme was initiated at Loe Pool in 2012. This survey method is based on permanent transects and was chosen to provide a more accurate and non-destructive method of searching for plant growth within the inundation communities, when compared to the long-established Loe boat and grapnel survey which commenced in 1997. The Loe Pool Forum aims to undertake this quantitative survey of four permanent transects biannually, on alternate years to the boat and grapnel survey of lakes deep water plant communities.

This quantitative permanent transect survey aims to:

i. Provide a long-term monitoring technique suitable for the inundation plant community
ii. Quantitatively record changes in plant abundance with water depth and over time.

The locations of the four permanent transects were selected systematically, based on the qualitative observations of the 2012 dive survey (Dinsdale, 2012). In 2012, the location of each transect was chosen with an aim to fulfil the following criteria:

- To sample existing inundation communities and, ideally with representations each of the three inundation species (Needle Spike Rush, Six-stamened Waterwort and Shoreweed)
- To represent the full geographic range of the community around the lake margins
- To represent the widest range of shore profiles, i.e. steeply sloping to shallow

Each transect was positioned perpendicular to the shore, in order to sample a linear transition from the shore out into deep water. The location of the four permanent transects are shown on Figure 1 and the 10-figure grid references to locate each of the transects are as follows:

- Transect 1: Carminowe Creek north shore (SW652322432-SW6523324320)
- Transect 2: Carminowe Creek south shore (SW6520024211-SW6519124220)
- Transect 3: Pentire Point (SW6474824347-SW6473824339)
- Transect 4: Penrose Inlet (SW6460925571-SW6473824339)

The botanical survey of these permanent transects were first undertaken in September 2012 and this survey was a repeat of that baseline, carried out on 13th and 15st September, 2014. A September survey date was chosen to coincide with the timing of the boat and grapnel survey, a date originally selected as all current species of the inundation community are in a vegetative state at this time and also the risk of poor water clarity due to algal blooms is low. A Garmin GPS was used to relocate the position of each permanent transect and at this site operated with an accuracy of ±1.0m.

For the duration of the survey, a weighted rope was used to indicate the location of the transects. A 0.5m x 0.5m quadrat was positioned along the linear transect, with sampling either side of the rope to record a continuous belt transect of 1.0m in width.

The 0.5m x 0.5m quadrat size was chosen as the most appropriate sampling scale, based on:

- The scale of individual plants to be sampled
- The distribution pattern of inundation plant communities to be sampled
- The benthic area visible through the bathyscope.

The DOMIN scale	
10	= 91-100% cover
9	= 76-90% cover
8	= 51-75% cover
7	= 34-50% cover
6	= 26-33% cover
5	= 11-25% cover
4	= 4-10 % cover
3	<4% many individuals
2	<4% several individuals
1	<4% few individuals

Vegetative cover for individual species in each 0.5m x 0.5m quadrat was recorded quantitatively using the DOMIN scale. Periodic checks and comparisons were carried out between the two surveyors (Dr Jan Dinsdale, Ecologist and Rebecca Morton-Clarke, Assistant) conferring on cover estimates to ensure consistency of recording. The depth of water was measured at 0.5m intervals using a metre rule.

Photo 2: Permanent transect survey equipment: Bathyscope, 0.5m quadrat and weighted rope
(Jan Dinsdale)

Photo 3: Surveying with bathyscope. Wearing a dry suit was very useful when surveying the deep end of the transects
(Jan Dinsdale)

The 2012 survey found that, using the bathyscope, it was difficult to accurately record plant abundance in water depths in excess of 1m due to poor visibility and poor light penetration. In 2014, we trialled the use of scuba-diving to assess plant abundance in deeper water. Diving was only employed for Transect 3, Pentire Point. Bathyscope observations were sufficient to see the full extent of the plant communities along the other three transects.

A team of three qualified scuba-diving staff (David Roberts, Des Glover and Chris Cattlin) surveyed the quadrats along Transect 3 that were located at water depths beyond 1m depth. Plant identification assistance was provided by the project ecologist, who remained on the shore. The diver's entry into the lake was from the shore (Photo 4). Divers worked in buddy

pairs at all times to comply with The Diving at Works Regulations 1997 (HSE 1997) and a third team member floated on the surface (Photo 5). A Diving Risk Assessment was produced prior to the dive operations in accordance with the Scientific and Archaeological Approved Code of Practice (HSE, 1998) (*Appendix 2*).

Photo 4: Kennack Divers preparing to enter Loe Pool from the shore to commence the Pentire Point dive
(Adrian Eggett)

Photo 5: Divers surface from undertaking the transect survey at Pentire Point
(Adrian Eggett)

Visibility was extremely poor during the 2014 survey, less than 0.5m. Divers needed to be within 0.3m of the lake floor, in order to carry out a thorough search for macrophytes rooted within the quadrat. Any contact with the lake's unstable benthic sediments rapidly reduced visibility to 0.0m. The need for accurate and careful movement underwater combined with poor visibility made the scuba-divers progress very slow at times, and inevitably resulted in significant disturbance of the benthic sediments.

National Trust

Property: Penrose

Title: Figure 1: Loe Pool Inundation Community Bathyscope

Transect Locations

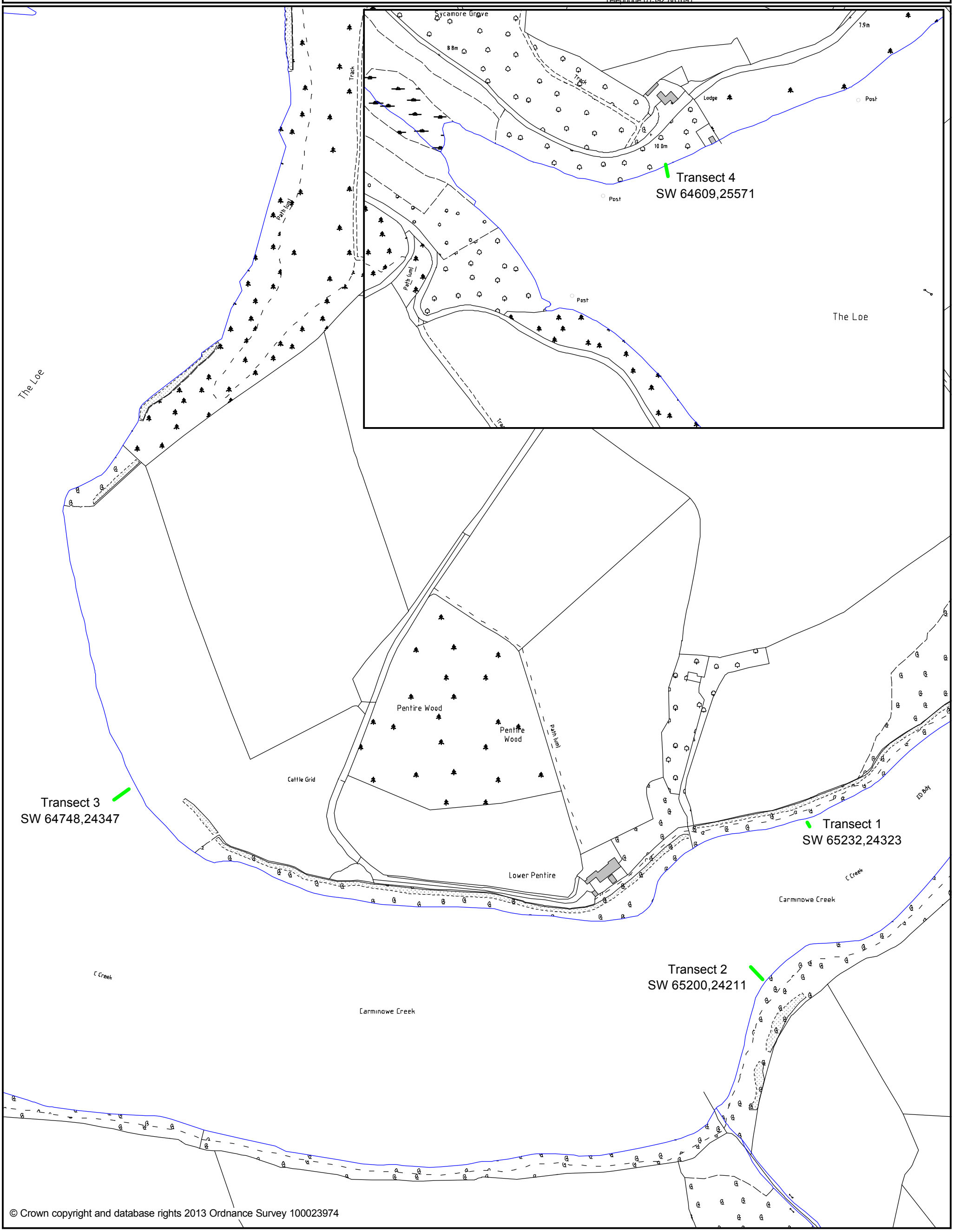
Scale: 1:2500 @ A3

Grid Ref: SW647250

Date: 04/02/2013

Filename: loe pool perm transects

South West: Exeter Consultancy Hub
Killerton House, Broadclyst, Exeter, Devon EX5 3LE
Telephone 01392 881691



3. Results

The 2014 quantitative survey results of the four permanent transects are shown in Figure 2 below and, for comparison, the 2012 results follow in Figure 3.

All three aquatic plant species recorded in 2012, Shoreweed, Needle Spike Rush and Six-stamened Waterwort were present in the quadrats in 2014. These three species frequently occurred together in Loe Pool on sandy and stony substrates in shallow water depths, up to 0.7m. They did not extend into deeper water or onto the mobile silts. Shoreweed alone was also recorded in areas of larger cobbles.

In many areas of the lake shore a community zonation is present, with Shoreweed more frequent in the shallows to a depth of 0.3m and Six-stamened Waterwort found in deeper water, 0.5m-0.6m. Needle Spike Rush, occurs across the full range of both other species.

The abundance of Shoreweed, Needle Spike Rush and Six-stamened Waterwort declined across all four transects in 2014 when compared to 2012. All three species were lost from Transect 1 and the abundance of each of the three species declined in Transect 2. Transect 3 exhibited the most stability in the plant community between 2012 and 2014; retaining all 3 species with an increase in the abundance of Shoreweed and a corresponding decrease in Needle Spike Rush in the lake's seasonally dry drawdown zone. Shoreweed was absent from Transect 4 in both 2012 and 2014; the abundance of both Needle Spike Rush and Six-stamened Waterwort declined between 2012 and 2014 along this transect

Cladophora type algae was abundant across all four transects on both sandy and stony substrates (Photos 6 and 7).

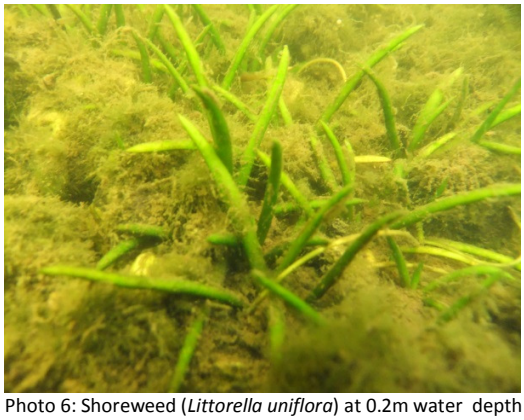


Photo 6: Shoreweed (*Littorella uniflora*) at 0.2m water depth on stony substrate clothed in algae
(Des Glover)

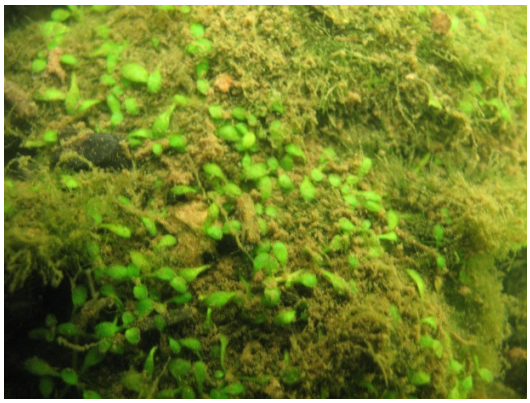
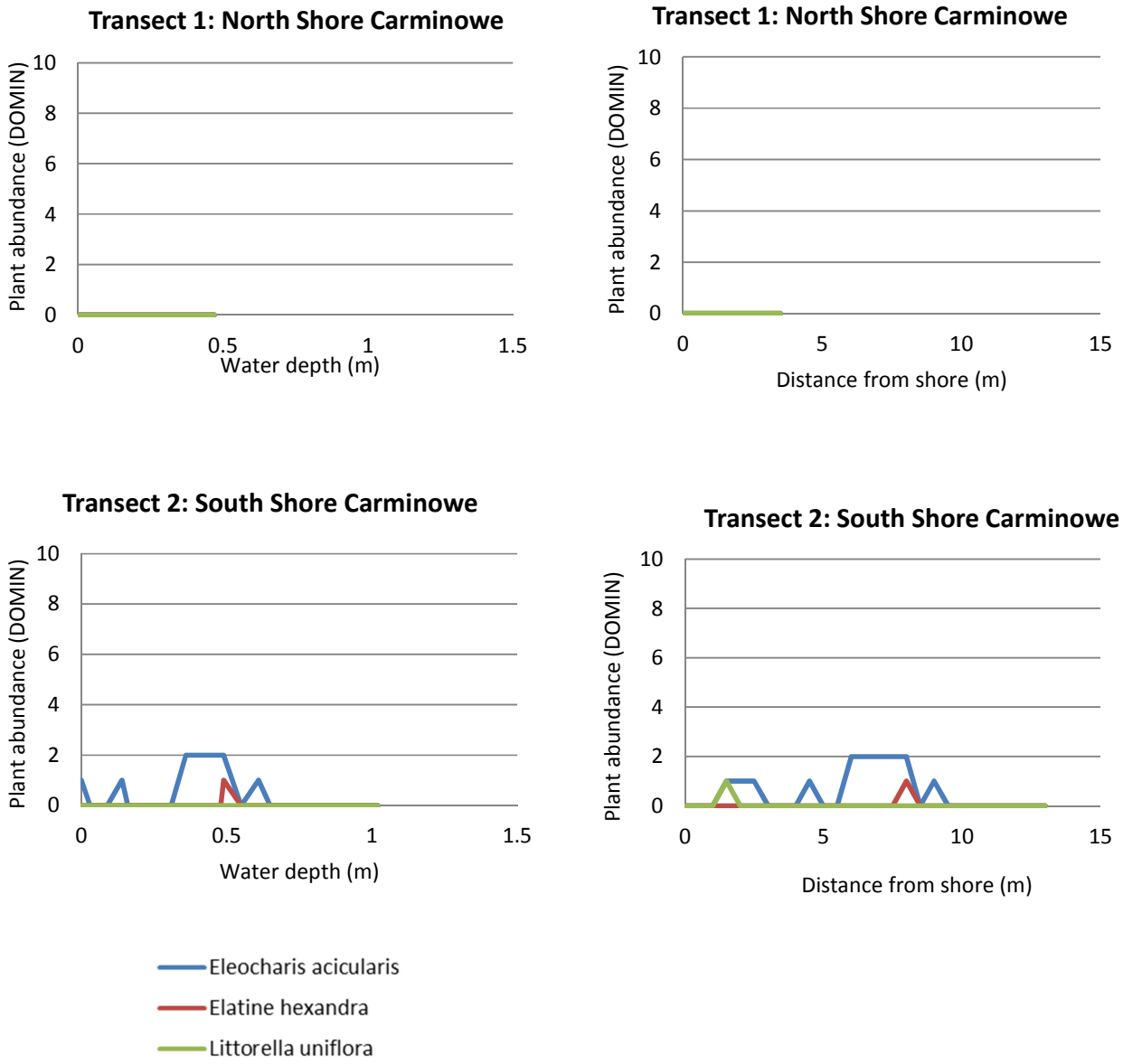
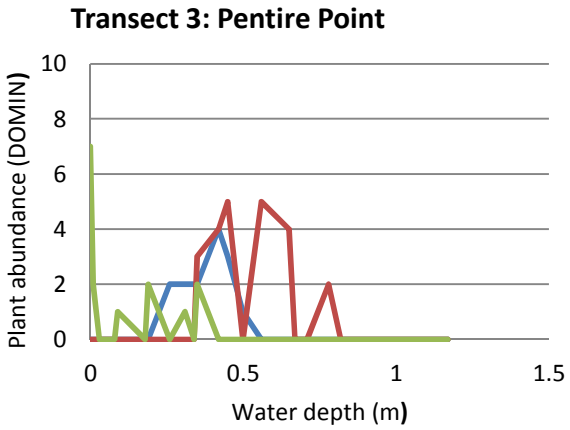
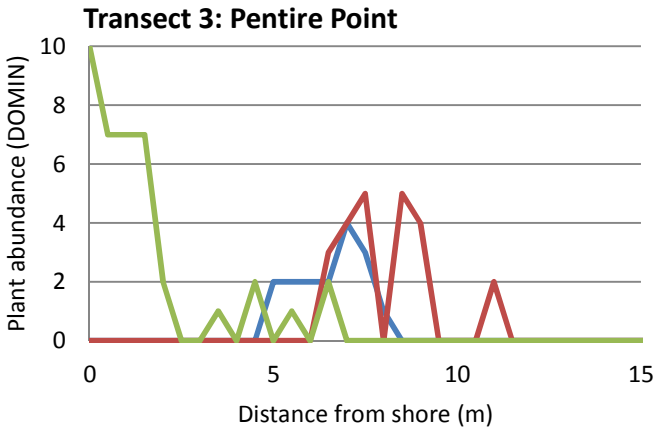


Photo 7: Six-stamened waterwort (*Elatine hexandra*) at 0.6m water depth on stony substrate clothed in algae
(Des Glover)

Figure 2: Variation of species abundance within the inundation community with water depth and distance from shore along four transects within Loe Pool SSSI, September 2014




Transect 3: Pentire Point
Plant abundance (DOMIN)
10
8
6
4
2
0
0
0.5
1
1.5
Water depth (m)


Transect 3: Pentire Point
Plant abundance (DOMIN)
10
8
6
4
2
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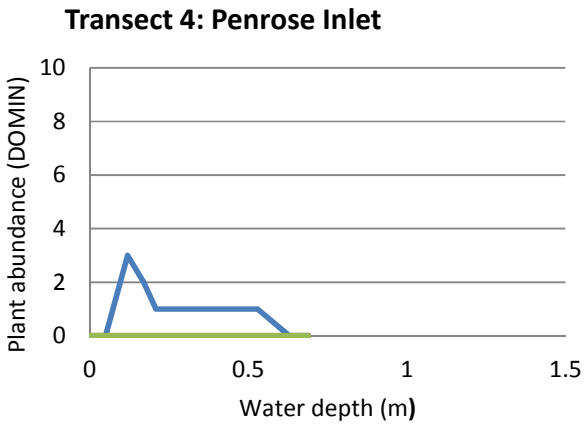
0
5
10
15
Distance from shore (m)


Transect 4: Penrose Inlet
Plant abundance (DOMIN)
10
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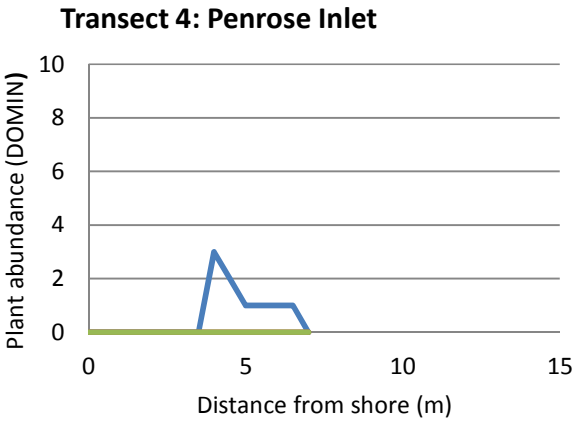
6
4
2
0
0
0.5
1
1.5
Water depth (m)


Transect 4: Penrose Inlet
Plant abundance (DOMIN)
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8
6
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2
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0
5
10
15
Distance from shore (m)

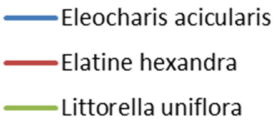
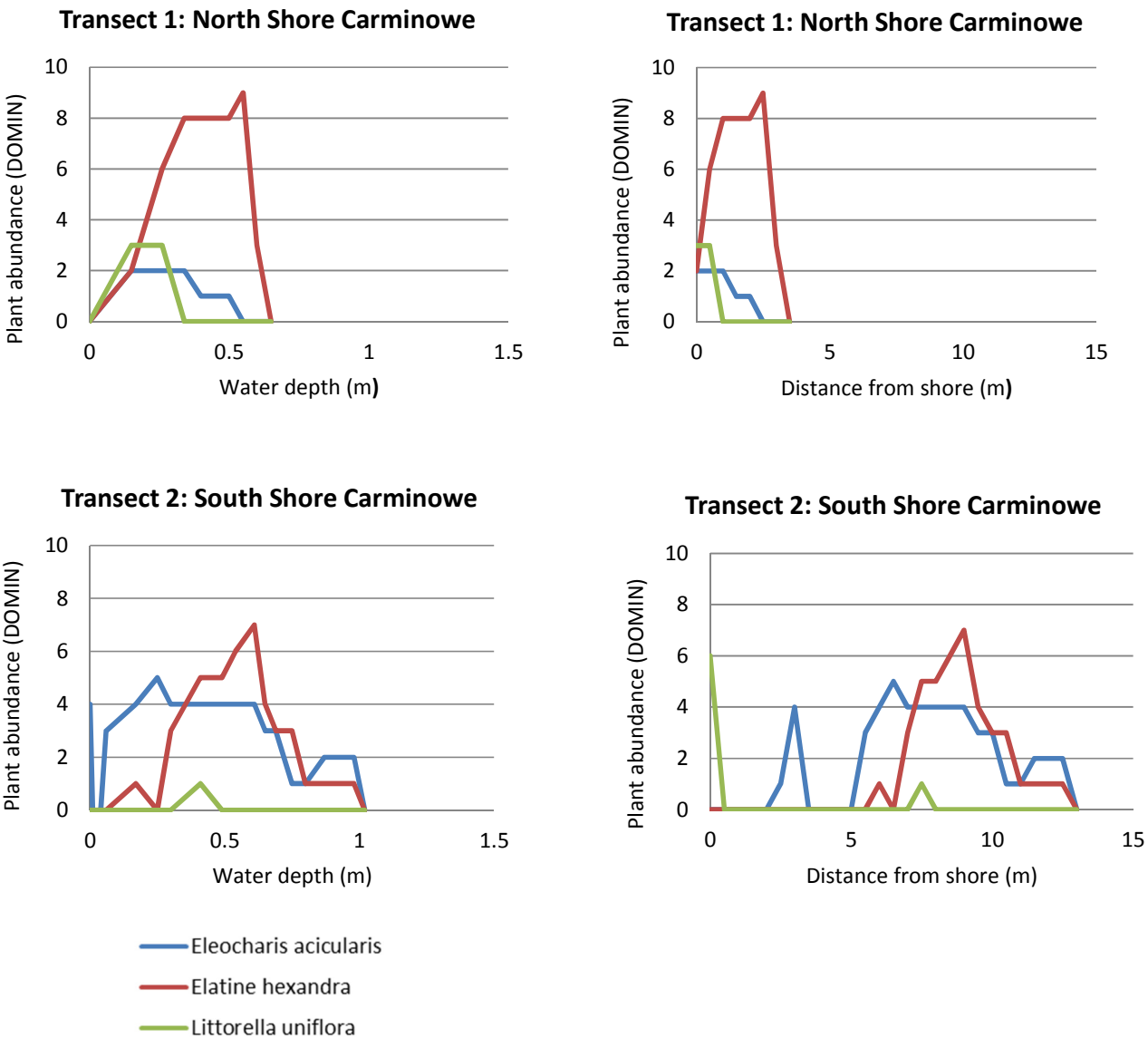
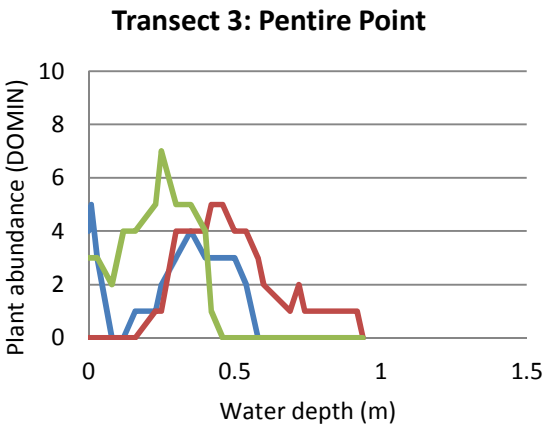

Eleocharis acicularis
Elatine hexandra
Littorella uniflora

Figure 3: Variation of species abundance within the inundation community with water depth and distance from shore along four transects within Loe Pool SSSI, September 2012




Transect 3: Pentire Point
Plant abundance (DOMIN)
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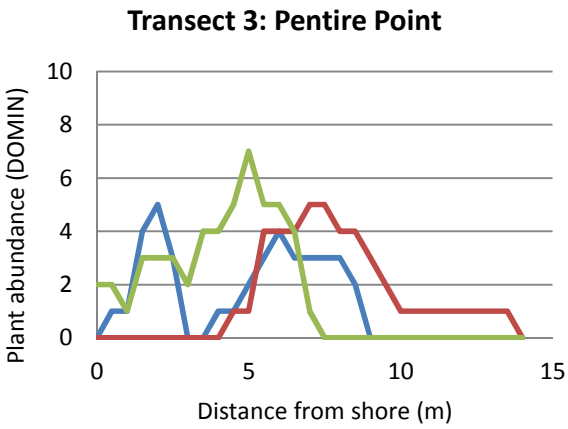
1
1.5
Water depth (m)


Transect 3: Pentire Point
Plant abundance (DOMIN)
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2
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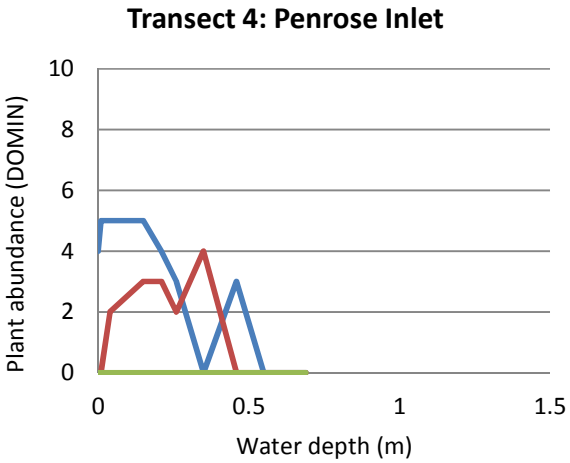
10
15
Distance from shore (m)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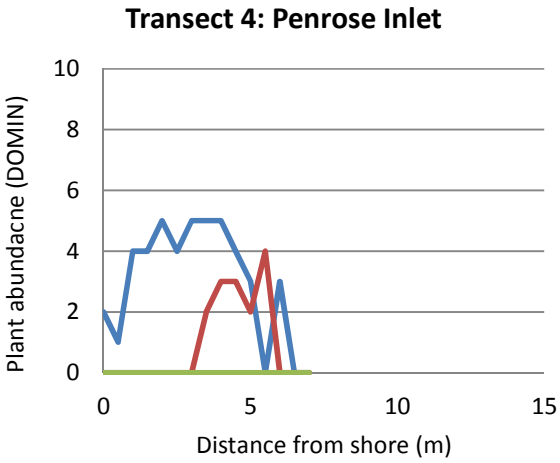
1.5
Water depth (m)


Transect 4: Penrose Inlet
Plant abundacne (DOMIN)
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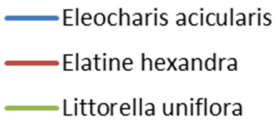
Distance from shore (m)


Eleocharis acicularis
Elatine hexandra
Littorella uniflora

4. Lake and Catchment Management Recommendations

This section outlines recommendations for further survey work and for management, both within the SSSI and across the catchment, based on the findings of the 2014 macrophyte survey.

4.1 A catchment based approach

The work of the Loe Pool Forum to reduce both sediment and nutrient inputs from diffuse and *point* sources across the Lake's catchment is considered to be critical to the successful rehabilitation of Loe Pool. In particular, the work of the Loe Pool Catchment Group to reduce nutrient inputs from the two water treatment works within the catchment and to address agricultural inputs through farm advisory and grant assistance continues to be invaluable (Clitherow and Dinsdale, 2014).

4.2 In-lake management

Delivery of improvements to water quality and sediment inputs towards the SSSI target levels may alone, in time, provide the required conditions for recovery of the macrophyte communities in order to meet the SSSI conservation objectives listed in *Appendix 1*. Great progress towards these macrophyte conservation objectives has been seen to date with a huge reduction in phosphorus inputs, a decline in algal blooms and corresponding improvement in water clarity. The absence or very low abundance of non-native plant species is also favourable, but the extent of established submerged vegetation remains very low.

In terms of the Lake's broader ecology, successful lake rehabilitation from a eutrophic algal dominated condition relies heavily upon the re-establishment of under-water vegetation. The importance of extensive beds of submerged vegetation for water clarity, and the numerous mechanisms by which rooted vegetation exerts positive effects on the lake rehabilitation process, are well documented (Moss, 1990; Jeppesen *et al*., 1990; Meijer, 2000; Jeppesen, 1998; Phillips, 2005). It is therefore worth considering in-lake management techniques which could 'kick-start' the growth of macrophytes within Loe Pool. The options available could include:

- biomanipulation of the Lake's fish communities
- exclusion of wildfowl from discrete areas to improve plant establishment
- disturbance of the shore sediments to stimulate emergence of plants from the seed bed

Each of these options would require in-situ trials before being undertaken as a management measure within the SSSI. A CES funded fish assessment is being undertaken at Loe Pool and survey work was completed in October 2014 (ECON Ltd, in prep). This fish survey and a successive fish management plan, proposed for 2015, will provide further information on the current status of the Loe fish community and the suitability of fish biomanipulation options.

One management recommendation that can be considered immediately is the delivery of a new water level management regime. Ensuring a summer-draw down within the lake will improve habitat conditions for the inundation plant community and will bring additional benefits for the establishment of deep-water macrophytes and, potentially, wider water quality benefits for the Lake.

The conservation objective for Loe Pool SSSI includes that 'There should be a **'natural'** hydrological regime' (Natural England, 2010). The water level within the lake is currently set at a constant level of 3.05mAOD at the outlet structure at Loe Bar. This water level management is an informal agreement between Natural England and the Environment Agency.

A wholly 'natural' lake hydrology is considered unrealistic since:

- Water levels in Loe Pool have been artificially controlled for over 200 years (Wilson and Dinsdale, 1998)
- The current water level regime is controlled using an engineered outlet structure at Loe Bar.
- The town of Helston has a history of high flood risk linked to water levels within the lake.

Perhaps then, rather than a 'natural lake hydrology', it would be more appropriate to set an objective to deliver 'a hydrological regime that best serves both the lake's ecology and flood risk management' (Lister and Dinsdale, 2014).

Historic shoreline flora data strongly indicate the presence of a summer drawdown zone at Loe Pool (Stewart, 2000). An increased summer drawdown zone would improve both the extent and quality of habitat for the inundation plant community: Six-stamened Waterwort, for example, does not flower beneath the water (Stace, 1997); Shoreweed can tolerate extreme inter-annual fluctuations in water levels and long periods of exposure (Natural England, 2010). Generative reproduction occurs during dry periods, on the emerging sediments or in extremely shallow water (Brouwer *et al*., 2002). Additionally, periodic emergence of the sediment of shallow lakes stimulates germination from the seed bank (Brouwer *et al*., 1999). Most softwater macrophytes produce long-lived seeds and re-establishment from the seed bank often occurs in large amounts (Bellemakers *et al*., 1996).

Seasonally fluctuating water levels would also bring wider ecological benefits for the Loe. Deep-water macrophytes are very poorly represented in the lake (Dinsdale, 2012; 2013). Reduced water depths during the summer months would allow more light to reach the lake floor which would potentially benefit these deep-water plants. A drop in summer water levels would also reduce the lakes' water residency time which, in turn, would reduce the availability of nutrients to the lake system. In addition, Knight (2003) stated that the macro-invertebrate communities would benefit from an increased area of seasonally inundated shore.

Lower summer water levels are likely to have an impact on the lake's riparian habitat, particularly the reed communities (Haycock, 2000). A reduction in the extent of the shoreline reed beds would be beneficial for the inundation plant communities with in areas where these macrophytes have been lost in recent years to competition from the expanding reed bed. However, the roots of *Phragmites australis* do provide some much needed habitat structure within the Loe; niches for macro-invertebrates for example. In some locations the reeds also act to intercept and trap sediment, and the associated nutrients and agri-chemicals, enroute to the Pool. It is therefore important to review the impacts of water level management on both the deep-water and riparian communities (see Section 4.3: Further survey recommendations).

Based on these predictions, it is recommended that a seasonally varying water level management is adopted, with winter lake levels maintained higher than summer levels. Using bathymetric data collected by Mason Survey in 2000, Haycock (2000) calculated that a fixed water level at 3.5mAOD constant year round delivered a normal range of approximately 3.5 to 4.1 mAOD and exposed a 7.6 ha of littoral edge during dry periods. These calculations can be extrapolated to predict that a new water level management regime of winter 3.5m AOD and summer 3.05mAOD would increase the littoral shore by up to 3.5 ha, giving a total littoral area of 11.1 ha. This extended drawdown zone could be delivered with the current outlet structure at Loe Bar and would benefit both the plant and the macro-invertebrate communities and also be consistent with Natural England's Conservation Objectives for the site (Natural England, 2010).

Photo 8: Needle spike rush (*Eleocharis acicularis*) in the drawdown zone, September 2014
(Jan Dinsdale)

Photo 9: Shore weed (*Littorella uniflora*) thriving in the drawdown zone, September 2014
(Jan Dinsdale)

Over-hanging tree branches, tree roots and deadwood all provide valuable habitat within the lake, however, recently established shoreline willow scrub along the southern shores Carminowe and Penrose inlet is likely to be limiting the establishment of the inundation plant community on these otherwise suitable rocky shores. Controlling the growth of these willows would help to improve habitat conditions to promote macrophyte growth in these areas. It is recommended that the willows in these priority areas are cut back and the stumps treated with a Glyphosate-based herbicide. Use of this systemic, low-toxicity compound will reduce regrowth

considerably but follow-up cutting will still be required. The use of any herbicide in or close to a waterbody requires written approval from the Environment Agency.

4.3 Further survey recommendations

In view of current water clarity in the Loe, a bathyscope provides a reliable method for surveying this community type up to a maximum depth of 1.0m. Scuba-diving is not currently required or recommend as part of the bi-annual permanent transect survey, as with such reduced visibility we found that the divers impose an unacceptable level of physical disturbance on both the vegetation and the benthic sediments along the route of the permanent transects.

It is recommended that this quantitative survey of the four permanent transects is repeated biannually September; the next survey date will be September 2016. In the future when the macrophyte communities improve significantly, consideration should then be given to a scuba-diving.

When a new water level management regime is implemented, consideration should be given to repeating Stewart (2000) Survey of the Botany and Vegetation of Loe Pool 1999, which provides a comprehensive map of the riparian habitat at that time, in order to measure the extent of shoreline vegetation change. Use of aerial photos could also be informative.

5. References

Bellemakers, M.J.S., Maessen, M.,Verheggen, G.M., Roelofs, J.G.M. (1996) Effects of liming on shallow acidified moorland pools: a culture and a seed bank experiment. *Aquatic Botany,* **54**, 37–50.

Brouwer, E., Soontiëns, J., Bobbink, R., Roelofs, J.G.M. (1999) Sulphate and bicarbonate as key factors in sediment degradation and restoration of Lake Banen. *Aquatic Conservation*, **9**, 121–132.

Brouwer, E, Bobbink, R, Roelofs, J.G.M. (2002) Restoration of aquatic macrophyte vegetation in acidified and eutrophied softwater lakes: an overview. *Aquatic Botany,* **73,** 405–431.

Clitherow, J. and Dinsdale, J. (2014) Loe Pool Forum: Catchment Group Activity List 2015/16. Unpublished.

Dinsdale, J. (2009) Loe Pool Catchment Management Project: 2009 Review. Report to the National Trust, South West Cornwall Office.

Dinsdale, J. (2007-2011) Loe Pool Annual Botanical Surveys 2007-2011: Annual Brief Summary of Findings. Reports to the National Trust South West Cornwall Office.

Dinsdale, J. (2012) Loe Pool SSSI Macrophyte Survey 2012. Report to Natural England.

Dinsdale, J. (2013) Loe Pool SSSI Macrophyte Monitoring Boat and Grapnel Survey 2013. Report to Natural England.

Haycock, N.E. (2000) Loe Pool Water Level Management Plan (Revised). Report to National Trust. Haycock Associates, St. Albans, Hertfordshire.

HSE (1997) Health and Safety - The Diving at Work Regulations 1997. SI 1997 No. 2776.

HSE (1998) Scientific and Archaeological Diving Projects. The Diving at Work Regulations 1997. Approved Code of Practice and Guidance – L107. HSE Books 1998.

Jeppesen, E. (1998) The ecology of shallow lakes – trophic interactions in the pelagial. Doctorate dissertation, Technical Report No. 247, National Environmental Research Institute.

Jeppesen, E., Søndergaard, M., Sortkjær, O., Mortensen, E. & Kristensen, P. (1990) Interactions between phytoplankton, zooplankton and fish in a shallow, hypertrophic lake: A study of phytoplankton collapses in Lake Søbygård, Denmark. *Hydrobiologia*, **191**, 149-64.

Knight, L.R.F.D (2003) A survey of the aquatic macro-invertebrate fauna of Loe Pool and its feeder watercourses. Report to the National Trust, South West Cornwall Office.

Lister, J. and Dinsdale, J. (2014) Loe Pool Forum: Lake and Lower Cober Group Activity List 2015/16. Unpublished.

Meijer, M.-L. (2000) Biomanipulation in the Netherlands. 15 years of experience. PhD Thesis, Wageningen University

Moss, B. (1990) Engineering and biological approaches to restoration from eutrophication of shallow lakes in which aquatic plant communities are important components. *Hydrobiologia*, **200/201**, 367-77.

Natural England (2010) Conservation Objective Loe Pool. Natural England.

Phillips, G.L. (2005) Eutrophication of Shallow Temperate Lakes. In: *The Lakes Handbook. Lake Restoration and Rehabilitation* (P.E. O'Sullivan and C.S. Reynolds ed.), pp. 261-278. Blackwell Publishing, Oxford.

Stace, C. (1997) *New Flora of the British Isles*. 2nd Ed. Cambridge University Press, Cambridge.

Stewart, N.F. (2000) Survey of the Botany and Vegetation of Loe Pool, Helston 1999. Report to National Trust.

Wilson, H. and Dinsdale, J. (1998) Loe Pool Catchment Management Project. Final Report. Report to the Loe Pool Management Forum. Environment Agency, Bodmin, Cornwall.

APPENDIX 1

Natural England SSSI citation and excerpt from SSSI condition statement

SSSI Citation

COUNTY: CORNWALL SITE NAME: LOE POOL
DISTRICT: KERRIER
Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981 (as amended)
Local Planning Authority: KERRIER DISTRICT COUNCIL; CORNWALL COUNTY COUNCIL
National Grid Reference: SW 647250 Area: 128.7 (ha) 318.0 (ac)
Ordnance Survey Sheet 1:50,000: 203 1:10,000: SW 62 SW SE NW NE
Date Notified (Under 1949 Act): 1951 Date of Last Revision: 1973
Date Notified (Under 1981 Act): 1986 Date of Last Revision: –

Other Information:
Cornwall Area of Outstanding Natural Beauty and Cornwall Heritage Coast. Site boundary amended by extension and deletion. Mainly National Trust owned.

Description and Reasons for Notification:
Loe Pool, located south of Helston on the South Cornish coast, is the largest freshwater lagoon in Cornwall covering an area of approximately 50 hectares and with maximum depth of 6 metres. The underlying rock is composed of Devonian shales and siltstones, locally overlain by head deposits. Soils developed over the surrounding area are mainly acidic brown earths. Both the pool and the shingle bar provide scarce habitat not found elsewhere in Cornwall, with rare species of higher plants, bryophytes, and algae, together with many rare and local insect species. The area is also important to wintering birds. The pool supports several locally rare aquatic plant species including Six-stamened Waterwort *Elatine hexandra*, Perfoliate Pondweed *Potamogeton perfoliatus*, Shoreweed *Littorella uniflora,* Horned Pondweed *Zannichellia palustris*, and Amphibious Bistort *Polygonum amphibium*. One noteworthy species of alga, Stonewort Alga *Nitella hyalina*, has also been recorded. The shingle bar supports local plant species including Sea Holly *Eryngium maritimum*, Sea Fern-grass *Catapodium marinum*, Yellow Horned-poppy *Glaucium flavum*, Sea Sandwort *Honkenya peploides*, Sea Mayweed *Tripleurospermum maritimm*, and the very rare Strapwort *Corrigiola litoralis*.

At the northern inflow area is an extensive area of willow carr, mainly Grey Willow *Salix cinerea*, with Common Reed *Phragmites australis* locally dominant within the willow. There is a wide fringe of Reed around the northern border of the lake. An area of relatively undisturbed ancient oakwood, mainly Pedunculate Oak *Quercus robur,* occurs in the west of the site. Areas of maritime grassland occur along the cliff edge with Red Rescue *Festuca rubra* forming an extensive mat. Other species include Thrift *Armeria maritima*, Wild Carrot *Daucus carota*, Wild Thyme, *Thymus drucei*, Spring Squill *Scilla verna*, and Western Clover *Trifolium occidentale.*

Loe Pool is the only known site in Britain for the Cornish subspecies of the Sandhill

Rustic Moth *Luperina nickerlii leechi*, which feeds on Sand Couch Grass *Agropyron junceiforme*. Nine species of Odonata, including the Keeled Skimmer *Orthetrum coerulescens* have been recorded here. The nutrient rich status of the pool has encouraged an abundance of benthic invertebrates, and there are also many rare or local species of Coleoptera and Hymenoptera. Loe Pool has the only recent record in Cornwall of the rare woodlouse, *Porcellio dilatatus.*

Loe Pool supports nearly 80 species of wintering birds with up to 1,200 wildfowl. Numbers of Shoveler *Anas clypeata* can reach nationally important levels and regionally important counts of Teal *Anas crecca* are not unusual.
There are also high counts for Pochard *Aythya ferina*, Tufted Duck *Aythya fuligula*, Mallard *Anas platyrhynchos*, Goldeneye *Bucephala clangula*, Cadwall *Anas strepera*, and Coot *Fulica astra*. Several rare birds have been recorded here in winter and on autumn migration. There is a breeding colony of about 20 pairs of Sand Martins *Riparia riperia* a species not well represented in Cornwall.

Loe Bar encloses a lagoon occupying part of a former ria, and forms an integral part of a beach system extending from Porthleven to Gunwalloe. The site is important for coastal geomorphology on two accounts. First, Loe Bar is a classic coastal landform; and second, the beach system is an essential member of a suite of major beaches formed and maintained by predominantly south-west wave regimes. The beach is formed mainly of flint shingles and coarse sand. Current inputs from adjacent cliffs are small, and overall, the beach is in deficit. The Bar is washed-over during periods of high wave energy as demonstrated by a series of washover fans. The annually laminated sediments composed of classic material are unique in Great Britain.

SSSI condition statement excerpt

Conservation objectives for the open water feature of Loe Pool SSSI, in terms of the macrophyte community composition and associated habitat conditions:

a. There should be no loss of characteristic species recorded from the site. Six out of ten sample spots should include at least one characteristic plant species.
   [The full national list of characteristic plant species for a lake of this type comprises 35 species (see Appendix 1). The Loe SSSI citation sheet, however, lists just 3 of these 35 characteristic species, namely: *Littorella uniflora*, *Elatine hexandra* and *Potamogeton perfoliatus*].
b. At this site, occurrence of non-native species should be no more than 50% frequency.
c. Characteristic zones of vegetation should be present, maximum depth distribution should be maintained and at least the present structure should be maintained.
d. Mean annual total phosphorus concentration less than target for appropriate lake type, namely 20µg P l^{-1} (as total phosphorus).
e. Stable pH/ANC values appropriate to lake type: pH 7.00 (circumneutral between 6.00 and 8.00); adequate dissolved oxygen levels for health of characteristic fauna
f. No excessive growth of cyanobacterial or green algae.
g. There should be a natural hydrological regime.
h. No loss of marginal vegetation and maintain the natural shoreline of the lake with no more than 5% of lakeshore being heavily modified.
i. Maintain natural and characteristic substrate and maintain natural sediment load.

Box 1. Characteristic species of oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Iseoto-Nanojuncetea.* ** mesotrophic species only

Characteristic species: *Littorelletea* flora:	**Other characteristic species:**	**Associates:**
Littorella uniflora	*Pilularia globulifera*	*Callitriche hamulata*
Isoetes lacustris	*Elatine hexandra*	*Callitriche brutia*
Isoetes echinospora	*Baldellia ranunculoides*	*Myriophyllum alterniflorum*
Lobelia dortmanna	*Carex rostrata*	*Potamogeton polygonifolius*
Subularia aquatica	*Utricularia* spp.	*Potamogeton berchtoldii*
Sparganium angustifolium	** *Nitella* spp.	*Potamogeton natans*
Luronium natans	***Sparganium natans*	*Nymphaea alba*
Potamogeton rutilis	**Broadleaved *Potamogeton* species:	*Juncus bulbosus*
	P. alpinus	*Eleogiton fluitans*
	P. praelongus	*Equisetum fluviatile*
	P. perfoliatus	*Nuphar lutea*
	P. gramineus	*Menyanthes trifoliata*
	P x nitens (and any other established hybrid of these species)	*Eleocharis acicularis*
	***Najas flexilis*	***Persicaria amphibia*

APPENDIX 2

Risk assessments: scuba-diving

Dive Project Plan + Risk Assessment for Underwater Plant survey with Jan Dinsdale/National Trust at Loe Pool/Carminowe Creek (Lower Pentire)

Date 15/9/14

FIRST DIVE
647502435 (-

Type of site/ Dive... Rock/pebble beach shore dive. FRESH WATER!

Type of Diving -

Trial Dives	☐
Guided dives	☐
Open Water Course Training	☐
Adv O/w Training	☐
Rescue Diver Course Training	☐
Dive master Training	☐
Other	☐ Details... SURVEY (PLANTS)

All Courses to be conducted according to PADI General Standards And Procedures and using the PADI RDP dive table ,general guidelines HSE Diving at Work ACOP'S 1997
ALL DIVERS TO CARRY OUT BUDDY CHECK BEFORE EVERY DIVE
ALL PERSONS TO SIGN THIS SHEET AT THE END OF DIVING ACTIVITIES

Personnel -
Dive Contractor ..... Des Glover ☐ ..... David Roberts ☐
Supervisors - Des Glover ☐ .....David Roberts ☐

DIVERS / SHORE SUPPORT

NAME	QUALIFICATION	ROLE	SIGNED
David Roberts	MI 609353	Instructor/DIVER	
Des Glover	MSDT 632321	Instructor/DIVER	
Jan Dinsdale		Ecologist/on shore at all times	
Chris Cattlin	Divemaster	Shore/logistics support	

Equipment - Full PADI Standard Scuba Equipment Inc SMB, Whistle / Signalling device, Knife/ cutting tool.
EXTRA EQUIPMENT -50 metres of 11mm Rope – Large fishing buoy for GPS attachment, 20metre rescue throw line,
Gas Mix - All Air Unless specified on Diver Log

Safety Equipment - The First Aid Kit and O2 are located in the large orange O2 box on site at all times!! ALL DIVERS ON THIS DIVE are First Aid, Emergency Oxygen and Diver Rescue trained!!

Communication Equipment ..... Emergency Phone – Helston Cottage Hospital
ORANGE/VODAFONE mobiles checked at site and work ok!

In event of accident .... Call 999 ask for Coastguard. Give details of Accident and location....

G.R (GPS check)

Lower Pentire . Grid reference 243652-Carminowe Creek/Loe Pool ~ 6475024351

Nearest Decompression Chamber - Derriford Hospital - Plymouth - Emergency contact Number 01752 209999.

If Coastguard Rescue Delayed - Navy Diving Doctor - 07831 151523 for advice

HAZARDS & ACTIONS
WALKING DOWN SLOPE TO BEACH.....Please ensure good footwear etc
BOAT TRAFFIC & POSSIBLE ANGLERS..... None anticipated SMB AT ALL TIMES
FISHING LINE UNDERWATER..... All divers to carry knife / cutting tool
WATER TEMP' .....Appropriate exposure to be worn
Wet/dry suit Gloves, Hood etc

HAZARDS SPECIFIC TO TODAY .....None anticipated, no untoward currents , thermoclines are anticipated also no specific threat of hazardous marine life.

Advise all divers of need for VERY close buddy contact at all times due to anticipated poor visibility and to be aware of potential underwater obstructions eg: Tree branches.....

Be aware of any water ingestion and observe correct hygiene procedures, alcohol wash available at all times.

Pool Water Level Low - 3.43 metres
MAX 5.75 - Winter.

Tide
High Water .....N'A.....Low Water.....N/A.....

Weather
Present.....Partial cloud East 5/4.....Forecast.....Similar.....
Water conditions
Sea State Present.....N/A Pool Calm Pool.....Expected Future.....Similar.....

Expected Viz.....1/2 METRES.....Expected Temperature .....13 Degrees C.....?
MAX
Actual 18° C.

This action plan and risk assessment has been agreed by the appointed contractor and supervisor. They have both agreed to their roles as laid down in the diving at work HSE regulations. The action plan and risk assessment have been relayed to all divers by the contractor

and all points explained and understood.

Signed .....DIVING CONTRACTOR

Signed.....DIVING SUPERVISOR

RISK ASSESSMENT

ACTIVITY:

Transect survey – wading and snorkling in lake

LOCATION:

Loe Pool, Helston

DATE OF ASSESSMENT:

28/08/2014

ASSESSED BY:

Jan Dinsdale

PROJECT NAME:

Loe Pool CES Transect Survey

SURVEYORS:

Janet Dinsdale

Rebecca Morton-Clarke

Key:

RISK RATING - L = Likelihood (Low, Medium, High), S = Severity (Low, Medium, High), R = Risk (Likelihood x Severity)

RISK LEVEL - L = Low; M = Medium; H = High; N/A = Not applicable

LIKELIHOOD

H Certain or near certain to occur
M Reasonably likely to occur
L Very seldom or never occurs

SEVERITY

H Fatality, major injury or illness causing long-term disability
M Injury or illness causing short-term disability
L Other injury or illness

PLOT ASSESSMENT OF SEVERITY v LIKELIHOOD AND HIGHLIGHT VALUE OBTAINED

H/H 100% avoid whenever possible
L/L 0% may be ignored
For all other values, control or minimise risk

Severity			
	L/H 10%	M/H 50%	H/H 100%
	L/M 5%	M/M 25%	H/M 50%
	L/L 0%	M/L 5%	H/L 10%
	Likelihood		

KEY:
Hazard (something with potential to cause harm)– this list is not exhaustive, consider and select relevant actions, and add any additional hazards identified
Risk (chance or likelihood of harm being caused
Who is at risk – staff, general public, landowners, people with special needs, other
Risk Level – write down whether Low, Medium or High
Precautions – List the safety measure to be put in place to lower risk level
Risk Level – following precautions what is risk level
Continue with activity? – Is risk level too high to continue?
Further action – consider and list other action to be taken to permit activity to continue
Action by whom – yourself, landowner, group leader, etc
Action done – date and initial

HAZARD Potential for harm	**Who is at risk and might be harmed?**	**RISK LEVEL:** Low Medium High	**PRECAUTIONS** To reduce the risk level	**RISK LEVEL** Following precautions	**Continue with activity or too hazardous?**	**Further action to be taken?**	**Action by whom**	**Action done**
Hazards – general	Surveyors	L	1. Ensure mobile phone battery is charged 2. Take first aid kit with up to date contents.	L				
Litter, metal, glass, hypodermic needles, etc	Surveyors	L	1. Wear appropriate footwear on site and be watchful	L				
Slips, trips, falls	Surveyors	L	1. Take care of slippy rocks 2. Wear waders/appropriate footwear 3. Work closely with buddy and be vigilant at all times for fall in water	L				
Deep water	Surveyors	M	1. Do not wade out in chest waders beyond waist deep 2. Buddy to stay on shore close to snorkel surveyor at all times	L				
Entanglement	Surveyors	M	1. Check for ropes and trees along route before surveying 2. Remove hazards or relocate transect to avoid risk	L				
Toxins in water	Surveyors	M	1. Do not ingest water 2. Use alcohol gel before eating	L				
Deep mobile sediment	Surveyors	M	1. Only wade on rocky substrates not on mobile mud 2. ~~Do not put feet down when snorkling over mud~~ 3. One buddy to remain shore on safe sediment at all times 4. Carry a 30m rope	L				
Weather	Surveyors	L	1. Wear protective clothing and sun block. 2. Cease work if inadequately prepared or extreme weather conditions are encountered.	L				

Signed ..... **Date** 12 Sept 2014

APPENDIX 3

Results of detailed permanent transect survey results 2012 and 2014

2012

Transect 1 north shore carminowe

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean
0	0.15	1	3	2	3	0	2	1	4	3
0.5	0.26	1	3	2	7	5	6	2	3	3
1	0.34	3	1	2	8	8	8	0	0	0
1.5	0.4	1	1	1	8	8	8	0	0	0
2	0.5	1	0	1	8	8	8	0	0	0
2.5	0.55	0	0	0	9	8	9	0	0	0
3	0.6	0	0	0	1	6	3	0	0	0
3.5	0.65	0	0	0	0	0	0	0	0	0

Transect 2 north shore carminowe

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean
0	0	0	0	0	0	0	0	6	7	6
0.5	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
2.5	0	0	1	1	0	0	0	0	0	0
3	0	4	4	4	0	0	0	0	0	0
3.5	0.01	0	0	0	0	0	0	0	0	0
4	0.03	0	0	0	0	0	0	0	0	0
4.5	0.03	0	0	0	0	0	0	0	0	0
5	0.04	0	0	0	0	0	0	0	0	0
5.5	0.06	2	3	3	0	0	0	0	0	0
6	0.17	4	4	4	0	1	1	0	0	0
6.5	0.25	5	4	5	0	0	0	0	0	0
7	0.3	4	4	4	4	0	3	0	0	0
7.5	0.41	3	4	4	4	5	5	1	0	1
8	0.49	4	4	4	5	5	5	0	0	0
8.5	0.54	4	3	4	7	4	6	0	0	0
9	0.61	4	3	4	7	6	7	0	0	0
9.5	0.65	2	4	3	4	4	4	0	0	0
10	0.69	3	2	3	1	4	3	0	0	0
10.5	0.75	1	0	1	3	3	3	0	0	0
11	0.8	0	2	1	1	1	1	0	0	0
11.5	0.87	2	2	2	1	1	1	0	0	0
12	0.94	2	2	2	1	1	1	0	0	0
12.5	0.98	2	2	2	1	1	1	0	0	0
13	1.02	0	0	0	0	0	0	0	0	0

Transect 3 Pentire Point

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean
0	0	0	0	0	0	0	0	0	3	2
0.5	0	1	0	1	0	0	0	0	3	2
1	0	0	1	1	0	0	0	0	1	1
1.5	0	4	4	4	0	0	0	3	3	3
2	0.01	5	5	5	0	0	0	3	3	3
2.5	0.03	4	3	3	0	0	0	4	1	3
3	0.08	0	0	0	0	0	0	3	1	2
3.5	0.12	0	0	0	0	0	0	4	3	4
4	0.16	0	1	1	0	0	0	4	4	4
4.5	0.23	1	1	1	2	1	1	5	6	5
5	0.25	2	1	2	1	1	1	6	7	7
5.5	0.3	2	3	3	3	4	4	4	5	5
6	0.35	4	3	4	3	4	4	5	5	5
6.5	0.4	3	3	3	4	4	4	3	4	4
7	0.42	3	3	3	4	5	5	0	1	1
7.5	0.46	3	2	3	5	4	5	0	0	0
8	0.5	3	3	3	4	4	4	0	0	0
8.5	0.54	2	0	2	4	3	4	0	0	0
9	0.58	0	0	0	3	3	3	0	0	0
9.5	0.6	0	0	0	3	0	2	0	0	0
10	0.69	0	0	0	0	0	0	0	0	0
10.5	0.72	0	0	0	2	2	2	0	0	0
11	0.74	0	0	0	0	0	0	0	0	0
11.5	0.81	0	0	0	2	2	2	0	0	0
12	0.85	0	0	0	0	0	0	0	0	0
12.5	0.87	0	0	0	2	2	2	0	0	0
13	0.89	0	0	0	0	0	0	0	0	0
13.5	0.92	0	0	0	2	2	2	0	0	0
14	0.94	0	0	0	0	0	0	0	0	0

Transect 4 Penrose Arm

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean
0	0	2	1	2	0	0	0	0	0	0
0.5	0	1	1	1	0	0	0	0	0	0
1	0	4	3	4	0	0	0	0	0	0
1.5	0	5	1	4	0	0	0	0	0	0
2	0	4	6	5	0	0	0	0	0	0
2.5	0	4	4	4	0	0	0	0	0	0
3	0.01	5	5	5	0	0	0	0	0	0
3.5	0.04	5	5	5	0	2	2	0	0	0
4	0.15	5	4	5	0	3	3	0	0	0
4.5	0.21	4	3	4	3	2	3	0	0	0
5	0.26	3	3	3	0	3	2	0	0	0
5.5	0.35	0	0	0	4	4	4	0	0	0
6	0.46	3	2	3	0	0	0	0	0	0
6.5	0.55	0	0	0	0	0	0	0	0	0
7	0.69	0	0	0	0	0	0	0	0	0

2014

Transect 1 north shore carminowe

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover me
0	0	0	0	0	0	0	0	0	0	0
0.5	0.02	0	0	0	0	0	0	0	0	0
1	0.09	0	0	0	0	0	0	0	0	0
1.5	0.16	0	0	0	0	0	0	0	0	0
2	0.21	0	0	0	0	0	0	0	0	0
2.5	0.28	0	0	0	0	0	0	0	0	0
3	0.41	0	0	0	0	0	0	0	0	0
3.5	0.47	0	0	0	0	0	0	0	0	0

Transect 2 north shore carminowe

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover me
0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
1.5	0	0	1	1	0	0	0	1	0	1
2	0	1	1	1	0	0	0	0	0	0
2.5	0	0	1	1	0	0	0	0	0	0
3	0.03	0	0	0	0	0	0	0	0	0
3.5	0.07	0	0	0	0	0	0	0	0	0
4	0.09	0	0	0	0	0	0	0	0	0
4.5	0.14	1	0	1	0	0	0	0	0	0
5	0.16	0	0	0	0	0	0	0	0	0
5.5	0.31	0	0	0	0	0	0	0	0	0
6	0.36	3	0	2	0	0	0	0	0	0
6.5	0.38	3	1	2	0	0	0	0	0	0
7	0.42	1	3	2	0	0	0	0	0	0
7.5	0.48	2	1	2	0	0	0	0	0	0
8	0.49	1	2	2	0	1	1	0	0	0
8.5	0.55	0	0	0	0	0	0	0	0	0
9	0.61	1	0	1	0	0	0	0	0	0
9.5	0.65	0	0	0	0	0	0	0	0	0
10	0.69	0	0	0	0	0	0	0	0	0
10.5	0.75	0	0	0	0	0	0	0	0	0
11	0.8	0	0	0	0	0	0	0	0	0
11.5	0.87	0	0	0	0	0	0	0	0	0
12	0.94	0	0	0	0	0	0	0	0	0
12.5	0.98	0	0	0	0	0	0	0	0	0
13	1.02	0	0	0	0	0	0	0	0	0

Transect 3 Pentire Point

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover me
0	0	0	0	0	0	0	0	9	10	10
0.5	0	0	0	0	0	0	0	5	8	7
1	0	0	0	0	0	0	0	7	7	7
1.5	0	0	0	0	0	0	0	7	6	7
2	0.01	0	0	0	0	0	0	3	0	2
2.5	0.03	0	0	0	0	0	0	0	0	0
3	0.08	0	0	0	0	0	0	0	0	0
3.5	0.09	0	0	0	0	0	0	0	1	1
4	0.18	0	0	0	0	0	0	0	0	0
4.5	0.19	0	0	0	0	0	0	1	2	2
5	0.26	0	3	2	0	0	0	0	0	0
5.5	0.31	2	2	2	0	0	0	0	2	1
6	0.34	2	1	2	0	0	0	0	0	0
6.5	0.35	4	0	2	4	2	3	3	0	2
7	0.42	3	4	4	4	4	4	0	0	0
7.5	0.45	2	4	3	5	5	5	0	0	0
8	0.5	0	2	1	0	0	0	0	0	0
8.5	0.56	0	0	0	5	4	5	0	0	0
9	0.65	0	0	0	4	3	4	0	0	0
9.5	0.67	0	0	0	0	0	0	0	0	0
10	0.68	0	0	0	0	0	0	0	0	0
10.5	0.71	0	0	0	0	0	0	0	0	0
11	0.78	0	0	0	0	3	2	0	0	0
11.5	0.82	0	0	0	0	0	0	0	0	0
12	0.84	0	0	0	0	0	0	0	0	0
12.5	0.88	0	0	0	0	0	0	0	0	0
13	0.95	0	0	0	0	0	0	0	0	0
13.5	0.98	0	0	0	0	0	0	0	0	0
14	1.03	0	0	0	0	0	0	0	0	0
14.5	1.07	0	0	0	0	0	0	0	0	0
15	1.14	0	0	0	0	0	0	0	0	0
15.5	1.16	0	0	0	0	0	0	0	0	0
16	1.17	0	0	0	0	0	0	0	0	0

Transect 4 Penrose Arm

		Eleocharis acicularis			Elatine hexandra			Littorella uniflora		
dist from shore	water depth	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover mean	% cover L	% cover R	% cover me
0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
3.5	0.05	0	0	0	0	0	0	0	0	0
4	0.12	4	1	3	0	0	0	0	0	0
4.5	0.17	2	1	2	0	0	0	0	0	0
5	0.21	1	1	1	0	0	0	0	0	0
5.5	0.31	1	0	1	0	0	0	0	0	0
6	0.41	0	1	1	0	0	0	0	0	0
6.5	0.53	0	1	1	0	0	0	0	0	0
7	0.63	0	0	0	0	0	0	0	0	0