Hydroclimate variability during the past millennium: a new record from West Basin Lake, Victoria

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HYDROCLIMATE VARIABILITY DURING THE PAST MILLENNIUM: A NEW RECORD FROM WEST BASIN LAKE, VICTORIA

HYDROCLIMATE VARIABILITY IN SOUTH-EASTERN AUSTRALIA

ABSTRACT

Our understanding of the long-term climate variability in Australia is limited by the number of high-resolution climate reconstructions. High-resolution palaeoenvironmental studies in Australia spanning more than a millennium are required to identify regional coherency among records and to recognise the relationships between climate and environmental conditions. This research project aims to investigate the nature of decadal-centennial scale climate and hydroclimate variability in south-eastern Australia. A record of hydrological change is established for the past millennium at West Basin Lake, a maar lake located in western Victoria. Palaeoclimate variability is inferred from sedimentary diatom analysis, and is used to reconstruct lake water salinity. These data are interpreted in conjunction with element concentration data. The record indicates that West Basin Lake underwent hydrological variability on a decadal-centennial timescale. The diatom record shows evidence of a more variable climate during 932-550 cal BP and less saline conditions from 500-100 cal BP. The record also identifies a multi-decadal period of increased salinity from 625-575 cal BP. This suggests a more variable climate during the past millennium than observed since European settlement. The record established from this study provides a regionally coherent palaeoclimate reconstruction of the last millennium for western Victoria, Australia.

KEYWORDS

Hydroclimate variability
Diatoms
Lake sediment
Palaeoclimatology
South-eastern Australia

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1. INTRODUCTION

The palaeoclimate records of the Southern Hemisphere are significantly less established than the Northern Hemisphere. Our understanding of decadal-centennial scale climate variability in the Southern Hemisphere is limited by the sparsity of available datasets (Barr et al. 2014). While many previous studies have focused on the climate of the past two millennia, there is a need in Australia for high-resolution, hydrologically sensitive records that span the past millennium (Jansen et al. 2007). Consequently, the causal mechanisms and geographical coherency behind long term droughts and pluvials remains uncertain (Jones et al. 2009).

Environmental climate proxies can provide the long records needed to understand past climate variability. A variety of proxy archives are used to reconstruct past climate, including marine and lake sediments, speleothems, tree rings, and coral (Jones et al. 2001, Neukom and Gergis 2012). In Tasmaina tree rings have been used to reconstruct mean warm-season temperatures (Cook et al. 2000). Throughout southern Australia speleothems have been studied for their ability to record environmental change (Fairchild and Treble 2009). Lake sediments are useful because they are ubiquitous, span periods of thousands to millions of years, are easy to access, and sediments are deposited frequently so cores can be studied in high-resolution (Battarbee 2000). Long records of terrestrial climate variability are obtained from lakes using a variety of proxies, such as diatom flora, ostracod chemistry and pollen flora. Previous research at West Basin Lake demonstrated that diatom microfossils provide a valuable source of palaeohydrological information throughout the Holocene (Gell et al. 1994).

Diatom analysis is a proxy used to reconstruct past water parameters (Baker et al. 2001). Diatom distribution is highly correlated with the hydrochemistry of a lake (Gasse et al. 1997). Central to the use of diatom microfossils and palaeoclimate tracers is the assumption that species assemblages within a sediment sample is representative of the living community from which it was derived (Ryves et al. 2001). Diatom preservation is influenced by pH, temperature, salinity and ionic strength, as well as biological interactions (Ryves et al. 2006). Partial diatom dissolution can bias assemblages to more resistant taxa, with implications for reconstructing environmental and ecological change (Ryves et al. 2006). Further bias to the fossil diatom record arises from breakage of diatom frustules, but saline waters cause a more severe problem of chemical dissolution and diagenesis of diatom frustule silica (Barker et al. 1994). Australia has numerous saline lakes due to the predominance of arid to semi-arid climates and closed drainage basins (Last and Deckker 1990). An objective method for assessing preservation is necessary to incorporate with diatom counting, such as assessing and classifying valve preservation into distinct categories to improve models and reduce uncertainty (Ryves et al. 2009, Mills et al. 2013).

Palaeoenvironmental reconstructions have progressed predominantly from the work of Imbrie and Kipp (1971) and have been developed for the reconstruction of temperature, productivity, conductivity/salinity, pH and lake depth (Gomes et al. 2014). Transfer function accuracy is improved by enhanced training sets and statistical techniques (Battarbee et al. 2008). Despite the inevitable information lost from the living community to the death assemblage, incorporating preservation information improves inferences of past environments (Ryves et al. 2009).

Understanding the major atmospheric and oceanic climate systems that influence Australia's climate, such as the El Nino-Southern Oscillation (ENSO), the Southern Annular Mode (SAM), the Indian Ocean Dipole (IOD) and the Inter-decadal Pacific Oscillation (IPO) is important for resolving hydroclimate variability (Turney et al. 2006). These systems are potentially highly sensitive to future climate change so it is necessary to understand these processes for economic, social and environmental reasons (Turney et al. 2006).

This project aims to build upon previous research by developing a decadally resolved record of hydrological change for the last 1000 years using diatom species assemblages and semi-quantitative estimates of diatom dissolution. Existing scanning micro X-ray fluorescence data are also used, and a detailed chronology is established. The multi-proxy record of hydrological change at West Basin Lake, coupled with a detailed and robust chronology obtained through radiocarbon dating provides valuable insights into the nature of climate and hydroclimate variability in south-eastern Australia, including the frequency and duration of multi-decadal droughts and the regional coherency of hydrological change.

2. BACKGROUND

West Basin Lake is a maar lake located in the volcanic plains of Western Victoria (Last and Deckker 1990) approximately 150 km west of Melbourne (Figure 2). The plains were formed approximately 60-110 million years ago during the rifting between Australia and Antarctica (Mutter et al. 1985). These plains are overlain by Cretaceous sandstone and Tertiary limestone and marl (Price et al. 1997). Numerous crater lakes and maars have led to the region being the focus of palaeoclimate research (Barr et al. 2014). West Basin Lake has steep inner walls that rise 20 meters above the surface of the lake (Gell et al. 1994). The steep-sided walls result in a relatively small non-water surface catchment area compared to water surface area (Figure 1). Last and Deckker (1990) suggested West Basin Lake to be a hydrologically and topographically closed basin with little influence from the regional groundwater aquifers. However, Barton et al. (2013) recently proposed that West Basin is an evaporating or terminal lake with high groundwater dependence and this interpretation is supported by unpublished geochemical data (P. Dahlhaus and M. Currell).

The climate variability of the mid- to late- Holocene is highlighted by several previous studies. The period of 650-800 CE was characterised by multi-decadal aridity, resulting in saline lake environments (Gouramanis et al. 2010, Barr et al. 2014). The climate was variable from 800-1400 CE, during which centennial-scale hydrological and temperature anomalies were widely reported (Wilkins et al. 2013, Barr et al. 2014). Following this, from 1400-1880 CE the climate records indicate persistently high Precipitation-Evaporation (P: E) ratio (Jones et al. 2001, Gergis et al. 2012, Wilkins et al. 2013, Barr et al. 2014). More recently, a reduction occurred in the P: E ratio, from

1880 CE to present (Jones et al. 2001, Barr et al. 2014). Millennium scale high-resolution studies of past climates in Australia are rare and there is still a need for better understanding of the past climate of Australia (Mayewski et al. 2004, Barr et al. 2014)

Figure 1: West Basin Lake from the top of the basin, taken in June 2015. Note the steep basin sides, lack of vegetation and exposed shoreline, as well as small area of revegetation work.

The modern regional climate of western Victoria is characterised by hot, dry summers and cool, wet winters (Barr et al. 2014). Mean annual rainfall varies from 1600 mm to 600 mm (Barr et al. 2014). The majority of winter rainfall is associated with the prevailing westerlies delivering moist air masses from the Southern Ocean (Barr et al. 2014). The strength and position of the westerlies is influenced by the SAM, in conjunction with the IOD, the ENSO and the IPO (Barr et al. 2014).

The vegetation surrounding West Basin is pastureland, with some remnants of original grasslands. Monthly average and median rainfall and temperature at Camperdown, a small town located approximately 30 km north-west of West Basin are given in Table 1 and mean annual temperature and rainfall statistics in Table 2 (BOM 2015).

Table 1: Monthly rainfall and temperature statistics for Camperdown, Victoria (BOM 2015). Mean max temp is the result of 64 years of data, mean min temp is the result of 63 years of data, mean rainfall is the result of 105 years of data and median rainfall in the result of 104 years of data.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Mean max temp (°C)	26.1	26.1	23.7	19.2	15.7	13.0	12.6	13.6	15.9	18.5	20.7	23.7
Mean min temp (°C)	11.6	12.3	11.0	8.7	6.8	4.8	4.2	4.8	6.1	7.4	8.8	10.4
Mean rainfall (mm)	38.2	38.7	46.6	60.5	75.0	78.9	81.4	91.5	82.1	73.6	61.1	48.8
Median rainfall (mm)	33.4	27.7	39.7	54.7	70.8	82.3	80.3	87.5	78.3	68.3	56.8	47.3

Table 2: Mean annual temperature and rainfall statistics for Camperdown, Victoria (Gell et al. 1994, BOM 2015).

Statistic	**Value**	**Years of data**	**Reference**
Mean annual rainfall (mm)	775.9	105	BOM 2015
Median annual rainfall (mm)	773.4	104	BOM 2015
Mean annual evaporation (mm)	1220		Gell 1994
Mean max temperature (°C)	19.1	64	BOM 2015
Mean minimum temperature (°C)	8.1	63	BOM 2015

3. METHODOLOGY

3.1 Sediment coring and subsampling

Four, six meter Mackereth cores were collected from West Basin in October 1986 (Gell et al. 1994). Core WB 86-2 was taken from near the deepest part of the lake (Figure 2c). WB 86-2 A is the topmost portion of the core. The uppermost 50 cm of core WB 86-2 A was used for this study. The core was opened and transported to the University of Adelaide in 2013 and is wrapped in polyethylene and stored in the dark at 4ºC. The upper 50 cm of core WB 86-2 A was removed using the 'LL-section method' (Nakagawa 2007). With a scalpel, 0.5 cm of contiguous samples were taken and transferred into labelled and weighed 15 ml plastic tubes. The scalpel was cleaned with deionised (DI) water between samples.

3.2 Chronology

To complement existing chronology for West Basin Lake on unidentified coarse organic fragments (J.J. Tyler unpublished), a series of radiocarbon analyses were conducted on ostracod fossils. Sediment samples of approximately 5 cm^3 (1 cm thickness) were disaggregated, sieved through a 250 µm stainless steel sieve with DI water, and freeze dried. Ostracods were picked under a binocular microscope and transferred to a labelled, ashed glass vial using a needle for depths 3-4 cm, 8-9 cm, 16-17 cm, 33-34 cm, 98-99 cm, 107-108 cm, 108-109 cm. Radiocarbon dates were obtained at Australian Nuclear Science and Technology Association (ANSTO) in Sydney, Australia. A Small Tandem for Applied Research (STAR) Accelerator and the Australian National Tandem Research Accelerator (ANTARES) Accelerator were used for radiocarbon dating.

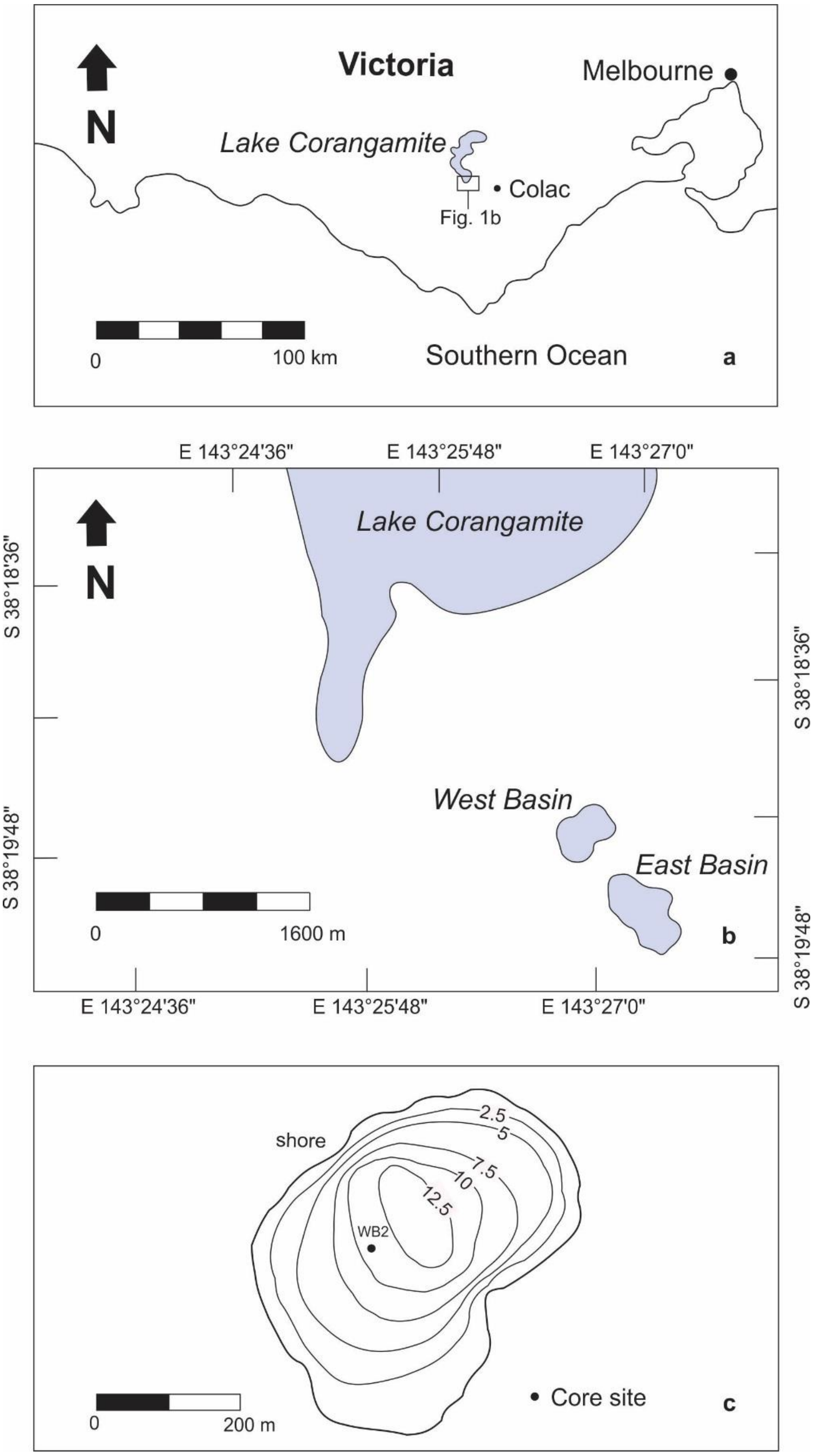

Figure 2: (a) location of lake area relative to regional setting, modified from Barr et al. (2014), (b) Simplified Google Earth (2015) base map showing the location of West Basin Lake, (c) bathymetry map of West Basin Lake, modified after Gell et al. (1994).

Data collection was funded by an AINSE honours scholarship. A combination of new and existing dates were used to derive an age model through the program 'R' and the package 'CLAM' (Blaauw 2010). The ages of specific sample depths were interpolated using a 0.3 spar smooth spline and errors inferred via 1000 Monte Carlo iterations.

3.3 Diatom sample preparation

Diatom preparation followed the method of Battarbee et al. (2001). Samples were treated with 3-4 ml of 10-15% hydrochloric acid (HCl) to remove carbonate material. To remove organic matter samples were treated with 5-6 ml of 25% Hydrogen Peroxide (H_2O_2). Ammonia was used as a flocculating agent to remove excess clay (Hinchey and Green 1994). During preparation samples were settled, rather than centrifuged, to minimise damage to fragile diatom valves (Battarbee et al. 2001).

Two cover slips were prepared for each sample (a and b) and affixed onto a microscope slide using NAPHRAX. The volume in the tube at the time each sample was taken, and the volume pipetted onto each coverslip was recorded. In some cases, a process of trial and error was required to optimise the concentration of diatoms on each slide.

Samples were counted using a Nikon Eclipse E600 light microscope with 1500x optical magnification. To maximise both the number of samples analysed in this study and the quality of data collected, counting 100 valves was deemed most efficient. The count of 100 valves is sufficient to identify short-term episodes (Renberg 1990). Samples were only counted for 10 transects of approximately 20 mm length if less than 100 valves were found.

Diatom species were identified using diatom species identification texts (Krammer and Lange-Bertalot 1986, Krammer and Lange-Bertalot 1988, Krammer and Lange-Bertalot 1991a, Krammer and Lange-Bertalot 1991b, Gell et al. 1999, Lange-Bertalot 2000). Modern nomenclature was determined through current online databases, including AlgaeBase (Guiry and Guiry 2015) and the World Register of Marine Species (Mees et al. 2015).

To account for possible variability in the degree of diatom dissolution, four dissolution states (D1-D4) were identified during counting and applied to each diatom valve counted following Ryves et al. (2009). A dissolution state of D1 indicates a pristine state and higher states indicates progressively increased dissolution (Table 3).

Table 3: Description of the four dissolution states identified during counting

Dissolution state	Description
D1	Perfectly preserved
D2	> 75% remain
D3	75% > 60% remain
D4	60% > 55% remain

3.4 Data analysis

The fractional index (FI) is used in this study and relates the proportion of pristine valves to all valves that can be classified (Barker et al. 1994). The index varies from 0 to 1, where F=1 indicates that all valves are perfectly preserved and F=0 indicates that valves appear dissolved under light microscopy (Ryves et al. 2001, Flower 1993).

Diatom data were plotted using the program ‘R’ and the package ‘rioja’ (Juggins 2015). Species occurrences with a relative abundance greater than 5% are shown, and samples with a minimum diatom count of less than 20 are not included. Three main zones were identified through the “coniss” algorithm (Grimm 1987). Ecology of species was identified through AlgaeBase (Guiry and Guiry 2015) and the World Register of Marine Species (Mees et al. 2015). Optimal salinity and pH ranges of various diatom species were determined from previous work by Gell (1997) and Wilson et al. (1996). The concentration of diatoms per gram of wet sediment was calculated in excel using the diatom counts, fraction of sediment subsampled and total area of transect analysed. Diatom data was compared with high-resolution element profiles collected from an Itrax-XRF core scanner.

Species were modelled using detrended correspondence analysis (DCA). DCA analysis was completed using modified script for the program ‘R’ using packages “analogue” (Simpson and Oksanen 2015) and “vegan” (Oksanen et al. 2015).

A salinity reconstruction was produced using a diatom salinity transfer function. Quantitative estimates of lake water salinity change were inferred using the Weighted Average Partial Leas Squares (WAPLS) salinity transfer function from Gell (1997; R^2 = 0.77, Root Mean Square Error of Prediction= 0.31).

4. RESULTS

4.1 Chronology

Seven samples were submitted to AINSE for ^{14}C age dating but due to small sample size only five were analysed. An age model for the upper sediments of West Basin Lake was constructed based on (Lead-210) ^{210}Pb and radiocarbon (^{14}C) ages. Sample OZS802 was of sufficient mass to be analysed on the STAR accelerator and returned a reasonable age that is included in the age model (Figure 3). The four smaller samples (OZS797, OZS799, OZS800, and OZS801) were measured on the ANTARES accelerator. These samples varied over 100 cm in depth, however, they all returned ages within 80 years of each other (from 710-790 years BP ± 1σ error). These four ages were rejected from the age model as they do not agree with the previous chronological work of West Basin Lake.

Table 4: Ostracod radiocarbon results obtained through the AINSE Honours Scholarship. Sample OZS802 was dated at the Australian Nuclear Science and Technology (ANSTO) facility using the Small Tandem for Applied Research (STAR) Accelerator, and the remaining samples using the Australian National Tandem for Applied Research (ANTARES) Accelerator due to small sample size (Fink et al. 2004). Note that ages are in years Before Present (cal BP), where BP= 1950 CE.

Accelerator	Laboratory code	Depth (cm)	$\delta^{13}C$ (per mil)	Percent Modern Carbon (pMC ± 1σ error)	Conventional Radiocarbon age (cal BP ± 1σ error)
STAR	OZS802	108-109	0.0	71.28 ± 0.27	2720 ± 30
ANTARES	OZS797	16-17	0.0	91.51 ± 1.04	710 ± 100
ANTARES	OZS799	107-108	0.0	90.81 ± 1.00	770 ± 90
ANTARES	OZS800	98-99	0.0	90.65 ± 1.11	790 ± 100
ANTARES	OZS801	8-9	0.0	91.56 ± 0.43	710 ± 40

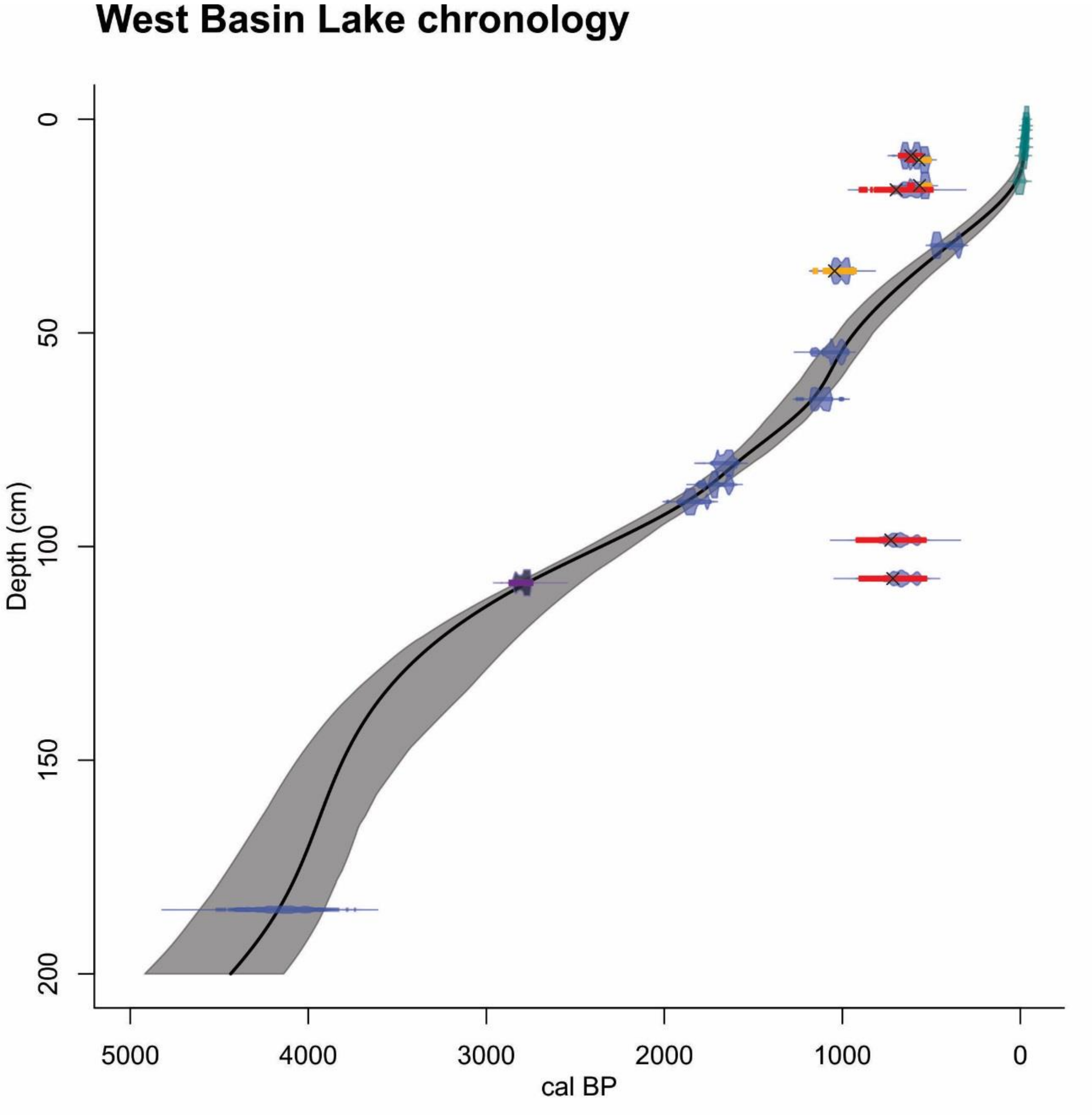

Figure 3: Age model of West Basin Lake. Green: previously accepted ^{210}Pb dates, Blue: previously accepted radiocarbon dates from coarse organic fragments, Orange, previously rejected radiocarbon dates from coarse organic fragments, Red: new ANTARES radiocarbon dates from ostracods, rejected, Purple: new STAR radiocarbon date from ostracods, accepted. Age model constructed using CLAM (Blaauw 2010), and a 0.3 spar smooth spline interpolation. Note that ages are in years Before Present (cal BP), where BP= 1950 CE.

4.2 Diatom analysis

The diatom diagram for West Basin Lake shows taxa with a relative abundance greater than 5% (Figure 4). Three main zones were identified in the record; zone 1 from -35 to 60 cal BP, zone 2 from 60 to ~600 cal BP, and zone 3 from ~600 to 932 cal BP.

Zone 3: ~600 to 932 cal BP (36-50 cm)

Achnanthes brevipes dominates this section, with a maximum relative abundance of 75.9%. The classification *Achnanthes brevipes* includes unidentified varieties as well as the variety *Achnanthes brevipes var brevipes*. This species shows cyclic fluctuations within zone 3 on a 150-200 year timescale. The peaks in *Achnanthes brevipes* occur during periods of very low, or the absence of the diatom *Rhopaloda acuminata*. Other taxa prevalent in zone 3 include *Pinnunavis yarrensis*, *Seminavis robusta, Cocconeis placentula var. euglypta* and *Cocconeis neodiminuta*, and *Rhopalodia musculus*. *Pinnunavis yarrensis* has a significant, prolonged occurrence around 575-625 cal BP. This is notable due to the very low relative abundance of *Pinnunavis yarrensis* previous to 625 cal BP and absence following 575 cal BP. *Seminavis robusta* has multiple occurrences in zone 3, all of which show an immediate peak followed with a decrease in abundance with shallower depth. *Seminavis robusta* abundance decreases in zone 3 with decreasing depth. The species *Cocconeis placentula var euglypta* and *Cocconeis neodiminuta* also shows significant occurrences. *Cocconeis placentula var. euglypta* has a greater relative abundance than *Cocconeis neodiminuta*, and both species have peaks in relative abundance at the time of low relative abundance of the other species. *Rhopalodia musculus* shows sporadic peaks throughout zone 3, with a maximum relative abundance of 50%.

Zone 2: 60 to ~ 600 cal BP (17-36 cm)

Achnanthes brevipes decreases in relative abundance with decreasing depth in zone 2 as does *Seminavis robusta*. *Cocconeis neodiminuta* and *Cocconeis placentula var. euglypta* continue to dominate the diatom record, however, *Cocconeis placentula var. euglypta* has a lower maximum relative abundance than occurred in zone 3. The species *Nitzchia frustulum* is more prevalent in zone 2 than in zone 3 with a maximum relative abundance of 30%. Sediments younger than 266 cal BP are marked by the appearance of a range of taxa including *Humidophila contenta*, *Luticola mutica*, and *Pinnularia borealis var rectangularis*, and the increase in the species *Rhopalodia musculus and Staurosirella pinnata.* The appearance of species not previously recorded corresponds with the significant decrease in *Achnanthes brevipes* and *Seminavis robusta*. The increase in abundance of *Staurosirella pinnata* with decreasing depth also corresponds with the decrease in *Achnanthes brevipes* and *Seminavis robusta*.

Zone 1: -35 to 60 cal BP (0-17 cm)

Zone 1 is dominated by the species *Cocconeis neodiminuta* and *Cocconeis placentula var. euglypta*. Both species have a high number of occurrences and reach their maximum relative abundances in zone 1. *Rhopalodia musculus* is common in zone 1, but they do not reach the maximum relative abundance observed in zone 3. *Staurosirella pinnata* is also increasingly abundant in zone 1 reaching a maximum relative abundance of 30%. The species *Rhopalodia acuminata, Seminavis yarrensis* and *Achnanthes brevipes* reappear at the top of the diatom record albeit in low relative abundances.

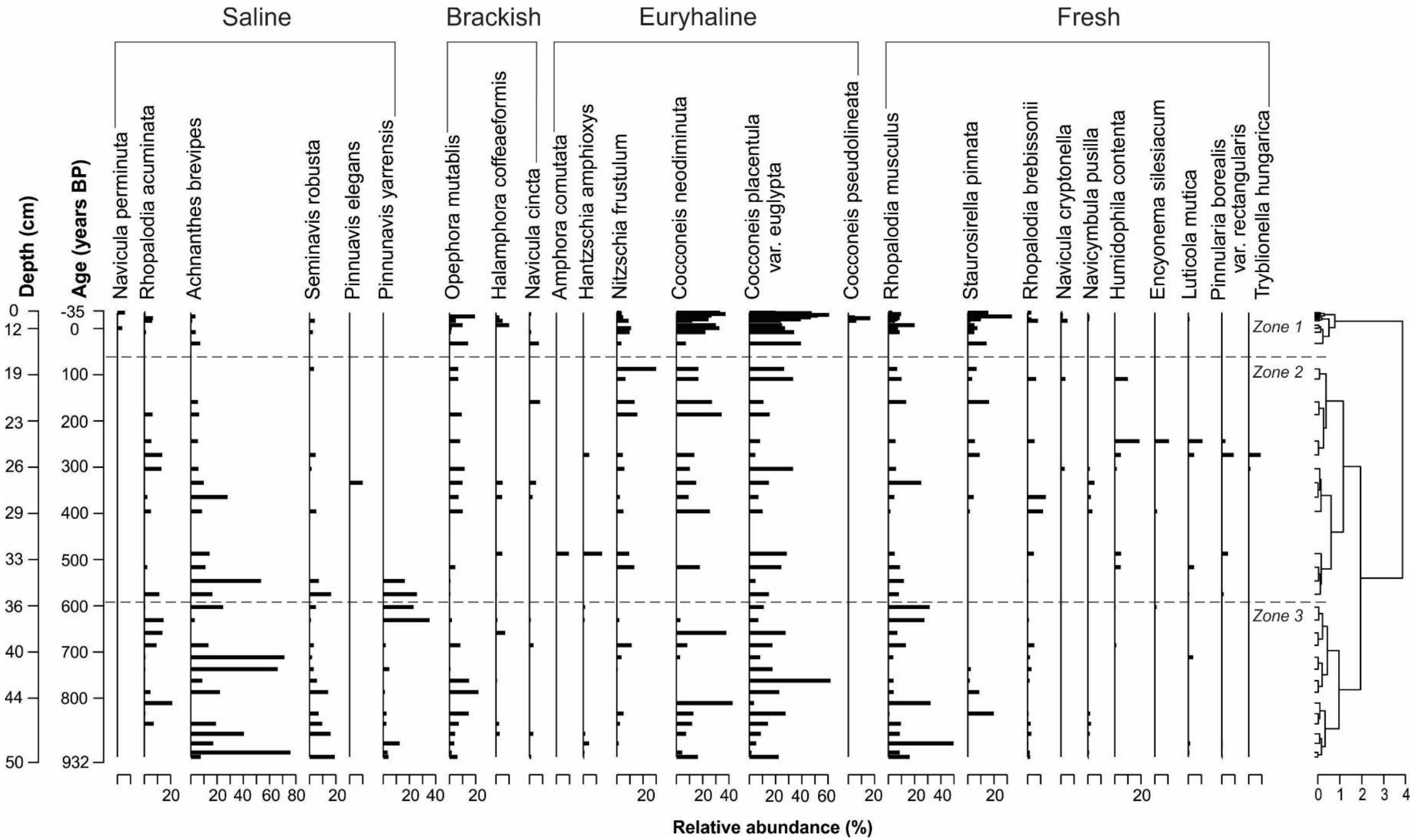

Figure 4: Diatom diagram for West Basin Lake showing the relative abundance of the taxa with greater than 5% relative abundance. Species are ordered according to ecological preferences; saline, brackish, euryhaline (have a broad salinity tolerance), and fresh AlgaeBase (Guiry and Guiry 2015), World Register of Marine Species (Mees et al. 2015). Diatom data plotted against age (years Before Present, BP=1950 CE), with depth (cm) for reference.

Comparison of three subsets of FI data (Figure 5) shows that small scale fluctuations in FI due to small sample size bias exist, but overall the same trends are indicated. The FI indicates the extent of dissolution on a scale of 0 to 1, with an index of F=0 indicating poor preservation, and F=1 indicating all valves are in perfect preservation state (Flower 1993, Ryves et al. 2001). Figure 6 shows the relationship between the concentration of diatoms in each sample (diatoms per gram of wet sediment) and the FI. Generally, the greater the number of diatoms counted, the lower the FI, indicating greater dissolution. The samples with the highest diatom count (greater than 100 counts) had some of the lowest FI.

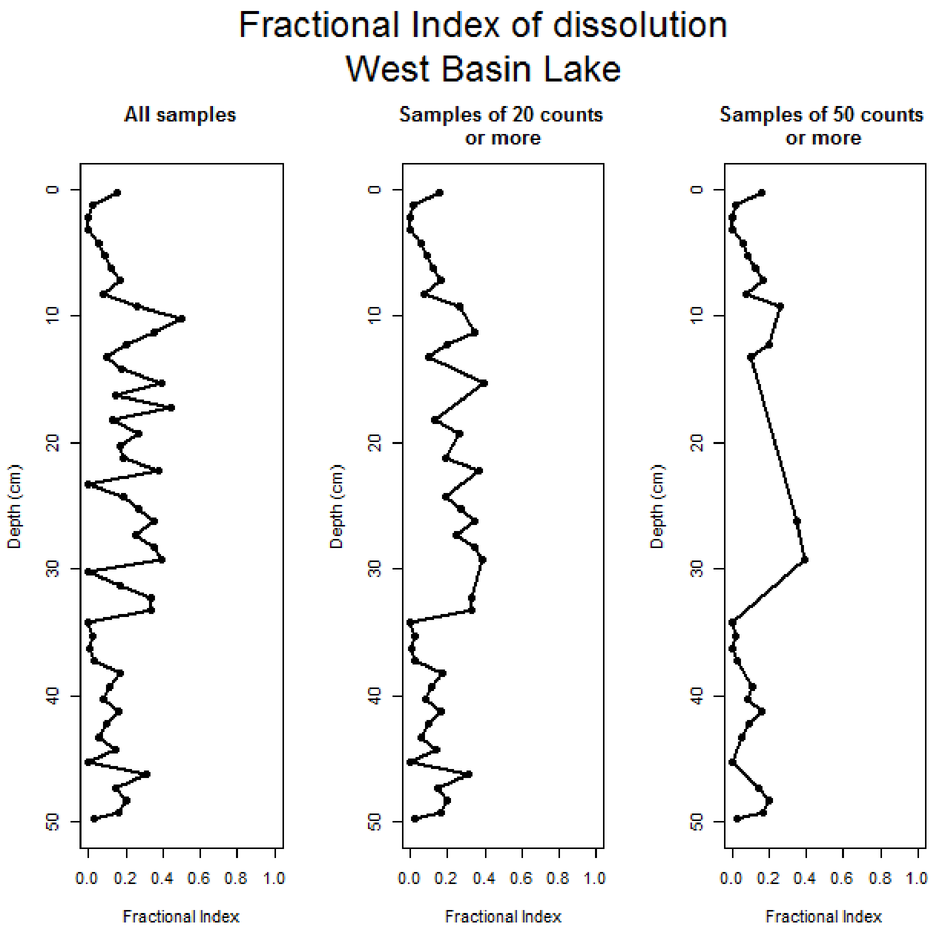

Figure 5: Fractional index (FI) for (a) all samples, (b) samples with 20 counts or more, and (c) samples with 50 counts or more illustrating the FI of diatom dissolution down core. FI plotted for a number of minimum sample diatom counts to identify trends that may exist due to low count bias.

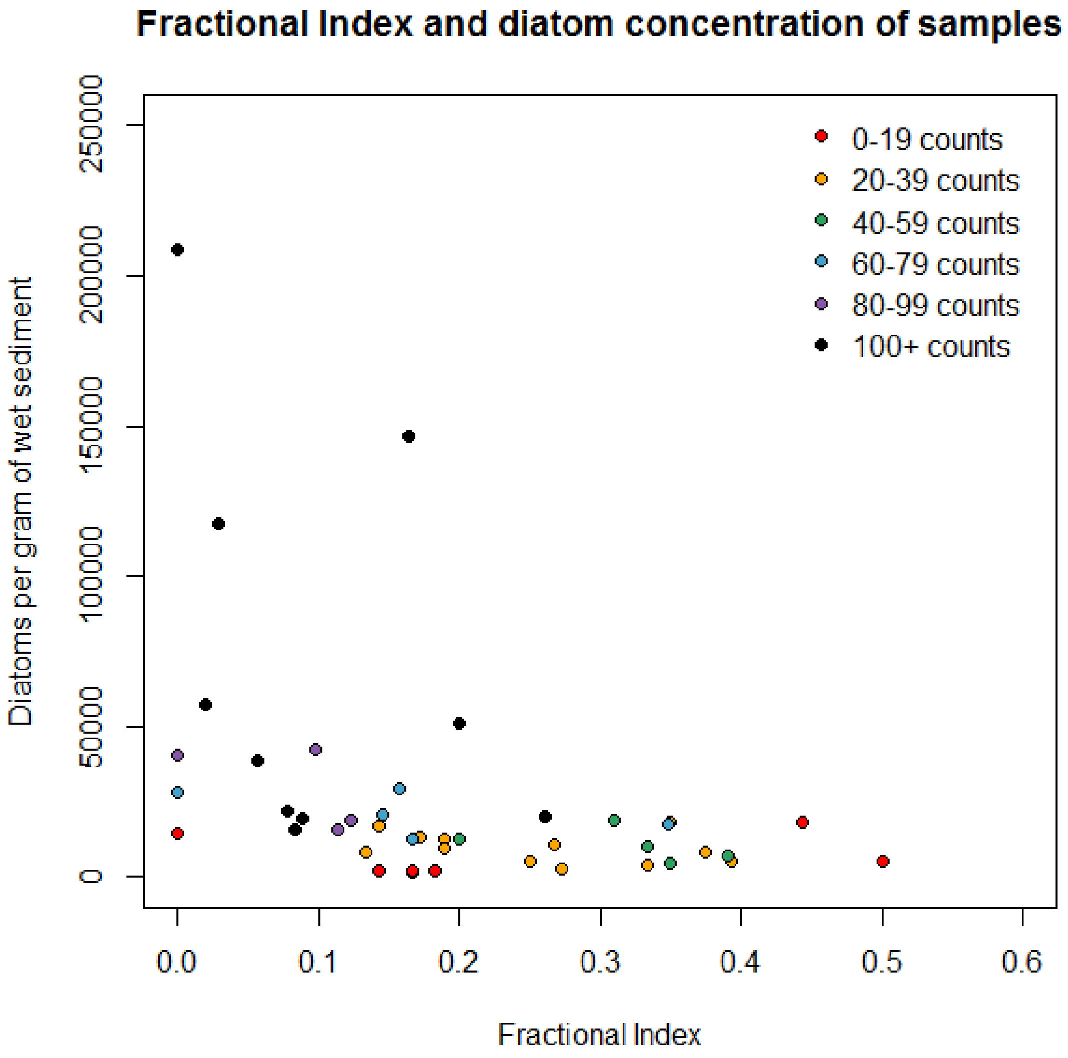

Figure 6: Fractional index of dissolution for each sample plotted against the total number of diatom valves/g within the sediment. FI = 0 reflects the more dissolved samples. Samples are plotted according to the number of diatoms counted as depicted in the legend.

4.3 Data analysis

Plotting the relative abundance of diatom species against the FI identifies correlations between species abundances and the FI (Figure 7). Many species demonstrate that increased relative abundance occurs with a greater FI value. Species such as *Rhopalodia acuminata*, *Rhopalodia brebissonii*, and *Opephora mutablis* show this pattern. Species such as *Seminavis robusta*, *Cocconeis placentula var euglypta*, and *Pinnunavis yarrensis* show the opposite trend; that increased relative abundance of a diatom species occurs with decreasing FI. Many species show no discernible trend and the relative abundance remains low despite a change in preservation.

Detrended correspondence analysis (DCA) compares the two axes of variance, DCA 1 and DCA 2 (Figure 8). The deeper (older) samples generally plot near the saline species, while the shallower (younger) samples plot closer to the fresh species. This transition from salty to fresh correlates with the diatom diagram (Figure 4).

Figure 9 shows a negative correlation between *Achannthes brevipes* concentration and logCa/logTi concentration, as well as a positive correlation between *Cocconeis neodiminuta* and logCa/logTi concentration. Both *Achnantehs brevipes* and *Cocconeis* neodiminuta vary cyclically on a ~100-200 year timescale, as does the logCa/logTi.

The salinity reconstruction of West Basin Lake shows a general decrease in the salinity of West Basin Lake (Figure 10). From 932-575 cal BP (1018-1375 CE) the salinity is high, then from 550 cal BP (1400 CE) shows a less saline record. Most recently around 300 cal BP (1650 CE) the salinity level is much lower. These patterns support the salinity reconstruction (Figure 10).

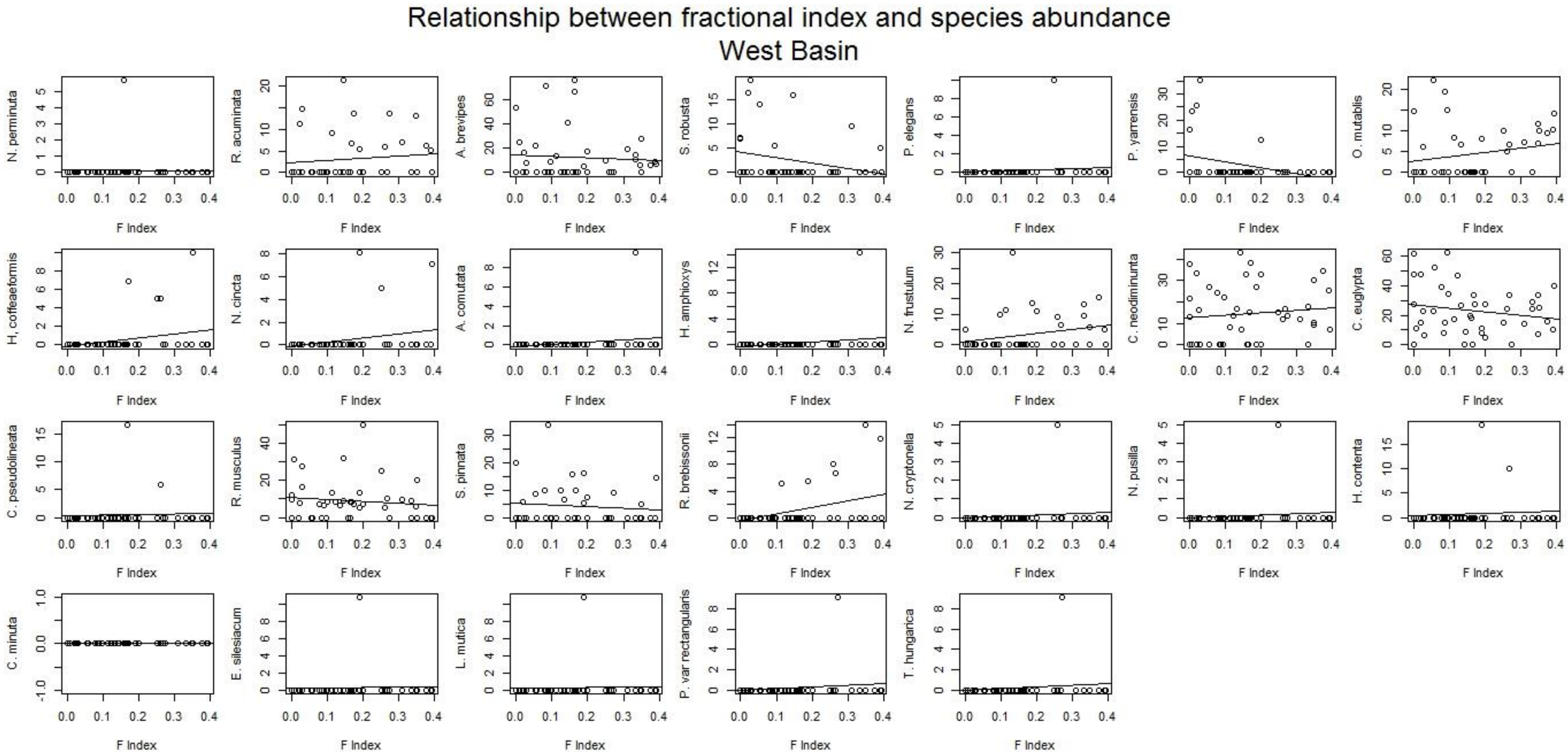

Figure 7: Diatoms species concentration (diatoms per gram of wet sediment) and fractional index (FI) showing the relationship between species abundance and preservation state

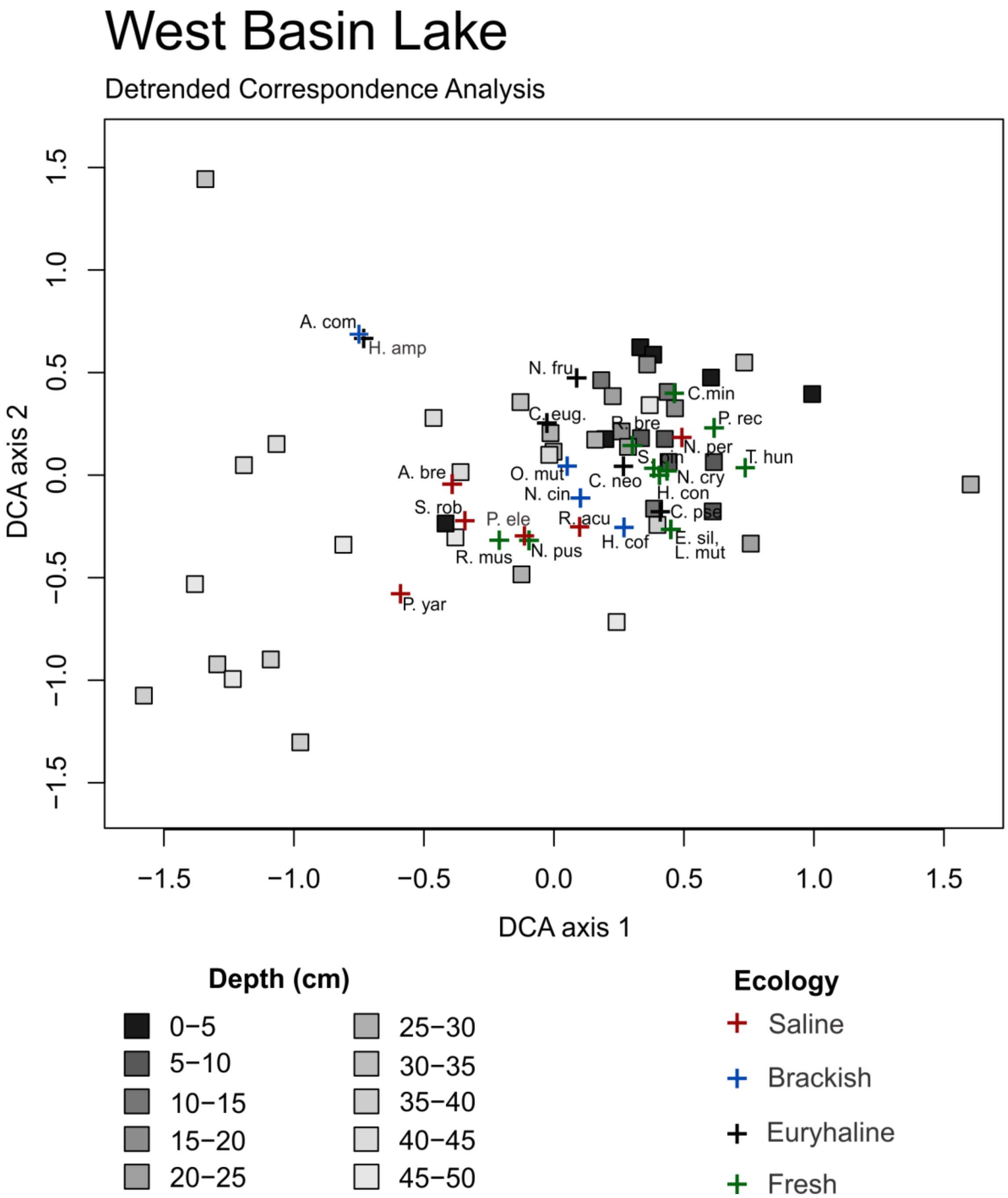

Figure 8: Detrended Corresponded Analysis for West Basin Lake, Victoria. DCA axis 1 shows the first fraction of variance and DCA axis 2 shows the second fraction of variance. Boxes represent samples and are shaded according to the depth (cm). Crosses represent diatom species and are coloured according to ecology; saline (red), brackish (blue), euryhaline (black), and fresh (green). Species abbreviations: A. bre (Achnanthes brevipes), A. com (Amphora comutata), C. eug (Cocconeis placentula var. euglypta), C. min (Cymbella minuta), C. neo (Cocconeis neodiminuta), C. pse (Cocconeis pseudolineata), E. sil (Encyonema silesiacum), H. amp (Hantzschia amphioxys), H. con (Humidophila contenta), L. mut (Luticola mutica), N. cin (Navicula cincta), N. cry (Naviucla cryptonella), N. fru (Nitzschia frustulum), N. per (Navicula perminuta), N. pus (Navicymbula pusilla), O. mut (Opephora mutablis), P. ele (Pinnunavis elegans), P. rec (Pinnularia borealis var. rectangularis), P. yar (Pinnunavis yarrensis), R. acu (Rhopalodia acuminata), R. mus (Rhopalodia musculus), S. pin (Staurosirella pinnata), S. rob (Seminavis robusta), and T. hun (Tryblionella hungarica)

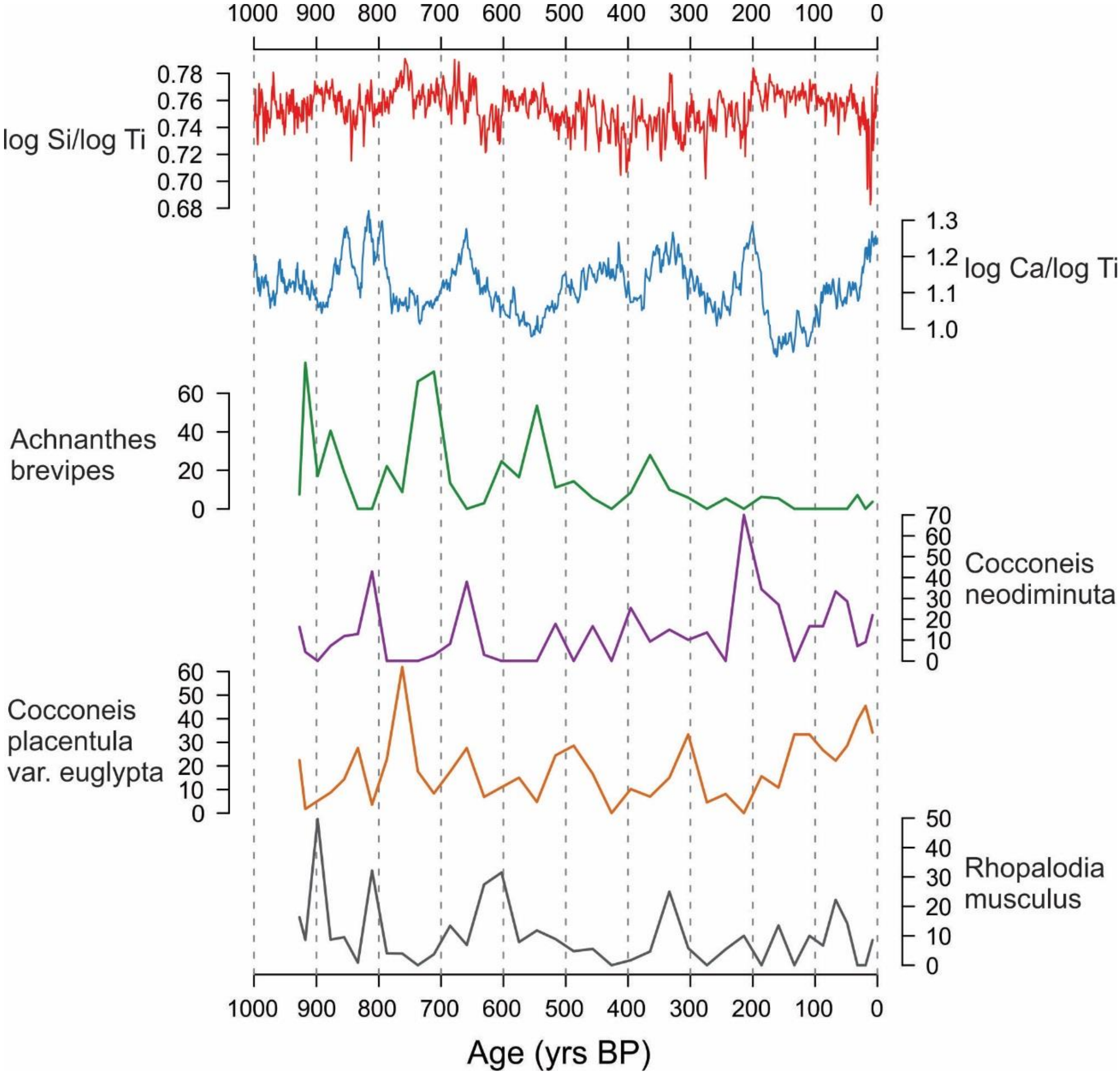

Figure 9: tsplot of logSi/logTi, logCa/logTi itrax data in comparison with relative abundance (%) of *Achnanthes brevipes*, *Cocconeis neodiminuta*, *Cocconeis placentula var euglypta*, and *Rhopalodia musculus*.

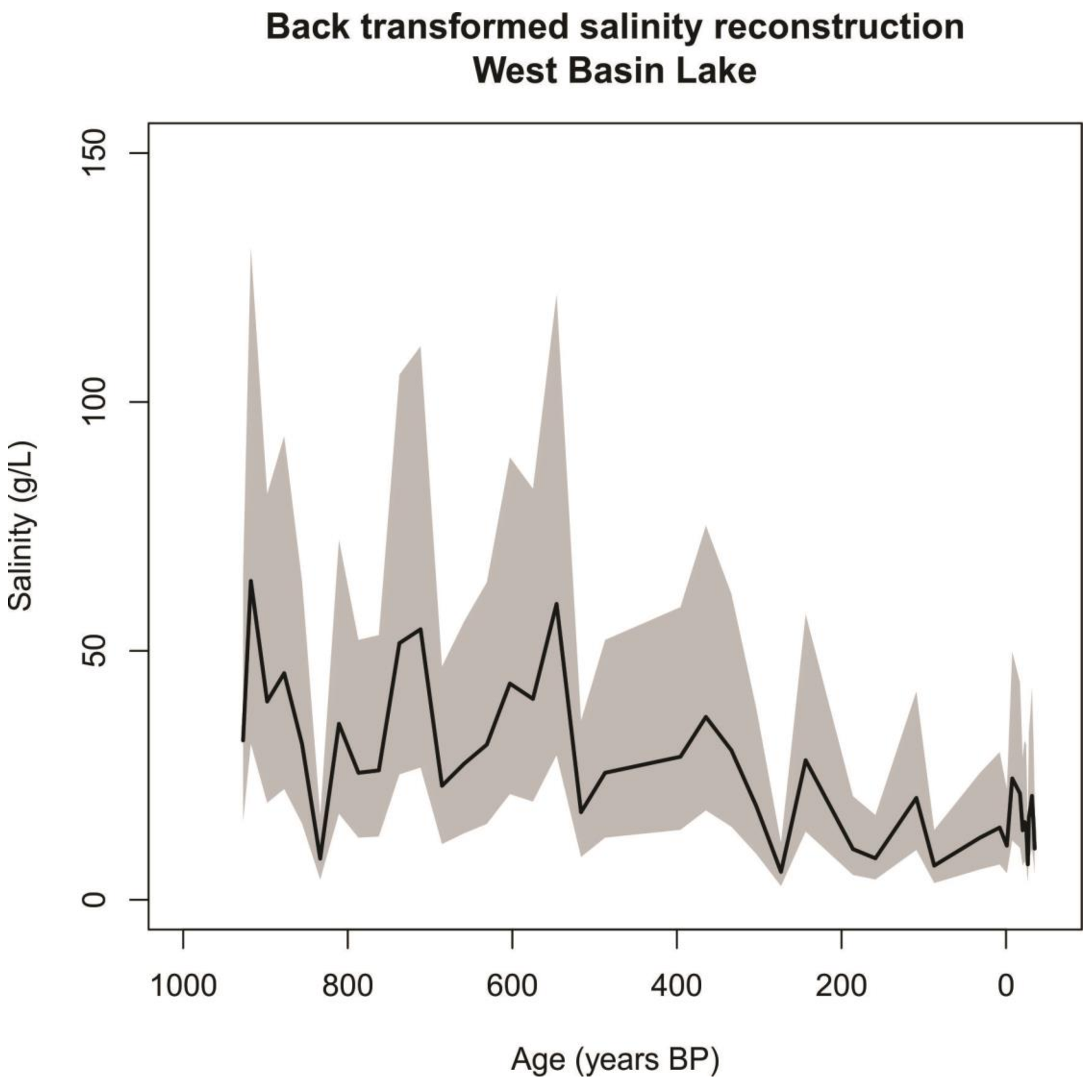

Figure 10: Salinity reconstruction using diatom salinity transfer function and training set developed by Gell (1997). Black line represents salinity reconstruction, and grey area represents uncertainty (RMSEP= 0.31).

5. DISCUSSION

5.1 Data interpretation

5.1.1 DEPOSITIONAL HISTORY

Palaeoclimate research requires a robust chronology. Existing ^{210}Pb and ^{14}C ages for West Basin Lake were analysed from bulk organic fragments. Though it is likely the fragments are from terrestrial plants, they may also consist of aquatic plant material (which can take in old carbon), or contain fragments of charcoal and appear older than the age of deposition (Oswald et al. 2005).

Ostracod shells are an excellent material for radiocarbon dating (Gouramanis et al. 2010, Wilkins et al. 2013). As an ostracod grows the chemical elements of the valves come directly from the ambient water (Turpen and Angell 1971). The carbon isotopic signature is the complex result of lake and external processes (Gouramanis et al. 2010). Ostracod carbonate has been used for radiocarbon analysis of lake sediments elsewhere in Victoria, providing ages consistent with other techniques (Gouramanis et al. 2010, Wilkins et al. 2013). However, problems with offset radiocarbon ages are common for western Victorian lakes (Wilkins et al. 2012, Barr et al. 2014). The region is underlain by limestone (Price et al. 1997) and ancient carbon is dissolved and transported to lake waters via groundwater, resulting in the reservoir effect. Unfortunately, all but one of the ostracod ages give a similar ag and are within 710-790 cal BP ± 1σ error. The other sample (OZS802) provided an age which falls roughly in line with the existing ages, at ~2000 cal BP and thus, appears to be realistic.

The ^{210}Pb and ^{14}C dating of coarse organic fragments for West Basin Lake indicate that the four ANTARES ^{14}C ostracod samples should span up to 2000 years. Instead, the ages fall within 90 years. Existing ages indicate these four similar ostracod ages obtained from West Basin Lake are unlikely to represent rapid sediment deposition or sediment mixing during a shallow water phase. Wilkins et al. (2012) ^{14}C dating of modern ostracod carbonate in Lake Keilambete, close to West Basin Lake, demonstrated a reservoir age of 670 ± 175 years. If the reservoir effect was the only factor affecting the ^{14}C ages, there would still be an age difference between the shallowest sample and the deepest. However, this is not the case. These similar ages are probably due to either a small sample size. Other possibilities such as a diagenetic effect causing the ostracods to re-precipitate carbonate, or older sediments exposed on the shoreline incorporated into the lake sediment would not result in all four samples returning a similar age. The ^{14}C in ostracods would still experience radioactive decay, therefore, the unusual ages for the small ostracod samples arise from analytical problems. Due to their small sample masses, the associated large mass corrections (machine and chemistry blank) and an absence of measured $\delta^{13}C$ values, the ages are meaningless (Alan Williams pers. comm.).

5.1.2 OVERVIEW OF DIATOM DATA

Diatoms are a widely used proxy for past environmental change due to their sensitivity to water conditions (Ryves et al. 2006). However, diatom palaeological records are also thought to be subject to preservation bias, particularly in alkaline, saline lakes where dissolution is prevalent (Ryves et al. 2006). The total diatom concentration varied throughout the analysed core such that a number of samples had limited diatoms. This fluctuation in diatom concentration may be a result of poor preservation, dissolution, or a low abundance of living diatoms during sediment deposition. Other material in the sediment such as clay and organic matter may also affect the number of diatoms.

Preservation bias of the diatom record needs to be considered, as does low diatom counts. Extensive dissolution and breakage of diatom valves indicates that species are not preserved and further bias exists. However, dissolution of diatom valves and concentration of diatoms are not positively correlated indicating the main bias influencing data is preservation bias (Figure 6). Despite bias, conclusions about palaeoclimate changes are made from the record and are supported by the correlation between diatom data and Itrax data.

5.1.3 DIATOM SPECIES CHANGES AT WEST BASIN LAKE

The diatom data shows three main zones; zone 1 from -35 cal BP to 60 cal BP (0-17 cm), zone 2 from 60 cal BP to ~ 600 cal BP (17-36 cm), and zone 3 from ~600 cal BP to 932 cal BP (36-50 cm). The euryhaline species *Cocconeis neodiminuta* and *Cocconeis placentula var. euglypta* dominate the diatom record. Accurate conclusions about changes in salinity from euryhaline species are difficult since they have broad salinity ranges. Understanding the optimal salinity levels and range of salinity tolerances is important for reconstructing the total salinity of the system and for understanding the species. *Cocconeis placentula var. euglypta* dominates the diatom record at 0-62 cal BP (0-17 cm). Wilson et al. (1996) produced estimates of taxon optima and tolerances from a study of 219 lakes in western North America and found the species C*occoneis placentula var. euglypta* have a tolerance of 0.02-5.2 g/L and an optima of 0.35 g/L. Fritz et al. (1993) found *Cocconeis placentula* have a salinity optima of 2.3 g/L and Gell (1997) found *Cocconeis placentula* to have a salinity optima of 12 g/L from his study of western Victorian lakes. The species *Cocconeis placentula* has a broad salinity tolerance and representing this range with a single value may produce an inaccurate absolute salinity reconstruction.

Additional conclusions can be made from the presence of *Cocconeis placentula var. euglypta* (Table 5). The species does not thrive below pH=7 (Tibby, pers. comm.). Since this species is abundant throughout the core we conclude that the pH of West Basin Lake is unlikely to have dropped below this level during the last ~1000 years.

Table 5: Optimal salinity levels (g/L) and salinity tolerances (g/L) for *Cocconeis placentula var. euglypta*, from Wilson et al. (1996), Fritz et al. (1993), and Gell (1997)

	Wilson et al. (1996)		Fritz et al. (1993)	Gell (1997)
	Tolerance (g/L)	Optima (g/L)	Optima (g/L)	Optima (g/L)
Cocconeis placentula var. euglypta	0.02-5.2	0.35	2.3	12

The abundance of the saline species *Pinnunavis yarrensis* from 34-38 cm depth (539-652 cal BP) indicates a high salinity event. Another saline diatoms species, *Achnanthes brevipes*, had a high abundance at this time. This indicates a period of low precipitation and high evaporation. *Achnanthes brevipes* also has a wide salt tolerance (Tomihiko 1979), with an optimal salinity of 51.3 g/L (Gell 1997), further supporting this high salinity event.

Sediments younger than 266 cal BP (25 cm depth) are marked by the appearance of a range of fresh taxa. These species are low in relative abundance but this increase in fresh species diversity is unprecedented. Many of these fresh species are aerophilic diatoms including *Humidophila contenta*, *Luticola mutica*, and *Pinnularia borealis var. rectangularis* (Reid et al. 2007). This pulse of aerophilic, fresh diatom species correlates with a significant decrease in the saline *Achnanthes brevipes* indicating a freshening event.

5.1.4 DISSOLUTION CHANGES AT WEST BASIN LAKE

The comparison of FI with diatom concentration (Figure 6) shows that samples with higher diatom counts had a lower FI and appeared more dissolved. Samples with lower counts had a greater FI, though this trend could represent a preservation bias where only the most robust taxa remain. A linear regression (Figure 7) shows that some species, have an increased relative abundance with an increasing FI. This correlation indicates that there are more diatoms of that species better preserved. Species showing an increase in relative abundance with decreasing FI occur more often in a higher state of dissolution. This indicates that these species are either the more robust species or existed during periods of greater dissolution. Many species have zero correlations and the relative abundance remains low despite changes in preservation as these species occur in few samples and have limited data.

5.1.5 SALINITY RECONSTRUCTION OF WEST BASIN LAKE

The Weighted Average Partial Least Squares (WAPLS) salinity transfer function of Gell (1997; R^2 = 0.77, Root Mean Square Error of Prediction= 0.3) was used to infer quantitative estimates of lake water salinity variation. Quantitative reconstructions from biological proxies using transfer functions have revolutionised palaeolimnology (Juggins 2013). Quantitative reconstructions are useful as they simplify the complex relationships between biota and the environments. Juggins (2013) identifies questions about the way palaeolimnological transfer functions are developed and applied. Reconstructed variables need to be critically considered to ensure that variance is represented by the component used for reconstruction, and is not related to another factor. Almost all palaeolimnological models are subject to the influence of secondary environmental variables due to the complex interaction of climate, anthropogenic activity and lake or catchment processes on biological assemblages. More research is required to determine if reconstruction techniques are immune to these effects (Juggins 2013).

Modern measurements show the salinity of West Basin Lake to be considerably higher than the reconstruction levels for the most recent time to as high as 72.4 g/L (Gell 1997). This level is twice as saline as the ocean which has a salinity of approximately 35 g/L (Elimelech and Phillip 2011). However, the salinity reconstruction (Figure 10) shows a much lower salinity level for the most recent period, approximately 25 g/L, though at present the uncertainty extends as far as 50 g/L.

Reconstructions are useful for identifying patterns of change but are not often effective for identifying absolute values. The marked difference between modern salinity levels and the salinity reconstruction could be due to the low diatom count for sample at the top of the core resulting in a different salinity reconstruction than if all species were accurately represented. In addition, the higher salinity levels may have increased the dissolution, further biasing the record. The broad salinity tolerance of a dominant species can impact the salinity reconstruction. For an accurate reconstruction, an optimum value needs to be identified to constrain the calculation. *Cocconeis placentula var. euglypta* dominates the diatom record at 0-62 cal BP (0-17 cm) and has a broad salinity tolerance (Table 5). Representing this euryhaline species with a single value could produce an inaccurate absolute salinity reconstruction. Salinity transfer functions can also be affected when dominant taxa in the data are not represented in the training set. The second most dominant diatom in zone 1, *Cocconeis neodiminuta*, was not represented in the training set from Gell (1997) and is also a euryhaline species (Hallfors 2004).

The training set established by (Gell 1997) was extensive and overlap between his training set and the data collected for West Basin Lake is valuable. 30.4 % of species identified in this study were identified in the training set. However, some species in the West Basin Lake data are not represented. The DCA analysis (Figure 8) shows a similar pattern of salinity change, independent from the salinity reconstruction thus supporting the fluctuations in salinity reconstructed for West Basin Lake.

5.2. Climate variability of south-eastern Australia

932- 550 cal BP (1018-1400 CE)

The diatom record for 932-550 cal BP shows a predominantly saline environment (Figure 4). There are minor fluctuations during this time, represented by the shifts in diatoms species abundance, indicating a saline environment with a variable climate. Previous research identified a variable climate in Victoria during 850-1400 CE (Mooney 1997, Gouramanis et al. 2010, Wilkins et al. 2013, Barr et al. 2014). Previous work also showed this period was characterised by a negative SOI, indicating more El Niño-dominated conditions (Yan et al. 2011, Vance et al. 2013).

625- 575 cal BP (1325- 1375 CE)

During this period, West Basin Lake records a highly saline environment from the significant signal of saline species, corresponding to a decrease in fresh diatom species (Figure 4). The highly saline conditions in West Basin Lake indicate a multi-decadal drought even occurred during this time.

500-100 cal BP (1450-1850 CE)

West Basin Lake records a less saline environment for this period as shown by the decrease in saline diatoms with increasing depth and the increase in freshwater diatoms. This also indicates an increased P:E ratio. A freshening event at this time is consistent with previous studies (Wilkins et al. 2013, Barr et al. 2014). A multi proxy study by Barr et al. (2014) compared Lake Surprise and Lake Elingamite (located near West Basin Lake) and identified a freshening phase at a similar time between 550-150 cal BP (1400-1800 CE). Yan et al. (2011) found that this period was characterised by more La Niña- dominated conditions.

100 cal BP – present

The environment of West Basin Lake during this time was and is changing towards more saline conditions. The euryhaline species dominate the diatom record and saline species reoccur (Figure 4). This saline environment indicates a lower P:E ratio, consistent with drought conditions observed since European settlement (Jones et al. 2001, Barr et al. 2014)

5.3 Data cyclicity and climate factors

Comparison of Itrax data and species abundance shows cyclic patterns (Figure 9). The plot of logCa/logTi exhibits peaks on approximately 200 year timescales (200 cal BP, 410 cal BP, 650 cal BP, 800 cal BP). The diatom species *Achnanthes brevipes* shows an inverse relationship with this fluctuation, with a lower abundance during peaks of logCa/logTi. The species *Cocconeis neodiminuta* peaks in relative abundance in correlation to the peaks in logCa/logTi. These approximately 200 year cycles indicate that climatic factors are driving change. Previous research identified cycles in climate factors including the IOD (Ummenhofer et al. 2009), SAM (Abram et al. 2014), and ENSO (Vance et al. 2013). However, to resolve the influence of climate factors on the 200 year cycles observed in West Basin Lake, additional high-resolution studies are required that cover the past millennium.

5.4 Future work

In this study, samples were settled, rather than centrifuged, to minimise damage to fragile diatom valves. However, recent research found centrifuging to not significantly increase the proportion of broken frustules and that centrifuged samples have a lower quality as a result of inorganic and organic matter (Blanco et al. 2008). Analysing the effect of centrifuging on samples from a highly saline study site where the diatom frustules are at greater risk of breakage would provide further understanding of the effects of centrifuging.

Historical records indicate the first European settlers arrived in the region around 1840 CE (Dodson 1974), or at approximately 19 cm depth in the core (Figure 3). A 10 cm gap in the sediment record remains unconstrained between the ^{210}Pb ages and ^{14}C ages. To further understand the environmental changes deduced from the diatom record, the timing of European settlement and the commencement of the widespread changes that occurred as a result need to be identified. Exotic pollen species are often used to identify European arrival in Australia and their appearance in sediment records can provide independent dating horizons (Tibby 2003, Leahy et al. 2005). Identification and dating of exotic pollen in this core (i.e. *Pinus*) would constrain the timing of European settlement near West Basin Lake.

6. CONCLUSIONS

Diatom analysis from the sediment of West Basin Lake investigated the nature of decadal-centennial scale climate and hydroclimate variability in south-eastern Australia. Diatom data were interpreted on the basis of species, their associated ecology and by using a diatom salinity transfer function. The pattern of decadal-centennial scale hydroclimate variability observed at West Basin is consistent with other lake sediment palaeoclimate records from southern Australia. The record displays a decadal-centennial scale record of hydrological change and indicates that West Basin Lake is susceptible to hydroclimate variability on this scale. The diatom record shows changes in relative abundance of diagnostic diatom species indicating changes to the environmental conditions of the lake. The palaeoclimate record of West Basin Lake revealed a more variable climate during 932-550 cal BP and less saline conditions from 500-100 cal BP. The record also provides evidence for a multi-decadal period of increased salinity from 625-575 cal BP, followed by a period of decreased salinity from 625-575 cal BP. A diatom based transfer function was used to reconstruct the salinity of West Basin Lake and supported the changes recorded in the diatom record. This indicates a more variable climate during the past millennium than before European settlement. West Basin Lake evidently responds to changes in climate.

High-resolution palaeoclimate studies in Australia spanning a millennium or more could identify the influence of climate factors such as IOD, IPO, ENSO and SAM on lake environments. An extended study investigating the relationship between element abundance and climate factors could provide insight into these relationships. Radiocarbon ages obtained on ostracod material from the sediment core of West Basin

Lake returned some ages that were discarded due to analytical uncertainty. This emphasizes the need for additional age dating to constrain important events including the European arrival in Australia.

The palaeoclimate record established for West Basin Lake in this study provides a regionally coherent palaeoclimate reconstruction of the past millennium for Victoria, Australia and provides new insights into the frequency and magnitude of large scale hydroclimate variability in southern Australia.

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APPENDIX A: DIATOM DATA, LABELLED AND SORTED BY DEPTH

Depth: 0-0.5 cm						
Slide: WB 86-2 A 0-0.5 (v4)						
Date: 21/7/15						
Magnification: 100x 15x						
Transects: (21, 100)- (40, 100); (40, 100.5)- (21, 100.5); (21, 101)- (40, 101); (40, 101.5)- (21, 101.5); (21, 102)- (40, 102); (40, 102.5)- (21, 102.5); (21, 105)- (41, 105); (41, 105.5)- (21, 105.5); (21, 95)- (41, 95); (41, 95.5)- (21, 95.5); (21, 96)- (41, 96)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia brebissonii	1	0	0	1	2	2.86
Cocconeis neodiminuta	0	5	9	9	23	32.86
Cocconeis placentula va. lineata	0	0	2	0	2	2.86
Tryblionella constricta	0	0	1	0	1	1.43
Navicula subminiscula	0	0	1	0	1	1.43
Cocconeis placentula var placentula	0	0	1	1	2	2.86
Navicula perminuta	0	1	2	1	4	5.71
Rhopalodia musculus	0	2	0	0	2	2.86
Fragilaria pinnata var pinata	8	3	0	0	11	15.71
Nitzschia frustulum var frustulum	1	1	0	0	2	2.86
Cocconeis placentula var euglypta	0	3	5	6	14	20.00
Parlibellus delongnei	0	0	1	1	2	2.86
Diploneis elliptica	1	0	0	0	1	1.43
Amphora staurophora	0	0	0	1	1	1.43
Stepanodiscus sp	0	0	1	0	1	1.43
Nitzschia sigma	0	1	0	0	1	1.43
TOTAL					70	100.00

Depth: 1-1.5 cm

Slide: WB 86-2 A 1-1.5 (v4)

Date: 27/7/15

Magnification: 100x 15x

Transects:
(20, 95)- (40-95); (40, 95.5)- (20, 95.5); (20, 96)- (40, 96); (40, 96.5)- (20, 96.5); (20, 97)- (40, 97); (40, 97.5)- (20, 97.5); (20, 98)- (40, 98); (40, 98.5)- (20, 98.5); (20, 99)- (40, 99)

	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	0	5	20	10	35	33.33
Fragilaria pinnata var pinata	1	3	1	1	6	5.71
Cocconeis placentula var euglypta	0	7	22	21	50	47.62
Navicula veneta	0	0	0	1	1	0.95
Navicula perminuta	0	0	0	1	1	0.95
Navicula cryptonella	0	0	1	0	1	0.95
Achnanthes exigua var exigua	0	1	0	0	1	0.95
Gomphonema parvulum	0	1	0	0	1	0.95
Rhopalodia musculus	1	0	0	1	2	1.90
Nitzschia frustulum var frustulum	0	1	2	1	4	3.81
Tryblionella constricta	0	1	0	1	2	1.90
Rhopalodia acuminata var acuminata	0	0	0	1	1	0.95
TOTAL					105	100.00

Depth: 2-2.5 cm						
Slide: WB 86-2 A 2-2.5 (v4)						
Date: 28/7/15						
Magnification: 100x 15x						
Transects: (25, 95)- (41, 95); (41, 95.5)- (20, 95.5); (20, 96)- (41, 96); (20, 96.5)- (41, 96.5); (41, 97)- (20, 97); (20, 97.5)- (41, 97.5); (41, 98)- (20, 98); (20, 98.5)- (40, 98.5); (40, 99)- (20, 99); (20, 99.5)- (40, 99.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	3	17	19	39	46.99
Cocconeis neodiminuta	0	1	15	15	31	37.35
Rhopalodia musculus	0	5	2	1	8	9.64
Nitzschi palea	0	0	0	1	1	1.20
Navicula cincta	0	1	0	0	1	1.20
Navicula halophila	0	0	1	0	1	1.20
Amphora delicatissima	0	0	1	0	1	1.20
Nitzschia frustulum var frustulum	0	0	1	0	1	1.20
TOTAL					83	100.00

Depth: 3-3.5 cm

Slide: WB 86-2 A 3-3.5 (v4)

Date: 29/7/15

Magnification: 100x 15x

Transects:
(14, 95)- (34, 95); (34, 95.5)- (14, 95.5); (14, 96)- (34, 96); (34, 96.5)- (14, 96.6); (14, 97)- (34, 97); (34, 97.5)- (14, 97.5); (14, 98)- (34, 98); (34, 98.5)- (13, 98.5); (13, 99)- (34, 99); (34, 99.5)- (13, 99.5)

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	7	20	15	42	60.87
Cocconeis neodiminuta	0	1	11	3	15	21.74
Fragilaria pinnata var pinnata	0	1	2	0	3	4.35
Nitzschia frustulum var frustulum	0	2	0	0	2	2.90
Navicula cryptonella	0	0	1	0	1	1.45
Navicula phyllepta	0	0	2	0	2	2.90
Caloneis molaris	0	1	0	0	1	1.45
Pleurosigma angulatum	0	1	0	0	1	1.45
Rhopalodia musculus	0	2	0	0	2	2.90
TOTAL					69	100.00

Depth: 4-4.5 cm						
Slide: WB 86-2 A 4-4.5 (v4)						
Date: 31/7/15						
Magnification: 100x 15x						
Transects: (49, 97)- (69, 97); (69, 97.5)- (48.5, 97.5); (48.5, 98)- (69, 98); (69, 98.5)- (48, 98.5); (48, 99)- (68, 99); (68, 99.5)- (48, 99.5); (48, 100)- (68, 100); (68, 100.5)- (48, 100.5); (48, 101)- (68, 101)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	1	8	12	7	28	26.67
Cocconeis placentula var euglypta	3	15	21	16	55	52.38
Nitzschia frustulum var frustulum	0	1	2	1	4	3.81
Mastogloia pumilla	0	1	0	0	1	0.95
Fragilaria pinnata var pinata	1	2	1	0	4	3.81
Pinnularia superdivergentissima	0	0	0	1	1	0.95
Brachysira sp	0	0	0	1	1	0.95
Rhopalodia sp	0	0	0	4	4	3.81
Navicula phyllepta	0	0	0	4	4	3.81
Epithemia adnata	0	0	0	1	1	0.95
Nitzschia fonticola	1	0	0	0	1	0.95
Rhopalodia acuminata	0	0	0	1	1	0.95
TOTAL					105	100.00

Depth: 5-5.5 cm						
Slide: WB 86-2 A 5-5.5 (b) (v4)						
Date: 31/7/15						
Magnification: 100x 15x						
Transects: (19, 98)- (39, 98); (39, 98.5)- (19, 98.5); (19, 99)- (25, 99); (25, 99)- (39, 99); (19, 100)- (39, 100); (39, 100.5)- (19, 100.5); (19, 101)- (39, 101); (39, 101.5)- (19, 101.5); (19, 102)- (39, 102); (39, 102.5)- (19, 102.5); (19, 103)- (39, 103)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Mastagloia pumila	0	1	2	0	3	2.65
Achnanthes distincta	0	2	0	0	2	1.77
Amphora staurofora	0	0	0	2	2	1.77
Fragilaria pinnata var pinata	5	17	15	1	38	33.63
Achnanthes brevipes	0	0	1	3	4	3.54
Tryblionella constricta	0	2	1	1	4	3.54
Opephora olsenii	4	9	6	3	22	19.47
Rhopalodia musculus	1	4	1	1	7	6.19
Cymbella sp a	0	0	0	1	1	0.88
Mastogloia lanceolata	0	1	1	1	3	2.65
Cocconeis placentula var euglypta	0	2	7	8	17	15.04
Cymbella pusilla	0	0	1	0	1	0.88
Navicula radiosa	0	0	1	1	2	1.77
Nitzschia frustulum var frustulum	0	2	1	1	4	3.54
Mastogloia pusilla	0	1	0	0	1	0.88
Rhopalodia brebissonii	0	1	0	0	1	0.88
Rhopalodia constricta	0	0	0	1	1	0.88
TOTAL					113	100.00

Depth: 6-6.5 cm

Slide: WB 86-2 A 6-6.5 (b) (v4)

Date: 4/8/15

Magnification: 100x 15x

Transects:
(20, 97)- (40, 97); (40, 97.5)- (20, 97.5); (20, 98)- (40, 98); (40, 98.5)- (20, 98.5); (20, 99)- (40, 99); (40, 99.5)- (20, 99.5);
(20, 100)- (40, 100); (40, 100.5)- (20, 100.5); (20, 101)- (40, 101); (40, 101.5)- (20, 101.5);

	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	1	10	15	12	38	46.91
Opephora olsenii	1	3	0	0	4	4.94
Rhopalodia musculus	2	1	1	3	7	8.64
Fragilaria pinnata var pinata	1	3	3	1	8	9.88
Cocconeis neodiminuta	0	5	2	4	11	13.58
Amphora coffeaeformis	1	1	0	0	2	2.47
Nitzschia frustulum var frustulum	2	1	1	0	4	4.94
Cymbella pusilla	0	1	0	0	1	1.23
Cocconeis placentula var pseudolineata	1	0	2	1	4	4.94
Entomoneis paludosa var paludosa	1	0	0	0	1	1.23
Navicula cryptonella	0	1	0	0	1	1.23
TOTAL					81	100.00

Depth: 7-7.5 cm						
Slide: WB 86-2 A 7-7.5 (v4)						
Date: 6/8/15						
Magnification: 100x 15x						
Transects: (20, 97)- (41, 97); (41, 97.5)- (20, 97.5); (20, 98)- (41, 98); (41, 98.5)- (20, 98.5); (20, 99)- (41, 99); (41, 99.5)- (20, 99.5); (20, 100)- (41, 100); (41, 100.5)- (20, 100.5); (20, 101)- (41, 101); (41, 101.5)- (20, 101.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var pseudolineata	0	2	5	3	10	16.67
Fragilaria pinnata var pinata	3	3	0	0	6	10.00
Cocconeis placentula var euglypta	0	2	11	7	20	33.33
Rhopalodia acuminata	2	0	1	1	4	6.67
Rhopalodia musculus	3	0	2	0	5	8.33
Cocconeis neodiminuta	0	4	4	1	9	15.00
Navicula radiosa	0	0	0	1	1	1.67
Entomoneis sp a	0	0	0	1	1	1.67
Opephora olsenii	0	2	0	0	2	3.33
Navicula sp c	1	0	0	0	1	1.67
Fragilaria elliptica	1	0	0	0	1	1.67
TOTAL					60	100.00

Depth: 8-8.5 cm

Slide: WB 86-2 A 8-8.5 (b) (v4)

Date: 7/8/15

Magnification: 100x 15x

Transects:
(14, 97)- (34, 97); (34, 97.5)- (14, 97.5); (14, 98)- (34, 98); (34, 98.5)- (14, 98.5); (14, 99)- (34, 99); (34, 99.5)- (14, 99.5); (14, 100)- (34, 100); (34, 100.5)- (14, 100.5)

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	11	22	7	40	39.22
Cocconeis neodiminuta	0	5	16	4	25	24.51
Nitzschia frustulum var frustulum	0	4	1	0	5	4.90
Fragilaria pinnata var pinata	3	6	1	0	10	9.80
sp g	0	1	0	0	1	0.98
Rhopalodia musculus	4	3	0	0	7	6.86
Achnanthes distincta	0	1	0	0	1	0.98
sp f	0	0	1	0	1	0.98
Entomoneis	0	0	0	2	2	1.96
Navicula veneta	0	0	0	1	1	0.98
Rhopalodia brebissonii	0	2	1	0	3	2.94
Cymbella pusilla	0	0	0	1	1	0.98
Luticola mutica	0	1	0	0	1	0.98
Opephora olsenii	0	2	0	0	2	1.96
Rhopalodia acuminata	1	0	0	0	1	0.98
Navicula cryptonella	0	1	0	0	1	0.98
TOTAL					102	100.00

Depth: 9-9.5 cm						
Slide: WB 86-2 A 9-9.5 (B) (v4)						
Date: 10/8/15						
Magnification: 100x 15x						
Transects: (16, 97)- (36, 97); (36, 97.5)- (16, 97.5); (16, 98)- (36, 98); (36, 98.5)- (16, 98.5); (16, 99)- (36, 99); (36, 99.5)- (16, 99.5); (16, 100)- (36, 100); (36, 100.5)- (16, 100.5); (16, 101)- (36, 101); (36, 101.5)- (16, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia acuminata	3	2	1	0	6	6
Cocconeis placentula var. euglypta	2	10	10	2	24	24
Rhopalodia brebissonii	3	4	1	0	8	8
sp h	0	1	0	0	1	1
Opephora olsenii	1	4	0	0	5	5
Nitzschia frustulum var frustulum	0	3	4	2	9	9
Cocconeis neodiminuta	3	8	1	0	12	12
Fragilaria pinnata var. pinnata	2	0	0	0	2	2
Amphora coffeaeformis	1	4	0	0	5	5
Entomoneis	0	0	1	0	1	1
Epithema sp a	0	1	0	0	1	1
Rhopalodia musculus	5	0	0	0	5	5
Seminavis yarrensis	3	0	1	0	4	4
Fragilaria elliptica	0	1	0	0	1	1
Amphora graeffeana	0	0	2	0	2	2
Cocconeis placentula var. pseudolineata	1	4	1	0	6	6
Navicula cryptonella	1	3	1	0	5	5
Achnanthes brevipes var. brevipes	1	0	0	0	1	1
Nitzschia pusilla	0	1	0	0	1	1
Surirella brebissonii	0	1	0	0	1	1
TOTAL					100	100

Depth: 10-10.5 cm						
Slide: WB 86-2 A 10-10.5 (b) (v4)						
Date: 10/8/15						
Magnification: 100x 15x						
Transects: (17, 97)- (37, 97); (37, 97.5)- (17, 97.5); (17, 98)- (37, 98); (37, 98.5)- (17, 98.5); (17, 99)- (37, 99); (37, 99.5)- (17, 99.5); (17, 100)- (37, 100); (37, 100.5)- (17, 100.5); (17, 101)- (37, 101); (37, 101.5)- (17, 101.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	1	0	1	0	2	33.33
Rhopalodia acuminata	1	0	0	0	1	16.67
Rhopalodia musculus	1	0	1	0	2	33.33
Cocconeis placentula var. pseudolineata	0	0	1	0	1	16.67
TOTAL					6	100.00

Depth: 11-11.5 cm						
Slide: WB 86-2 A 11-11.5 (v4)						
Date: 11/8/15						
Magnification: 100x 15x						
Transects: (14, 97)- (34, 97); (34, 97.5)- (14, 97.5); (14, 98)- (34, 98); (34, 98.5)- (14, 98.5); (14, 99)- (34, 99); (34, 99.5)- (14, 99.5); (14, 100)- (34, 100); (34, 100.5)- (14, 100.5); (14, 101)- (34, 101); (34, 101.5)- (14, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	2	2	1	5	25
Cocconeis neodiminuta	1	1	3	1	6	30
Ophephora olsenii	1	1	0	0	2	10
Rhopalodia musculus	4	0	0	0	4	20
Amphora coffeaeformis	0	2	0	0	2	10
Fragilaria pinnata var pinata	1	0	0	0	1	5
TOTAL					20	100

Depth: 12-12.5 cm						
Slide: WB 86-2 A 12-12.5 (v4)						
Date: 12/8/15						
Magnification: 100x 15x						
Transects: (15, 97)- (35, 97); (35, 97.5)- (15, 97.5); (15, 98)- (35, 98); (35, 98.5)- (15, 98.5); (15, 99)- (35, 99); (35, 99.5)- (15, 99.5); (15, 100)- (35, 100); (35, 100.5)- (15, 100.5); (15, 101)- (35, 101); (35, 101.5)- (15, 101.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	2	9	3	1	15	27.3
Fragilaria pinnata var pinata	1	3	0	0	4	7.3
Opephora olsenii	1	0	0	0	1	1.8
Cocconeis neodiminuta	1	9	6	2	18	32.7
Nitzschia constricta	0	1	0	0	1	1.8
Rhopalodia musculus	4	0	0	0	4	7.3
Navicula perminuta	2	0	0	0	2	3.6
Nitzschia frustulum var frustulum	0	1	5	0	6	10.9
Navicula pseudolanceolata	0	0	0	2	2	3.6
Entomoneis	0	0	0	1	1	1.8
Amphora graeffeana	0	0	1	0	1	1.8
TOTAL					55	100.0

Depth: 13-13.5 cm

Slide: WB 86-2 A 13-13.5 (v4)

Date: 12/8/15

Magnification: 100x 15x

Transects:
(44, 97)- (64, 97); (64, 97.5)- (44, 97.5); (44, 98)- (64, 98); (64, 98.5)- (44, 98.5); (44, 99)- (64, 99);
(64, 99.5)- (44, 99.5); (44, 100)- (64, 100); (64, 100.5)- (44, 100.5); (44, 101)- (64, 101); (64, 101.5)- (44, 101.5);

	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	0	9	7	2	18	22.0
Cocconeis placentula var euglypta	1	14	11	2	28	34.1
Navicula cincta	1	0	0	0	1	1.2
Rhopalodia musculus	3	3	1	0	7	8.5
Fragilaria pinnata var pinata	1	3	0	0	4	4.9
Amphora graeffeana	0	0	1	0	1	1.2
Nitzschia frustulum var frustulum	0	4	4	0	8	9.8
Achnanthes brevipes	0	3	0	0	3	3.7
Nitzschia constricta	1	1	1	0	3	3.7
Seminavis yarrensis	0	1	0	1	2	2.4
sp n	0	2	0	0	2	2.4
sp o	0	0	1	0	1	1.2
sp p	0	0	2	0	2	2.4
Rhopalodia acuminata	0	1	0	0	1	1.2
Opephora olsenii	1	0	0	0	1	1.2
TOTAL					82	100.0

Depth: 14-14.5 cm						
Slide: WB 86-2 A 14-14.5 (v4)						
Date: 13/8/15						
Magnification: 100x 15x						
Transects: (15, 97)- (35, 97); (35, 97.5)- (15, 97.5); (15, 98)- (35, 98); (35, 98.5)- (15, 98.5); (15, 99)- (35, 99); (15, 96)- (35, 96); (35, 99.5)- (15, 99.5); (15, 100)- (35, 100); (35, 100.5)- (15, 100.5); (15, 101)- (35, 101);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	1	1	2	1	5	45.5
Rhopalodia constricta	1	0	0	0	1	9.1
Navicula cincta	0	2	1	0	3	27.3
Cocconeis neodiminuta	0	1	0	0	1	9.1
Naviucla sp c	0	1	0	0	1	9.1
TOTAL					11	100.0

Depth: 15-15.5 cm						
Slide: WB 86-2 A 15-15.5 (v4)						
Date: 12/8/15						
Magnification: 100x 15x						
Transects: (60, 92)- (60. 113); (60.5, 113)- (60.5, 92); (61, 92)- (61, 113); (61.5, 113)- (61.5, 92); (62, 92)- (62, 113); (62.5, 113)- (62.5, 113); (63, 92)- (63, 113); (63.5, 113)- (63.5, 92); (64, 92)- (64, 113); (64.5, 113)- (64.5, 92);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Epithema argus	0	1	0	0	1	3.6
Cocconeis placentula var euglypta	4	2	3	2	11	39.3
Opephora olsenii	3	1	0	0	4	14.3
Achnanthes brevipes	0	1	1	0	2	7.1
Navicula cincta	0	1	1	0	2	7.1
Cocconeis neodiminuta	1	0	1	0	2	7.1
Mastogloia pusilla	0	1	0	0	1	3.6
Fragilaria pinnata	3	1	0	0	4	14.3
Nitzschia frustulum	0	1	0	0	1	3.6
TOTAL					28	100.0

Depth: 16-16.5 cm						
Slide: WB 86-2 A 16-16.5 (v4)						
Date: 14/8/15						
Magnification: 100x 15x						
Transects: (62, 97)- (43, 97); (43, 97.5)- (62, 97.5); (62, 98)- (43, 98); (43, 98.5)- (62, 98.5); (62, 99)- (43, 99); (43, 99.5)- (62, 99.5); (62, 100)- (43, 100); (43, 100.5)- (62, 100.5); (62, 101)- (43, 101); (43, 101.5)- (62, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	0	2	0	0	2	28.6
Seminavis yarrensis	0	1	0	0	1	14.3
Cocconeis placentula var euglypta	0	2	0	0	2	28.6
Entomoneis	0	0	1	0	1	14.3
Rhopalodia musculus	1	0	0	0	1	14.3
TOTAL					7	100.0

Depth: 17-17.5 cm						
Slide: WB 86-2 A 17-17.5 (v4)						
Date: 14/8/15						
Magnification: 100x 15x						
Transects: (18, 97)- (38, 97); (38, 97.5)- (18, 97.5); (18, 98)- (38, 98); (38, 98.5)- (18, 98.5); (18, 99)- (38, 99); (38, 99.5)- (18, 99.5); (18, 100)- (38, 100); (38, 100.5)- (18, 100.5); (18, 101)- (38, 101); (38, 101.5)- (18, 101.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	1	1	0	2	22.2
Cocconeis neodiminuta	0	3	0	0	3	33.3
Amphora coffaeformis	2	0	0	0	2	22.2
Rhopalodia musculus	2	0	0	0	2	22.2
TOTAL					9	100.0

Depth: 18-18.5 cm						
Slide: WB 86-2 A 18-18.5 (v4)						
Date: 25/5/15						
Magnification: 100x 15x						
Transects: (21, 97)- (41, 97); (41, 97.5)- (21, 97.5); (21, 98)- (41, 98); (41, 98.5)- (21, 98.5); (21, 99)- (41, 99); (41, 99.5)- (21, 99.5); (21, 100)- (41, 100); (41, 100.5)- (21, 100.5); (21, 101)- (41, 101); (41, 101.5)- (21, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	3	4	1	8	26.7
Nitzschia frustulum	0	5	4	0	9	30.0
Cocconeis neodiminuta	1	3	1	0	5	16.7
Diploneis smithii	0	1	0	0	1	3.3
Fragilaria pinnata var pinata	0	2	0	0	2	6.7
Seminavis yarrensis	1	0	0	0	1	3.3
Opephora olsenii	0	2	0	0	2	6.7
Rhopalodia musculus	2	0	0	0	2	6.7
TOTAL					30	100.0

Depth: 19-19.5 cm

Slide: WB 86-2 A 19-19.5 (v4)

Date: 26/8/15

Magnification: 100x 15x

Transects:
(48, 97)- (69, 97); (69, 97.5)- (48, 97.5); (48, 98)- (69, 98); (69, 98.5)- (48, 98.5); (48, 99)- (69, 99); (69, 99.5)- (48, 99.5); (48, 100)- (69, 100); (69, 100.5)- (48, 100.5); (48, 101)- (69, 101); (69, 101.5)- (48, 101.5)

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	3	4	0	3	10	33.3
Cocconeis neodiminuta	1	3	1	0	5	16.7
Nitzschia frustulum var frustulum	0	1	1	0	2	6.7
Rhopalodia musculus	1	2	0	0	3	10.0
Rhopalodia brebissonii	2	0	0	0	2	6.7
Navicula contenta	0	2	1	0	3	10.0
Fragilaria pinnata var pinata	0	1	0	0	1	3.3
sp b	0	1	0	0	1	3.3
Opephora olsenii	1	1	0	0	2	6.7
Navicula cryptonella	0	1	0	0	1	3.3
TOTAL					30	100.0

Depth: 20-20.5 cm						
Slide: WB 86-2 A 20-20.5 (v4)						
Date:						
Magnification: 100x 15x						
Transects: (26, 97)- (44, 97); (44, 97.5)- (26, 97.5); (26, 98)- (44, 98); (44, 98.5)- (26, 98.5); (26, 99)- (44, 99); (44, 99.5)- (26, 99.5); (26, 100)- (44, 100); (44, 100.5)- (26, 100.5); (26, 101)- (44, 101); (44, 101.5)- (26, 101.5); (26, 102)- (44, 102)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Navicula contenta	0	0	1	0	1	16.7
Cocconeis placentula var euglypta	0	1	1	0	2	33.3
Amphora coffeaformis	0	1	0	0	1	16.7
Nitzschia frustulum var frustulum	0	1	0	0	1	16.7
Luticola mutica	1	0	0	0	1	16.7
TOTAL					6	100.0

Depth: 21-21.5 cm

Slide: WB 86-2 A 21-21.5 (b) (v4)

Date: 27/8/15

Magnification: 100x 15x

Transects:
(26, 97)- (47, 97); (47, 97.5)- (26, 97.5); (26, 98)- (47, 98); (47, 98.5)- (26, 98.5); (26, 99)- (47,99); (47, 99.5)- (26, 99.5); (26, 100)- (47, 100); (47, 100.5)- (26, 100.5); (26, 101)- (47, 101); (47, 101.5)- (26, 101.5);

	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Amphora graeffeana	0	1	0	0	1	2.7
Rhopalodia musculus	1	4	0	0	5	13.5
Achnanthes brevipes	1	0	0	1	2	5.4
Fragilaria pinnata var pinata	1	4	1	0	6	16.2
Cocconeis neodiminuta	3	3	1	3	10	27.0
Navicula cincta	0	2	1	0	3	8.1
Cocconeis placentula var euglypta	1	2	1	0	4	10.8
Nitzschia frustulum var frustulum	0	4	1	0	5	13.5
Epithema adnata	0	0	1	0	1	2.7
TOTAL					37	100.0

Depth: 22-22.5 cm						
Slide: WB 86-2 A 22-22.5 (b) (v4)						
Date: 28/8/15						
Magnification: 100x 15x						
Transects: (22, 97)- (43, 97); (43, 97.5)- (22, 97.5); (22, 98)- (43, 98); (43, 98.5)- (22, 98.5); (22, 99)- (43, 99); (43, 99.5)- (22, 99.5); (22, 100)- (43, 100); (43, 100.5)- (22, 100.5); (22, 101)- (43, 101); (43, 101.5)- (22, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Amphora graeffeana	0	0	1	0	1	3.1
Cocconeis neodiminuta	5	5	1	0	11	34.4
Achnanthes brevipes	0	1	1	0	2	6.3
Cocconeis placentula var euglypta	2	2	1	0	5	15.6
Nitzschia frustulum var frustulum	0	3	2	0	5	15.6
Rhopalodia acuminata	2	0	0	0	2	6.3
sp q	0	1	0	0	1	3.1
Caloneis bacillum	0	0	1	0	1	3.1
Opephora olsenii	2	1	0	0	3	9.4
Navicula margalithii	1	0	0	0	1	3.1
TOTAL					32	100.0

Depth: 23-23.5 cm						
Slide: WB 86-2 A 23-23.5 (b) (v4)						
Date: 28/8/15						
Magnification: 100x 15x						
Transects: (25, 97)- (45, 97); (45, 97.5)- (25, 97.5); (25, 98)- (45, 98); (45, 98.5)- (25, 98.5); (25, 99)- (45, 99); (45, 99.5)- (25, 99.5); (25, 100)- (45, 100); (45, 100.5)- (25, 100.5); (25, 101)- (45, 101); (45, 101.5)- (25, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	0	4	2	1	7	70.0
Rhopalodia musculus	0	0	1	0	1	10.0
Rhopalodia brebissonii	0	2	0	0	2	20.0
TOTAL					10	100.0

Depth: 24-24.5 cm						
Slide: WB 86-2 A 24-24.5 (a) (v4)						
Date: 28/8/15						
Magnification: 100x 15x						
Transects: (43, 97)- (63, 97); (63, 97.5)- (43, 97.5); (43, 98)- (63, 98); (63, 98.5)- (43, 98.5); (43, 99)- (63,99); (63, 99.5)- (43, 99.5); (43, 100)- (63, 100); (63, 100.5)- (43, 100.5); (43, 101)- (63, 101); (63, 101.5)- (43, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia acuminata	0	0	2	0	2	5.4
Cymbella silesiaca	2	1	1	0	4	10.8
Rhopalodia brebissonii	1	1	0	0	2	5.4
Fragilaria eliptica	1	0	0	0	1	2.7
Pinnularia borealis var rectangularis	0	1	0	0	1	2.7
Rhopalodia musculus	1	0	1	0	2	5.4
Diatomella sp	0	0	1	0	1	2.7
sp r	0	0	1	0	1	2.7
Fragilaria pinnata var pinata	0	1	1	0	2	5.4
Navicula contenta	0	5	1	1	7	18.9
Opephora olsenii	0	2	1	0	3	8.1
Amphora graeffeana	0	1	0	0	1	2.7
Navicula constricta	1	0	0	0	1	2.7
Cocconeis placentula var euglypta	0	2	1	0	3	8.1
Navicula mutica	0	1	3	0	4	10.8
Achnanthes brevipes	1	0	0	1	2	5.4
TOTAL					37	100.0

Depth: 25-25.5 cm						
Slide: WB 86-2 A 25-25.5 (b) (v4)						
Date: 31/8/15						
Magnification: 100x 15x						
Transects: (21, 96)- (41, 96); (41, 96.5)- (21, 96.5); (21, 97)- (41, 97); (41, 97.5)- (21, 97.5); (21, 98)- (41, 98); (41, 98.5)- (21, 98.5); (21, 99)- (41, 99); (41, 99.5)- (21, 99.5); (21, 100)- (41, 100); (41, 100.5)- (21, 100.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Amphora subacutiuscula	0	0	1	0	1	4.5
Navicula mutica	0	1	0	0	1	4.5
Cocconeis neodiminuta	1	2	0	0	3	13.6
Nitzschia hungarica	0	1	0	1	2	9.1
Rhopalodia acuminata	3	0	0	0	3	13.6
Pinnularia sp a	0	1	0	0	1	4.5
Fragilaria pinnata var pinata	0	2	0	0	2	9.1
Pinnularia borealis var rectangularis	1	0	0	1	2	9.1
Entomoneis paludosa	0	1	0	0	1	4.5
Nitzschia frustulum	0	0	1	0	1	4.5
Cocconeis placentula var euglypta	0	1	0	0	1	4.5
Seminavis yarrensis	1	0	0	0	1	4.5
Cymbella minuta	0	1	0	0	1	4.5
Hantzschia amphioxys	0	0	1	0	1	4.5
Navicula contenta	0	1	0	0	1	4.5
TOTAL					22	100.0

Depth: 26-26.5 cm						
Slide: WB 86-2 A 26-26.5 (a) (v4)						
Date: 31/8/15						
Magnification: 100x 15x						
Transects: (45, 97)- (65, 97); (65, 97.5)- (45, 97.5); (45, 98)- (65, 98); (65, 98.5)- (45, 98.5); (45, 99)- (65, 99); (65, 99.5)- (45, 99.5); (45, 100)- (65, 100); (65, 100.5)- (45, 100.5); (45, 101)- (65, 101); (65, 101.5)- (45, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia acuminata	1	3	3	2	9	13.0
Navicula cryptonella	0	2	0	0	2	2.9
Navicula contenta	1	0	0	0	1	1.4
Cocconeis neodiminuta	3	4	0	0	7	10.1
Nitzschia frustulum	0	3	1	0	4	5.8
Cocconeis placentula var euglypta	6	5	7	5	23	33.3
Opephora olsenii	4	4	0	0	8	11.6
Seminavis yarrensis	1	0	0	0	1	1.4
sp e	0	1	0	0	1	1.4
Achnanthes bahusiensis	1	1	0	0	2	2.9
Cymbella pusilla	1	0	0	0	1	1.4
Cymbella minuta	1	0	0	0	1	1.4
Achnanthes brevipes	2	0	1	1	4	5.8
Rhopalodia musculus	3	0	1	0	4	5.8
Nitzschia hungarica	0	1	0	0	1	1.4
TOTAL					69	100.0

Depth: 27-27.5 cm

Slide: WB 86-2 A 27-27.5 (a) (v4)

Date: 31/8/15

Magnification: 100x 15x

Transects:
(44, 97)- (64, 97); (64, 97.5)- (44, 97.5); (44, 98)- (64, 98); (64, 98.5)- (44, 98.5); (44, 99)- (64, 99); (64, 99.5)- (44, 99.5); (44, 100)- (64, 100); (64, 100.5)- (44, 100.5); (44, 101)- (64, 101); (64, 101.5)- (44, 101.5)

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	0	3	0	0	3	15.0
Cocconeis placentula var euglypta	1	1	1	0	3	15.0
Rhopalodia musculus	1	2	2	0	5	25.0
Amphora coffeaeformis	0	1	0	0	1	5.0
Achnanthes brevipes	1	0	1	0	2	10.0
Opephora olsenii	1	1	0	0	2	10.0
Pinnuavis elegans	0	1	0	1	2	10.0
Navicula cinta	0	1	0	0	1	5.0
Cymbella pusilla	1	0	0	0	1	5.0
TOTAL					20	100.0

Depth: 28-28.5 cm						
Slide: WB 86-2 A 28-28.5 (b) (v4)						
Date: 1/9/15						
Magnification: 100x 15x						
Transects: (21, 97)- (42, 97); (42, 97.5)- (21, 97.5); (21, 98)- (42, 98); (42, 98.5)- (21, 98.5); (21, 99)- (42, 99); (42, 99.5)- (21, 99.5); (21, 100)- (42, 100); (42, 100.5)- (21, 100.5); (21, 101)- (42, 101); (42, 101.5)- (21, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia acuminata	0	1	0	0	1	2.3
Navicula pseudolanceolata	2	0	0	0	2	4.7
Achnanthes brevipes	6	4	1	1	12	27.9
Rhopalodia brebissonii	3	1	2	0	6	14.0
Cocconeis placentula var euglypta	1	0	2	0	3	7.0
Cymbella pusilla	0	1	0	0	1	2.3
Fragilaria pinnata var pinata	1	1	0	0	2	4.7
Rhopalodia musculus	1	1	0	0	2	4.7
Amphora graeffeana	0	1	1	0	2	4.7
Cocconeis neodiminuta	0	3	1	0	4	9.3
Opephora olsenii	0	2	1	0	3	7.0
Amphora coffeaeformis	0	1	1	0	2	4.7
Navicula cincta	0	1	0	0	1	2.3
Achnanthes delicatula	1	0	0	0	1	2.3
Nitzschia frustulum	0	0	1	0	1	2.3
TOTAL					43	100.0

Depth: 29-29.5 cm						
Slide: WB 86-2 A 29-29.5 (B) (v4)						
Date: 1/9/15						
Magnification: 100x 15x						
Transects: (20, 97)- (40, 97); (40, 97.5)- (20, 97.5); (20, 98)- (40, 98); (40, 98.5)- (20, 98.5); (20, 99)- (40, 99); (40, 99.5)- (20, 99.5); (20, 100)- (40, 100); (40, 100.5)- (20, 100.5); (20, 101)- (40, 101); (40, 101.5)- (20, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cymbella pusilla	0	2	0	0	2	3.4
Cocconeis neodiminuta	7	7	1	0	15	25.4
Achnanthes brevipes	3	1	1	0	5	8.5
Seminavis robusta	1	0	2	0	3	5.1
Rhopalodia brebissonii	6	0	1	0	7	11.9
Cocconeis placentula var euglypta	3	1	1	1	6	10.2
Nitzschia frustulum	0	1	1	1	3	5.1
Opephora olsenii	0	5	1	0	6	10.2
Rhopalodia musculus	0	0	1	0	1	1.7
Achnanthes bahusiensis	0	1	0	0	1	1.7
Caloneis molaris	0	0	1	0	1	1.7
Rhopalodia acuminata	3	0	0	0	3	5.1
Cymbella minuta	0	1	0	0	1	1.7
Amphora graeffeana	0	0	2	0	2	3.4
Entomoneis	0	0	0	1	1	1.7
Cymbella silesiaca	0	1	0	0	1	1.7
Fragilaria pinnata var pinata	0	1	0	0	1	1.7
TOTAL					59	100.0

Depth: 30-30.5 cm						
Slide: WB 86-2 A 30-30.5 (b) (v4)						
Date: 1/9/15						
Magnification: 100x 15x						
Transects: (19, 97)- (40, 97); (40, 97.5)- (19, 97.5); (19, 98)- (40, 98); (40, 98.5)- (19, 98.5); (19, 99)- (40, 99); (40, 99.5)- (19, 99.5); (19, 100)- (40, 100); (40, 100.5)- (19, 100.5); (19, 101)- (40, 101); (40, 101.5)- (19, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
NIL						
TOTAL					0	

Depth: 31-31.5 cm						
Slide: WB 86-2 A 31-31.5 (b) (v4)						
Date: 2/9/15						
Magnification: 100x 15x						
Transects: (23, 97)- (43, 97); (43, 97.5)- (23, 97.5); (23, 98)- (43, 98); (43, 98.5)- (23, 98.5); (23, 99)- (43, 99); (43, 99.5)- (23, 99.5); (23, 100)- (43, 100); (43, 100.5)- (23, 100.5); (23, 101)- (43, 101); (43, 101.5)- (23, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia brebissonii	1	3	0	0	4	22.2
Navicula contenta	0	0	1	0	1	5.6
Cocconeis placentula var euglypta	0	1	0	2	3	16.7
Cymbella minuta	0	2	0	0	2	11.1
Cocconeis neodiminuta	1	0	0	2	3	16.7
Rhopalodia musculus	0	1	0	0	1	5.6
Achnanthes brevipes	0	1	0	0	1	5.6
Nitzschia frustulum	0	0	2	0	2	11.1
Pinnularia borealis var rectangularis	1	0	0	0	1	5.6
TOTAL					18	100.0

Depth: 32-32.5 cm						
Slide: WB 86-2 A 32-32.5 (a) (v4)						
Date: 2/9/15						
Magnification: 100x 15x						
Transects: (45, 97)- (65, 97); (65, 97.5)- (45, 97.5); (45, 98)- (65, 98); (65, 98.5)- (45, 98.5); (45, 99)- (65, 99); (65, 99.5)- (45, 99.5); (45, 100)- (65, 100); (65, 100.5)- (45, 100.5); (45, 101)- (65, 101); (65, 101.5)- (45, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Amphora coffeaeformis	0	1	0	0	1	4.8
Achnanthes brevipes	1	2	0	0	3	14.3
Cocconeis placentula var euglypta	2	2	1	1	6	28.6
Rhopalodia brebissonii	0	0	1	0	1	4.8
Hantzschia amphioxys	3	0	0	0	3	14.3
Amphora comutata	0	0	2	0	2	9.5
Pinnularia borealis var rectangularis	1	0	0	0	1	4.8
Nitzschia frustulum	0	0	1	1	2	9.5
Navicula contenta	0	0	1	0	1	4.8
Rhopalodia musculus	0	1	0	0	1	4.8
TOTAL					21	100.0

Depth: 33-33.5 cm

Slide: WB 86-2 A 33-33.5 (a) (v4)

Date: 2/9/15

Magnification: 100x 15x

Transects:
(47, 97)- (67, 97); (67, 97.5)- (47, 97.5); (47, 98)- (67, 98); (67, 98.5)- (47, 98.5); (47, 99)- (67, 99);
(67, 99.5)- (47, 99.5); (47, 100)- (67, 100); (67, 100.5)- (47, 100.5); (47, 101)- (67, 101); (67, 101.5)- (47, 10.5);

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis neodiminuta	3	5	0	0	8	17.8
Navicula mutica	1	1	0	0	2	4.4
Cocconeis placentula var euglypta	5	5	0	1	11	24.4
Achnanthes brevipes	2	2	1	0	5	11.1
sp j	0	1	0	0	1	2.2
Amphora graffeana	0	1	0	0	1	2.2
Nitzschia frustulum	0	1	5	0	6	13.3
Opephora olsenii	2	0	0	0	2	4.4
Pinnularia divergentissima	0	1	0	0	1	2.2
Rhopalodia musculus	1	1	1	1	4	8.9
Nitzschia constricta	0	1	0	0	1	2.2
Rhopalodia acuminata	1	0	0	0	1	2.2
Navicula contenta	0	1	0	1	2	4.4
TOTAL					45	100.0

Depth: 34-34.5 cm						
Slide: WB 86-2 A 34-34.5 (a) (v4)						
Date: 2/9/15						
Magnification: 100x 15x						
Transects: (45, 97)- (65, 97); (65, 97.5)- (59, 97.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
sp a	0	3	13	5	21	16.5
Rhopalodia musculus	0	5	9	1	15	11.8
Achnanthes brevipes	0	26	33	9	68	53.5
Cocconeis placentula var euglypta	0	1	1	4	6	4.7
Seminavis yarrensis	0	2	3	4	9	7.1
Opephora olsenii	0	1	0	0	1	0.8
Entomoneis	0	0	3	3	6	4.7
Rhopalodia brebissonii	0	1	0	0	1	0.8
TOTAL					127	100.0

Depth: 35-35.5 cm						
Slide: WB 86-2 A 35-35.5 (v4)						
Date: 18/9/15						
Magnification: 100x 15x						
Transects: (44, 97)- (65, 97)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	3	7	11	21	15.0
Rhopalodia musculus	0	8	3	0	11	7.9
Opephora olsenii	0	1	0	0	1	0.7
Rhopalodia acuminata	0	7	3	6	16	11.4
Seminavis yarrensis	0	2	5	16	23	16.4
sp a	0	18	11	7	36	25.7
Diploneis smithii	3	0	0	2	5	3.6
Achnanthes brevipes	0	14	6	3	23	16.4
Navicula mutica	0	0	0	1	1	0.7
Amphora coffeaeformis	0	0	1	0	1	0.7
Pinnularia borealis var rectangularis	0	1	1	0	2	1.4
TOTAL					140	100

Depth: 36-36.5 cm						
Slide: WB 86-2 A 36-36.5 (a) (v4)						
Date: 3/9/15						
Magnification: 100x 15x						
Transects: (46, 97)- (65, 97)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	1	10	5	16	11.0
sp a	0	15	8	11	34	23.3
Entomoneis	0	0	0	1	1	0.7
Achnanthes brevipes	0	16	14	6	36	24.7
Rhopalodia musculus	0	19	20	7	46	31.5
Seminavis yarrensis	0	0	2	5	7	4.8
Cymbella silesiaca	1	0	1	0	2	1.4
Navicula contenta	0	0	1	0	1	0.7
Hantzschia amphioxys	0	0	2	0	2	1.4
Rhopalodia acuminata	0	1	0	0	1	0.7
TOTAL					146	100.0

Depth: 37-37.5 cm						
Slide: WB 86-2 A 37-37.5 (a) (v4)						
Date: 3/9/15						
Magnification: 100x 15x						
Transects: (46, 97)- (66, 97); (66, 97.5)- (46, 97.5); (46, 98)- (60, 98)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Opephora olsenii	0	2	0	0	2	2.0
Rhopalodia musculus	0	3	16	9	28	27.5
Cocconeis placentula var euglypta	2	2	3	0	7	6.9
sp a	0	10	16	10	36	35.3
Achnanthes brevipes	0	1	1	1	3	2.9
Cocconeis neodiminuta	1	2	0	0	3	2.9
sp d	0	1	0	0	1	1.0
Amphora coffeaeformis	0	1	0	0	1	1.0
Rhopalodia acuminata	0	8	5	2	15	14.7
Nitzschia frustulum	0	0	2	0	2	2.0
Rhopalodia brebissonii	0	1	0	0	1	1.0
Seminavis yarrensis	0	1	0	0	1	1.0
Navicula cincta	0	1	0	0	1	1.0
Hatzschia amphioxys	0	1	0	0	1	1.0
TOTAL					102	100.0

Depth: 38-38.5 cm						
Slide: WB 86-2 A 38-38.5 (b) (v4)						
Date: 3/9/15						
Magnification: 100x 15x						
Transects: (22, 97)- (42, 97); (42, 97.5)- (22, 97.5); (22, 98)- (42, 98); (42, 98.5)- (22, 98.5); (22, 99)- (42, 99); (42, 99.5)- (22, 99.5); (22, 100)- (42, 100); (42, 100.5)- (22, 100.5); (22, 101)- (42, 101); (42, 101.5)- (22, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	1	6	1	0	8	27.6
Amphora graffeana	0	1	0	0	1	3.4
Rhopalodia musculus	0	0	1	1	2	6.9
Rhopalodia acuminata	0	3	1	0	4	13.8
sp c	0	1	0	0	1	3.4
Cocconeis neodiminuta	4	5	2	0	11	37.9
Amphora coffeaeformis	0	2	0	0	2	6.9
TOTAL					29	100.0

Depth: 39-39.5 cm						
Slide: WB 86-2 A 39-39.5 (b) (v4)						
Date: 3/9/15						
Magnification: 100x 15x						
Transects: (19, 97)- (40, 97); (40, 97.5)- (19, 97.5); (19, 98)- (40, 98); (40, 98.5)- (19, 98.5); (19, 99)- (39, 99); (39, 99.5)- (19, 99.5); (19, 100)- (39, 100); (39, 100.5)- (19, 100.5); (19, 101)- (39, 101); (39, 101.5)- (19, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	3	6	8	0	17	17.5
Nitzschia frustulum	0	2	8	1	11	11.3
Rhopalodia acuminata	0	7	1	1	9	9.3
Rhopalodia musculus	0	7	2	4	13	13.4
Amphora graffeana	0	2	2	0	4	4.1
Achnanthes brevipes	4	2	1	6	13	13.4
Opephora olsenii	1	6	1	0	8	8.2
Navicula cincta	0	2	0	1	3	3.1
Cocconeis neodimunta	2	5	1	0	8	8.2
Seminavis yarrensis	0	0	3	0	3	3.1
Rhopalodia brebissonii	1	4	0	0	5	5.2
sp a	0	2	0	0	2	2.1
Navicula contenta	0	1	0	0	1	1.0
TOTAL					97	100.0

Depth: 40-40.5 cm						
Slide: WB 86-2 A 40-40.5 (a) (v4)						
Date: 4/9/15						
Magnification: 100x 15x						
Transects: (46, 97)- (66, 97); (66, 97.5)- (46, 97.5); (46, 98)- (66, 98); (66, 98.5)- (46, 98.5); (46, 99)- (66, 99); (66, 99.5)- (46, 99.5); (46, 100)- (66, 100); (66, 100.5)- (46, 100.5); (46, 101)- (66, 101); (66, 101.5)- (46, 101.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Achnanthes brevipes	2	23	22	30	77	71.3
Nitzschia frustulum	0	0	3	1	4	3.7
Cocconeis placentula var euglypta	2	2	3	2	9	8.3
Navicula mutica	1	1	1	1	4	3.7
Cocconeis neodiminuta	1	2	0	0	3	2.8
sp i	1	0	0	0	1	0.9
Rhopalodia brebissonii	0	1	1	0	2	1.9
Achnanthes bahusiensis	0	1	0	0	1	0.9
Rhopalodia musculus	2	2	0	0	4	3.7
Rhopalodia acuminata	0	1	0	0	1	0.9
Seminavis yarrensis	0	1	1	0	2	1.9
TOTAL					108	100.0

Depth: 41-41x.5 cm						
Slide: WB 86-2 A 41-41.5 (a) (v4)						
Date: 4/9/15						
Magnification: 100x 15x						
Transects: (46, 97)- (62, 97)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Achnanthes brevipes	21	35	15	15	86	66.2
sp a	0	2	1	3	6	4.6
Cocconeis placentula var euglypta	0	7	7	9	23	17.7
Opephora olsenii	0	1	0	0	1	0.8
Nitzschia constricta	0	1	0	0	1	0.8
Seminavis yarrensis	0	0	1	3	4	3.1
Rhopalodia brebissonii	0	2	2	0	4	3.1
Rhopalodia acuminata	0	0	0	1	1	0.8
Fragilaria pinnata var pinata	0	1	2	0	3	2.3
Nitzschia frustulum	0	0	1	0	1	0.8
TOTAL					130	100.0

Depth: 42-42.5 cm						
Slide: WB 86-2 A 42-42.5 (a) (v4)						
Date: 4/9/15						
Magnification: 100x 15x						
Transects: (45, 97)- (49.1, 97)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	35	29	14	78	61.9
Opephora olsenii	5	10	4	0	19	15.1
Navicula cari	1	0	0	0	1	0.8
Rhopalodia musculus	3	1	1	0	5	4.0
Achnanthes brevipes	2	4	2	3	11	8.7
Rhopalodia brebissonii	0	2	0	0	2	1.6
Amphora coffeaeformis	0	1	0	0	1	0.8
Fragilaria pinnata var pinata	1	1	0	0	2	1.6
Seminavis yarrensis	0	2	0	5	7	5.6
TOTAL					126	100.0

Depth: 43-43.5 cm						
Slide: WB 86-2 A 43-43.5 (a) (v4)						
Date: 17/9/15						
Magnification: 100x 15x						
Transects: (46, 97)- (53, 97)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
sp a	1	0	0	1	2	1.3
Cocconeis placentula var euglypta	0	3	14	17	34	22.8
Fragilaria pinnata	0	0	10	3	13	8.7
Achnanthes brevipes	4	4	7	18	33	22.1
Rhopalodia acuminata	0	1	1	5	7	4.7
Opephora olsenii	0	8	19	6	33	22.1
Rhopalodia musculus	3	0	1	2	6	4.0
Seminavis yarrensis	0	6	6	9	21	14.1
TOTAL					149	100.0

Depth: 44-44.5 cm

Slide: WB 86-2 A 44-44.5 (b) (v4)

Date: 4/9/15

Magnification: 100x 15x

Transects:
(18, 97)- (38, 97); (38, 97.5)- (18, 97.5); (18, 98)- (38, 98); (38, 98.5)- (18, 98.5); (18, 99)- (38, 99); (38, 99.5)- (18, 99.5); (18, 100)- (38, 100); (38, 100.5)- (18, 100.5); (18, 101)- (38, 101); (38, 101.5)- (18, 101.5);

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia musculus	0	5	3	1	9	32.1
Cocconeis neodiminuta	3	9	0	0	12	42.9
Cocconeis placentula var euglypta	1	0	0	0	1	3.6
Rhopalodia acuminata	0	2	0	4	6	21.4
TOTAL					28	100.0

Depth: 45-45.5 cm						
Slide: WB 86-2 A 45-45.5 (v2) b						
Date: 16/7/15						
Magnification: 100x 15x						
Transects: (22, 100)- (43, 100); (22, 101)- (43, 101); (43, 101.5)- (22, 101.5); (22, 102)- (43, 102)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Cocconeis placentula var euglypta	0	2	12	7	21	18.10
Ophephora olsenii	0	5	4	8	17	14.66
Fragilaria pinnata var intercedens	0	2	0	2	4	3.45
Cocconeis placentula var euglyptoides	0	1	6	4	11	9.48
Stauroneis anceps var anceps	0	1	0	0	1	0.86
Fragilaria pinnata var pinata	0	7	7	5	19	16.38
Navicula digitoradiata	0	0	1	0	1	0.86
Navicula seminulum	0	1	0	0	1	0.86
Nitzschia frustulum var frustulum	0	1	3	2	6	5.17
Cocconeis neodiminuta	0	0	5	10	15	12.93
Navicula sp a	0	0	0	1	1	0.86
Navicula bulnheinii	0	0	0	1	1	0.86
Rhopalodia acuminata var acuminata	0	0	1	0	1	0.86
sp k	0	0	0	1	1	0.86
Entomoneis paludosa var acuminata	0	0	1	0	1	0.86
Rhopalodia brebissonii	0	0	1	0	1	0.86
Rhopalodia musculus	0	1	0	0	1	0.86
Seminavis yarrensis	0	3	1	4	8	6.90
sp a	0	0	0	3	3	2.59
Cymbella pusilla	0	0	1	1	2	1.72
TOTAL					116	100.00

Depth: 46-46.5 cm

Slide: WB 86-2 A 46-46.5 (b) (v4)

Date: 4/9/15

Magnification: 100x 15x

Transects:
(18, 97)- (38, 97); (38, 97.5)- (18, 97.5); (18, 98)- (38, 98); (38, 98.5)- (18, 98.5); (18, 99)- (38, 99); (38, 99.5)- (18, 99.5); (18, 100)- (38, 100); (38, 100.5)- (18, 100.5); (18, 101)- (38, 101); (38, 101.5)- (18, 101.5);

	Counts (#)				Total	rel. abun.
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Opephora olsenii	1	2	0	0	3	7.1
Cocconeis placentula var euglypta	1	2	3	0	6	14.3
Cocconeis neodiminuta	2	3	0	0	5	11.9
Seminavis yarrensis	1	3	0	0	4	9.5
Nitzschia frustulum	0	0	1	0	1	2.4
Achnanthes brevipes	2	1	0	5	8	19.0
Cymbella pusilla	0	1	0	0	1	2.4
Caloneis bacillum	0	1	0	0	1	2.4
Navicula leptostriata	1	0	0	0	1	2.4
Navicula soodensis	0	1	0	0	1	2.4
Rhopalodia acuminata	1	0	1	1	3	7.1
sp a	0	1	0	0	1	2.4
Rhopalodia musculus	2	2	0	0	4	9.5
Achnanthes delicatula	1	0	0	0	1	2.4
Amphora coffeaeformis	1	0	0	0	1	2.4
Rhopalodia brebissonii	0	1	0	0	1	2.4
TOTAL					42	100.0

Depth: 47-47.5 cm						
Slide: WB 86-2 A 47-47.5 (b) (v4)						
Date: 4/9/15						
Magnification: 100x 15x						
Transects: (19, 100)- (39, 100); (39, 100.5)- (19, 100.5); (19, 101)- (39, 101); (39, 101.5)- (20, 101.5); (20, 102)- (39, 102); (39, 102.5)- (20, 102.5); (20, 103)- (40, 103); (40, 103.5)- (19, 103.5); (19, 104)- (39, 104); (39, 104.5)- (19, 104.5);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Opephora olsenii	0	2	1	0	3	4.3
Achnanthes brevipes	5	11	3	9	28	40.6
Rhopalodia brebissonii	0	0	1	1	2	2.9
Rhopalodia musculus	2	1	1	2	6	8.7
Seminavis yarrensis	0	6	3	2	11	15.9
Amphora coffeaeformis	0	2	0	0	2	2.9
Cocconeis placentula var euglypta	1	3	2	0	6	8.7
Cocconeis neodiminuta	1	4	0	0	5	7.2
Hantzschia amphioxys	0	1	0	0	1	1.4
Cymbella pusilla	0	1	0	0	1	1.4
Achnanthes delicatula	0	1	0	0	1	1.4
Navicula cincta	0	2	0	0	2	2.9
Diploneis smithii	1	0	0	0	1	1.4
TOTAL					69	100.0

Depth: 48-48.5 cm						
Slide: WB 86-2 A 48-48.5 (b) (v4)						
Date: 5/9/15						
Magnification: 100x 15x						
Transects: (15, 97)- (35, 97); (35, 97.5)- (15, 97.5); (15, 98)- (36.5, 98); (36.5, 98.5)- (15, 98.5); (15, 99)- (35, 99);						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Rhopalodia musculus	7	19	29	12	67	49.6
Achnanthes brevipes	3	8	5	7	23	17.0
Pinnularia borealis var rectangularis	0	0	1	0	1	0.7
sp a	10	4	2	1	17	12.6
Hantzschia amphioxys	1	1	2	2	6	4.4
Cocconeis placentula var euglypta	1	4	0	2	7	5.2
Navicula mutica	0	1	1	0	2	1.5
Diploneis smithii	0	0	1	3	4	3.0
Nitzschia frustulum var frustulum	0	0	2	0	2	1.5
Opephora olsenii	5	0	0	0	5	3.7
Rhopalodia brebissonii	0	1	0	0	1	0.7
TOTAL					135	100.0

Depth: 49-49.5 cm						
Slide: WB 86-2 A 49-49.5 (b) (v4)						
Date: 5/9/15						
Magnification: 100x 15x						
Transects: (19, 97)- (40, 97); (40, 97.5)- (29, 97.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Achnanthes brevipes	10	27	25	26	88	75.9
Rhopalodia musculus	1	6	3	0	10	8.6
Opephora olsenii	2	0	0	0	2	1.7
Cocconeis neodiminuta	2	3	0	0	5	4.3
sp a	3	0	0	1	4	3.4
Cocconeis placentula var euglypta	0	1	0	1	2	1.7
Rhopalodia brebissonii	0	1	0	1	2	1.7
Cymbella pusilla	1	0	0	0	1	0.9
Hantzschia amphioxys	0	1	0	0	1	0.9
Navicula mutica	0	1	0	0	1	0.9
TOTAL					116	100.0

Depth: 49.5-50 cm						
Slide: WB 86-2 A 49.5-50 (v2) b						
Date: 17/7/15 & 5/9/15						
Magnification: 100x 15x						
Transects: (20, 100)- (24.5, 100); (20, 100.5)- (41, 100.5); (41, 101)- (20, 101); (20, 101.5)- (42, 101.5)						
	Counts (#)				**Total**	**rel. abun.**
Genus Species	**D1**	**D2**	**D3**	**D4**	**#**	**%**
Seminavis yarrensis	0	4	12	12	28	19.0
Cocconeis neodiminuta	0	8	11	5	24	16.3
Cocconeis placentula var euglypta	2	12	15	4	33	22.4
Rhopalodia supresemicirculatus	0	1	0	0	1	0.7
Opephora olsenii	0	7	2	0	9	6.1
Rhopalodia musculus	0	10	4	10	24	16.3
sp a	0	3	3	0	6	4.1
Achnanthes brevipes	2	2	3	4	11	7.5
Nitzschia consticta	0	2	0	0	2	1.4
Cymbella pusilla	0	1	0	0	1	0.7
Navicula cincta	0	2	0	0	2	1.4
Rhopalodia brebissonii	0	3	0	0	3	2.0
Diploneis smithii	0	0	1	0	1	0.7
Hantzschia amphioxys	0	0	1	0	1	0.7
Pinnularia borealis var rectangularis	0	0	0	1	1	0.7
TOTAL					147	100.0

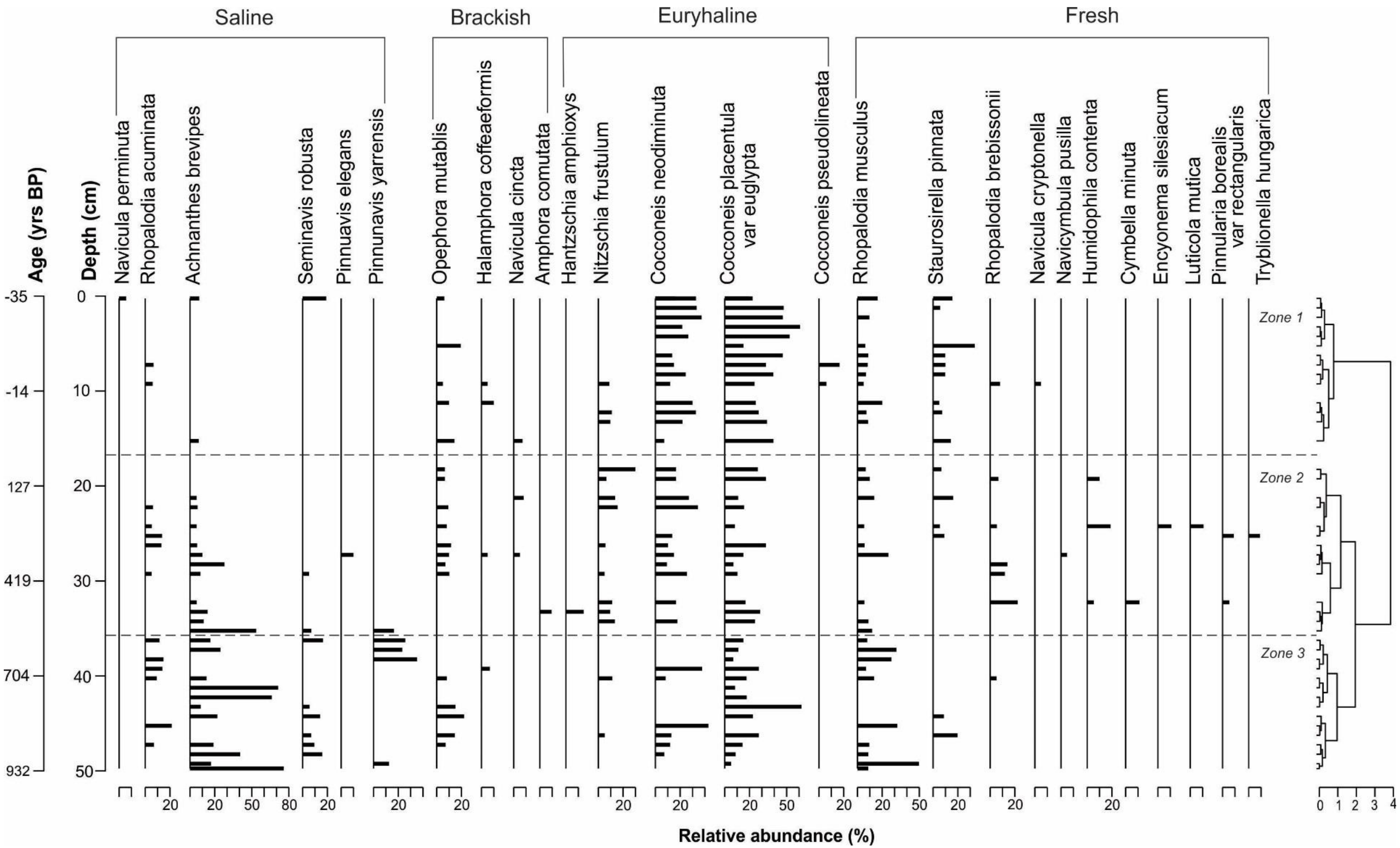
APPENDIX B: DIATOM CONCENTRAION CALCULATIONS

Sample depth (cm)	Sediment in tube (g)	Volume in tube (ml)	Volume taken (ml)	Fraction sampled	Mass sediment sampled (g)	Total area of coverslip (cm^2)	Total area of coverslip (mm^2)	Number of transects done	Total length of transects (mm)	Diameter of field of view (mm)	Radius of field of view (mm)	Area of field of view (mm^2)	Total area viewed (mm^2)	Fraction of coverslip viewed	Total sediment analysed (g)	Diatoms counted	D/g wet sediment
0.25	0.2888	5	0.6	0.1200	0.0347	4	400	11	214	0.15	0.075	0.018	32.925	0.0823	0.0028526	70	24538.83
1.25	0.4276	8	0.6	0.0750	0.0321	4	400	9	180	0.15	0.075	0.018	27.675	0.0692	0.0022188	105	47321.96
2.25	0.4689	8	0.6	0.0750	0.0352	4	400	10	182	0.15	0.075	0.018	28.050	0.0701	0.0024661	83	33656.09
3.25	0.5675	8	0.6	0.0750	0.0426	4	400	10	182	0.15	0.075	0.018	28.050	0.0701	0.0029847	69	23117.94
4.25	0.5844	5	0.4	0.0800	0.0468	4	400	9	182	0.15	0.075	0.018	27.975	0.0699	0.0032697	105	32112.86
5.25	0.7462	5	0.6	0.1200	0.0895	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0068837	112	16270.33
6.25	0.6729	6	0.6	0.1000	0.0673	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0051729	81	15658.47
7.25	0.5788	5	0.6	0.1200	0.0695	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0055999	60	10714.50
8.25	0.8019	5.25	0.6	0.1143	0.0916	4	400	8	160	0.15	0.075	0.018	24.600	0.0615	0.0056362	102	18097.26
9.25	0.6581	5	0.6	0.1200	0.0790	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0060710	100	16471.83
10.25	0.1174	5	0.8	0.1600	0.0188	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0014440	6	4155.07
11.25	0.0871	5	1	0.2000	0.0174	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0013392	20	14934.71
12.25	0.5814	5	0.6	0.1200	0.0698	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0053634	55	10254.66
13.25	0.6051	8	0.4	0.0500	0.0303	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0023259	82	35255.88
14.25	0.7684	5	0.6	0.1200	0.0922	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0070885	11	1551.81
15.25	0.7275	5.5	0.6	0.1091	0.0794	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0063987	27	4219.61
16.25	0.8144	5.5	0.4	0.0727	0.0592	4	400	10	190	0.15	0.075	0.018	29.250	0.0731	0.0043311	7	1616.21
17.25	0.0526	5.5	0.8	0.1455	0.0077	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0005882	9	15301.86
18.25	0.4539	5	0.6	0.1200	0.0545	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0041872	30	7164.65

Sample depth (cm)	Sediment in tube (g)	Volume in tube (ml)	Volume taken (ml)	Fraction sampled	Mass sediment sampled (g)	Total area of coverslip (cm^2)	Total area of coverslip (mm^2)	Number of transects done	Total length of transects (mm)	Diameter of field of view (mm)	Radius of field of view (mm)	Area of field of view (mm^2)	Total area viewed (mm^2)	Fraction of coverslip viewed	Total sediment analysed (g)	Diatoms counted	D/g wet sediment
19.25	0.5007	5	0.4	0.0800	0.0401	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0032295	30	9289.32
20.25	0.674	5	0.6	0.1200	0.0809	4	400	11	180	0.15	0.075	0.018	27.825	0.0696	0.0056262	6	1066.44
21.25	0.6269	12	0.8	0.0667	0.0418	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0033696	37	10980.57
22.25	1.0604	13	0.7	0.0538	0.0571	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0046036	32	6951.14
23.25	0.0856	5	0.6	0.1200	0.0103	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0007897	10	12663.68
24.25	0.7491	4	0.3	0.0750	0.0562	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0043190	37	8566.74
25.25	0.78	4	0.6	0.1500	0.1170	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0089944	22	2445.97
26.25	0.7571	4	0.3	0.0750	0.0568	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0043652	69	15807.00
27.25	0.7441	4	0.3	0.0750	0.0558	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0042902	20	4661.79
28.25	0.8987	4	0.6	0.1500	0.1348	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0108687	43	3956.33
29.25	0.8297	4	0.6	0.1500	0.1245	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0095675	59	6166.72
30.25	0.2015	3	0.6	0.2000	0.0403	4	400	10	210	0.15	0.075	0.018	32.250	0.0806	0.0032492	0	0.00
31.25	0.7642	4	0.6	0.1500	0.1146	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0088122	18	2042.63
32.25	0.932	4	0.3	0.0750	0.0699	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0053736	21	3908.02
33.25	0.8233	4	0.3	0.0750	0.0617	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0047468	45	9479.99
34.25	0.862	4	0.3	0.0750	0.0647	4	400	2	26	0.15	0.075	0.018	4.050	0.0101	0.0006546	127	194017.17
35.25	0.8397	4	0.3	0.0750	0.0630	4	400	1	11	0.15	0.075	0.018	1.725	0.0043	0.0002716	140	515482.01
36.25	0.7022	4	0.3	0.0750	0.0527	4	400	1	19	0.15	0.075	0.018	2.925	0.0073	0.0003851	146	379109.69
37.25	0.587	4	0.3	0.0750	0.0440	4	400	3	54	0.15	0.075	0.018	8.325	0.0208	0.0009163	102	111320.86
38.25	0.1993	4	0.6	0.1500	0.0299	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0022982	29	12618.69
39.25	0.5521	4	0.6	0.1500	0.0828	4	400	10	204	0.15	0.075	0.018	31.350	0.0784	0.0064906	97	14944.63
40.25	0.5456	3.5	0.6	0.1714	0.0935	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0071902	108	15020.38

Sample depth (cm)	Sediment in tube (g)	Volume in tube (ml)	Volume taken (ml)	Fraction sampled	Mass sediment sampled (g)	Total area of coverslip (cm²)	Total area of coverslip (mm²)	Number of transects done	Total length of transects (mm)	Diameter of field of view (mm)	Radius of field of view (mm)	Area of field of view (mm²)	Total area viewed (mm²)	Fraction of coverslip viewed	Total sediment analysed (g)	Diatoms counted	D/g wet sediment
41.25	0.5315	4	0.3	0.0750	0.0399	4	400	1	16	0.15	0.075	0.018	2.475	0.0062	0.0002466	130	527064.31
42.25	0.4875	3.5	0.3	0.0857	0.0418	4	400	1	4.1	0.15	0.075	0.018	0.690	0.0017	0.0000721	126	1748049.05
43.25	0.3848	4	0.3	0.0750	0.0289	4	400	1	7	0.15	0.075	0.018	1.125	0.0028	0.0000812	149	1835681.84
44.25	0.1282	3.5	0.6	0.1714	0.0220	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0016895	28	16573.02
45.25	0.2663	5	0.2	0.0400	0.0107	4	400	4	84	0.15	0.075	0.018	12.900	0.0323	0.0003435	116	337673.60
46.25	0.1474	3	0.6	0.2000	0.0295	4	400	10	200	0.15	0.075	0.018	30.750	0.0769	0.0022663	42	18532.61
47.25	0.2211	3	0.6	0.2000	0.0442	4	400	10	198	0.15	0.075	0.018	30.450	0.0761	0.0033662	69	20497.60
48.25	0.331	3	0.6	0.2000	0.0662	4	400	5	103	0.15	0.075	0.018	15.825	0.0396	0.0026190	135	51545.65
49.25	0.2416	3	0.6	0.2000	0.0483	4	400	2	42	0.15	0.075	0.018	6.450	0.0161	0.0007792	116	148878.28
49.75	0.3946	5	0.2	0.0400	0.0158	4	400	4	68.5	0.15	0.075	0.018	10.575	0.0264	0.0004173	147	352273.42

APPENDIX C: DIATOM DIAGRAM FIGURE, PLOTTED BY DEPTH



APPENDIX D: EXTENDED METHODS

1. Sediment coring and subsampling

Four, six meter Mackereth cores were collected from West Basin in October 1986 (Gell et al. 1994). The core was opened and transported to the University of Adelaide in 2013 and is wrapped in polyethylene and stored in the dark at 4ºC. The upper 50 cm of core WB 86-2 A was removed using the 'LL-section method' (Nakagawa 2007). With a scalpel, 0.5 cm of contiguous samples were taken and transferred into labelled and weighed 15 ml plastic tubes.
The scalpel was cleaned with deionised (DI) water between samples.

2. Chronology

To complement existing chronology for West Basin Lake on unidentified coarse organic fragments (J.J. Tyler unpublished), a series of radiocarbon analyses were conducted on ostracod fossils. Sediment samples of approximately 5 cm^3 (1 cm thickness) were placed in a 100ml beaker of distilled water on a hotplate for 1 hour at 60°C to aid disaggregation.
The sediment was sieved through a 250 µm stainless steel sieve with DI water, then transferred to a container and freeze dried. To prepare these samples for radiocarbon dating, ashed glass vials were labelled and weighed. Samples were prepared for depths 3-4 cm, 8-9 cm, 16-17 cm, 33-34 cm, 98-99 cm, 107-108 cm, 108-109 cm. Ostracods were picked under a binocular microscope and transferred to the appropriate ashed glass vial using a needle.

Radiocarbon dates were obtained at Australian Nuclear Science and Technology Association (ANSTO) in Sydney, Australia. A Small Tandem for Applied Research (STAR) Accelerator and the Australian National Tandem Research Accelerator (ANTARES) Accelerator were used for radiocarbon dating. Data collection was funded by an AINSE honours scholarship.
A combination of these new dates and existing dates, including previously obtained ^{210}Pb analyses were used to derive an age model through the program 'CLAM' for 'R' (Blaauw 2010). The ages of specific sample depths were interpolated using a 0.3 spar smooth spline and errors inferred via 1000 Monte Carlo iterations.

3. Diatom analysis

Diatom preparation followed the method of Battarbee et al. (2001). Samples were treated with 3-4 ml of 10-15% hydrochloric acid (HCl) to remove carbonate material, and left to react for approximately 2 hours. Each sample was filled to 14 ml total volume with distilled water and left overnight to settle. Samples were settled, rather than centrifuged, to minimise damage to fragile diatom valves (Battarbee et al. 2001). Samples were decanted and filled with DI water, left overnight, and then decanted to rinse out the HCl. This procedure was repeated to a total of three rinses.

To remove organic matter, samples were treated with 5-6 ml of 25% Hydrogen Peroxide (H_2O_2) and left overnight to react. Samples were placed in a water bath at 75°C for 3.5 hours then 2-3 ml of 35% H_2O_2 was added. Samples remained in the water bath for an additional hour at 75°C. Vials were taken out of the water bath and left overnight to cool and settle.
Samples were rinsed three times with distilled water, following the same procedure used to rinse HCl. Ammonia was used as a flocculating agent to remove excess clay in suspension (Hinchey and Green 1994). Approximately 3 drops of 30% Ammonia were added to the 14 ml vial, agitated and left overnight.

To prepare cover slips, approximately 1 ml of distilled water was pipetted onto two cover slips (a, and b). A smaller amount of sample in suspension (generally 300 µl) was pipetted onto slip (a) and greater amount (generally 600 µl) onto slip (b). The volume in the tube at the time sample was taken, and the amount pipetted onto each coverslip was recorded.
Cover slips were left to dry overnight then inverted onto a microscope slide and affixed using NAPHRAX. In some cases, a process of trial and error was required to optimise the concentration of diatoms on each slide.

Samples were counted using a Nikon Eclipse E600 light microscope with 1500x optical magnification. In order to maximise both the number of samples analysed in this study and the quality of data collected, counting 100 valves was deemed most efficient. The count of 100 valves is sufficient to identify short-term episodes (Renberg 1990). Samples were only counted for 10 transects of approximately 20 mm length if less than 100 valves were found. To remove sampling bias, samples with less than 20 total valve counts were not included in the analysis for the diatom diagram (Figure 5).

Diatom species were identified using diatom species identification texts (Krammer and Lange-Bertalot 1986, Krammer and Lange-Bertalot 1988, Krammer and Lange-Bertalot 1991a, Krammer and Lange-Bertalot 1991b, Gell et al. 1999, Lange-Bertalot 2000). Modern nomenclature was determined through current online databases, including AlgaeBase (Guiry and Guiry 2015) and the World Register of Marine Species (Mees et al. 2015).

To account for possible variability in the degree of diatom dissolution, four dissolution states were identified during counting and applied to each diatom valve counted, following Ryves et al. (2009). A dissolution state of D1 indicates a pristine state, D2 indicates greater than 75% of diatom valve remains, D3 indicates between 75% and 60% of valve remains, and D4 indicates between 60% to 55% of diatom valve remains.

There are multiple indices of dissolution that can be calculated from diatom dissolution data. In this study the fractional index (FI) is used to relate the proportion of pristine valves to all valves that can be classified (Barker et al. 1994). The index varies from 0 to 1, where F=1 indicates that all valves are perfectly preserved and F=0 indicates that valves appear dissolved under light microscopy (Ryves et al. 2001, Flower 1993).

The diatom data were plotted using the program 'R' and the package 'rioja' (Juggins 2015). Species occurrences with a relative abundance greater than 5% are shown, and samples with a minimum diatom count of less than 20 are not included. Three main zones were identified through the "coniss" algorithm (Grimm 1987). Ecology of species was identified through AlgaeBase (Guiry and Guiry 2015) and the World Register of Marine Species (Mees et al. 2015). Optimal salinity and pH ranges of various diatom species were determined from previous work by Gell (1997) and Wilson et al. (1996). The concentration of diatoms per gram of wet sediment was calculated in excel using using the diatom counts, fraction of sediment subsampled and total area of transect analysed. Diatom data was compared with high-resolution element profiles collected form an Itrax-XRF core scanner.

4. Data analysis

Taxa were modelled using detrended correspondence analysis (DCA) to reduce errors carried over from counting. DCA analysis was completed using modified script for R using packages "analogue" (Simpson and Oksanen 2015) and "vegan" (Oksanen et al. 2015).

A salinity reconstruction was produced using a diatom salinity transfer function. Previous studies used fossil diatom records to reconstruct the salinity of lakes and identify past climate change (Wilson et al. 1996, Gell 1997, Barr et al. 2014). Quantitative estimates of lake water salinity change were inferred using the Weighted Average Partial Leas Squares (WAPLS) salinity transfer function from Gell (1997; R^2 = 0.77, Root Mean Square Error of Prediction= 0.31).