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Environmental Change Research Centre

Palaeoecological study of Loch Ussie

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Loch Ussie – a view from the west © Northern Ecological Services 2006

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COMMISSIONED REPORT
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Palaeoecological study of Loch Ussie

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BACKGROUND

Loch Ussie is a relatively shallow, mesotrophic loch located near Dingwall in the Scottish Highlands which has been designated as a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation for its freshwater habitat, particularly its diverse submerged macrophyte flora. There are increasing concerns about water quality with at least one major algal bloom occurring in recent years and the apparent loss of *Pillularia globulifera*, a notified interest in the SSSI. Catchment management plans are being drafted that will consider incentives to reduce nutrient input from the agricultural areas of the catchment and proposals to manage loch water levels. In order to inform these plans, information about past nutrient conditions in the loch is desirable.

This project aimed to build on an earlier palaeolimnological study of diatom assemblages in a sediment core from the loch to fully assess the magnitude and trends in water quality change at Loch Ussie over the last 150 years, and particularly over the last two or three decades. This report examines diatoms in an additional 10 samples from an archived sediment core, USSI1, and involves application of a diatom transfer function to infer past total phosphorus concentrations in the loch.

MAIN FINDINGS

- Loch Ussie's diatom profile is dominated throughout by taxa typical of circumneutral to alkaline waters.
- The loch's pre-1700 diatom flora is indicative of nutrient-poor conditions, as reflected in low diatom-inferred total phosphorus values (12-13 µg l^{-1}).
- From the 1700s to 1800s, the loch's diatom assemblage composition is similar to that observed pre-1700, although small increases in the relative abundance of nutrient tolerant taxa are reflected in higher inferred total phosphorus values (17-20 µg l^{-1}).
- Throughout the 1900s, epiphytic diatom taxa increase in relative abundance, perhaps indicating increased aquatic macrophyte biomass and therefore greater habitat availability for epiphytes.
- During the latter half of the 20th century (1960s to 1998), the relative abundances of nutrient sensitive diatom taxa decline and diatom-inferred total phosphorus concentrations increase to ~30 µg l^{-1}. However, taxa indicative of eutrophic conditions do not appear.
- The floristic composition and reconstructed total phosphorus concentration of the surface sediment diatom sample appears to suggest some degree of recovery, however this sample probably represents a 'seasonal artefact'. Analysis of recent (post-1998) diatom assemblages is necessary before a true recovery trend can be established although the inferred phosphorus concentration for the surface sample of 18 µg l^{-1} is in good agreement with contemporary measured annual mean total phosphorus concentrations which indicate relatively stable mesotrophic conditions.
- Sensitive management of Loch Ussie and its catchment is required to safeguard the loch's mesotrophic status and high conservation value.

TO BE COMPLETED BY SNH NOMINATED OFFICER

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Publishing Unit, Scottish Natural Heritage, Battleby, Redgorton, Perth PH1 3EW.

1 INTRODUCTION AND OBJECTIVES

1.1 Background

Loch Ussie is a relatively shallow, mesotrophic loch located near Dingwall in the Scottish Highlands (see Tables 1 and 2 for loch and catchment details and Table 3 for summary chemistry). It has been designated as a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC) for its freshwater habitat that supports a wide range of macrophytes including a relatively large number of pondweeds.

The loch was part of a previous palaeolimnological study of Scottish lochs (Bennion *et al*., 2001). The results of diatom analysis and application of a transfer function to infer total phosphorus concentrations (DI-TP) for a core from Loch Ussie indicated that DI-TP increased from 11-12 µg l^{-1} in the lower part of the core to 25 µg l^{-1} in the 1955 sample but then declined again to 18 µg l^{-1} at the surface. However this was a low resolution study involving analysis of only four samples and the decline in the DI-TP was due to the high relative abundance of *Cyclotella glomerata* in the surface sample of the core. Hence, analysis of additional samples was advised (Bennion *et al*., 2001).

Water chemistry, and wider water management, at Loch Ussie is of interest at present due to a number of factors. There has been at least one major algal bloom in recent years, raising concerns about the input of nutrients, and until recently macrophyte surveys failed to find *Pilularia globulifera*, a nationally scarce species. The loch also has a sluice at its outflow, a relic of the loch's past use as the public water supply for Dingwall. The loch is no longer used as a public water supply and as a result the water level is consistently high. Discussions are ongoing to investigate ways of managing the water level so that there is a more natural annual fluctuation. Better information about past nutrient conditions in the loch is essential and will help inform any decisions about future management of water levels. There is also the potential for a catchment management plan using incentives to reduce nutrient input from the agricultural areas of the catchment.

Table 1 Site characteristics of Loch Ussie

National Grid Reference	NH 505 574
Altitude (m asl)	125
Loch area (km^2)	0.82
Loch volume (m^3)	1.9×10^6
Mean loch depth (m)	2.4
Max loch depth (m)	12
Flushing rate (loch volumes per year)	0.97
Catchment area (km^2)	4.7
Catchment nutrient sources	Diffuse agricultural inputs, forestry.

Table 2 Land cover in the Loch Ussie catchment

LAND COVER CATEGORY	*PERCENT*
coniferous plantation	35
improved grassland	21
Water	18.6
smooth grassland	11.2
broadleaved woodland	5.1
Arable	4.2
open canopy young plantation	2.5
heather all types	1
mixed woodland	0.9
woodland recently felled	0.5
Wetland	0.2

Table 3 Summary total phosphorus and chlorophyll a data (SEPA)

Year	Mean Total Phosphorus (µg L^{-1})	Mean chlorophyll a (µg L^{-1})
1995	18.5	-
2002	14	3
2003	12	5
2004	9	8
2005	14	7
2006	18	9

1.2 Objectives

The main aim of the study was to build on the existing low resolution diatom analysis carried out as part of the SNIFFER project (Bennion *et al*., 2001) to enable the magnitude and directions in water quality at Loch Ussie over the last 150 years, and particularly over the last two or three decades, to be fully assessed. Specifically the objectives were:

1. To prepare and analyse 10 diatom samples from the archived sediment core, USSI1, collected as part of a past SNIFFER project (Bennion *et al*., 2001).
2. To analyse the data and report on the results alongside the results for Loch Ussie reported in Bennion *et al*. (2001).

2 METHODS

2.1 Core details and chronology

A 91 cm sediment core (USSI11) was taken on 4 July 1998 in a water depth of 12 m using a mini-Mackereth piston corer (Mackereth, 1969) as part of the SNIFFER project ‘Palaeolimnological investigation of Scottish freshwater lochs’ (Bennion *et al*., 2001). The core was extruded in the laboratory at 0.5 cm intervals from 0-50 cm and thereafter at 1.0 cm intervals to the core base. Selected sediment samples from each core were analysed for

^{210}Pb, ^{226}Ra, ^{137}Cs and ^{241}Am in order to provide a chronology (Appleby *et al*., 1986). The full results are given in Bennion *et al*. (2001) but essentially the core had a good record of recent sediments with a uniform sedimentation rate of 0.021 g cm^{-2} yr^{-1} (0.12 cm yr^{-1}) from the mid 19th century through to ~1955, followed by a small but significant acceleration in the last few decades with a mean sedimentation rate for the past 20 years of 0.036 g cm^{-2} yr^{-1} (0.29 cm yr^{-1}) (Table 4).

Table 4 ^{210}Pb chronology of Loch Ussie core USSI1

Depth		Chronology			Sedimentation Rate		
cm	g cm^{-2}	Date AD	Age Y	±	g cm^{-2} yr^{-1}	cm yr^{-1}	± (%)
0.0	0.00	1998	0				
1.0	0.11	1995	3	2	0.042	0.32	9.2
2.0	0.25	1992	6	2	0.036	0.28	9.2
3.0	0.38	1988	10	2	0.033	0.25	9.4
4.0	0.51	1984	14	2	0.033	0.25	9.6
5.0	0.63	1980	18	2	0.032	0.25	9.9
6.0	0.76	1976	22	2	0.032	0.24	10.3
7.0	0.90	1972	26	2	0.031	0.22	10.8
8.0	1.04	1967	31	3	0.029	0.20	12.3
9.0	1.19	1961	37	3	0.026	0.17	14.7
10.0	1.34	1955	43	3	0.022	0.14	17.0
11.0	1.50	1948	50	4	0.021	0.13	19.1
12.0	1.67	1940	58	5	0.021	0.13	20.9
13.0	1.84	1932	66	6	0.021	0.13	22.6
14.0	2.01	1924	74	6	0.022	0.13	24.4
15.0	2.17	1916	82	7	0.022	0.13	26.2
16.0	2.35	1908	90	9	0.022	0.13	28.1
17.0	2.52	1900	98	11	0.021	0.12	30.1
18.0	2.70	1891	107	14	0.021	0.12	32.1
19.0	2.88	1883	115	17	0.020	0.11	34.1
20.0	3.06	1874	124	19	0.020	0.11	36.1

2.2 Diatom analysis

The methods followed those employed in Bennion *et al*. (2001). Ten sub-samples from core USSI1 were prepared and analysed for diatoms using standard techniques (Battarbee, 1986). The selected samples were chosen to supplement the diatom analysis carried out on four samples by Bennion *et al.* (2001) and focused on the upper 20 cm of the core as this represents approximately the last 150 years. The samples counted in the Bennion *et al*. (2001) study were from the following depths: 0, 10, 50, 90 cm. At least 300 valves were counted from each sample using a Leitz research microscope with a 100 x oil immersion objective (magnification x 1000) and phase contrast. Principal floras used in identification were Krammer & Lange-Bertalot (1986-1991). All slides are archived at the ECRC.

The data were added to those from the four samples analysed in the previous study to produce a total of 14 samples. The taxonomy was harmonised and the counts were transformed to percentages. All diatom data in this report are expressed as percentage relative abundances. Cluster analysis was performed on the diatom data to identify the major zones in the diatom profile using CONISS (Grimm, 1987), implemented by TGView v.2.0.2 (Grimm, 2004). CONISS is a program for stratigraphically constrained cluster analysis by the method of incremental sum of squares.

2.3 Diatom-phosphorus transfer function

The technique of weighted averaging (WA) regression and calibration (ter Braak & van Dam, 1989) has become a standard technique in palaeolimnology for reconstructing past environmental variables. A predictive equation known as a transfer function is generated that enables the inference of a selected environmental variable from fossil diatom assemblages, based on the relationship between modern surface-sediment diatom assemblages and contemporary environmental data for a large training (or calibration) set of lakes. This approach has been successfully employed to infer lake pH (e.g. Birks *et al*., 1990) and total phosphorus (TP) concentrations (Hall & Smol, 1999), whereby modern diatom pH and TP optima and tolerances are calculated for each taxon based on their distribution in the training set, and then past pH and TP concentrations are derived from the weighted average of the optima of all diatoms present in a given fossil sample. The methodology and the advantages of WA over other methods of regression and calibration are well documented (e.g. ter Braak & van Dam, 1989). More recently the technique has been improved by extension to a method called WA partial least squares (WA-PLS) (ter Braak & Juggins, 1993). This method overcomes some of the limitations of simple WA by using the residual correlation in the diatom data to improve the estimates of the taxa ‘optima’ or regression coefficients, as shown by Bennion *et al*. (1996).

A diatom transfer function was applied to the diatom data for the Loch Ussie core, following taxonomic harmonisation between the training set and the fossil data. Reconstructions of DI-TP were produced using a Northwest European training set of 152 relatively shallow lakes (< 10 m maximum depth) with a median value for the dataset of 104 µg TP l^{-1} and a root mean squared error of prediction (RMSEP) of 0.21 $\log_{10}$ µg TP l^{-1} for the weighted averaging partial least squares two-component (WA-PLS2) model (Bennion *et al*. 1996). The reconstruction was implemented using C^2 (Juggins, 2003).

3 RESULTS

3.1 Diatom composition

Diatom preservation was good throughout the core. The assemblages were quite diverse and a total of 130 taxa were observed. The complete list of taxon names and codes is given in Appendix 1. Figure 1 illustrates the results for the major taxa (>3% abundance), along with radiometric dates and the DI-TP results. Some taxa have been aggregated following harmonisation. For example, *Fragilaria capucina* agg. comprises all *Fragilaria capucina* varieties (predominantly *F. capucina* var. *amphicephala* and *F. capucina* var. *vaucheriae*) and *Fragilaria* (*pseudo*)*construens* comprises both *F. construens* and *F. pseudoconstruens*.

There have been changes in the diatom species composition of Loch Ussie over the period represented by the 90 cm core. Extrapolation of the mean sedimentation rates provided by the dating results in Table 4 gives a date of approximately 1250 AD for the core base, with the top 20 cm representing approximately the last 150 years.

Cluster analysis defined two main zones in the diatom stratigraphic record and these are displayed in Figure 1 (zone 1 is below 40 cm and zone 2 is above 40 cm). Although CONISS identified further zone boundaries at ~11 cm (1942±5) and ~1 cm (1994±2), the former does not appear to correspond with any major shifts in diatom floristic composition or changes in DI-TP and the latter merely identifies the surface sediment sample, which is most likely a seasonal artefact (see discussion).

Zone 1: 90 - 40 cm (~ 1250-1700)
The assemblages in this zone were quite diverse and were comprised of both planktonic (30%) and non-planktonic (70%) taxa. The major planktonic taxa were *Cyclotella comensis* (c. 10%), *Cyclotella radiosa* (c. 5%), *Cyclotella glomerata* (c. 5%) and *Tabellaria flocculosa* (c. 5%). The non-planktonic taxa included *Achnanthes minutissima* (c. 20%), *Fragilaria exigua* (c. 10%), *Achnanthes pusilla* (c. 5%), and *Brachysira vitrea* (c. 5-10%). A number of other taxa, e.g. *Cymbella cesatii*, *Cymbella gracilis*, *Nitzschia fonticola*, *Fragilaria capucina* agg., *Fragilaria (pseudo)construens* and *Achnanthes pusilla* were also present in relative abundances of less than 5%.

Zone 2: 40 - 0 cm (~1700-1998)
The assemblages in this zone differed in a number of respects from those described above. Although many diatom taxa were common to both zones 1 and 2, their relative abundances exhibit some changes. There was a modest increase in the non-planktonic species of the genus *Fragilaria (e.g. Fragilaria pinnata* and *Fragilaria elliptica)* and *Cocconeis placentula*. These latter three taxa are widespread and tolerant to a wide range of nutrient concentrations but are commonly observed in the assemblages of shallow, moderately nutrient-rich, alkaline waters, attached to plant surfaces or the surface sediments. The relative abundances of some of the formerly important taxa declined, in particular *Achnanthes minutissima*, *Brachysira vitrea*, *Tabellaria flocculosa* agg. and to some extent *Cyclotella comensis* and *Nitzschia fonticola*. In the surface sample, *Cyclotella radiosa* and *Cyclotella glomerata* increased markedly to relative abundances of 25% and 20%, respectively. The proportion of plankton to non-plankton thus increased to around 50% in the uppermost sample.

3.2 Diatom-inferred phosphorus

Approximately 90% of the fossil assemblage in all samples (except for the 18.5 cm sample with only 82%) was represented by the diatom-TP training set. The DI-TP reconstruction using the WA-PLS2 model (Figure 1) shows that concentrations were stable at ~12-13 µg TP l^{-1} in the lower part of the core (Zone 1). Between 50 cm (~1600) and 30.5 cm (~1780), values increased slightly with a DI-TP value of 17 µg TP l^{-1} for the ~1780 sample. Between 30.5 cm (~1780) and 8.5 cm (1964±3), DI-TP values increased and remained relatively stable at ~25 µg TP l^{-1} for much of this period. From 8.5 cm (1964±3) to 6.5 cm (1974±2) DI-TP increased further to ~32 µg TP l^{-1} and remained at just above 30 µg TP l^{-1} until 2.5 cm (1990±2). The surface sediment sample (1998) records a significant decline in DI-TP to 18 µg TP l^{-1}.

4 DISCUSSION

Pre - 1700
The early assemblages contain a number of taxa that are typical of relatively nutrient-poor, circumneutral to alkaline waters. This is reflected in the DI-TP values of the lower two samples which were ~12-13 µg TP l^{-1}.

1700 - present day

Although many of the pre-1700 taxa remain common to this period, a number were replaced or superseded by taxa indicative of slightly higher nutrient concentrations. DI-TP concentrations increased during this period, to between two (late 1800s to 1960s) and three (1960s to 1990s) times the values estimated for the early part of the loch's history. During the latter period, the diatom taxa with the lowest TP optima (*Cymbella helvetica*, *B. vitrea* and *T. flocculosa*) decrease in relative abundance, suggesting perhaps that at this time nutrient sensitive taxa are being outcompeted by nutrient tolerant taxa. The increases in *Fragilaria* taxa and *Cocconeis placentula* could signal enhanced biomass of submerged aquatic plants in the loch which would have increased the habitat availability for epiphytic taxa. Similar changes were observed in Loch Eye (Bennion *et al*., 2001). The increased biomass of aquatic macrophytes could have been stimulated by the increasing availability of nutrients.

The current diatom flora is generally indicative of mesotrophic conditions. This is reflected by the DI-TP for the surface sample (18 µg TP l^{-1}) which is in excellent agreement with the mean TP concentration of the loch at around the time the sediment core was taken (18.5 µg TP l^{-1} in 1995). The decline in DI-TP recorded by the surface sediment diatom assemblage is largely due to the high relative abundance of *Cyclotella glomerata*, whose TP optima in the NW European training set is 17 µg TP l^{-1}. Despite the close agreement between measured and inferred TP concentrations, it is not possible to state with any certainty that Loch Ussie has experienced a recent recovery from nutrient enrichment, although measured annual mean TP concentrations from 2002 to 2006 (9-18 µg TP l^{-1}, see Table 3) indicate that the loch is in a relatively stable mesotrophic state in terms of it's TP levels. To provide convincing evidence of ecological recovery, further sediment and diatom plankton samples spanning the post-1998 period would need to be analysed. In the interim it is more plausible to conclude that the surface sediment diatom assemblage represents a 'seasonal artefact' i.e. that it is composed mainly of diatom frustules that were laid down during / after a recent plankton 'bloom'. This interpretation seems rational because the sediment core was taken from Loch Ussie in July and planktonic centric diatom species such as *C. glomerata* and *C. radiosa* are frequently observed in summer diatom plankton samples (Burgess, 2004).

Loch Ussie still supports a diverse macrophyte flora and has not experienced enrichment to the extent that the system has become phytoplankton dominated or the submerged macrophyte community has been lost. The centric diatom taxa from the genera *Stephanodiscus* and *Cyclostephanos*, indicative of a shift towards eutrophy, such as those seen in Carlingwark Loch, Castle Loch, Castle Semple Loch, Kilbirnie Loch and Mill Loch (Bennion *et al*. 2001), have not yet been observed in the diatom record of Loch Ussie. Nonetheless, catchment pressures including diffuse agricultural runoff, forestry fertilisation / felling, increased housing development, and recreation all present potential sources of nutrients to the loch (Hardie, 1995). Furthermore, the slow flushing rate of the loch means that much of the phosphorus entering the system is retained in the sediments (May & Gunn, 2000). Compounded by the shallow nature of the loch, this increases the potential for nutrient resuspension into the water column, which in turn can stimulate the development of algal blooms. Two algal blooms have been reported by SEPA from Loch Ussie in the last ten years (Northern Ecological Services, 2006), but if internal nutrient loads increase, the occurrence of algal blooms may become more frequent. Therefore extensive monitoring of water quality in the future is recommended.

In 2006 the nationally rare plant, *Pilularia globulifera* was relocated in Loch Ussie (Northern Ecological Services, 2006). *P. globulifera*, along with other desirable aquatic macrophyte species such as *Elatine* spp. are favoured by fluctuating and/or low water levels. However undesirable algal blooms are also favoured by such conditions. The different conservation objectives for Loch Ussie must be delicately balanced to achieve its maximum ecological potential.

5 SUMMARY

The diatom stratigraphy of Loch Ussie is dominated by taxa typical of circumneutral to alkaline waters. The floristic composition of the pre-1700 diatom assemblages are indicative of nutrient-poor conditions, as reflected in the low DI-TP values (12-13 µg TP l^{-1}). During the 1700s and 1800s, diatom assemblage composition begins to change and DI-TP values increase and then stabilise at concentrations approximately double those of pre-1700. This trend continues throughout the 1900s, when the relative abundances of epiphytic taxa increase. During the latter half of the 20th century a number of nutrient sensitive taxa decline in relative abundance and DI-TP concentrations increase to approximately three times their pre-1700 values. The floristic composition of the surface sediment sample and the corresponding DI-TP value appears to suggest recovery; however this sample probably represents a seasonal artefact. To provide convincing evidence of ecological recovery, analysis of post-1998 sediment and plankton samples would be required but nevertheless measured annual mean TP concentrations from 2002 to 2006 (9-18 µg TP l^{-1}) indicate that the loch is in a relatively stable mesotrophic state.

Catchment pressures presenting potential sources of nutrients to the loch include diffuse agricultural runoff, forestry fertilisation / felling, increased housing development and recreation. The slow flushing rate of Loch Ussie increases the probability of excess nutrients being stored internally and the shallow nature of the loch increases the likelihood of resuspension of nutrient enriched sediments into the water column, in turn stimulating the development of algal blooms. The centric diatom taxa from the genera *Stephanodiscus* and *Cyclostephanos*, indicative of a shift towards eutrophy, have not been observed in the diatom record of Loch Ussie, suggesting that the loch is currently in a mesotrophic state. Sensitive management of Loch Ussie and its catchment is required to ensure that the loch's mesotrophic status and high conservation value are maintained.

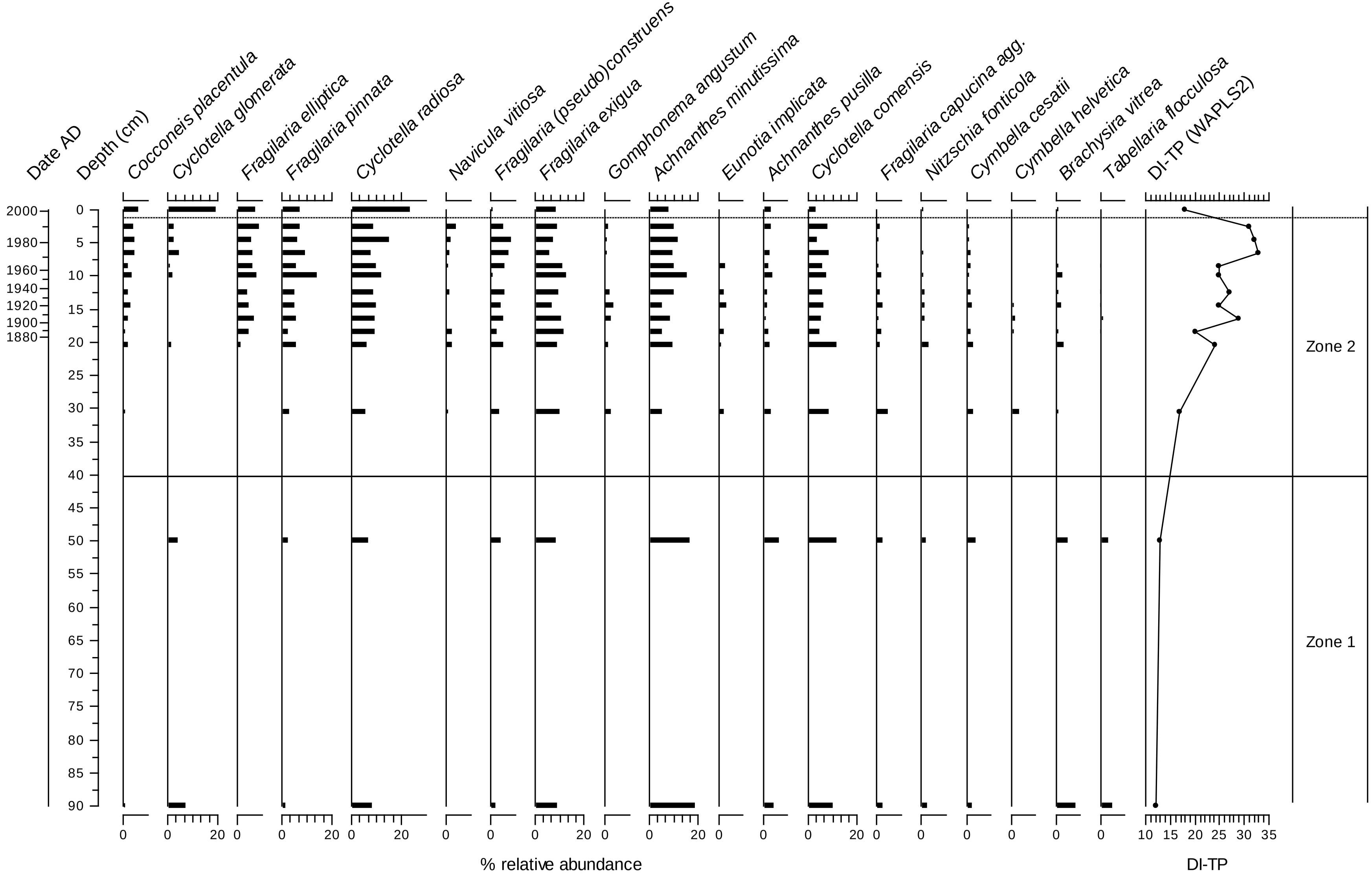

Figure 1 Summary diatom diagram and diatom-inferred TP (DI-TP µg l^{-1}) for core USSI1, showing the two major zones and the surface sediment sample

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Appendix 1: Complete diatom list with codes for core USSI1

Code	Name
AC001A	Achnanthes lanceolata
AC007A	Achnanthes oestrupii
AC013A	Achnanthes minutissima
AC022A	Achnanthes marginulata
AC025A	Achnanthes flexella
AC034A	Achnanthes suchlandii
AC035A	Achnanthes pusilla
AC042A	Achnanthes cf. detha
AC134A	Achnanthes helvetica
AC161A	Achnanthes ventralis
AM004A	Amphora veneta
AM011A	Amphora libyca
AM012A	Amphora pediculus
AM013A	Amphora inariensis
AM9999	Amphora sp.
AP001A	Amphipleura pellucida
AS001A	Asterionella formosa
AU005A	Aulacoseira cf. distans
BR001A	Brachysira vitrea
CA003A	Caloneis silicula
CA9999	Caloneis sp.
CM004A	Cymbella microcephala
CM008A	Cymbella hybrida
CM009A	Cymbella naviculiformis
CM013A	Cymbella helvetica
CM015A	Cymbella cesatii
CM018A	Cymbella gracilis
CM020A	Cymbella gaeumannii
CM022A	Cymbella affinis
CM031A	Cymbella minuta
CM050A	Cymbella cf. subaequalis
CM051A	Cymbella elginensis
CM052A	Cymbella descripta
CM070A	Cymbella caespitosa
CM103A	Cymbella silesiaca
CM9999	Cymbella sp.
CN001A	Cymbellonitzschia diluviana
CO001A	Cocconeis placentula
CO005A	Cocconeis pediculus
CO9999	Cocconeis sp.
CY004A	Cyclotella stelligera
CY006B	Cyclotella kuetzingiana var. planetophora
CY007A	Cyclotella glomerata
CY010A	Cyclotella comensis
CY019A	Cyclotella radiosa
CY028B	Cyclotella distinguenda var. unipunctata
CY054A	Cyclotella krammeri
CY061A	Cyclotella gordonensis
DE001A	Denticula tenuis
DE002A	Denticula elegans
DP009A	Diploneis elliptica
DP012A	Diploneis marginestriata
DT001A	Diatoma tenuis
EP001A	Epithemia sorex
EP007A	Epithemia adnata
EU003A	Eunotia cf. praerupta
EU009A	Eunotia exigua
EU013A	Eunotia arcus
EU016A	Eunotia diodon
EU032B	Eunotia serra var. diadema
EU047A	Eunotia incisa
EU070A	Eunotia bilunaris
EU106A	Eunotia rhyncocephala
EU107A	Eunotia implicata
EU108A	Eunotia intermedia
EU110A	Eunotia cf. minor
EU9999	Eunotia sp.
FA023A	Fallacia tenera
FR001A	Fragilaria pinnata
FR002A	Fragilaria construens
FR002B	Fragilaria construens var. binodis
FR002C	Fragilaria construens var. venter
FR005A	Fragilaria virescens
FR006A	Fragilaria brevistriata
FR009B	Fragilaria capucina var. mesolepta
FR009G	Fragilaria capucina var. rumpens
FR009H	Fragilaria capucina var. gracilis
FR009L	Fragilaria capucina var.amphicephala
FR014A	Fragilaria leptostauron
FR018A	Fragilaria elliptica
FR019A	Fragilaria intermedia
FR045A	Fragilaria parasitica
FR056A	Fragilaria pseudoconstruens
FR064A	Fragilaria exigua
FU002A	Frustulia rhomboides
GO001A	Gomphonema olivaceum
GO004A	Gomphonema gracile
GO006A	Gomphonema acuminatum
GO023A	Gomphonema truncatum
GO025H	Gomphonema cf. vibrio
GO050A	Gomphonema minutum
GO073A	Gomphonema angustum
GO080A	Gomphonema pumilum
GO9999	Gomphonema sp.
GY005A	Gyrosigma accuminatum
NA002A	Navicula jaernefeltii
NA003A	Navicula radiosa
NA007A	Navicula cryptocephala
NA008A	Navicula rhyncocephala
NA013A	Navicula pseudoscutiformis
NA014A	Navicula pupula
NA032A	Navicula cocconeiformis
NA037A	Navicula angusta
NA048A	Navicula soehrensis
NA066A	Navicula capitata
NA156A	Navicula leptostriata
NA433D	Navicula ignota var. acceptata
NA577B	Navicula porifera var. opportuna
NA738A	Navicula vitiosa
NA745A	Navicula capitoradiata
NA751A	Navicula cryptotenella
NA9999	Navicula sp.
NE036A	Neidium ampliatum
NI002A	Nitzschia fonticola
NI008A	Nitzschia frustulum
NI015A	Nitzschia dissipata
NI020A	Nitzschia angustata
PI001A	Pinnularia gibba
PI005A	Pinnularia maior
PI007A	Pinnularia viridis
PI014A	Pinnularia appendiculata
PI016A	Pinnularia divergentissima
PI9999	Pinnularia sp.
RE001A	Reimeria sinuata
RH001A	Rhopalodia gibba
SA001A	Stauroneis anceps
SA003A	Stauroneis smithii
SY011A	Synedra delicatissima
TA9997	Tabellaria [flocculosa (short)]
TA9998	Tabellaria [flocculosa (long)]
TA001A	Tabellaria flocculosa agg.
FR009A	Fragilaria capucina agg.