Linear regression analysis of Australian lacustrine sediments using geochemical and remote sensing techniques

Thesis submitted in accordance with the requirements of the University of Adelaide for an Honours Degree in Geology

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November 2016

THE UNIVERSITY of ADELAIDE

LINEAR REGRESSION ANALYSIS OF AUSTRALIAN LACUSTRINE SEDIMENTS USING GEOCHEMICAL AND REMOTE SENSING TECHNIQUES

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ABSTRACT

Our understanding of carbon cycling is based on a short time period of satellite or instrumental monitoring, which are limited with respect to understanding long term patterns in terrestrial carbon cycle. Our understanding of past changes in terrestrial biomass has been primarily derived from pollen and plant macrofossils preserved within sediments. Geochemical tracers offer a different perspective on past land cover and provide important constraints on source and deposition of sedimentary organic matter in the catchment area for the purpose of regional palaeoenvironmental reconstruction. We combine stable isotope analysis, source rock pyrolysis and remote sensing techniques to see whether we can observe a shift in geochemical signatures of lake sediments in response to changes in vegetation density and catchment hydrology. We hypothesize that we should see an increase in terrestrial organic carbon concentrations in catchments with higher vegetation density. Simultaneously increased rates of precipitation have been associated with increase in vegetation abundance and therefore hydrological shifts should also be reflected in geochemical signatures of sediments.

Our results confirm that there is a positive correlation between vegetation density and terrestrial organic carbon concentrations, with sediments from heavily vegetated catchments showing high concentrations of terrestrially derived organic matter. On the other hand, shifts in precipitation appear to only effect geochemical signatures of sediments from semi-arid regions with low vegetation densities.

KEYWORDS

Lacustrine
Organic carbon flux
Sediments
Semi-arid
Murray Darling Basin
Stable isotope
Remote sensing
Regression analysis

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INTRODUCTION

The continuous rise of atmospheric CO_2 concentrations, linked with anthropogenic emissions represents a major concern regarding the modern climatic and ecological changes (Haverd et al., 2013; IPCC, 2013). During the period prior to the industrial revolution (AD 1750 onwards), globally averaged CO_2 concentrations were around 280 ppm (parts per million) while today they exceed 400 ppm, with present day emissions accounting for approximately ten billion tons of carbon released into the atmosphere per year (Haverd et al., 2013; IPCC 2013; Poulter et al., 2014). Increased carbon uptake subsequently accompanies the increase in emissions by the oceanic and terrestrial carbon sinks, which account for approximately 40% of global carbon emissions (Poulter et al., 2014; Ahlstrom et al., 2015). Despite the continuous emission uptake by the carbon sinks, the airborne fraction of CO_2 exhibits large interannual variability, which is driven primarily by terrestrial ecosystem processes. While the tropical rainforests account for the majority of carbon uptake, they are also relatively stable through time. By contrast, semi-arid vegetation is extremely sensitive to climate and hydrological change and has recently been demonstrated also to play a major role in carbon sequestration (Poulter et al., 2014; Ahlstrom et al., 2015).

By looking at the evolution of the terrestrial carbon sink over the past 30 years using a terrestrial biogeochemical model, atmospheric carbon dioxide inversion and global carbon budget accounting, focusing primarily on the exceptionally large anomaly in 2011, Poulter et al., (2014) concluded that this anomaly was driven by growth of vegetation in the semi-arid ecosystems of the southern hemisphere regions of Australia, South America, and Southern Africa. Furthermore, 60 percent of the carbon uptake during this time was attributed to precipitation as the primary driver in moisture depleted environment (Cleverly et al., 2015). Similar results were observed in the early 2000s by Shim et al., (2009) north-east of Fort Collins, Colorado, USA. The strong correlation at an annual timescale between precipitation and productivity illustrates the primary control of photosynthetic productivity by precipitation (Cleverly et al., 2015).

Different ecosystems can store absorbed CO_2 over a range of time periods. Tropical forests tend to store carbon in dense hardwoods that have a relatively long lifespan. Semi-arid environments are much more volatile, highly susceptible to variations in rainfall, temperature as well as other forcing factors. By modeling the changes in organic carbon burial as a result of climatic variability, we can gain a better insight into the source and burial rate of organic carbon in response to climatic forcing, further increasing our understanding of the role semi-arid environments play in global carbon cycle.

Most of our understanding of carbon cycling is based on a short time period of satellite or instrumental monitoring, which are limited with respect to understanding long term patterns in terrestrial carbon cycle. Our understanding of past changes in terrestrial biomass has been primarily derived from pollen and plant macrofossils preserved within sediments. These data are invaluable because they provide information about what plant species were present in the region (Rodríguez-Gallego, Masciadri, and Nin, 2012; Sottile et al., 2015). However, they are limited due to inherent issues of bias by certain plant types which generate more pollen or leaf litter, bias by the plant types that are located nearest to the wetland and because in the absence of plant macrofossils, pollen types can rarely be identified to species. Thus it's challenging to determine changes within major groups (e.g. Eucalyptus, grasses) despite wide ranges in the ecology, climate preference and biomass of taxa within those broad groupings (Kershaw, 1979; D'Costa and Kershaw, 1995). Geochemical tracers offer a different perspective on past land cover. The geochemical and isotopic signatures of lake sediments provide important constraints on source and deposition of sedimentary organic matter (OM) in the catchment area for the purpose of regional palaeoenvironmental reconstruction (Meyers et al., 1999; Mayr et al., 2009). The primary source of OM in lake sediments is the particulate detritus of plants divided into two geochemically distinctive groups: vascular (C3 and C4) and non-vascular algae. The contributions from these two groups are strongly dependent on lake morphology, watershed morphology, climate variability, and vegetation abundance, with some lake sediments showing predominantly algal organic source, while others are dominated by land-derived plant sources (Meyers et al., 1999). To date, major applications of organic geochemical tracers have been to understand shifts between C3/C4 plant dominance and vegetation types in the absence of pollen (Ficken et al., 2002; Wooller et al., 2003). Geochemical tracers do not address the taxonomic composition of land cover, and they too are undoubtedly biased by proximity, plant source type, and taphonomy. However, in principle, the organic geochemical composition of a sediment should offer a more indiscriminate, overarching tracer of the organic biomass within a catchment.

To date, the vast majority of palaeoenvironmental research using organic geochemical tracers is based upon qualitative interpretation, which in turn limits the value of the data with regards understanding changes in past carbon sequestration, transport and storage.

There is a need for a way to calibrate the broad spectrum of geochemical data available, in order to make quantitative inferences. Correlating the geochemical and isotopic signatures from modern sediment samples across a region with data for land cover, terrestrial biomass, hydrological and land use shifts over the catchment area could lead to the development of working regression models. Such models could then be applied to other samples as well as sediment cores to provide a new way of interpreting sediment geochemistry, reconstructing past environments and quantifying the palaeo-fluxes of carbon within both aquatic and terrestrial ecosystems, further assisting in palaeoenvironmental reconstruction. It is hypothesized that changes in the terrestrial land cover are significantly correlated to the % of terrestrial organic carbon in lake sediments, as determined using multiple geochemical tracers. Periods and regions with enhanced regional precipitation are usually associated with the greater terrestrial biomass and should therefore also record an enhanced flux of terrestrial organic carbon to lake sediments. A successful model would show a shift in isotopic signatures of sediments correlated with shifts in vegetation density and or other parameters, such as catchment hydrology. If successful, the model could then be applied to sediment cores with available, previously obtained data. This research, therefore, offers a new means of investigating past interactions between land cover and atmospheric CO_2, with potential benefits for unraveling the history of the global carbon cycle.

GEOLOGICAL SETTING/BACKGROUND

Groundwater-dominated lakes are an important feature of many landscapes. Their sediments are a particularly valuable source of paleoenvironmental information in semiarid regions where perennial lakes may otherwise be scarce. Many investigations of continental paleoclimates employ indirect information or proxies, preserved in chemically or biogenically precipitated lacustrine carbonate sediments (Shapley et al., 2005). Previous attempts at using lacustrine and terrestrial sediments for reconstruction of paleoclimates have consisted predominantly of correlation between isotopic and geochemical data to constrain possible sources of organic carbon. The limitation of this approach is that there is no clear indication of the environmental parameters such as vegetation density, mean annual rainfall. Previous studies have shown that variability of carbon flux in semi-arid grasslands could be explained by its relation to temporal dynamics among precipitation pulses (Ma et al., 2012; Zhang et al., 2015), antecedent soil moisture, and activity of plant functional groups (Shim et al., 2009). A strong link between precipitation and primary productivity has also been demonstrated, with increased precipitation usually correlating with increased vegetation cover density over the region and thus an overall increase in primary production (Gabarrón-Galeote, Trigalet, and Wesemael, 2015). The enhanced input of OM from aquatic macrophytes, however, have been shown to occur during dryer intervals and low lake levels, which is supported by radiocarbon dated outcropping lacustrine sediments.

The origin of sedimentary OM can be distinguished between aquatic and terrestrial sources using a variety of geochemical tracers. Principal among those is the carbon to nitrogen ratio (C/N), which exhibit distinct patterns whereby terrestrial carbon is typically characterised by having higher C/N ratios (>15). By contrast, algal sources of OM have low C/N ratios (<10). Lakes dominated by OM from land sources usually show increased algal productivity as well relatively low (between 4 and 10) C/N values during periods of arid climate, and accompanied by a less negative δ13C values seen in shift of land vegetation from C_3 to C_4 plants (Meyers et al., 1999; Mayr et al., 2009;

Moschen et al., 2009). The changes in bulk soil isotopic signatures could, therefore, be used to model vegetation shifts in the region. Hydrogen and Oxygen indices (HI and OI) obtained through Rock-Eval pyrolysis techniques can provide further constraints on the nature of OM in lake sediments (Sebag et al., 2016).

Site description

The project focuses on lake sediments in south-eastern Australia, with a particular focus on the Murray-Darling Basin (MDB) region as well as western Tasmania and southern Queensland. The MDB is of interest due to its significance as a regional carbon sink as well as the potential for the integration of the carbon flux from the surrounding catchment areas by the river-fed wetlands. The MDB is Australia's largest river basin, spanning 1.06 x 10^6 km^2 and supporting a highly variable climate. Climate in the MDB is subtropical in the northeast, cool and humid in the eastern uplands, temperate over the southeast, and hot, dry semiarid and arid in the far west (van Dijk et al., 2007; Cruz et al., 2010; Gell & Reid 2014), with strong NE to SW temperature gradient. The basin can be described as predominantly flat and dry, with greater relief and rainfall towards the southern and eastern divides. The MDB drains approximately 14% of Australian landmass through numerous, slow flowing river systems, including the major Murray and Darling Rivers (2,508 and 1,472 km long respectively). Most runoff is generated in the uplands, and a substantial part is intercepted in storage reservoirs. About 11,000 of the 25,000 GL average annual stream flow are diverted further downstream, while another 11,000 GL is lost from the system, mainly by evaporation from the river, storages, and floodplain.

The samples collected for the study were taken from 20 sites split between 4 states (Fig.

1a and 1b). The sites were chosen based on the availability of existing sediment samples, which are thought to represent recent deposition. Samples from eight sites in the MDB were provided by Dr. Michael Reid, University of New England. Of these eight sites, four are located near the Queensland – New South Wales border, close to the Macintyre River: Whynot Billabong (WNB), Booberoi Lagoon (BOOL), Macintyre Downs Billabong (MIDB) and Pungbougal Lagoon (PUNL). The sites are characterized by fairly low surrounding vegetation density as well as low annual rainfall. Bishop Swamp (BS), to the south east of the Macintyre River, is a high altitude wetland located within the northern section of Werrikimbe National Park, New South Wales. It is a densely vegetated region with high diversity of native plants, with a single drainage channel dominating its hydrology (Thoms et al., 2011). The last three sites from the MDB are located near the New South Wales – Victoria border, adjacent to the Murray River: Moira Lake (MOIL), 2 Carp Billabong (2CB) and Dairy Billabong (DAIB). Located near the transition between subtropics and temperate climate zone, this region is characterized by moderate vegetation density and low annual rainfall. North Stradbroke Island (NSI) is one of the world's largest sand islands, covering 285 km^2 and framing the east side of Moreton Bay in southeast Queensland, Australia and is surrounded by extensive seagrass meadows (Leach 2011; Arnold et al., 2014). Samples from three sites on NSI, Queensland were provided by Dr. John Tibby, University of Adelaide: Swallow Lagoon (SWL), Blue Lake (BLU) and 18 Mile Swamp (18MS). Finally, samples from nine sites in Tasmania were provided by Dr. Michael Shawn-Fletcher, University of Melbourne (Fig. 1b): Basin Lake (BAL), Lake Rolleston (ROL), Lake Dove (DOL), Lake Spicer (SPIL), Lake Gwendolen (GWL), Lake Tahune (TAL), Lake Vera (VEL), Godwin Tarn (GWT) and Square Tarn (SQT). We included sites from Tasmania as the temperate climate of the region would provide an interesting contrast to the semi-arid conditions of the MDB and the humid climate of the NSI.

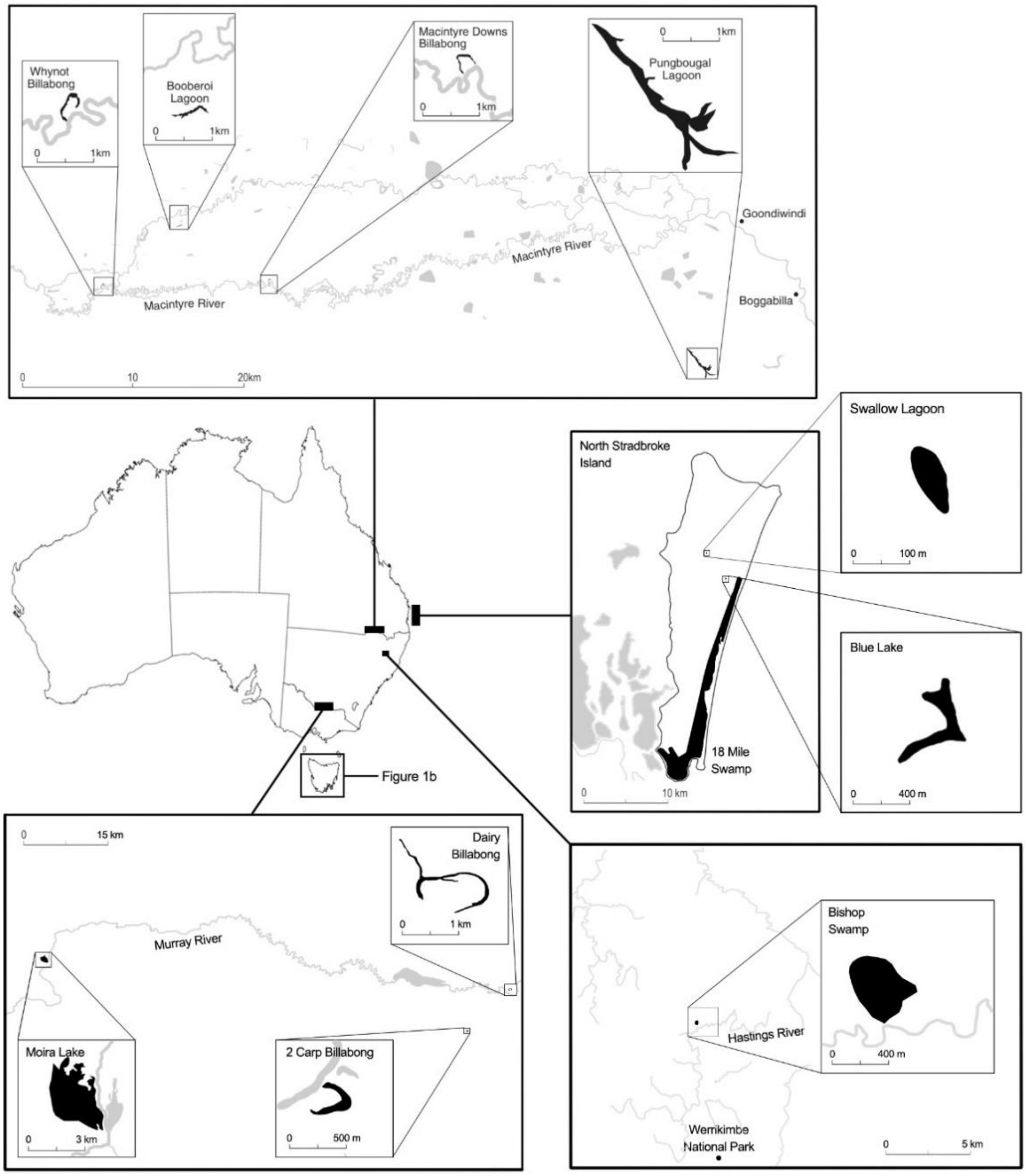


Figure 1: Map showing the locations of the sites from mainland Australia used in the study. One of the images comprising the map was obtained from Davidson et. al 2013.

Figure 2: Map showing the location of the sites from Tasmania used for the study.Figure 3: Map showing the locations of the sites from mainland Australia used in the study. One of the images comprising the map was obtained from Davidson et. al 2013.

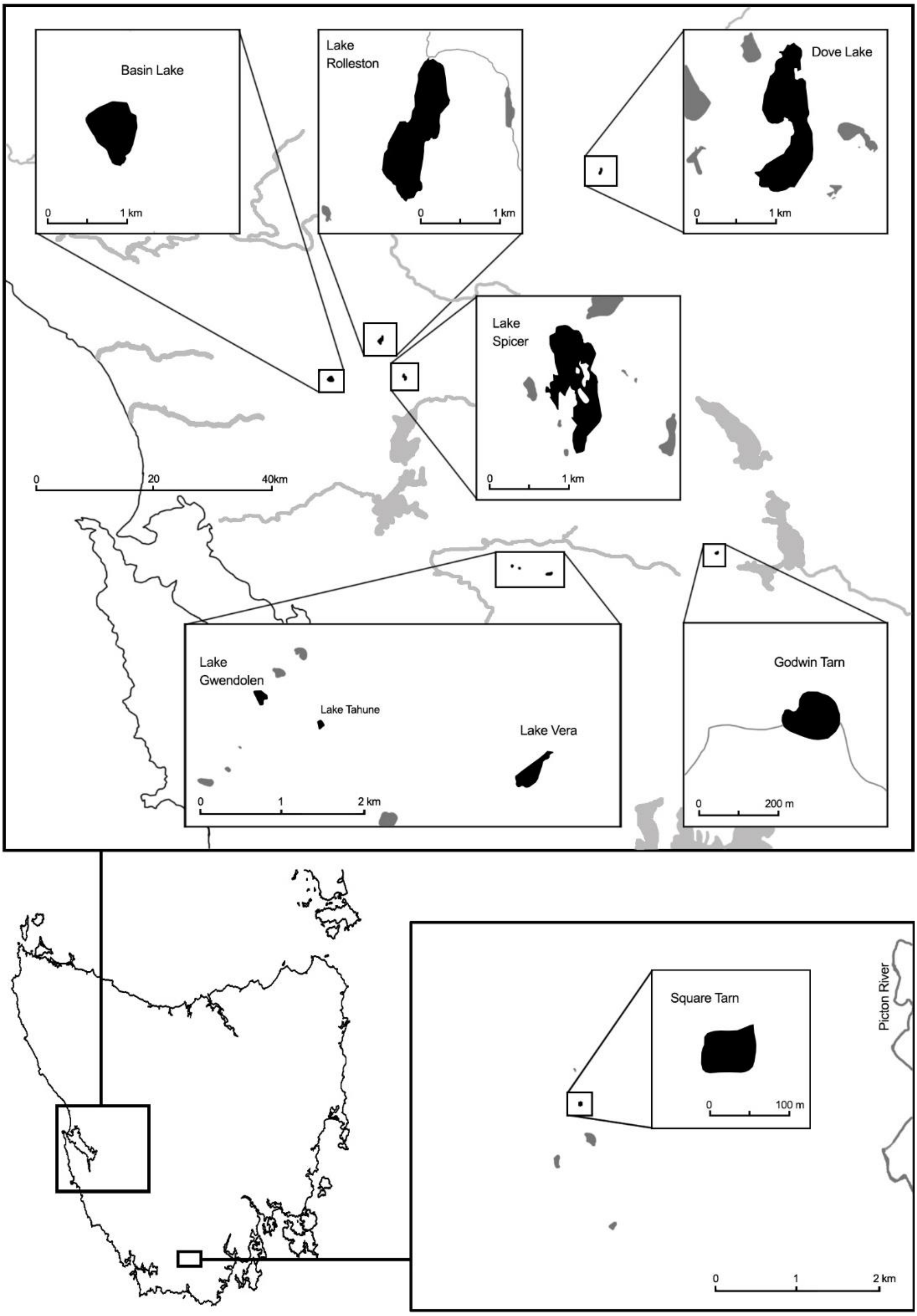


Figure 4: Map showing the location of the sites from Tasmania used for the study.

METHODS

This study utilised two broad approaches to characterising the contemporary biomass and environment of the 20 studied sites, and the way those environmental conditions are reflected in sediments. Contemporary environmental conditions were quantified using remote sensing and GIS techniques. Lake/wetland sediment geochemistry was then investigated through Isotope-ratio mass spectrometry (IRMS) and Rock-Eval pyrolysis.

Sediment sample pre-treatment

Surface sediment samples were taken from various sites, as described above (Fig. 1a and 1b). Each sample was approximately 0.6 ml in volume. The aim was to sample the uppermost (most recent) 0-5 cm to 5-10 cm of sediment where possible. Certain sediment cores where surface sediment was missing were sampled at the uppermost available section. Each sample was weighed individually and placed inside flat-bottomed Eppendorf tube. A total of 110 samples were collected (See Appendix A). The three sites from NSI (SWL, 18MS, and BLU) were sampled at 1 cm intervals, and the top 10 cm of surface sediment was used. The sites within the MDB (WNB, BOOL, MIDB, PUNL, DAIB, BS, MOIL, and 2CB) only had the top 4 cm of homogenized surface sediment available as single samples per site. Tasmanian sites were sampled at 0.5 cm intervals, and the first 5 cm of surface sediment was collected. The samples that contained significant quantities of moisture and were centrifuged for approximately 2 minutes each to collect the wet sediment at the bottom of the tube, the excess water was drained. In preparation for freeze-drying, the samples first had to be frozen (Hjorth 2004). The samples were suspended in liquid nitrogen (N_2) for approximately 5 to 10 minutes. Once frozen, all 110 samples were placed inside a freeze dryer where they were left for approximately 110 hours. Freeze-drying reduces the likelihood of volatile organic losses that would occur with regular oven drying (Brodie et al., 2011). Once the samples were sufficiently dry they were weighed again and further subdivided, with approximately 60% of each sample transferred into a different tube for use in future analysis. The remaining dry sediment was ground down into powder using a ball mill.

Prior to carbon isotope analysis, samples were fumigated with HCL to remove any traces of inorganic (carbonate) carbon. The accurate measurements of the isotopic composition of OM depend heavily on complete removal of inorganic carbon fraction, which can contaminate the sample and result in major offsets in isotope data (Brodie et al., 2011; Ramnarine et al., 2011). As there is an ongoing debate on the effects of acid treatment on $\delta^{15}N$ and TN values, with evidence suggesting a possibility of significant shifts in isotopic values (Kennedy et al., 2005; Jaschinski et al., 2008; Brodie et al., 2011), nitrogen isotopes were measured on a separate sediment fraction. For fumigation, samples were weighed out into small tin capsules and transferred into a sample tray. Approximately 0.05 ml of deionized water was added to each sample, allowing the acid fumes to dissolve into the water and attack the inorganic component of the sample. Hydrochloric acid (HCl) was added to the base of the desiccator, and the sample tray was placed above it. The samples were fumigated for 3 hours, after which they were left to dry in a 40^{o}C oven for four days. Once dry, each of the tin capsules was placed inside a larger silver capsule and crimped to seal it. Carbon and nitrogen concentration and associated 13C/12C and 15N/14N isotopic composition were measured using an Elementar elemental analyser (EA) linked by continuous flow to a Nu Horizon isotope ratio mass spectrometer (IRMS). Glycine, Glutamic and Tertiary Butyl Alcohol (TBA) were used as standards for the measurement.

Rock-Eval Pyrolysis

67 samples were selected with sufficient residual sediment (>50 mg) for Rock-Eval Pyrolysis (See Appendix A). Where possible the chosen sample depth was consistent across all sites (unless the original sample suite was limited or the leftover sample was insufficient). The analysis was performed by Weatherford Laboratories in Queensland using SRA-M-2 analyzer according to standardized methods. S1 (in mg HC/g) represents the free, thermally extractable hydrocarbons present in the entire sample that are distilled out at initial heating of up to 350^{o} C. S2 (in mg HC/g) represents the high molecular weight hydrocarbons that did not vaporize in the S1 peak and are generated from the thermal cracking of nonvolatile organic matter when heated up to 550^{o}C. S3 (in mg organic CO_2/g) is the trapped CO_2 released during low temperature pyrolysis (< 390^{o} C nominal) and is proportional to the oxygen present in the kerogen. The measured S1, S2, and S3 outputs were converted into HI, OI and PI using the data from stable isotope analysis through application of the following formulaes:

HI = (S2 / TOC) x 100 (mg HC/g TOC)

OI = (S3 / TOC) x 100 (mg OC/g TOC)

PI = S1 / (S1 + S2)

Remote Sensing and GIS

In order to quantify the hydrological status and terrestrial carbon budget for the catchments surrounding each lake/wetland site, remotely sensed data were processed using ArcGIS software. The geodatabase was set using WGS84 geodetic datum, with subsequent layers projected to the same datum to ensure spatial accuracy. The location of each site was identified, and an approximate catchment area was estimated using a contour map created through Digital Elevation Map (DEM) layer obtained from ELVIS Elevation Information System, courtesy of Geoscience Australia . The accuracy of the estimated catchment outline is dependent on the surrounding topography. As such sites located within more pronounced topography (predominantly sites located in Tasmania) have more defined catchment area outlines, which were transformed into individual raster layers. Modeled precipitation amount and leaf carbon output quantities were obtained using the BIOS2 modeling system, courtesy of Peter Briggs, CSIRO, Candberra. For each of these parameters, 168 layers were added to ArcGIS, representing monthly data over 14 years (2000 – 2014).

To obtain monthly data for each catchment, the raster layers were extracted using the catchment raster as a mask and the pixel value was manually measured for each layer of every catchment (Fig. 3). The results were tabulated (See Appendix B) and annual and seasonal averages were calculated for every year. Note that precipitation and plant carbon content from BIOS2 was modeled using raster layers of low resolution (40 km^2 pixel size). As a result, certain smaller catchments fell within a single pixel value and therefore provide only a rough approximation of the data.

To estimate approximate vegetation cover extent over each catchment we used MODIS Fractional Cover Metrics. Annual and seasonal mean composite raster data was obtained for years 2000 – 2013. Just as before, each layer was extracted for every catchment and the mean values measured (See Appendix B). This data was modelled at a higher resolution (0.30 km^2 pixel size) and therefore provide a more accurate approximation of the vegetation fraction values.

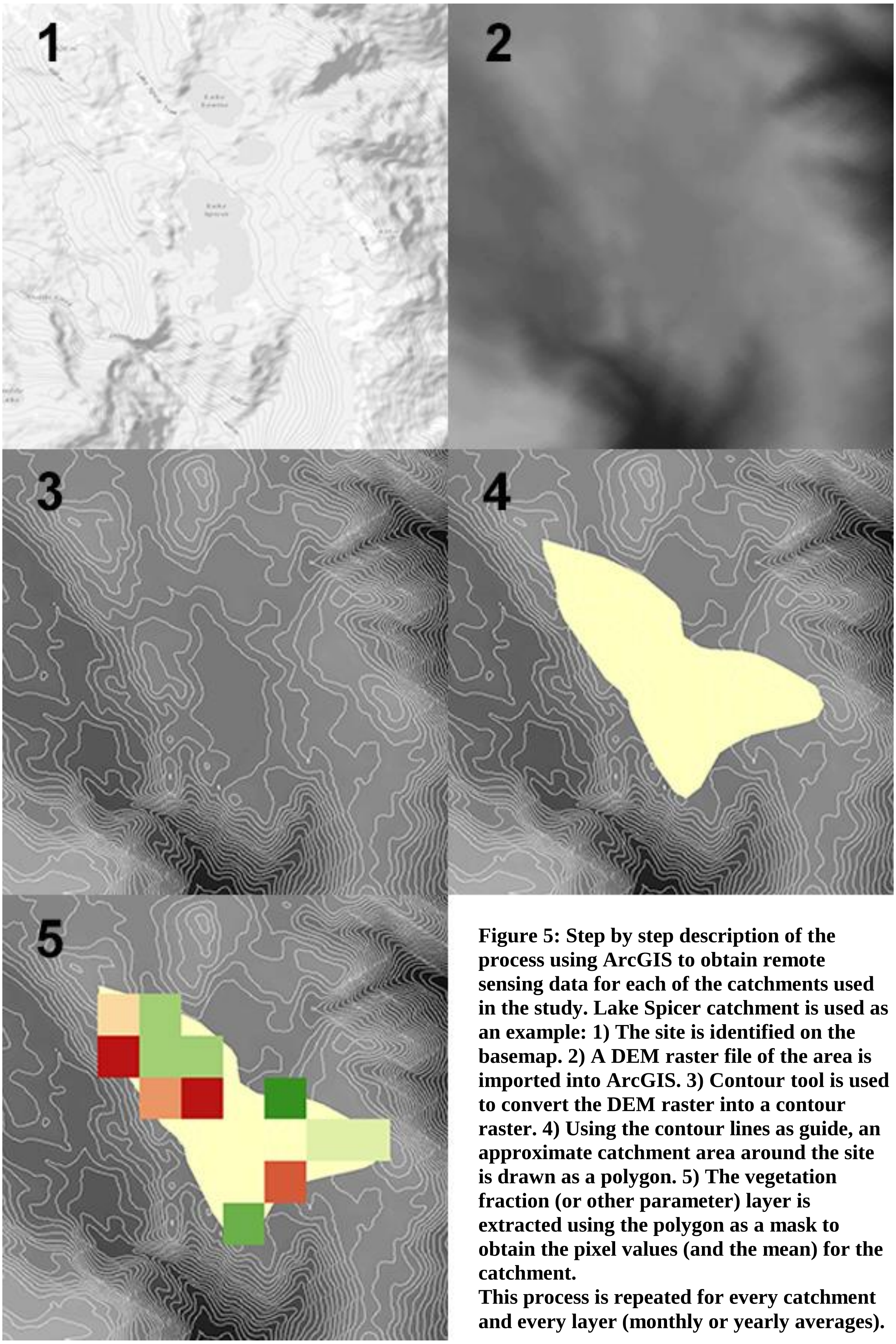


Figure 5: Step by step description of the process using ArcGIS to obtain remote sensing data for each of the catchments used in the study. Lake Spicer catchment is used as an example: 1) The site is identified on the basemap. 2) A DEM raster file of the area is imported into ArcGIS. 3) Contour tool is used to convert the DEM raster into a contour raster. 4) Using the contour lines as guide, an approximate catchment area around the site is drawn as a polygon. 5) The vegetation fraction (or other parameter) layer is extracted using the polygon as a mask to obtain the pixel values (and the mean) for the catchment.
This process is repeated for every catchment and every layer (monthly or yearly averages).

OBSERVATIONS AND RESULTS

The down-core $\delta^{13}C$, $\delta^{15}N$, TOC, C/N, HI, OI and PI data is presented in for each site Figure 4. In the same figures, the years 2000 – 2013, precipitation (m per day), vegetation cover (%) and plant carbon content ($g.m^{-2}$) is plotted against time. The carbon values were taken from the acidified samples while the nitrogen values were taken from the non-acidified samples as they represent the isotope values most accurately. Note that since the samples were not dated, the sample depth and the ages shown on the axis are not correlated. For those sites for which only single samples were analysed (WNB, BOOL, MIDB, PUNL, DAIB, BS, MOIL, and 2CB), the isotope and pyrolysis results were summarised in Table 1 and the environmental data for those sites are plotted in Figure 5.

In order to compare spatial patterns in lake sediment geochemistry with lake catchment environmental data, it is necessary to determine averages for both the sediment analyses and the environmental data through time. With this in mind, averages for the upper 4 cm and the upper 10 cm were compared. For the environmental data we compare the averages for the entire length of the record with the average for the last two years measured. For sites with sufficient number of isotopic measurements down-core, the mean values were calculated and plotted onto the graphs. As mentioned earlier, the carbon values (TOC and $\delta^{13}C$) used were taken from the acidified sediment fraction, while the nitrogen values (TN and $\delta^{15}N$) were taken from the non-acidified sediment fraction.

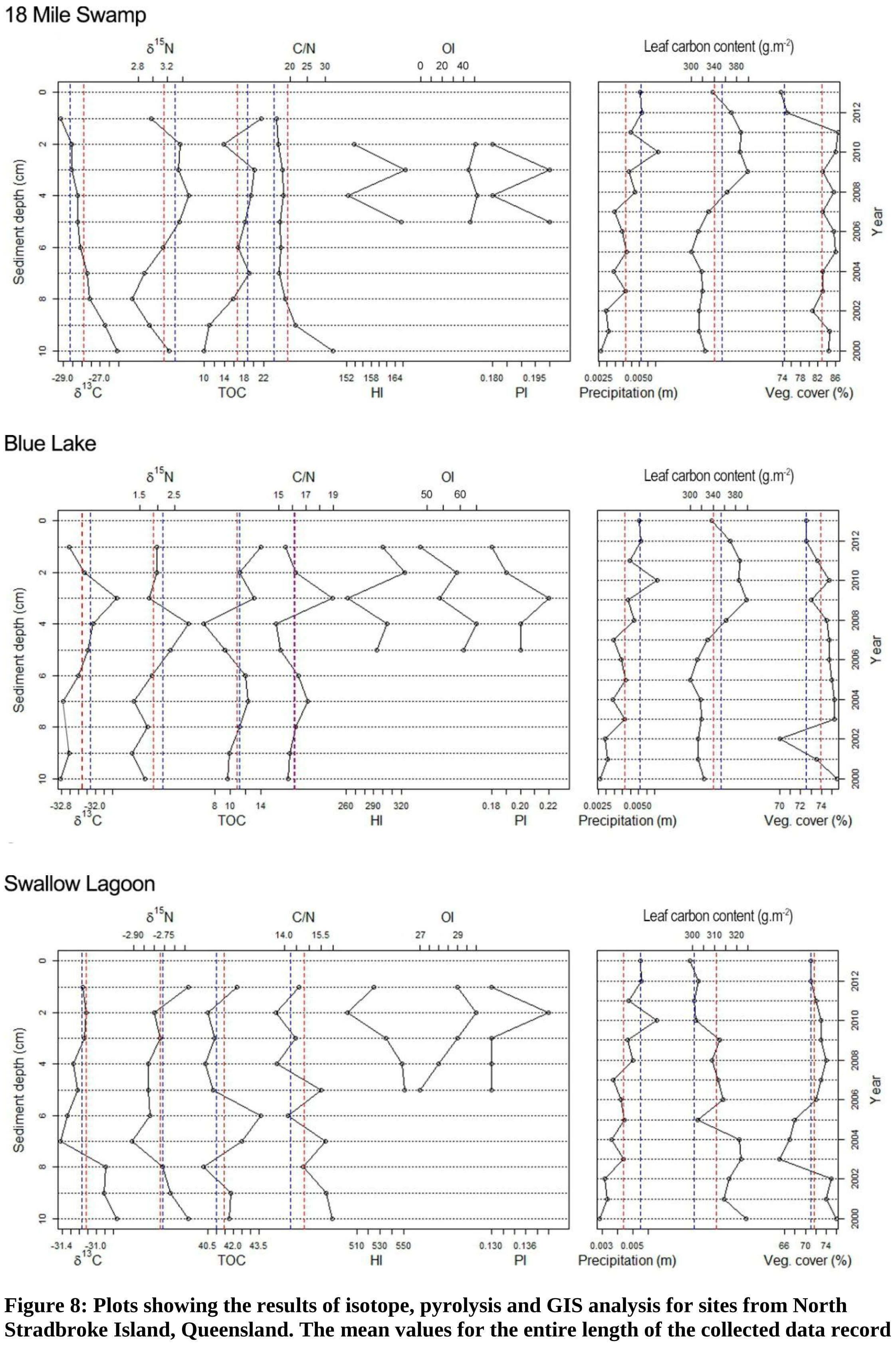


Figure 8: Plots showing the results of isotope, pyrolysis and GIS analysis for sites from North Stradbroke Island, Queensland. The mean values for the entire length of the collected data record are plotted as red dashed lines. The mean values for the top 4 cm (geochemical) and the last 2 years (GIS) of data are plotted as blue dashed lines.

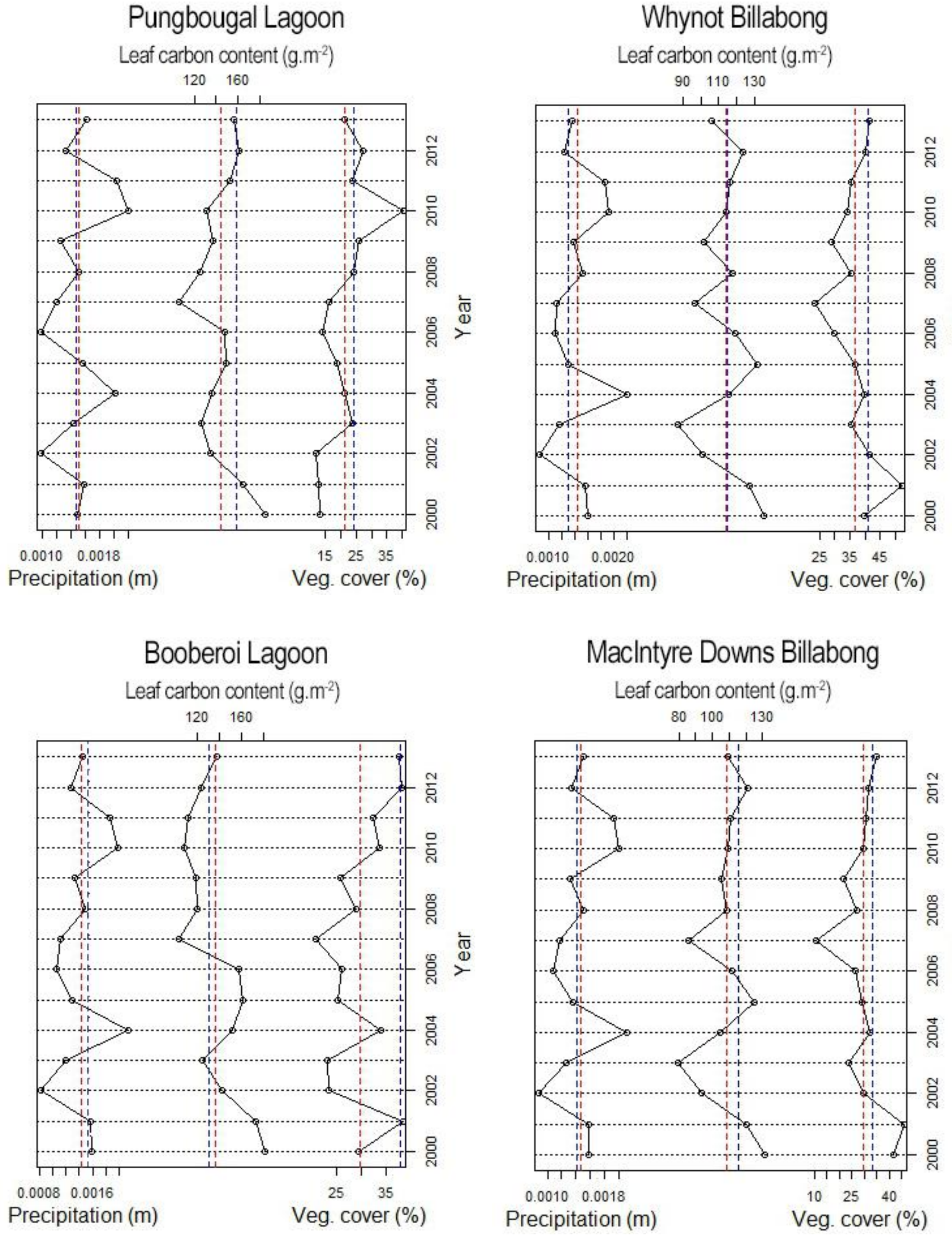


Figure 9: Scatter plots showing results of GIS analysis for sites in the Murray Darling Basin. The mean values for the entire length of the collected data record are plotted as red dashed lines. The mean values for the top 4 cm (geochemical) and the last 2 years (GIS) of data are plotted as blue dashed lines.

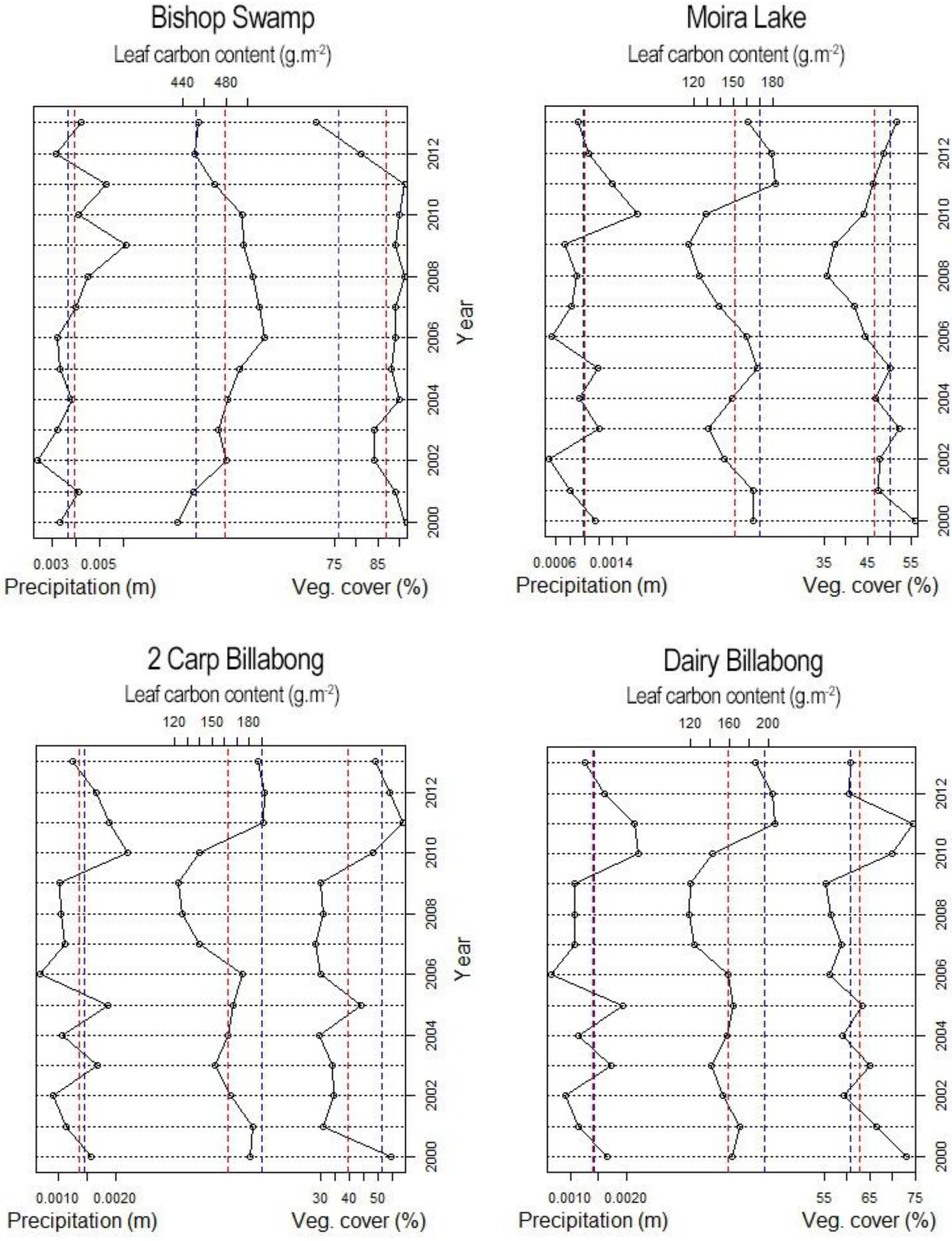


Figure 5 (cont.): Scatter plots showing results of GIS analysis for sites in the Murray Darling Basin. The mean values for the entire length of the collected data record are plotted as red dashed lines. The mean values for the top 4 cm (geochemical) and the last 2 years (GIS) of data are plotted as blue dashed lines.

	d13C	TOC	d15N	C/N	HI	OI	PI
Pungbougal Lagoon	-22.33	2.92	5.59	8.04	230.90	89.28	0.07
Whynot Billabong	-27.44	1.56	3.51	8.96	83.41	152.06	0.20
Booberoi Lagoon	-26.86	1.33	5.50	7.29	89.69	156.21	0.30
Macintyre Downs Billabong	-26.89	3.37	6.48	9.22	150.17	97.74	0.08
Bishop Swamp	-27.74	26.32	3.27	15.02	-	-	-
Moira Lake	-24.18	0.99	3.85	6.53	70.42	194.17	0.25
2 Carp Billabong	-28.90	1.53	3.29	8.26	139.79	124.77	0.15
Dairy Billabong	-29.60	3.43	2.68	9.18	165.38	75.70	0.14

Table 1: A summary of the isotope and pyrolysis results obtained from sites in the Murray Darling Basin.

In all but four cases, the δ^{13}C values seem to fluctuate around the mean values for the top 4 cm. Site 18MS, ROL, DOL and GWT appear to have a decreasing trend up-core, with δ^{13}C variation of up to 0.7 between the mean for overall data and the top 4 cm. Two sites in Tasmania (VEL and SQT) did not have sufficient number of sediment samples for the mean values to be significant. The eight sites from the MDB (WNG, BOOL, MIDB, PUNL, DAIB, BS, MOIL and 2CB) came from single homogenized samples of top 4 cm and the resulting values (Table 1) are therefore the mean of the data. In general NSI sites show the lowest δ^{13}C values, ranging from -28.6 to -32.1, while sites within the MDB show some of the highest δ^{13}C values, ranging from -22.3 to -29.6. Shifts in δ^{15}N values down-core appear to correlate with shifts in δ^{13}C values in sites BL, SWL, GWL, TAL, GWT and SQT. The remaining sites (excluding those with single measurements) show no distinct correlations. Overall the δ^{15}N values show no significant increasing or decreasing trends down-core for any of the sites and appear to fluctuate around the top 4 cm mean values. The sites within the MDB show highest δ^{15}N values of all groups, ranging from 2.68 to 5.59, while majority of the sites from NSI and Tasmania show values ranging from 1.0 to 2.5, with only one site (18MS) with values above 3.0.

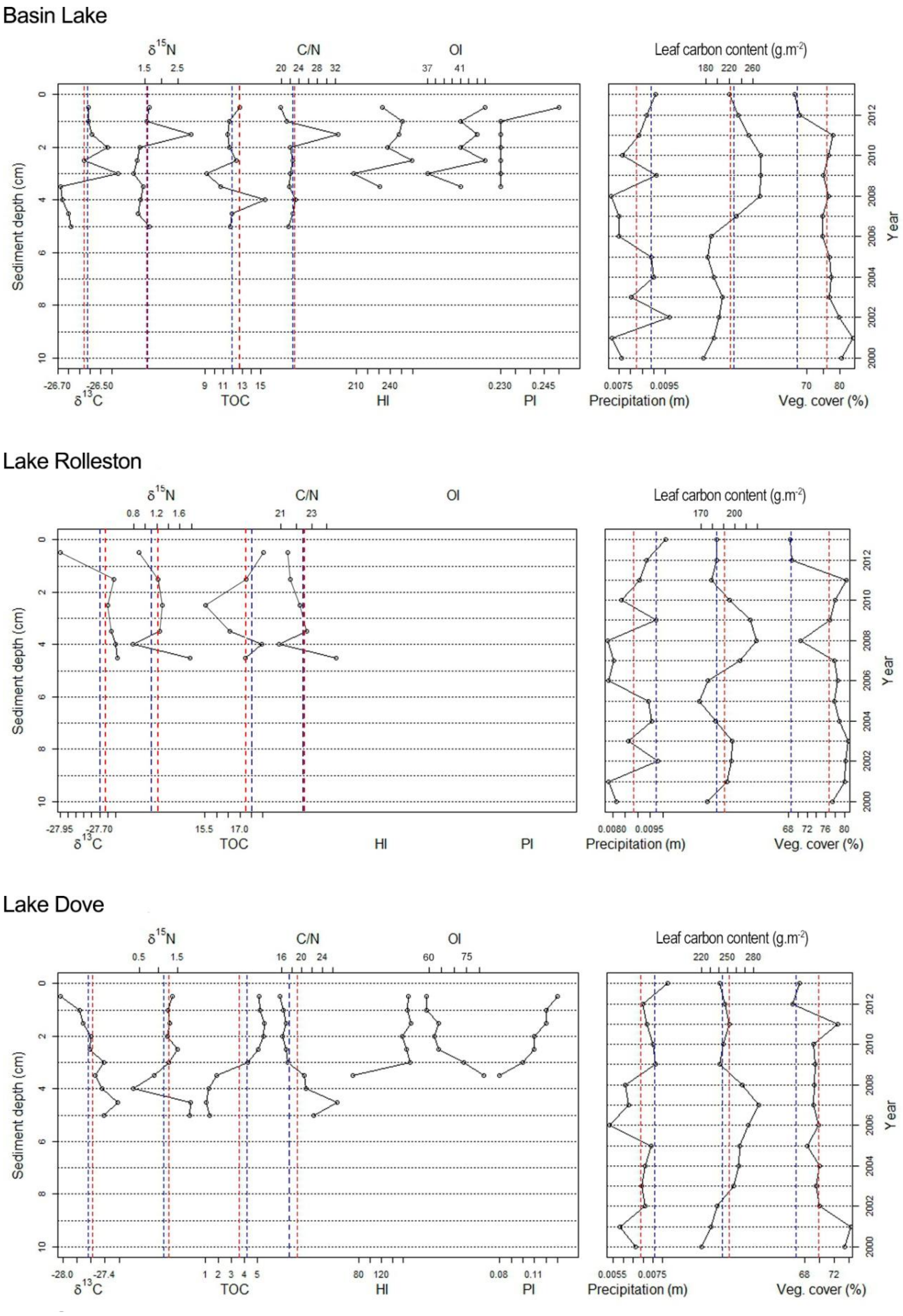
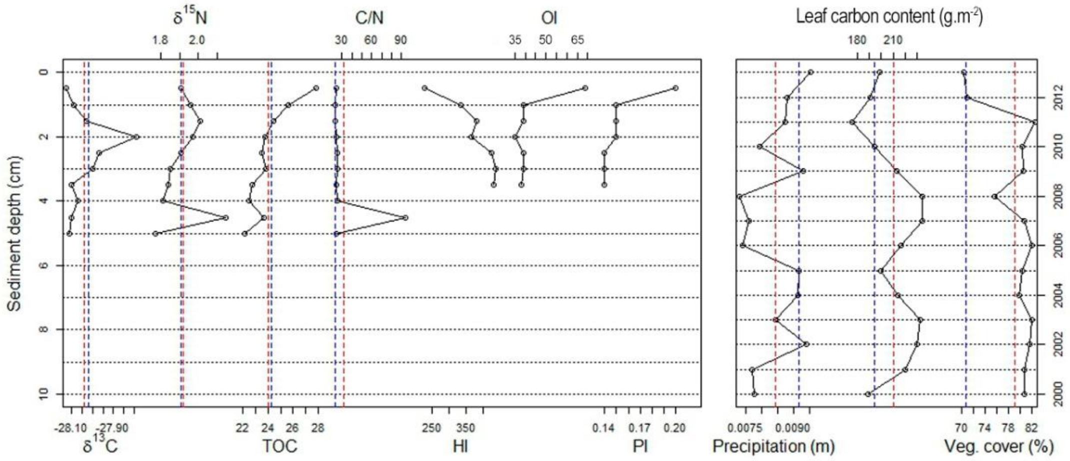
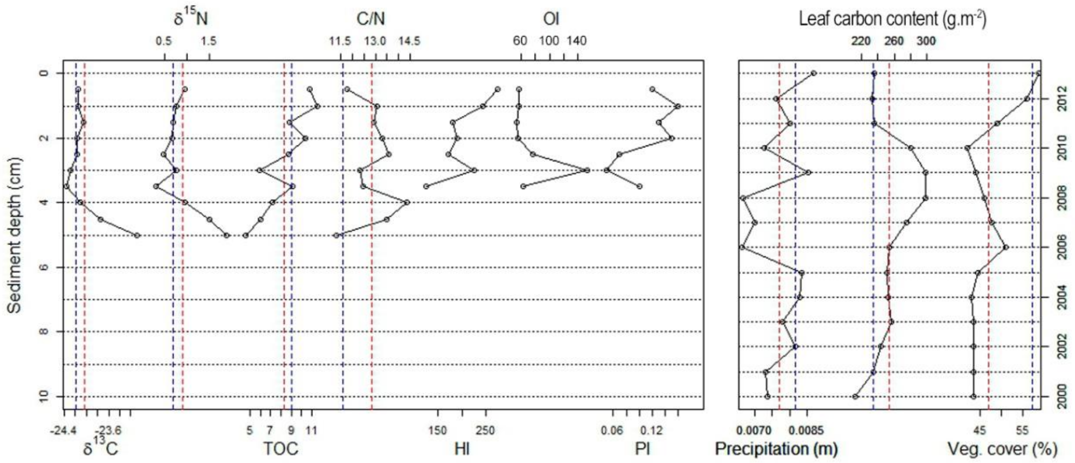


Figure 6: Plots showing the results of isotope, pyrolysis and GIS analysis for sites from Tasmania. The mean values for the entire length of the collected data record are plotted as red dashed lines. The mean values for the top 4 cm (geochemical) and the last 2 years (GIS) of data are plotted as blue dashed lines.

Lake Spicer



Lake Gwendolen



Lake Tahune

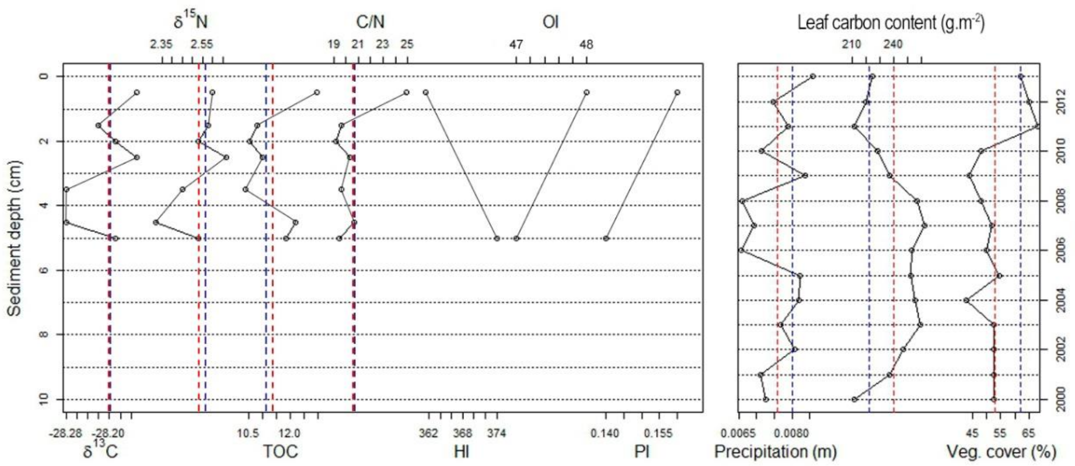


Figure 6 (cont.): Plots showing the results of isotope, pyrolysis and GIS analysis for sites from Tasmania. The mean values for the entire length of the collected data record are plotted as red dashed lines. The mean values for the top 4 cm (geochemical) and the last 2 years (GIS) of data are plotted as blue dashed lines.

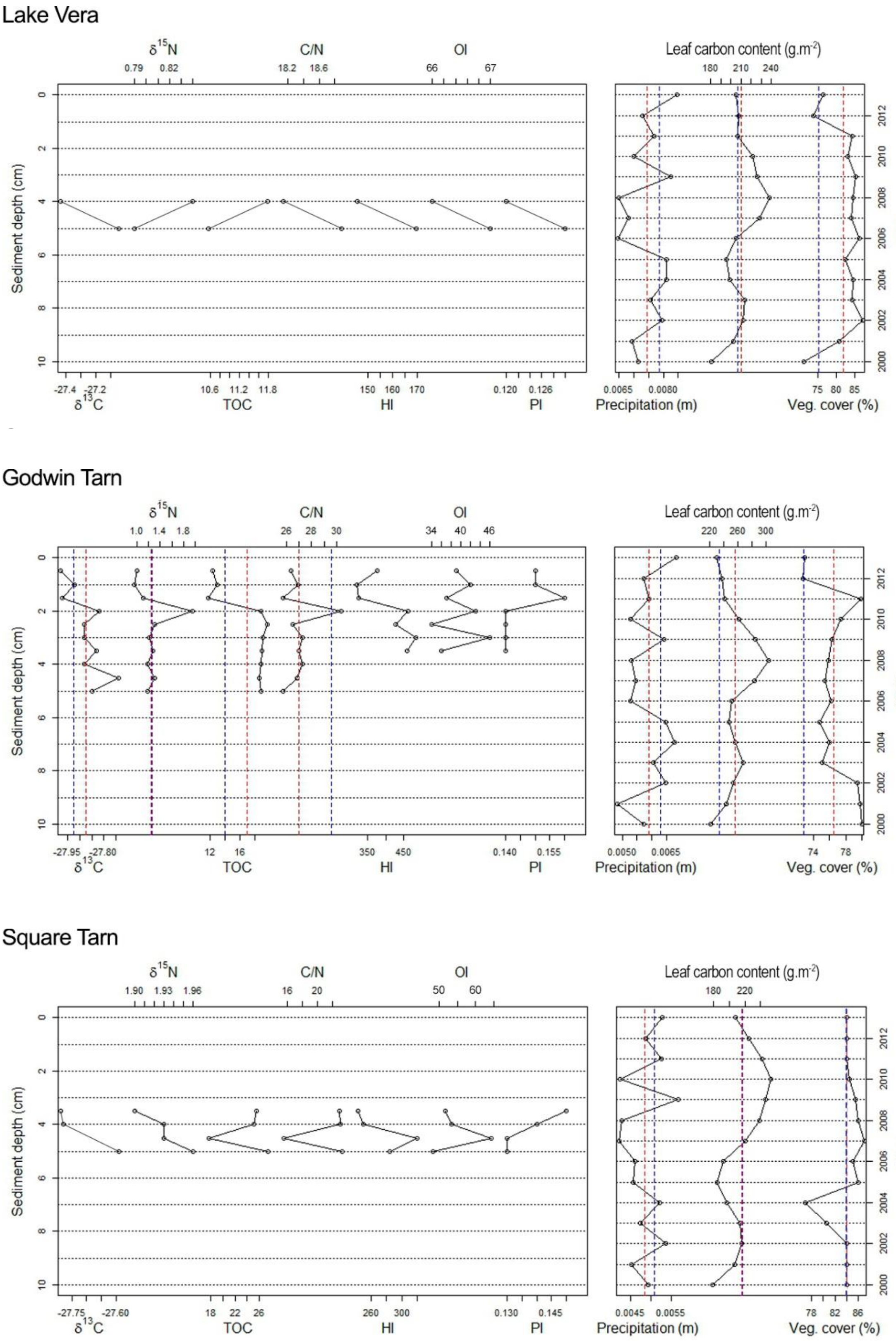


Figure 6 (cont.): Plots showing the results of isotope, pyrolysis and GIS analysis for sites from Tasmania. The mean values for the entire length of the collected data record are plotted as red dashed lines. The mean values for the top 4 cm (geochemical) and the last 2 years (GIS) of data are plotted as blue dashed lines.

Of all sites, the shifts in values in TOC appear to correlate with C/N in six sites (BLU, SWL, GWL, TAL, GWT and SQT), with the rest of the sites either showing no correlation or inverse correlation (eg. ROL and DOL). Sites within the MDB have the lowest C/N values ranging from 6.53 to 9.22, with one site (BS) with C/N value of 15.02. Sites in NSI show slightly higher C/N values ranging from 17.12 to 18.59. Tasmanian sites show the highest C/N values ranging from 14.25 to 25.42.

The data obtained from GIS shows that for the majority of sites, there is a positive correlation between modelled precipitations and modelled leaf carbon content. Sites in Tasmania are shown to experience highest average daily precipitation (4.84 – 8.84 mm per day). Contrary, sites in MDB tend to experience lowest daily precipitation (0.99 – 3.90 mm per day), with all 3 sites in NSI showing slightly higher values (4.12 – 4.40 mm per day). With the exception of BS (87.38 %), sites in MDB show the lowest vegetation fraction values, ranging from 29.8 to 62.8 %. Both Tasmanian and NSI sites show similar vegetation fraction values, ranging from 71.69 to 82.85 % (NSI) and 47.81 to 84.13 % (Tasmania). The MDB sites show positive correlation between vegetation fraction shifts and shifts in precipitation and plant carbon content, while there appears to be little to no correlation in NSI and Tasmanian sites.

DISCUSSION

This study aimed to investigate the relationship between organic geochemical tracers of carbon burial and the biomass and/or hydrological climate of lake catchments in south-east Australia. In doing so we tested a variety of sediments and made geochemical measurements as well as remote sensing GIS analysis to explore how the data correlates. Figures 4, 5 and 6 as well as Table 1, summarise results for both geochemical tracers and the GIS analysis. As we did not have radiometric dates for the sediment samples, there was no clear way of comparing the isotope and pyrolysis data with biomass and hydrological measurements. With a few exceptions, the majority of the geochemical data across all sites show the very little change between total mean values and top 4 cm. We can, therefore, make the assumption that the top 4 cm of the surface sediment is an accurate representation of the data. Using the top 4 cm of the geochemical analysis data allows for consistency across all sites as well as consistency with the available pyrolysis data. This of course has potential for being misrepresentative, particularly in sites that show an increasing or decreasing trend in the data. Note also that some of the sites (eg. VEL and SQT) are missing the top 3 cm of surface sediment and therefore the mean values are calculated from one or two measurements, which could also lead to misrepresentation.

When looking at environmental data several sites (particularly 18MS, BS, BAL, ROL, VEL, GWL, GWT and SPIL) show significant variation in vegetation fraction (around 10%) between overall data and the average of the last two years. In most cases this is caused by a sudden loss of vegetation towards the later years. While it is uncertain what might be the cause of this shift, we believe that the entire length of the record is a more accurate representation of the data.

We use $\delta^{13}C$ and C/N values as indicators of OM sources (Fig. 8). Sources of sedimentary OM can be distinguished from non-vascular algae and vascular land plants through their characteristic C/N compositions (Meyer & Lallier-Vergès 1999). For the majority of the samples in the MDB region and NSI (Fig. 8a) OM is sourced from a mix of both non-vascular lacustrine algae and vascular C_3 land plants, while the organic carbon from sites within Tasmania (8b) show a predominant C_3 land plant source. These results are consistent with conclusions made by Meyer & Lallier-Vergès 1999 as heavier vegetated sites within Tasmania show a significant clustering around the C/N value of above 20, which is characteristic of C_3 vascular plants.

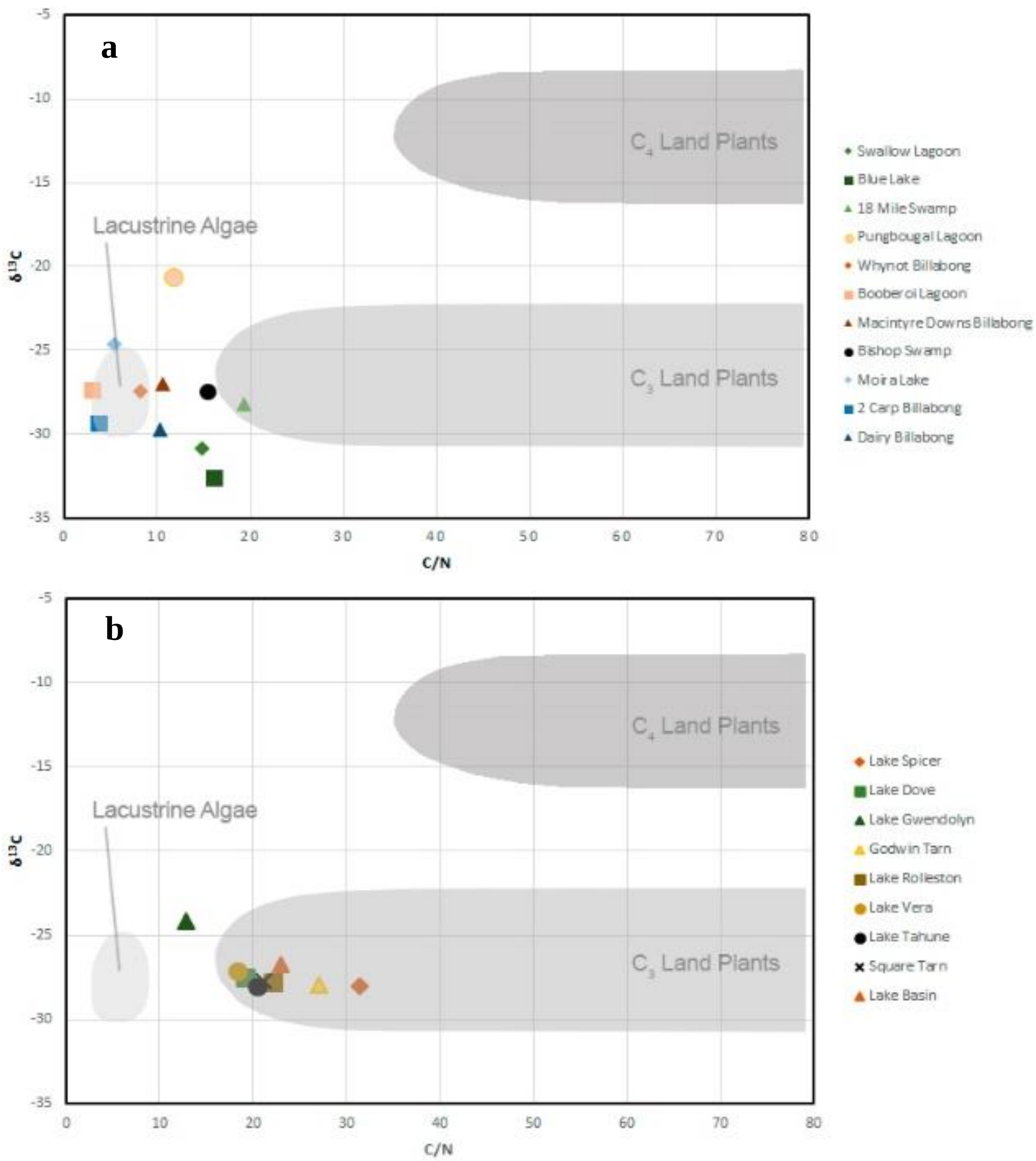


Figure 7: Scatter plots of average data of $\delta^{13}C$ plotted against the average data of C/N ratios for sites in (a) MDB and NSI and (b) Tasmania. The representative elemental and carbon isotopic compositions of organic matter from lacustrine algae, C_3 land plants, and C_4 land plants obtained from Meyers and Lallier-Vergès, 1999, is added to the data.

Independently, average HI values are plotted versus average OI values in a Van-Krevelen-type plot (Fig. 8) along with evolution pathway of kerogen. Type I, II and III kerogens of lacustrine sediments were attributed to waxy OM, algal OM and vascular plant OM respectively (Meyers and Teranes, 2001). The entire data shows (Fig. 8a) shows the majority of the sites falling between type II and III kerogen pathways. Sites within mainland Australia (Fig. 8b) show a similar distribution with approximately half of the sites being located between type II and III pathway, with only one site (SWL) placed close to type I pathway and three located below type III (WNB, BOOL, MOIL), indicating a vascular land plant source. This however runs contradictory to the previously discussed results, as those sites are characterized by low C/N values, usually associated with non-vascular lacustrine algal source of OM.

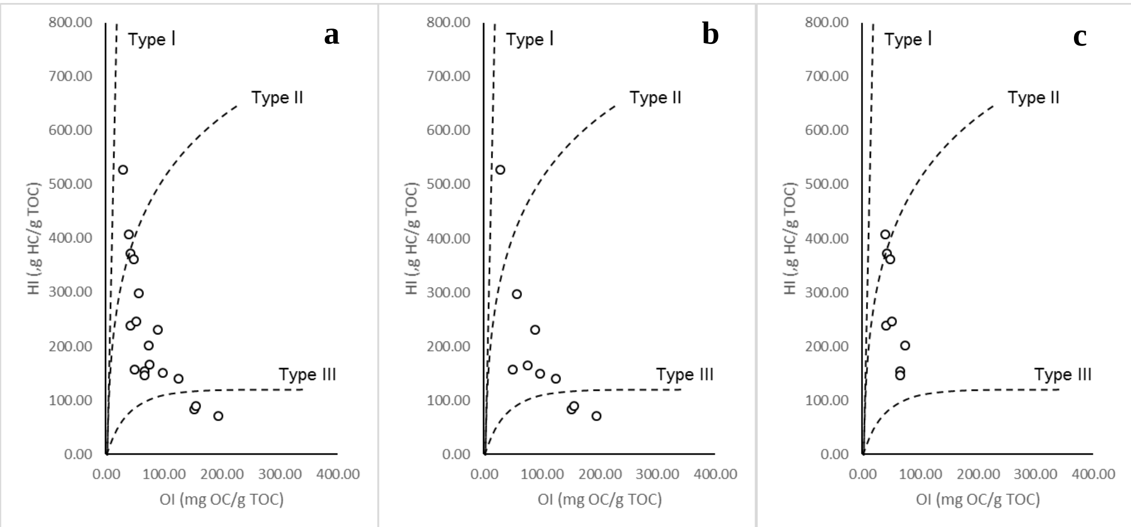


Figure 8: Rock Eval data of the sediments from the (a) all sites, (b) MDB and NSI sites and (c) Tasmania sites given as Van-Krevelen-type plot.

Despite being on average more heavily vegetated, no data from sites within Tasmania (Fig. 8c) show type III kerogen pathway, with three of the eight sites sitting predominantly on the type II pathway, while the remaining sites fall between type II and III. This appears to be contrary to the results observed in Figure 8, however it is possible that matrix effects can bias Rock-Eval data due to absorption of hydrocarbons

(Mayr et al. 2009). S2 values may be reduced by the effects of weathering as atomic H/C ratios are reduced by oxidation (Katz, 1983; van Krevelen, 1984), while the S3 values may be affected by the decomposition of inorganic matrix particularly due to weathering or mineral matrix interaction. From this data it is difficult to draw distinct conclusions on the origin of OM, with most data falling between type II and type III kerogen pathway, indicating a mixing of algal and terrestrial OM sources. Studies suggest that characterization of organic matter through the use of a modified van Krevelen diagram, can produce questionable results (Katz, 1983; Disnar et al., 2003). This is attributed to HI and OI being strongly affected by matrix mineralogy and organic enrichment. We believe that this is might be the case for our data, as it appears to contradict the C/N data indicating the source of OM.

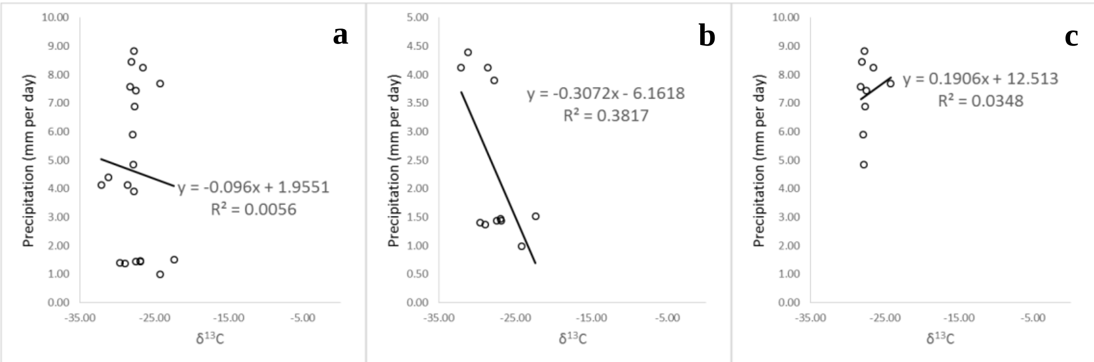


Figure 9: Plot of average daily precipitation (mm per day) against $\delta^{13}C$ values for (a) all sites, (b) NSI and MDB sites and (c) Tasmania sites. Trend line, r^2 and linear regression equations are provided.

Figure 9 (above) shows the relationship between average daily precipitation of catchment and $\delta^{13}C$ values of sediments. There appears to be significant correlation between daily precipitation and $\delta^{13}C$ values of surface sediments in MDB and NSI catchments, while only a weak correlation in Tasmanian catchments. While it is possible that the observed relationships are caused by changes in erosion due to increase

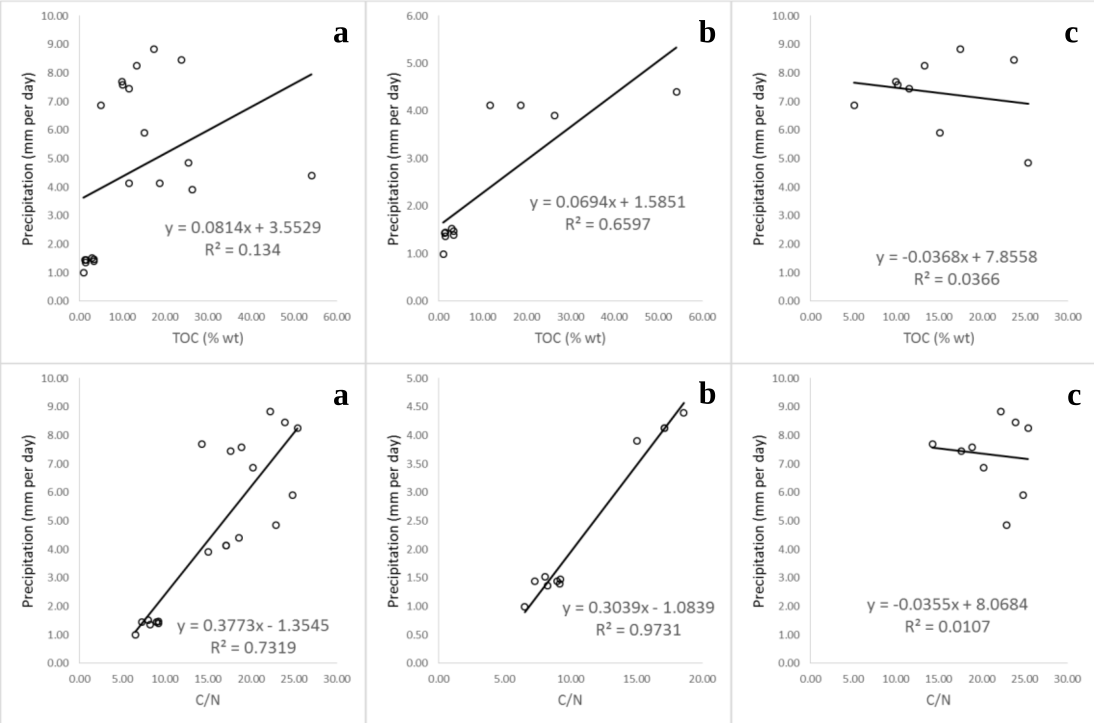


Figure 10: Plot of average daily precipitation (mm per day) against TOC (above) and C/N (below) values for (a) all sites, (b) NSI and MDB sites and (c) Tasmania sites. Trend line, r^2 and linear regression equations are provided.

in precipitation, and subsequent increase in organic carbon flux into lake sediment, we hypothesize that carbon fluxes in semi-arid environments are more susceptible to hydrological shifts than densely vegetated regions. Increased precipitation could lead to a sudden pulse in vegetation density in the region, allowing for increased organic carbon sequestration and deposition into lake sediments. Our results are consistent with conclusions drawn by Ma et al., 2012, who observed similar relationships between precipitation and $\delta^{13}C$ values in semi-arid regions of China.

When modelling precipitation against TOC and C/N (Fig. 10), we observe similar relationships, consistent with previously discussed results. There is a particularly strong positive linear fit observed in the relationship between precipitation in semi-arid environment and measured C/N ratios. This data, although limited, shows that a relationship can be inferred between changes in average precipitation and geochemical tracers of carbon burial in semi-arid, moisture depleted environments (Gabarrón-Galeote, Trigalet, and Wesemael, 2015). However it is important to distinguish whether or not the primary productivity is derived from terrestrial sources. By comparing the geochemical tracers of carbon burial to the average vegetation fraction of the catchment, we can infer relationships between organic carbon flux and shifts in terrestrial vegetation (Figure 11).

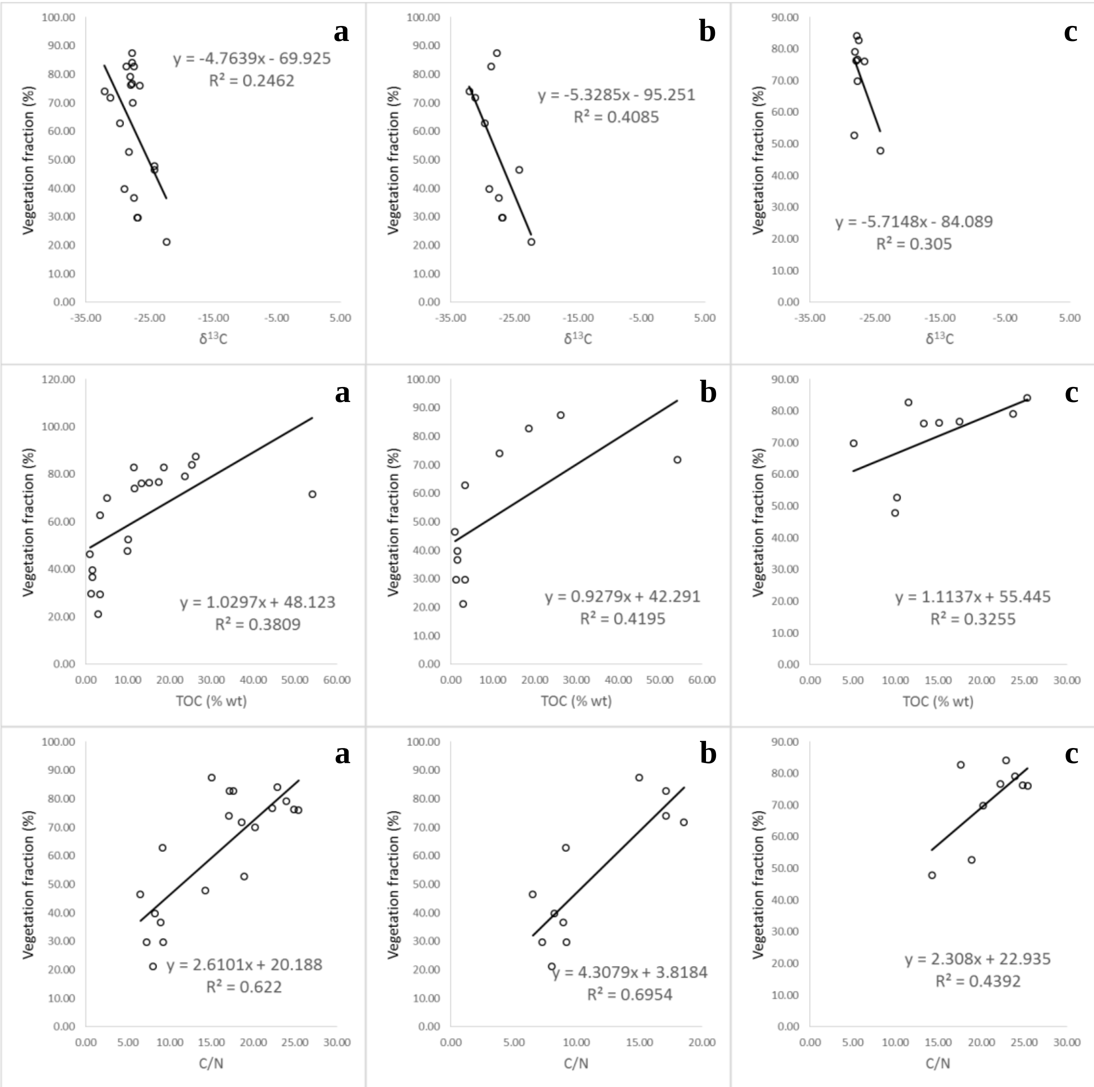


Figure 11: Plot of vegetation fraction (%) against $\delta^{13}C$ (top), TOC (middle) and C/N (bottom) values for (a) all sites, (b) NSI and MDB sites and (c) Tasmania sites. Trend line, r^2 and linear regression equations are provided.

There appears to be a strong correlation between vegetation fraction and organic carbon flux in sediments (Qin et al., 2014**)**. The correlation between the data of MDB/NSI is only slightly higher than that of Tasmanian sites. As hypothesized, terrestrial vegetation density is reflected in isotopic values of lake sediments. Finally we model the vegetation fraction against average daily precipitation to see whether shifts in biomass are correlated with hydrological changes within catchments (Fig. 12). As expected, MDB/NSI sites show significant positive correlation between precipitation and vegetation density, while Tasmanian sites show very little correlation. This allows us to propose that while vegetation density has a significant effect on organic carbon flux, changes in hydrology appear to have a significant impact on isotopic signatures in semi-arid, moisture deprived regions with low vegetation abundance, while being less significant in more stable, densely vegetated areas.

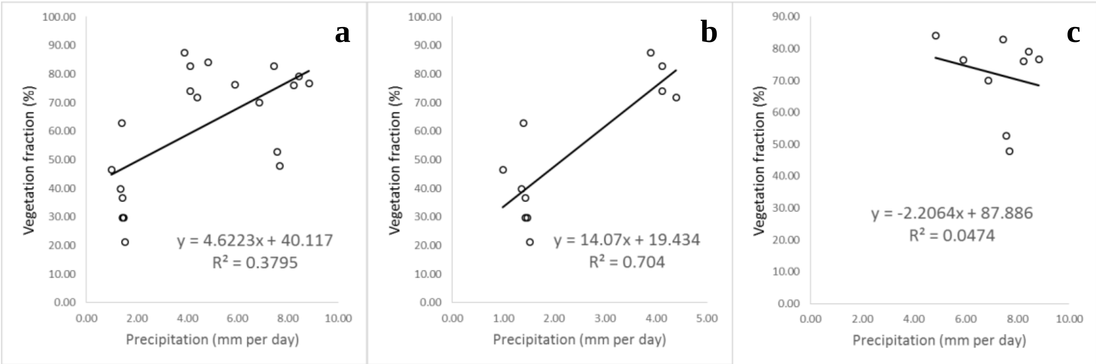


Figure 12: Plot of vegetation fraction (%) against average precipitation values (mm per day) for (a) all sites, (b) NSI and MDB sites and (c) Tasmania sites. Trend line, r^2 and linear regression equations are provided.

The effect of precipitation on the OM concentration in sediments appears to be only significant in regions of low vegetation density (MDB, and to an extent NSI). We attribute this to the fact that Tasmania has high average precipitation throughout the year, thus the vegetation fraction is a lot more stable and any shifts in precipitation rates will not be sufficient to have a significant offset on the deposition of terrestrial organic carbon. The MDB and NSI regions on the other hand, show strong correlation between increase in precipitation and increase in organic carbon concentration in the sediment, as well as a strong positive correlation between precipitation and C/N ratio, which would indicate that increased precipitation correlates with increased terrestrial organic carbon flux into the sediment. These results are consistent with observation made by Poulter et al. (2014).

Limitations, uncertainties and future research

Given the scope and timeframe of the project, there are an number of uncertainties that we were unable to rectify, which could have had a significant impact on our results and conclusions. One of major uncertainties is the method by which we correlated geochemical sediment data with our GIS measurements. As we are dealing with a large number of sites spanning across a spectrum environments, it is likely that sedimentation rates are quite varied for different sites and would therefore correlate differently with our GIS measurements. Without available radiometric dates, we had to resort to an approximate estimation on which range of data would give us most accurate correlation possible, based on its representation of the mean values. Another uncertainty concerns the resolution of GIS data, particularly regarding BIOS2 model system. As most of our sites and their associated catchments were small (approximately 6 – 7 km^2), low resolution spatial information can provide only a rough estimate of the average value. To improve the accuracy of the data, any future research should aim to utilize highest resolution spatial information possible, looking into independent remote sensing studies done for each area of interest.

In this study we investigated the effects of precipitation shifts on changes in average vegetation cover as well as correlations with shifts in isotopic signatures of the sediments. We however did not take into account the effects of precipitation on weathering and erosion of sediments, and subsequently how that effects the deposition of organic carbon into lakes. Additional research could utilize grain size analysis to constrain the effects of hydrological shifts on sediment weathering and quantify how this impacts organic carbon flux into lake sediments.

It might be possible to increase the accuracy of the model through multivariate regression analysis, incorporating multiple variables. While linear regression gives us an indication on how environmental parameters may correlate with shifts in isotope data, it does not account for nonlinear data (eg. Vegetation fraction plotted against TOC in Fig. 11). Multivariate regression analysis could allow for incorporation of multiple variables (such as vegetation fraction, precipitation, weathering and erosion rates) to explain shifts in organic carbon flux of lake sediments.

CONCLUSIONS

The organic matter accumulated in lake sediments can be used as an indicator of shifts in surrounding vegetation as well as changes in regional hydrology. We used multiple geochemical tracers, combined with remote sensing measurements to investigate the effects of changes in vegetation density and precipitation on organic carbon flux into lake sediments. We conclude that there is a significant positive correlation between regional vegetation fraction and organic carbon concentration in lake sediments. We attribute this to increased terrestrial carbon flux due to increase in biomass, which subsequently increases the flux of organic carbon into sediment. There is also a strong correlation between vegetation fraction and C/N values, indicating that with increase in terrestrial biomass, we can observe an increase in terrestrial-derived organic carbon being deposited into sediments.

Precipitation variation seems to only impact the concentrations of terrestrial organic carbon in semi-arid regions of the MDB, while having very poor correlation with vegetated regions of Tasmania. This is likely due to extreme sensitivity of the dry region to hydrological changes which could easily result in rapid loss or gain of vegetation, while the organic carbon burial in denser vegetated regions with higher rainfall, is less susceptible to hydrological variation. These models could be used as supplement to pollen based vegetation studies, however a more robust model could be developed to multivariate regression analysis, incorporating other variables not measured in this study.

ACKNOWLEDGMENTS

The author would like to thank the following individuals for their contribution to this project: Dr. Jonathan Tyler, Dr. John Tibby, Dr. Francesca McInerney, Mark Rollog, Robyn Williamson, Martin Ankor, Dr. Michael Reid, Dr. Michael Shawn-Fletcher, Peter Briggs, Chris Smith, Nick Robson, Sofanit Girma Araya.
The author would like to extend further thanks to Dr. Katie Howard and Dr. Juraj Farkas.

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APPENDIX A: RAW ISOTOPE AND PYROLYSIS DATA

		Acidified								Not Acidified												
SITE	Sample depth (cm)	d13C	sd	d15N	sd	TOC	sd	TN	sd	d13C	sd	d15N	sd	TOC	sd	TN	sd	S1	S2	S3	HI	OI
SWL	1	-31.16	0.23	-2.77	0.08	54.43	4.35	2.63	0.18	-30.98	0.13	-2.63	0.07	42.18	2.87	2.89	0.32	43.33	285.76	15.93	525.01	29.27
SWL	2	-31.12	0.23	-3.00	0.08	55.27	4.42	2.65	0.18	-30.86	0.13	-2.80	0.07	40.50	2.75	2.97	0.33	44.05	277.84	16.79	502.69	30.38
SWL	3	-31.14	0.23	-3.07	0.08	53.46	4.28	2.57	0.17	-30.88	0.13	-2.77	0.07	40.89	2.78	2.83	0.31	42.49	285.83	15.29	534.71	28.60
SWL	4	-31.27	0.23	-3.07	0.08	53.19	4.26	2.53	0.17	-30.84	0.13	-2.83	0.07	40.34	2.74	2.95	0.32	42.36	291.88	14.75	548.73	27.73
SWL	5	-31.22	0.23	-3.12	0.08	53.14	4.25	2.50	0.17	-30.95	0.13	-2.83	0.07	40.80	2.77	2.63	0.29	43.63	292.60	14.50	550.57	27.28
SWL	6	-31.34	0.23	-3.02	0.08	53.48	4.28	2.49	0.17	-30.97	0.13	-2.82	0.07	43.58	2.96	3.08	0.34					
SWL	7	-31.43	0.23	-3.00	0.08	53.96	4.32	2.32	0.16	-30.80	0.13	-2.91	0.07	42.49	2.89	2.71	0.30					
SWL	8	-30.89	0.23	-2.77	0.08	47.57	3.81	2.33	0.16	-30.76	0.13	-2.76	0.07	40.27	2.74	2.73	0.30					
SWL	9	-30.91	0.23	-2.77	0.08	34.85	2.79	1.69	0.11	-30.72	0.13	-2.72	0.07	41.86	2.85	2.66	0.29					
SWL	10	-30.76	0.23	-2.63	0.08	45.41	3.63	2.08	0.14	-30.47	0.13	-2.63	0.07	41.72	2.84	2.61	0.29					
BLU	1	-32.62	0.23	1.26	0.08	13.45	1.08	0.89	0.06	-33.00	0.13	1.98	0.07	13.98	0.95	0.90	0.10	9.11	40.28	6.49	299.49	48.25
BLU	2	-32.26	0.23	1.34	0.08	10.72	0.86	0.67	0.05	-32.57	0.13	1.98	0.07	11.22	0.76	0.69	0.08	8.28	34.74	6.36	324.13	59.34
BLU	3	-31.49	0.23	0.85	0.08	13.02	1.04	0.70	0.05	-31.78	0.13	1.75	0.07	13.07	0.89	0.69	0.08	9.58	34.10	7.08	261.85	53.98
BLU	4	-32.05	0.23	1.63	0.08	9.36	0.75	0.67	0.05	-32.36	0.13	2.89	0.07	6.67	0.45	0.45	0.05	6.93	28.53	6.09	304.67	65.04
BLU	5	-32.17	0.23	1.52	0.08	10.29	0.82	0.68	0.05	-32.23	0.13	2.37	0.07	9.40	0.64	0.62	0.07	7.34	30.19	6.25	298.36	60.73
BLU	6	-32.39	0.23	1.46	0.08	26.70	2.14	1.42	0.10	-33.05	0.13	1.83	0.07	12.01	0.82	0.73	0.08					
BLU	7	-32.75	0.23	0.29	0.08	9.66	0.77	0.55	0.04	-32.65	0.13	1.32	0.07	12.33	0.84	0.72	0.08					
BLU	8									-32.92	0.13	1.71	0.07	11.22	0.76	0.69	0.08					
BLU	9	-32.62	0.23	1.12	0.08	10.88	0.87	0.65	0.04	-32.86	0.13	1.27	0.07	9.97	0.68	0.63	0.07					
BLU	10	-32.82	0.23	0.80	0.08	9.82	0.79	0.62	0.04	-32.94	0.13	1.64	0.07	9.71	0.66	0.62	0.07					
18MS	1	-29.16	0.23	2.47	0.08	19.89	1.59	1.23	0.08	-29.26	0.13	2.98	0.07	21.55	1.47	1.33	0.15					
18MS	2	-28.55	0.23	2.57	0.08	16.69	1.33	1.00	0.07	-28.78	0.13	3.37	0.07	13.92	0.95	0.83	0.09	5.66	25.68	8.47	153.90	50.76
18MS	3	-28.53	0.23	2.93	0.08	19.46	1.56	1.15	0.08	-28.68	0.13	3.35	0.07	20.09	1.37	1.12	0.12	8.32	32.41	8.82	166.55	45.32
18MS	4	-28.23	0.23	2.95	0.08	18.70	1.50	1.08	0.07	-28.64	0.13	3.49	0.07	19.42	1.32	1.07	0.12	6.18	28.51	9.84	152.45	52.62
18MS	5	-28.22	0.23	2.66	0.08	18.76	1.50	1.08	0.07	-28.46	0.13	3.36	0.07	18.26	1.24	1.06	0.12	7.86	31.03	8.70	165.42	46.38
18MS	6	-28.07	0.23	2.50	0.08	17.54	1.40	1.02	0.07	-28.43	0.13	3.14	0.07	16.80	1.14	0.97	0.11					
18MS	7	-27.73	0.23	2.40	0.08	19.08	1.53	1.11	0.08	-28.03	0.13	2.88	0.07	19.20	1.31	1.13	0.12					
18MS	8	-27.59	0.23	2.21	0.08	16.69	1.33	0.96	0.07	-27.95	0.13	2.72	0.07	15.84	1.08	0.85	0.09					
18MS	9	-26.75	0.23	1.61	0.08	11.30	0.90	0.56	0.04	-27.18	0.13	2.95	0.07	11.01	0.75	0.51	0.06					
18MS	10	-26.10	0.23	0.80	0.08	8.22	0.66	0.33	0.02	-26.46	0.13	3.22	0.07	10.00	0.68	0.31	0.03					
PUNL	4	-22.33	0.09	2.56	0.94	2.92	0.18	0.23	0.03	-20.66	0.13	5.59	0.07	4.29	0.29	0.36	0.04	0.52	6.75	2.61	230.90	89.28
WNB	4	-27.44	0.23	0.21	0.08	1.56	0.12	0.20	0.01	-27.45	0.13	3.51	0.07	1.42	0.26	0.17	0.02	0.33	1.30	2.37	83.41	152.06
BOOL	4	-26.87	0.09	4.55	0.62	1.34	0.08	0.08	0.01	-27.45	0.13	5.50	0.07	0.57	0.10	0.18	0.02	0.52	1.20	2.09	89.69	156.21
MIDB	4	-26.90	0.09	2.35	0.86	3.38	0.21	0.26	0.03	-26.97	0.13	6.48	0.07	3.87	0.26	0.37	0.04	0.47	5.07	3.30	150.17	97.74
BS	4	-27.74	0.09	2.43	0.13	26.32	1.66	1.43	0.19	-27.48	0.13	3.27	0.07	27.23	1.85	1.75	0.19					
MOIL	4	-24.19	0.09	2.95	1.81	0.99	0.06	0.06	0.01	-24.72	0.13	3.86	0.07	0.43	0.08	0.15	0.02	0.23	0.70	1.93	70.43	194.17
MOIL	4	-24.16	0.09	3.13	2.27	0.76	0.05	0.02	0.00	-24.52	0.13	4.35	0.07	0.80	0.14	0.10	0.01	0.24	0.44	1.73	57.58	226.38
2CB	4	-28.90	0.09	3.40	0.23	1.53	0.10	0.09	0.01	-29.33	0.13	3.29	0.07	0.70	0.13	0.19	0.02	0.39	2.14	1.91	139.80	124.77
2CB	4	-28.97	0.09	2.59	0.00	1.27	0.08	0.05	0.01	-29.50	0.13	2.44	0.07	0.73	0.13	0.18	0.02	0.39	2.20	1.97	173.69	155.53
DAIL	4	-29.60	0.09	1.22	0.08	3.43	0.22	0.31	0.04	-29.80	0.13	2.68	0.07	3.80	0.26	0.37	0.04	0.90	5.68	2.60	165.38	75.70
DAIL	4	-29.93	0.23	1.58	0.08	2.14	0.17	0.32	0.02	-29.68	0.13	3.07	0.07	3.68	0.25	0.35	0.04	0.95	5.72	2.72	267.14	127.08

		Acidified								Not Acidified												
SITE	Sample depth (cm)	d13C	sd	d15N	sd	TOC	sd	TN	sd	d13C	sd	d15N	sd	TOC	sd	TN	sd	S1	S2	S3	HI	OI
SPIL	0.5	-28.13	0.11	2.20	0.12	28.24	1.55	1.27	0.57	-28.10	0.09	1.91	0.40	27.86	1.59	1.12	0.06	16.00	65.16	19.50	230.73	69.05
SPIL	1	-28.09	0.11	2.27	0.12	25.81	1.42	1.20	0.54	-27.91	0.09	1.96	0.40	25.63	1.46	1.10	0.06	15.70	86.14	9.96	333.70	38.58
SPIL	1.5	-28.03	0.11	2.27	0.12	23.17	1.27	1.07	0.48	-27.82	0.09	2.01	0.40	24.41	1.39	1.03	0.05	15.78	88.58	8.98	382.25	38.75
SPIL	2	-27.79	0.11	2.82	0.12	25.02	1.38	1.21	0.54	-27.91	0.09	1.97	0.40	23.77	1.35	0.98	0.05	15.91	91.43	8.83	365.48	35.30
SPIL	2.5	-27.97	0.11	2.14	0.12	22.23	1.22	1.03	0.46	-27.98	0.09	1.91	0.40	23.51	1.34	0.94	0.05	15.83	94.83	8.61	426.55	38.73
SPIL	3	-28.00	0.11	2.14	0.12	21.54	1.18	1.01	0.45	-27.92	0.09	1.85	0.40	23.87	1.36	0.95	0.05	15.90	94.23	8.38	437.40	38.90
SPIL	3.5	-28.10	0.11	2.07	0.12	21.37	1.18	0.99	0.44	-27.93	0.09	1.84	0.40	22.72	1.29	0.92	0.05	14.46	92.39	8.19	432.25	38.32
SPIL	4	-28.07	0.11	2.08	0.12	22.56	1.24	1.03	0.46	-28.07	0.09	1.81	0.40	22.50	1.28	0.90	0.05					
SPIL	4.5	-28.10	0.11	2.02	0.12	23.25	1.28	1.05	0.47	-28.07	0.09	2.15	0.40	23.63	1.35	0.25	0.01					
SPIL	5	-28.11	0.11	1.99	0.12	21.70	1.19	1.01	0.45	-28.13	0.09	1.77	0.40	22.17	1.26	0.91	0.05					
DOL	0.5	-28.04	0.11	1.56	0.12	6.75	0.37	0.47	0.21	-27.94	0.09	1.38	0.40	5.16	0.29	0.33	0.02	1.69	11.39	3.96	168.70	58.65
DOL	1	-27.76	0.11	1.65	0.12	6.48	0.36	0.45	0.20	-27.78	0.09	1.25	0.40	5.24	0.30	0.32	0.02	1.51	10.86	3.83	167.54	59.09
DOL	1.5	-27.71	0.11	1.87	0.12	6.20	0.34	0.43	0.19	-27.78	0.09	1.31	0.40	5.57	0.32	0.33	0.02	1.43	10.75	3.94	173.34	63.53
DOL	2	-27.60	0.11	1.55	0.12	6.13	0.34	0.42	0.19	-27.70	0.09	1.24	0.40	5.51	0.31	0.34	0.02	1.26	9.70	3.79	158.16	61.80
DOL	2.5	-27.62	0.11	1.85	0.12	5.74	0.32	0.39	0.17	-27.60	0.09	1.52	0.40	5.07	0.29	0.30	0.02	1.21	9.50	3.66	165.55	63.78
DOL	3	-27.42	0.11	1.86	0.12	4.74	0.26	0.33	0.15	-27.53	0.09	1.28	0.40	4.29	0.24	0.25	0.01	0.95	8.14	3.53	171.57	74.40
DOL	3.5	-27.54	0.11	3.26	0.12	2.59	1.45	0.20	0.09	-27.48	0.09	0.88	0.80	1.84	0.11	0.09	0.00	0.16	1.81	2.12	69.80	81.76
DOL	4	-27.44	0.11	2.85	0.12	2.10	1.17	0.16	0.07	-26.96	0.09	0.33	0.80	1.25	0.07	0.06	0.00					
DOL	4.5	-27.22	0.11	0.19	0.12	1.89	1.06	0.16	0.07	-27.45	0.09	1.87	0.80	1.08	0.06	0.04	0.00					
DOL	5	-27.42	0.11	1.70	0.12	2.16	1.21	0.18	0.08	-27.36	0.09	1.84	0.80	1.34	0.08	0.06	0.00					
BAL	0.5	-26.56	0.11	-0.37	0.12	13.84	0.76	2.12	0.12	-26.72	0.09	1.63	0.40	12.73	0.73	0.64	0.03	10.49	32.21	6.04	232.75	43.65
BAL	1	-26.56	0.11	1.68	0.12	13.44	0.74	0.72	0.33	-26.77	0.09	1.54	0.40	11.66	0.66	0.55	0.03	9.97	33.72	5.53	250.98	41.16
BAL	1.5	-26.54	0.11	1.63	0.12	12.71	0.70	0.67	0.30	-26.63	0.09	2.90	0.40	11.42	0.65	0.35	0.02	9.32	31.52	5.49	247.93	43.18
BAL	2	-26.47	0.11	1.80	0.12	13.70	0.75	0.71	0.32	-26.57	0.09	1.34	0.40	11.65	0.66	0.53	0.03	9.64	32.59	5.60	237.84	40.87
BAL	2.5	-26.58	0.11	1.62	0.12	12.69	0.70	0.65	0.29	-26.65	0.09	1.27	0.40	12.37	0.71	0.55	0.03	9.92	32.90	5.55	259.27	43.74
BAL	3	-26.42	0.11	1.65	0.12	14.64	0.81	0.74	0.33	-26.66	0.09	1.16	0.40	9.22	0.53	0.42	0.02	8.99	30.40	5.35	207.63	36.54
BAL	3.5	-26.69	0.11	1.69	0.12	11.98	0.66	0.61	0.28	-26.69	0.09	1.45	0.40	10.66	0.61	0.49	0.03	8.13	27.62	4.97	230.61	41.50
BAL	4	-26.68	0.11	1.77	0.12	13.39	0.74	0.72	0.32	-26.81	0.09	1.38	0.40	15.49	0.88	0.67	0.03					
BAL	4.5	-26.65	0.11	1.69	0.12	11.39	0.63	0.62	0.28	-26.79	0.09	1.30	0.40	11.94	0.68	0.53	0.03					
BAL	5	-26.64	0.11	1.63	0.12	10.86	0.60	0.59	0.26	-26.80	0.09	1.64	0.40	11.72	0.67	0.54	0.03					
GWL	0.5	-24.14	0.11	0.98	0.12	11.97	0.66	1.00	0.45		0.09	0.95	0.40	10.80	0.62	0.92	0.05	4.59	32.87	6.78	274.50	56.62
GWL	1	-24.15	0.11	0.96	0.12	11.78	0.65	0.99	0.44	-24.14	0.09	0.75	0.40	11.50	0.66	0.88	0.05	5.37	28.72	6.77	243.78	57.46
GWL	1.5	-24.05	0.11	1.18	0.12	11.16	0.61	0.93	0.42	-24.22	0.09	0.70	0.40	8.79	0.50	0.68	0.04	3.08	20.14	6.06	180.42	54.29
GWL	2	-24.17	0.11	0.93	0.12	11.14	0.61	0.96	0.43	-24.28	0.09	0.67	0.40	10.35	0.59	0.78	0.04	3.60	21.18	6.10	190.06	54.74
GWL	2.5	-24.16	0.11	0.75	0.12	9.58	0.53	0.77	0.35	-24.34	0.09	0.47	0.40	8.68	0.49	0.64	0.03	1.31	16.40	7.29	171.15	76.08
GWL	3	-24.29	0.11	1.26	0.12	7.87	0.43	0.69	0.31	-24.36	0.09	0.76	0.40	5.91	0.34	0.48	0.03	0.84	17.70	12.15	224.98	154.43
GWL	3.5	-24.37	0.11	1.31	0.12	8.50	0.47	0.74	0.33	-24.50	0.09	0.31	0.40	9.08	0.52	0.73	0.04	1.16	10.72	5.36	126.08	63.04
GWL	4	-24.11	0.11	1.32	0.12	7.86	0.43	0.64	0.29	-24.23	0.09	0.95	0.40	7.19	0.41	0.50	0.03					
GWL	4.5	-23.75	0.11	1.55	0.12	5.69	0.31	0.46	0.21	-23.87	0.09	1.49	0.40	6.07	0.35	0.45	0.02					
GWL	5	-23.09	0.11	2.72	0.12	6.72	0.37	0.64	0.29	-23.35	0.09	1.89	0.40	4.63	0.26	0.41	0.02					

		Acidified								Not Acidified												
SITE	Sample depth (cm)	d13C	sd	d15N	sd	TOC	sd	TN	sd	d13C	sd	d15N	sd	TOC	sd	TN	sd	S1	S2	S3	HI	OI
GWT	0.5	-27.98	0.11	1.37	0.12	11.98	0.66	0.57	0.26	-27.94	0.09	1.00	0.40	12.39	0.71	0.47	0.02	7.81	45.12	4.72	376.50	39.39
GWT	1	-27.92	0.11	1.29	0.12	12.15	0.67	0.55	0.25	-28.02	0.09	0.96	0.40	12.91	0.74	0.48	0.02	6.95	38.98	5.12	320.79	42.14
GWT	1.5	-27.97	0.11	1.49	0.12	11.58	0.64	0.55	0.25	-27.91	0.09	1.11	0.40	11.85	0.68	0.46	0.02	6.91	37.53	4.25	324.17	36.71
GWT	2	-27.82	0.11	1.68	0.12	16.87	0.93	0.84	0.38	-27.86	0.09	1.96	0.40	18.85	1.07	0.62	0.03	12.52	77.74	7.32	460.73	43.38
GWT	2.5	-27.88	0.11	1.93	0.12	17.85	0.98	0.85	0.38	-27.92	0.09	1.31	0.40	19.63	1.12	0.74	0.04	12.30	76.33	6.13	427.67	34.35
GWT	3	-27.88	0.11	1.66	0.12	16.23	0.89	0.75	0.34	-28.08	0.09	1.22	0.40	19.09	1.09	0.70	0.04	12.55	78.44	7.44	483.19	45.83
GWT	3.5	-27.83	0.11	1.62	0.12	16.80	0.92	0.78	0.35	-27.98	0.09	1.27	0.40	18.92	1.08	0.70	0.04	12.07	77.08	6.07	458.75	36.13
GWT	4	-27.88	0.11	1.59	0.12	17.28	0.95	0.80	0.36	-28.01	0.09	1.18	0.40	18.82	1.07	0.69	0.04					
GWT	4.5	-27.74	0.11	2.18	0.12	17.11	0.94	0.80	0.36	-27.97	0.09	1.30	0.40	18.54	1.06	0.69	0.04					
GWT	5	-27.85	0.11	1.57	0.12	17.53	0.96	0.84	0.38	-27.92	0.09	1.19	0.40	18.78	1.07	0.73	0.04					
ROL	0.5	-27.95	0.09	0.84	0.31	18.54	1.17	0.84	0.11	-28.04	0.09	0.90	0.40	18.02	1.03	0.84	0.04					
ROL	1																					
ROL	1.5	-27.61	0.09	0.88	0.34	17.18	1.08	0.74	0.10	-27.59	0.09	1.22	0.40	17.28	0.99	0.80	0.04					
ROL	2																					
ROL	2.5	-27.65	0.09	1.10	0.32	18.45	1.16	0.78	0.10	-27.56	0.09	1.30	0.40	15.55	0.89	0.70	0.04					
ROL	3																					
ROL	3.5	-27.63	0.09	0.97	0.36	16.32	1.03	0.68	0.09	-27.58	0.09	1.25	0.40	16.57	0.94	0.73	0.04					
ROL	4	-27.60	0.09	1.08	0.33	16.77	1.06	0.71	0.10	-28.14	0.09	0.79	0.40	17.94	1.02	0.86	0.04					
ROL	4.5	-27.59	0.09	0.97	0.37	16.67	1.05	0.69	0.09	-28.19	0.09	1.78	0.40	17.24	0.98	0.70	0.04					
	5																					
VEL	0.5																					
VEL	1																					
VEL	1.5																					
VEL	2																					
VEL	2.5																					
VEL	3																					
VEL	3.5																					
VEL	4	-27.44	0.09	0.12	0.53	11.52	0.73	0.49	0.07	-27.21	0.13	0.84	0.07	11.79	0.80	0.65	0.07	2.19	16.82	7.63	145.95	66.21
VEL	4.5																					
VEL	5	-27.05	0.09	0.36	0.51	9.93	0.63	0.45	0.06	-27.10	0.13	0.79	0.07	10.58	0.72	0.56	0.06	2.61	16.82	6.62	169.45	66.69
TAL	0.5	-28.15	0.09	1.27	0.58	9.31	0.59	0.40	0.05	-28.00	0.13	2.60	0.07	12.97	0.88	0.52	0.06	6.25	33.65	4.47	361.48	48.02
TAL	1																					
TAL	1.5	-28.22	0.09	1.54	0.53	10.66	0.67	0.44	0.06	-28.15	0.13	2.58	0.07	10.81	0.73	0.55	0.06					
TAL	2	-28.19	0.09	1.50	0.51	10.32	0.65	0.44	0.06	-28.09	0.13	2.53	0.07	10.55	0.72	0.55	0.06					
TAL	2.5	-28.15	0.09	1.14	0.62	10.42	0.66	0.43	0.06	-28.14	0.13	2.67	0.07	10.99	0.75	0.54	0.06					
TAL	3																					
TAL	3.5	-28.28	0.09	1.47	0.51	10.02	0.63	0.45	0.06	-28.14	0.13	2.45	0.07	10.41	0.71	0.53	0.06					
TAL	4																					
TAL	4.5	-28.28	0.09	1.22	0.55	11.46	0.72	0.47	0.06	-28.26	0.13	2.32	0.07	12.20	0.83	0.59	0.06					
TAL	5	-28.19	0.09	1.37	0.54	10.85	0.68	0.47	0.06	-28.15	0.13	2.53	0.07	11.86	0.81	0.61	0.07	6.68	40.57	5.08	374.06	46.84
SQT	0.5																					
SQT	1																					
SQT	1.5																					
SQT	2																					
SQT	2.5																					
SQT	3																					
SQT	3.5									-27.79	0.13	1.90	0.07	25.63	1.74	1.12	0.12	10.87	62.41	13.21		
SQT	4									-27.78	0.13	1.93	0.07	25.11	1.71	1.09	0.12	9.84	62.73	13.37		
SQT	4.5											1.93	0.07	17.75	1.21	1.14	0.13	8.62	56.73	11.43		
SQT	5									-27.59	0.13	1.96	0.07	27.46	1.87	1.18	0.13	12.03	77.92	13.24		

APPENDIX B: RAW PRECIPITATION DATA

		JAN	FEB	MAR	APR	MAY	JUN
Swallow Lagoon	2000	0.003687	0.004859	0.001923	0.004377	0.003232	0.004787
	2001	0.002139	0.009789	0.004661	0.002670	0.001932	0.001313
	2002	0.001619	0.002886	0.004855	0.004557	0.004197	0.002580
	2003	0.000645	0.012521	0.007219	0.006207	0.009945	0.003510
	2004	0.006213	0.006255	0.005932	0.004110	0.000519	0.001020
	2005	0.002006	0.002443	0.001787	0.005880	0.006974	0.011520
	2006	0.009061	0.005393	0.008684	0.001957	0.002777	0.006310
	2007	0.002197	0.006057	0.002810	0.002677	0.002713	0.006350
	2008	0.008681	0.008621	0.001910	0.005023	0.003423	0.004527
	2009	0.003542	0.007729	0.003806	0.013213	0.011290	0.007343
	2010	0.002081	0.009600	0.010423	0.004867	0.004497	0.001400
	2011	0.011035	0.005564	0.007548	0.010163	0.003894	0.001247
	2012	0.021406	0.008072	0.007939	0.007763	0.002645	0.007527
	2013	0.008765	0.017336	0.005519	0.010520	0.002868	0.006087
Blue Lake	2000	0.003374	0.004372	0.001874	0.004177	0.002948	0.004463
	2001	0.001955	0.008725	0.004784	0.002650	0.001774	0.001257
	2002	0.001361	0.002761	0.004661	0.004363	0.004119	0.002410
	2003	0.000590	0.012071	0.006774	0.005897	0.009326	0.003147
	2004	0.005813	0.006334	0.005626	0.003943	0.000490	0.000887
	2005	0.001952	0.002225	0.001565	0.005597	0.006319	0.011737
	2006	0.008235	0.005046	0.008232	0.001910	0.002642	0.005987
	2007	0.001961	0.005843	0.002661	0.002397	0.002452	0.005817
	2008	0.008132	0.007855	0.001752	0.004673	0.003190	0.004257
	2009	0.003342	0.007236	0.003748	0.013020	0.010229	0.006717
	2010	0.002016	0.009229	0.009390	0.004400	0.004455	0.001273
	2011	0.009510	0.005032	0.007229	0.009810	0.003616	0.001147
	2012	0.019623	0.007648	0.007142	0.007723	0.002361	0.007160
	2013	0.008152	0.015686	0.005500	0.009627	0.002610	0.005850
18 Mile Swamp	2000	0.003374	0.004372	0.001874	0.004177	0.002948	0.004463
	2001	0.001955	0.008725	0.004784	0.002650	0.001774	0.001257
	2002	0.001361	0.002761	0.004661	0.004363	0.004119	0.002410
	2003	0.000590	0.012071	0.006774	0.005897	0.009326	0.003147
	2004	0.005813	0.006334	0.005626	0.003943	0.000490	0.000887
	2005	0.001952	0.002225	0.001565	0.005597	0.006319	0.011737
	2006	0.008235	0.005046	0.008232	0.001910	0.002642	0.005987
	2007	0.001961	0.005843	0.002661	0.002397	0.002452	0.005817
	2008	0.008132	0.007855	0.001752	0.004673	0.003190	0.004257
	2009	0.003342	0.007236	0.003748	0.013020	0.010229	0.006717
	2010	0.002016	0.009229	0.009390	0.004400	0.004455	0.001273
	2011	0.009510	0.005032	0.007229	0.009810	0.003616	0.001147
	2012	0.019623	0.007648	0.007142	0.007723	0.002361	0.007160
	2013	0.008152	0.015686	0.005500	0.009627	0.002610	0.005850
Pungbougal Lagoon	2000	0.001232	0.002500	0.003329	0.000693	0.001006	0.000623
	2001	0.001813	0.003775	0.002165	0.000847	0.001058	0.000863
	2002	0.000608	0.001364	0.002823	0.000073	0.000139	0.000427
	2003	0.000171	0.002496	0.002055	0.002830	0.000019	0.000923
	2004	0.004748	0.001807	0.004077	0.001323	0.000590	0.000170
	2005	0.000806	0.000254	0.000845	0.000027	0.001255	0.005827
	2006	0.002358	0.003118	0.000632	0.000760	0.000158	0.000680
	2007	0.000608	0.001386	0.001129	0.001090	0.000571	0.001730
	2008	0.001697	0.004007	0.000003	0.000327	0.000087	0.001130
	2009	0.002045	0.004646	0.000429	0.000617	0.002400	0.000897

		JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Swallow Lagoon	2000	0.001023	0.001132	0.000063	0.002571	0.003637	0.002735	0.002836	0.003760	0.002314
	2001	0.002006	0.000594	0.000890	0.002603	0.007417	0.004068	0.003340	0.005332	0.001304
	2002	0.000042	0.004994	0.000613	0.002406	0.003363	0.005487	0.003133	0.003331	0.002539
	2003	0.001971	0.002165	0.000353	0.002442	0.002043	0.003448	0.004372	0.005538	0.002549
	2004	0.000468	0.000642	0.001157	0.002542	0.005990	0.008187	0.003586	0.006885	0.000710
	2005	0.002939	0.000729	0.000443	0.005929	0.005333	0.007419	0.004450	0.003956	0.005063
	2006	0.003132	0.002819	0.004933	0.000416	0.002400	0.002794	0.004223	0.005749	0.004087
	2007	0.000410	0.005487	0.003350	0.004919	0.004133	0.003542	0.003720	0.003932	0.004082
	2008	0.006110	0.000468	0.002877	0.002245	0.012377	0.003781	0.005004	0.007028	0.003702
	2009	0.000539	0.000313	0.000860	0.001926	0.001230	0.003935	0.004644	0.005069	0.002732
	2010	0.003381	0.003913	0.002753	0.013400	0.003090	0.018635	0.006503	0.010105	0.002898
	2011	0.001297	0.003206	0.000690	0.005323	0.000510	0.006255	0.004728	0.007618	0.001917
	2012	0.003626	0.000016	0.001003	0.001406	0.003723	0.001529	0.005555	0.010336	0.003723
	2013	0.006355	0.000016	0.000913	0.000935	0.005060	0.001065	0.005453	0.009055	0.004153
Blue Lake	2000	0.000955	0.001029	0.000050	0.002329	0.003270	0.002674	0.002626	0.003473	0.002149
	2001	0.001903	0.000506	0.000903	0.002239	0.006773	0.003784	0.003104	0.004821	0.001222
	2002	0.000045	0.004632	0.000610	0.002213	0.002987	0.005123	0.002940	0.003082	0.002362
	2003	0.001974	0.002094	0.000390	0.002358	0.001790	0.003390	0.004150	0.005350	0.002405
	2004	0.000426	0.000590	0.001157	0.002387	0.005987	0.007352	0.003416	0.006500	0.000634
	2005	0.003055	0.000668	0.000407	0.005226	0.004817	0.006861	0.004202	0.003679	0.005153
	2006	0.002923	0.002706	0.004577	0.000416	0.002173	0.002584	0.003953	0.005288	0.003872
	2007	0.000897	0.005032	0.003190	0.004652	0.003733	0.003377	0.003459	0.003727	0.003749
	2008	0.005842	0.000435	0.002730	0.002087	0.011730	0.003835	0.004710	0.006607	0.003511
	2009	0.000487	0.000290	0.000830	0.001694	0.001183	0.003645	0.004368	0.004741	0.002498
	2010	0.003213	0.003506	0.002487	0.012903	0.002743	0.018010	0.006135	0.009752	0.002664
	2011	0.001265	0.003106	0.000673	0.005448	0.000510	0.006013	0.004447	0.006852	0.001839
	2012	0.003323	0.000016	0.000923	0.001229	0.003177	0.001658	0.005165	0.009643	0.003500
	2013	0.006048	0.000016	0.000853	0.000874	0.004593	0.000990	0.005067	0.008276	0.003971
18 Mile Swamp	2000	0.000955	0.001029	0.000050	0.002329	0.003270	0.002674	0.002626	0.003473	0.002149
	2001	0.001903	0.000506	0.000903	0.002239	0.006773	0.003784	0.003104	0.004821	0.001222
	2002	0.000045	0.004632	0.000610	0.002213	0.002987	0.005123	0.002940	0.003082	0.002362
	2003	0.001974	0.002094	0.000390	0.002358	0.001790	0.003390	0.004150	0.005350	0.002405
	2004	0.000426	0.000590	0.001157	0.002387	0.005987	0.007352	0.003416	0.006500	0.000634
	2005	0.003055	0.000668	0.000407	0.005226	0.004817	0.006861	0.004202	0.003679	0.005153
	2006	0.002923	0.002706	0.004577	0.000416	0.002173	0.002584	0.003953	0.005288	0.003872
	2007	0.000897	0.005032	0.003190	0.004652	0.003733	0.003377	0.003459	0.003727	0.003749
	2008	0.005842	0.000435	0.002730	0.002087	0.011730	0.003835	0.004710	0.006607	0.003511
	2009	0.000487	0.000290	0.000830	0.001694	0.001183	0.003645	0.004368	0.004741	0.002498
	2010	0.003213	0.003506	0.002487	0.012903	0.002743	0.018010	0.006135	0.009752	0.002664
	2011	0.001265	0.003106	0.000673	0.005448	0.000510	0.006013	0.004447	0.006852	0.001839
	2012	0.003323	0.000016	0.000923	0.001229	0.003177	0.001658	0.005165	0.009643	0.003500
	2013	0.006048	0.000016	0.000853	0.000874	0.004593	0.000990	0.005067	0.008276	0.003971
Pungbougal Lagoon	2000	0.000632	0.000471	0.000110	0.001571	0.004700	0.001045	0.001493	0.001592	0.000575
	2001	0.002742	0.000281	0.000333	0.001352	0.002773	0.001135	0.001595	0.002241	0.001295
	2002	0.000452	0.001539	0.000323	0.000548	0.001083	0.002542	0.000993	0.001508	0.000806
	2003	0.001323	0.000577	0.000013	0.002252	0.000880	0.003697	0.001436	0.002121	0.000941
	2004	0.000497	0.000523	0.002533	0.000919	0.003290	0.003745	0.002019	0.003433	0.000397
	2005	0.000235	0.000287	0.000657	0.001913	0.004463	0.002177	0.001562	0.001079	0.002116
	2006	0.001729	0.000113	0.000760	0.000094	0.001083	0.000432	0.000993	0.001969	0.000841
	2007	0.000029	0.001048	0.000080	0.001939	0.002297	0.002658	0.001213	0.001549	0.000936
	2008	0.001265	0.000297	0.002323	0.000587	0.004127	0.002458	0.001510	0.002724	0.000897
	2009	0.000842	0.000065	0.000747	0.000242	0.000400	0.002381	0.001268	0.003024	0.000435

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Whynot Billabong	2000	0.001777	0.002793	0.003967	0.000883	0.001152	0.000600	0.000310	0.000368	0.000097	0.001832	0.004713	0.000726	0.001603	0.001765	0.000426
	2001	0.001829	0.002968	0.002271	0.000280	0.001226	0.001103	0.002958	0.000258	0.000273	0.001026	0.003303	0.001113	0.001551	0.001970	0.001440
	2002	0.000558	0.001436	0.001894	0.000483	0.000113	0.000513	0.000281	0.001461	0.000887	0.000474	0.000527	0.002265	0.000866	0.001420	0.000752
	2003	0.000252	0.001514	0.001574	0.001570	0.000019	0.001793	0.001148	0.000735	0.000000	0.001587	0.000940	0.002852	0.001165	0.001539	0.001225
	2004	0.004619	0.001034	0.005342	0.001623	0.000487	0.000233	0.000461	0.000603	0.001883	0.000781	0.004480	0.004658	0.002184	0.003437	0.000432
	2005	0.000932	0.000621	0.000577	0.000017	0.001519	0.003797	0.000197	0.000213	0.000390	0.001935	0.002877	0.002477	0.001296	0.001343	0.001402
	2006	0.001913	0.004418	0.001119	0.000737	0.000068	0.001023	0.000945	0.000152	0.001017	0.000135	0.001430	0.000377	0.001111	0.002236	0.000707
	2007	0.000981	0.000775	0.000903	0.000650	0.000348	0.000977	0.000016	0.000913	0.000017	0.001323	0.002623	0.003897	0.001119	0.001884	0.000635
	2008	0.002368	0.003941	0.000008	0.000280	0.000216	0.001847	0.001674	0.000142	0.002767	0.000542	0.002730	0.001684	0.001516	0.002664	0.001221
	2009	0.002061	0.005421	0.000116	0.000787	0.002658	0.000547	0.000329	0.000052	0.000833	0.000210	0.000467	0.003023	0.001375	0.003502	0.000309
	2010	0.001126	0.002464	0.004277	0.000060	0.000700	0.000393	0.002190	0.001323	0.002963	0.001923	0.003340	0.002177	0.001911	0.001922	0.001302
	2011	0.001835	0.000789	0.000965	0.001157	0.000726	0.000363	0.000671	0.001003	0.002160	0.001248	0.005257	0.005961	0.001845	0.002862	0.000679
	2012	0.002977	0.003914	0.001184	0.000890	0.001171	0.000943	0.001516	0.000161	0.000440	0.000252	0.000630	0.000965	0.001245	0.002619	0.000673
	2013	0.004810	0.001450	0.004158	0.000240	0.000684	0.000830	0.000681	0.000132	0.000627	0.000339	0.002043	0.000384	0.001365	0.002215	0.000548
Booberoi Lagoon	2000	0.001810	0.002597	0.003729	0.000920	0.001145	0.000583	0.000339	0.000419	0.000083	0.001839	0.004777	0.000816	0.001588	0.001741	0.000447
	2001	0.001697	0.002957	0.002365	0.000503	0.001216	0.001077	0.002826	0.000277	0.000273	0.000968	0.003493	0.001097	0.001562	0.001917	0.001393
	2002	0.000658	0.001246	0.001906	0.000397	0.000113	0.000450	0.000271	0.001542	0.000327	0.000394	0.000643	0.002119	0.000831	0.001341	0.000754
	2003	0.000229	0.002025	0.001623	0.001687	0.000026	0.001667	0.001155	0.000694	0.000000	0.001610	0.000883	0.002861	0.001205	0.001705	0.001172
	2004	0.004742	0.001208	0.005000	0.001540	0.000429	0.000197	0.000448	0.000506	0.002080	0.000703	0.004137	0.004494	0.002119	0.003480	0.000384
	2005	0.000687	0.000607	0.000506	0.000030	0.001519	0.004023	0.000216	0.000219	0.000503	0.002087	0.002613	0.002452	0.001289	0.001249	0.001486
	2006	0.001952	0.004150	0.000948	0.000817	0.000077	0.000890	0.000890	0.000161	0.000923	0.000139	0.001440	0.000452	0.001070	0.002185	0.000647
	2007	0.000774	0.000800	0.000832	0.000610	0.000381	0.001070	0.000013	0.000929	0.000010	0.001458	0.002813	0.003694	0.001115	0.001756	0.000671
	2008	0.002365	0.003779	0.000019	0.000303	0.000190	0.001693	0.001545	0.000142	0.002593	0.000587	0.002907	0.001823	0.001496	0.002656	0.001127
	2009	0.001916	0.005189	0.000152	0.000820	0.002510	0.000707	0.000303	0.000061	0.000710	0.000187	0.000450	0.002881	0.001324	0.003329	0.000357
	2010	0.001171	0.002336	0.004510	0.000047	0.000706	0.000367	0.002213	0.001377	0.003207	0.001958	0.003223	0.002435	0.001963	0.001981	0.001319
	2011	0.002203	0.000771	0.001097	0.001257	0.000745	0.000380	0.000665	0.001052	0.002150	0.001400	0.004797	0.005735	0.001854	0.002903	0.000699
	2012	0.003742	0.003166	0.001255	0.000877	0.001116	0.000987	0.001516	0.000168	0.000410	0.000281	0.000643	0.001116	0.001273	0.002675	0.000890
	2013	0.005294	0.001543	0.004355	0.000250	0.000632	0.000830	0.000665	0.000135	0.000620	0.000435	0.002127	0.000406	0.001441	0.002414	0.000543
McIntyre Downs Bill	2000	0.001668	0.002697	0.003690	0.000900	0.001148	0.000587	0.000371	0.000410	0.000093	0.001806	0.004893	0.000719	0.001582	0.001695	0.000456
	2001	0.001648	0.003254	0.002490	0.000573	0.001210	0.000963	0.002732	0.000265	0.000290	0.001023	0.003333	0.001129	0.001576	0.002010	0.001320
	2002	0.000665	0.001382	0.002232	0.000330	0.000132	0.000473	0.000287	0.001571	0.000323	0.000403	0.000653	0.002087	0.000878	0.001378	0.000777
	2003	0.000229	0.002118	0.001797	0.001970	0.000026	0.001470	0.001261	0.000671	0.000003	0.001687	0.000923	0.003000	0.001263	0.001782	0.001134
	2004	0.004819	0.001362	0.004829	0.001517	0.000455	0.000197	0.000484	0.000503	0.002003	0.000765	0.004010	0.004381	0.002110	0.003521	0.000395
	2005	0.000661	0.000625	0.000532	0.000030	0.001374	0.004670	0.000252	0.000229	0.000577	0.002019	0.003087	0.002332	0.001366	0.001206	0.001717
	2006	0.002297	0.003850	0.000881	0.000767	0.000065	0.000880	0.001210	0.000158	0.000840	0.000135	0.001433	0.000455	0.001081	0.002201	0.000749
	2007	0.000813	0.000993	0.000852	0.000717	0.000452	0.001203	0.000019	0.001023	0.000027	0.001590	0.002927	0.003548	0.001180	0.001785	0.000748
	2008	0.002268	0.003855	0.000026	0.000360	0.000206	0.001520	0.001465	0.000142	0.002437	0.000558	0.003140	0.002026	0.001500	0.002716	0.001042
	2009	0.001935	0.005114	0.000174	0.000830	0.002406	0.000777	0.000319	0.000065	0.000760	0.000223	0.000437	0.002748	0.001316	0.003266	0.000387
	2010	0.001281	0.002204	0.004261	0.000067	0.000819	0.000367	0.002368	0.001471	0.003553	0.001903	0.003087	0.002584	0.001997	0.002023	0.001402
	2011	0.002229	0.000954	0.001300	0.001467	0.000794	0.000487	0.000645	0.001094	0.002170	0.001513	0.004637	0.005781	0.001923	0.002988	0.000742
	2012	0.004319	0.002924	0.001229	0.000997	0.001165	0.000973	0.001506	0.000132	0.000393	0.000339	0.000733	0.001300	0.001334	0.002848	0.000870
	2013	0.005761	0.001614	0.004348	0.000817	0.000606	0.000843	0.000648	0.000129	0.000627	0.000490	0.002180	0.000419	0.001499	0.002598	0.000540
Bishop Swamp	2000	0.003358	0.001876	0.009739	0.004187	0.001610	0.000873	0.001171	0.000884	0.000730	0.003084	0.009277	0.003294	0.003340	0.002843	0.000976
	2001	0.003642	0.009154	0.019732	0.001260	0.005552	0.000263	0.001013	0.000206	0.000597	0.001097	0.004500	0.001997	0.004084	0.004931	0.000494
	2002	0.002313	0.006293	0.004952	0.001710	0.001510	0.001067	0.000032	0.001745	0.000880	0.001284	0.003103	0.003655	0.002380	0.004087	0.000955
	2003	0.001329	0.009804	0.004248	0.003167	0.003894	0.001460	0.000423	0.000529	0.000150	0.003661	0.004547	0.005332	0.003212	0.005488	0.000804
	2004	0.007806	0.006076	0.006674	0.001823	0.000365	0.000580	0.001439	0.000935	0.001507	0.011874	0.001857	0.004629	0.003797	0.006170	0.000985
	2005	0.006829	0.003243	0.002361	0.002393	0.002935	0.004923	0.000997	0.000139	0.003547	0.004826	0.005377	0.002219	0.003316	0.004097	0.002020
	2006	0.007055	0.003436	0.004068	0.002240	0.000103	0.001643	0.002165	0.003471	0.003490	0.002700	0.005707	0.002323	0.003200	0.004271	0.002426
	2007	0.002200	0.008632	0.004848	0.002280	0.000948	0.003250	0.000281	0.007816	0.001563	0.003858	0.006347	0.005800	0.003985	0.005544	0.003782
	2008	0.006713	0.009408	0.000710	0.007197	0.001023	0.006908	0.001155	0.000797	0.005340	0.003503	0.006263	0.005103	0.004509	0.007073	0.002952
	2009	0.002387	0.014843	0.005619	0.010613	0.013158	0.004270	0.001152	0.000323	0.000840	0.005590	0.005290	0.008768	0.006071	0.008666	0.001915

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Lake Moira	2000	0.000158	0.001472	0.000461	0.001117	0.001135	0.001283	0.000994	0.001100	0.001247	0.002116	0.002570	0.000187	0.001153	0.000606	0.001126
	2001	0.000781	0.000568	0.000535	0.001353	0.000145	0.001000	0.001000	0.000987	0.000633	0.001745	0.000530	0.000252	0.000794	0.000534	0.000996
	2002	0.000403	0.001443	0.000619	0.000367	0.000503	0.000737	0.000429	0.000203	0.000577	0.000155	0.000560	0.000113	0.000509	0.000653	0.000456
	2003	0.000603	0.001082	0.000000	0.001293	0.000958	0.001367	0.001945	0.001848	0.000683	0.001000	0.001580	0.002126	0.001207	0.001270	0.001720
	2004	0.000103	0.000097	0.000074	0.000533	0.000852	0.001560	0.000784	0.000881	0.001430	0.000229	0.002027	0.002548	0.000927	0.000916	0.001075
	2005	0.000681	0.003329	0.000081	0.000233	0.000152	0.002177	0.000874	0.001700	0.001043	0.002552	0.001003	0.000484	0.001192	0.001498	0.001584
	2006	0.000703	0.000625	0.000219	0.000917	0.000265	0.001347	0.001135	0.000226	0.000550	0.000003	0.000450	0.000158	0.000550	0.000495	0.000903
	2007	0.000681	0.000939	0.000639	0.000943	0.001297	0.000843	0.001297	0.000158	0.000183	0.000271	0.001113	0.001561	0.000827	0.001060	0.000766
	2008	0.002019	0.000283	0.000371	0.000243	0.000677	0.000540	0.001074	0.000935	0.000317	0.000332	0.002177	0.001803	0.000898	0.001368	0.000850
	2009	0.000023	0.000093	0.000416	0.000927	0.000300	0.001723	0.000900	0.000568	0.000937	0.000632	0.002140	0.000271	0.000736	0.000129	0.001064
	2010	0.001081	0.002164	0.002129	0.001003	0.001574	0.000870	0.000910	0.002171	0.001187	0.003177	0.002377	0.002177	0.001735	0.001807	0.001317
	2011	0.003085	0.003650	0.001261	0.001130	0.000426	0.000523	0.000990	0.001561	0.000873	0.000694	0.001683	0.001003	0.001394	0.002563	0.001025
	2012	0.001352	0.001921	0.003287	0.000403	0.000345	0.000793	0.001577	0.000723	0.000560	0.001158	0.000307	0.000361	0.001066	0.001211	0.001031
	2013	0.000100	0.001346	0.000403	0.000090	0.000761	0.002253	0.001542	0.001097	0.000957	0.000500	0.000500	0.001406	0.000913	0.000951	0.001631
2 Carp Billabong	2000	0.000142	0.001221	0.001190	0.001190	0.002061	0.001517	0.001629	0.002797	0.002120	0.001890	0.002810	0.000213	0.001565	0.000525	0.001981
	2001	0.000748	0.002125	0.000974	0.000810	0.000323	0.001460	0.001229	0.001306	0.001340	0.002516	0.000537	0.000368	0.001145	0.001080	0.001332
	2002	0.000326	0.002207	0.001561	0.000783	0.000545	0.001297	0.000581	0.001077	0.001450	0.000352	0.000433	0.000242	0.000905	0.000925	0.000985
	2003	0.000574	0.000979	0.000058	0.002387	0.001355	0.001867	0.002297	0.002603	0.001053	0.002013	0.001277	0.003658	0.001677	0.001737	0.002256
	2004	0.000313	0.000059	0.000074	0.000547	0.001010	0.002220	0.001329	0.001187	0.001700	0.000168	0.001927	0.002229	0.001064	0.000867	0.001579
	2005	0.001135	0.005886	0.000294	0.000273	0.000171	0.002863	0.001139	0.002139	0.001897	0.003158	0.002160	0.001387	0.001877	0.002803	0.002054
	2006	0.000587	0.000396	0.000571	0.001293	0.000461	0.001217	0.001381	0.000432	0.000767	0.000000	0.001013	0.000097	0.000685	0.000360	0.001010
	2007	0.000403	0.001279	0.001171	0.001150	0.001997	0.000933	0.002090	0.000287	0.000253	0.000429	0.001593	0.001774	0.001113	0.001152	0.001103
	2008	0.001797	0.000493	0.000800	0.000437	0.000706	0.000590	0.002029	0.000832	0.000607	0.000800	0.002170	0.001739	0.001042	0.001343	0.001150
	2009	0.000123	0.000161	0.000490	0.001403	0.000187	0.002767	0.001187	0.001187	0.001410	0.000897	0.002193	0.000400	0.001034	0.000228	0.001714
	2010	0.000958	0.002996	0.003016	0.000963	0.001384	0.001113	0.001642	0.002832	0.001390	0.003852	0.002160	0.004148	0.002205	0.002701	0.001862
	2011	0.002290	0.007875	0.001177	0.000593	0.000874	0.000877	0.001868	0.001755	0.001337	0.000855	0.002127	0.001087	0.001893	0.003751	0.001500
	2012	0.001561	0.004810	0.004881	0.000833	0.000681	0.000650	0.001967	0.001210	0.000610	0.001287	0.000450	0.000981	0.001653	0.002451	0.001282
	2013	0.000097	0.001014	0.001877	0.000340	0.001523	0.002393	0.001845	0.001487	0.001360	0.000939	0.000467	0.001674	0.001251	0.000928	0.001908
Dairy Billabong	2000	0.000184	0.001190	0.001742	0.001003	0.002326	0.001607	0.001732	0.002771	0.002223	0.001974	0.002750	0.000310	0.001651	0.000561	0.002037
	2001	0.000832	0.002257	0.000965	0.000740	0.000323	0.001370	0.001219	0.001190	0.001330	0.002561	0.000447	0.000435	0.001139	0.001175	0.001260
	2002	0.000416	0.002461	0.001535	0.000730	0.000552	0.001163	0.000623	0.000929	0.001457	0.000326	0.000400	0.000239	0.000903	0.001039	0.000905
	2003	0.000387	0.001032	0.000068	0.001997	0.001219	0.001997	0.002403	0.002926	0.001133	0.002161	0.001430	0.003926	0.001723	0.001782	0.002442
	2004	0.000429	0.000038	0.000068	0.000597	0.000952	0.002660	0.001352	0.001232	0.001623	0.000152	0.001973	0.002587	0.001139	0.001018	0.001748
	2005	0.001606	0.005482	0.000332	0.000293	0.000177	0.003030	0.001216	0.002313	0.001803	0.002997	0.002413	0.001565	0.001936	0.002884	0.002186
	2006	0.000458	0.000329	0.000445	0.001297	0.000348	0.001283	0.001429	0.000371	0.000860	0.000000	0.001073	0.000029	0.000660	0.000272	0.001028
	2007	0.000474	0.001200	0.001045	0.000927	0.002194	0.000887	0.002310	0.000277	0.000223	0.000506	0.001260	0.001629	0.001078	0.001101	0.001158
	2008	0.001752	0.000679	0.000823	0.000423	0.000577	0.000570	0.002061	0.000897	0.000680	0.000806	0.002160	0.001974	0.001075	0.001468	0.001176
	2009	0.000168	0.000139	0.000510	0.001533	0.000087	0.003030	0.001161	0.001316	0.001307	0.000832	0.002297	0.000448	0.001069	0.000252	0.001836
	2010	0.001284	0.002743	0.002855	0.000927	0.001387	0.000943	0.001697	0.002558	0.001537	0.004377	0.002340	0.003800	0.002204	0.002609	0.001733
	2011	0.002574	0.009393	0.001594	0.000677	0.000926	0.000847	0.001887	0.001765	0.001410	0.000858	0.002417	0.001387	0.002145	0.004451	0.001500
	2012	0.001487	0.004276	0.004600	0.000933	0.000677	0.000570	0.002194	0.001187	0.000470	0.001326	0.000470	0.000997	0.001599	0.002253	0.001317
	2013	0.000103	0.000661	0.001865	0.000320	0.001532	0.002783	0.001977	0.001435	0.001323	0.000939	0.000450	0.001790	0.001265	0.000851	0.002065
Lake Spicer	2000	0.004226	0.005248	0.005052	0.005197	0.015458	0.007863	0.009545	0.005103	0.013007	0.011345	0.003123	0.007990	0.007763	0.005821	0.007504
	2001	0.002677	0.002225	0.008652	0.005917	0.003506	0.013590	0.005442	0.015726	0.008050	0.011161	0.008833	0.006781	0.007713	0.003894	0.011586
	2002	0.008610	0.005082	0.005761	0.002473	0.004816	0.018423	0.015716	0.010819	0.016730	0.010777	0.006727	0.006923	0.009405	0.006872	0.014986
	2003	0.005561	0.001968	0.006023	0.006543	0.006016	0.013413	0.012119	0.015497	0.018280	0.007435	0.003127	0.005348	0.008444	0.004292	0.013676
	2004	0.009665	0.003252	0.004490	0.004703	0.013248	0.020027	0.012635	0.009574	0.011363	0.007161	0.008050	0.005632	0.009150	0.006183	0.014079
	2005	0.005674	0.004986	0.004548	0.006230	0.011535	0.004650	0.012939	0.015194	0.007440	0.012084	0.008750	0.016055	0.009174	0.008905	0.010928
	2006	0.003926	0.004721	0.004226	0.014623	0.009439	0.005633	0.008529	0.009358	0.011153	0.007252	0.004540	0.005352	0.007396	0.004666	0.007840
	2007	0.007965	0.001454	0.008519	0.002153	0.014542	0.003760	0.006984	0.013629	0.010217	0.013474	0.001330	0.006990	0.007585	0.005470	0.008124
	2008	0.001642	0.005907	0.005577	0.006077	0.007635	0.009030	0.008839	0.008852	0.012490	0.005858	0.007887	0.007848	0.007304	0.005132	0.008907
	2009	0.006894	0.004700	0.007771	0.007403	0.011694	0.005367	0.016197	0.022574	0.011523	0.003990	0.004807	0.008661	0.009298	0.006752	0.014713

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Lake Dove	2000	0.002758	0.003814	0.003387	0.003653	0.010777	0.007267	0.009768	0.005439	0.010833	0.010884	0.005270	0.006016	0.006614	0.004196	0.007491
	2001	0.002845	0.001332	0.006119	0.004110	0.003842	0.009393	0.003455	0.012058	0.006770	0.008400	0.006790	0.004916	0.005836	0.003031	0.008302
	2002	0.005652	0.002936	0.002677	0.001930	0.003461	0.014693	0.013713	0.009148	0.013787	0.008739	0.005153	0.003365	0.007105	0.003984	0.012518
	2003	0.003858	0.000707	0.004281	0.006297	0.006939	0.010547	0.011245	0.013677	0.014883	0.005439	0.001400	0.003945	0.006943	0.002837	0.011823
	2004	0.010610	0.003479	0.002677	0.003270	0.011048	0.013887	0.010158	0.008787	0.005417	0.005352	0.007277	0.003297	0.007105	0.005795	0.010944
	2005	0.003303	0.003600	0.001929	0.005583	0.007035	0.005800	0.010652	0.013684	0.007193	0.013600	0.007230	0.009381	0.007416	0.005428	0.010045
	2006	0.002158	0.002825	0.001929	0.011617	0.007584	0.005227	0.007497	0.005800	0.009047	0.005194	0.001633	0.003239	0.005313	0.002741	0.006175
	2007	0.005242	0.001089	0.004377	0.001857	0.016258	0.001957	0.005219	0.011952	0.009140	0.009394	0.001207	0.007403	0.006258	0.004578	0.006376
	2008	0.000555	0.005279	0.003197	0.005590	0.005935	0.008007	0.008977	0.006616	0.011590	0.003062	0.008363	0.006077	0.006103	0.003970	0.007867
	2009	0.004965	0.003025	0.005932	0.006050	0.009594	0.006090	0.014587	0.020074	0.010270	0.003294	0.004207	0.003719	0.007651	0.003903	0.013584
	2010	0.001058	0.005339	0.007371	0.006543	0.006306	0.008497	0.007242	0.010794	0.009517	0.007755	0.008443	0.010923	0.007482	0.005773	0.008844
	2011	0.009194	0.005400	0.006606	0.004237	0.004145	0.011193	0.011071	0.010687	0.006453	0.006200	0.007997	0.003032	0.007185	0.005875	0.010984
	2012	0.003529	0.004386	0.007600	0.007737	0.007777	0.011470	0.005716	0.012023	0.010327	0.004435	0.003513	0.005358	0.006989	0.004424	0.009736
	2013	0.002552	0.002282	0.006329	0.004613	0.009055	0.004353	0.013590	0.020790	0.009993	0.012116	0.007363	0.005723	0.008230	0.003519	0.012911
Lake Basin	2000	0.004016	0.005628	0.005335	0.005653	0.016681	0.008270	0.008529	0.004365	0.012097	0.010339	0.001973	0.008487	0.007614	0.006044	0.007055
	2001	0.002242	0.002414	0.007890	0.005340	0.002935	0.013833	0.005016	0.015029	0.007640	0.009713	0.007797	0.006748	0.007216	0.003801	0.011293
	2002	0.008787	0.005329	0.006490	0.002547	0.004903	0.019217	0.017052	0.010874	0.015660	0.010510	0.006900	0.007587	0.009655	0.007234	0.015714
	2003	0.005800	0.002264	0.005019	0.005740	0.005190	0.012933	0.012242	0.014423	0.017063	0.007332	0.003180	0.005074	0.008022	0.004379	0.013199
	2004	0.008613	0.003055	0.004577	0.004390	0.013335	0.020480	0.012348	0.009085	0.011803	0.006897	0.007810	0.005777	0.009010	0.005815	0.013954
	2005	0.005745	0.004475	0.004952	0.006220	0.011871	0.003957	0.012939	0.014526	0.006243	0.011048	0.008490	0.016077	0.008879	0.008766	0.010474
	2006	0.003852	0.005021	0.004387	0.013947	0.009126	0.005927	0.008832	0.010252	0.010800	0.007339	0.004777	0.005706	0.007497	0.004860	0.008337
	2007	0.008094	0.001004	0.009210	0.002067	0.014216	0.004040	0.007219	0.013110	0.009817	0.013687	0.001217	0.006542	0.007519	0.005213	0.008123
	2008	0.001719	0.005438	0.005977	0.006127	0.008332	0.008890	0.008329	0.008739	0.011893	0.005919	0.006973	0.007716	0.007171	0.004958	0.008653
	2009	0.006945	0.004625	0.007710	0.007473	0.011868	0.004943	0.016358	0.021326	0.010893	0.003697	0.004477	0.009190	0.009125	0.006920	0.014209
	2010	0.003355	0.001693	0.006982	0.009390	0.006684	0.009017	0.009087	0.011658	0.014127	0.006210	0.006603	0.006968	0.007644	0.004005	0.009921
	2011	0.005774	0.006007	0.005519	0.005703	0.006803	0.014743	0.012397	0.007161	0.012333	0.007797	0.012597	0.003632	0.008372	0.005138	0.011434
	2012	0.005994	0.003424	0.009161	0.008007	0.011519	0.010447	0.008158	0.012961	0.012617	0.008055	0.005847	0.008129	0.008693	0.005849	0.010522
	2013	0.005781	0.002839	0.007642	0.008820	0.006129	0.006143	0.010774	0.021894	0.011627	0.013890	0.005060	0.008239	0.009069	0.005620	0.012937
Lake Gwendolyn	2000	0.004471	0.004534	0.004268	0.004673	0.013490	0.006193	0.010145	0.005787	0.011827	0.011961	0.002733	0.008210	0.007358	0.005738	0.007375
	2001	0.002587	0.001761	0.008274	0.006163	0.003103	0.012467	0.005316	0.014423	0.006937	0.011174	0.008283	0.007006	0.007291	0.003785	0.010735
	2002	0.006687	0.004332	0.004384	0.002673	0.004184	0.016527	0.013287	0.009010	0.015757	0.010187	0.005403	0.005465	0.008158	0.005495	0.012941
	2003	0.004210	0.001650	0.007403	0.005493	0.005635	0.012143	0.011290	0.014413	0.017167	0.006735	0.002160	0.005203	0.007792	0.003688	0.012615
	2004	0.010410	0.003434	0.003874	0.004830	0.011755	0.017240	0.011381	0.009197	0.008733	0.006568	0.007060	0.004735	0.008268	0.006193	0.012606
	2005	0.005335	0.005457	0.003361	0.006167	0.009929	0.004383	0.010906	0.013477	0.007507	0.012055	0.008060	0.013481	0.008343	0.008091	0.009589
	2006	0.003558	0.003750	0.003471	0.014187	0.008474	0.004780	0.008155	0.007023	0.010330	0.007274	0.003740	0.004868	0.006634	0.004059	0.006653
	2007	0.007713	0.001850	0.007000	0.002377	0.013477	0.003447	0.006642	0.012706	0.009383	0.011790	0.001223	0.006477	0.007007	0.005347	0.007598
	2008	0.001390	0.006148	0.005206	0.005500	0.005916	0.008067	0.007877	0.008152	0.012473	0.005226	0.006770	0.007148	0.006656	0.004895	0.008082
	2009	0.005742	0.004386	0.007358	0.006957	0.008926	0.007070	0.012965	0.021384	0.011620	0.004213	0.005240	0.006316	0.008515	0.005481	0.013806
	2010	0.002029	0.003686	0.006558	0.007760	0.006203	0.007803	0.006445	0.011529	0.012960	0.006919	0.007533	0.007826	0.007271	0.004514	0.008592
	2011	0.006110	0.006764	0.007213	0.006540	0.005519	0.012270	0.011339	0.008758	0.009933	0.007668	0.010183	0.003768	0.008005	0.005547	0.010789
	2012	0.004861	0.003293	0.007697	0.007383	0.012339	0.008910	0.006045	0.010923	0.012380	0.006152	0.004780	0.006677	0.007620	0.004944	0.008626
	2013	0.003965	0.002825	0.007661	0.006953	0.006603	0.004440	0.010855	0.019739	0.010667	0.015958	0.007353	0.006955	0.008665	0.004582	0.011678
Godwin Tarn	2000	0.003345	0.003197	0.002794	0.003250	0.010081	0.004860	0.006703	0.004187	0.010600	0.010629	0.001860	0.007319	0.005727	0.004620	0.005250
	2001	0.001860	0.007319	0.002168	0.001079	0.006390	0.004657	0.001694	0.010253	0.004390	0.007865	0.005093	0.005297	0.004839	0.004825	0.005535
	2002	0.004023	0.003311	0.003545	0.002100	0.002610	0.014600	0.011381	0.006458	0.013487	0.008013	0.004110	0.004074	0.006476	0.003803	0.010813
	2003	0.002300	0.001007	0.006126	0.003357	0.003939	0.009627	0.009294	0.010710	0.015117	0.006039	0.001200	0.004010	0.006061	0.002439	0.009877
	2004	0.009665	0.003128	0.003323	0.003740	0.010013	0.014070	0.009594	0.007684	0.005970	0.005458	0.005420	0.003361	0.006786	0.005385	0.010449
	2005	0.004913	0.004636	0.002329	0.005053	0.007542	0.003467	0.008703	0.009535	0.005387	0.010045	0.005703	0.010574	0.006474	0.006641	0.007235
	2006	0.002326	0.002332	0.002119	0.012717	0.007190	0.003510	0.006245	0.005284	0.008453	0.006768	0.002523	0.003865	0.005278	0.002841	0.005013
	2007	0.005642	0.001257	0.005481	0.001870	0.010142	0.002237	0.004900	0.010703	0.007660	0.010110	0.000710	0.004887	0.005467	0.003929	0.005947
	2008	0.000926	0.004952	0.003800	0.004480	0.004232	0.007210	0.006316	0.006729	0.011710	0.003639	0.004383	0.005345	0.005310	0.003741	0.006752
	2009	0.005619	0.003504	0.005935	0.005007	0.007261	0.003763	0.009387	0.017735	0.008340	0.003003	0.003243	0.004077	0.006406	0.004400	0.010295

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Lake Rolleston	**2000**	0.004106	0.005917	0.005248	0.005420	0.018123	0.008483	0.009568	0.005290	0.012347	0.012494	0.003117	0.007777	0.008158	0.005933	0.007780
	2001	0.002552	0.002554	0.009306	0.006153	0.004165	0.013710	0.005748	0.015758	0.007523	0.011868	0.007867	0.006677	0.007823	0.003928	0.011739
	2002	0.008645	0.005679	0.006397	0.002577	0.006000	0.019120	0.016903	0.011235	0.015527	0.011981	0.006763	0.006752	0.009798	0.007025	0.015753
	2003	0.005448	0.002161	0.005835	0.007167	0.006535	0.013447	0.012539	0.015955	0.017747	0.008648	0.003127	0.005035	0.008637	0.004215	0.013980
	2004	0.009674	0.003876	0.004968	0.004667	0.016035	0.020223	0.012965	0.009765	0.010513	0.007923	0.007873	0.005929	0.009551	0.006560	0.014318
	2005	0.005758	0.005811	0.004968	0.006493	0.013345	0.004697	0.013597	0.015648	0.006760	0.013335	0.007943	0.014881	0.009436	0.008817	0.011314
	2006	0.003490	0.005550	0.004545	0.016147	0.011755	0.005770	0.008932	0.010181	0.010220	0.007632	0.004503	0.005190	0.007826	0.004743	0.008294
	2007	0.007761	0.001661	0.009448	0.002157	0.017503	0.003877	0.007226	0.013958	0.009647	0.015219	0.001257	0.006887	0.008050	0.005436	0.008354
	2008	0.001561	0.007334	0.006245	0.006493	0.009926	0.009477	0.009881	0.009235	0.011660	0.006252	0.007650	0.007990	0.007809	0.005628	0.009531
	2009	0.007016	0.005829	0.008597	0.007787	0.014823	0.005323	0.016755	0.023265	0.010727	0.004245	0.004370	0.008168	0.009742	0.007004	0.015114
	2010	0.003013	0.003043	0.008368	0.009863	0.007758	0.009453	0.009274	0.012816	0.013633	0.007952	0.007300	0.007568	0.008362	0.004541	0.010514
	2011	0.006813	0.007496	0.006916	0.006247	0.008145	0.015497	0.013510	0.008323	0.011650	0.009210	0.011913	0.003390	0.009093	0.005900	0.012443
	2012	0.005548	0.004759	0.011197	0.008890	0.013642	0.010917	0.008065	0.013571	0.013043	0.009287	0.005363	0.007900	0.009349	0.006069	0.010851
	2013	0.005290	0.003418	0.008490	0.009323	0.008335	0.006143	0.012065	0.024316	0.011997	0.017419	0.006153	0.008194	0.010095	0.005634	0.014175
Lake Vera	**2000**	0.004277	0.004317	0.003977	0.004523	0.013432	0.006027	0.009281	0.005461	0.011650	0.012165	0.002530	0.008194	0.007153	0.005596	0.006923
	2001	0.002545	0.001682	0.008019	0.005897	0.002913	0.012017	0.005148	0.013858	0.006317	0.010745	0.007450	0.006616	0.006984	0.003614	0.010341
	2002	0.006058	0.004343	0.004374	0.002627	0.003990	0.016560	0.013048	0.008581	0.015480	0.010216	0.005130	0.005139	0.007962	0.005180	0.012730
	2003	0.003765	0.001600	0.007342	0.005050	0.005626	0.011717	0.011035	0.013771	0.016897	0.007006	0.001913	0.005019	0.007562	0.003461	0.012174
	2004	0.010468	0.003569	0.003794	0.004650	0.011971	0.016633	0.011213	0.008939	0.008080	0.006658	0.006770	0.004442	0.008099	0.006160	0.012262
	2005	0.005345	0.005643	0.003197	0.005970	0.009603	0.004253	0.010665	0.012606	0.007023	0.012242	0.007510	0.012897	0.008096	0.007962	0.009175
	2006	0.003297	0.003552	0.003200	0.014208	0.008706	0.004557	0.007903	0.006594	0.009963	0.007523	0.003477	0.004568	0.006460	0.003799	0.006351
	2007	0.007258	0.001736	0.006832	0.002270	0.013329	0.003223	0.006335	0.012506	0.009070	0.011897	0.001087	0.006090	0.006803	0.005028	0.007355
	2008	0.001319	0.006259	0.004932	0.005327	0.005713	0.008123	0.007719	0.007952	0.012553	0.004965	0.006220	0.006855	0.006495	0.004811	0.007931
	2009	0.005390	0.004275	0.007165	0.006660	0.008884	0.007647	0.012310	0.020719	0.011150	0.004203	0.004943	0.005674	0.008252	0.005113	0.013559
	2010	0.001826	0.003811	0.006390	0.007327	0.006026	0.007393	0.005968	0.011071	0.012370	0.006865	0.007400	0.007361	0.006984	0.004333	0.008144
	2011	0.005632	0.006679	0.007206	0.006308	0.005345	0.011527	0.011284	0.008468	0.009213	0.007519	0.009357	0.003526	0.007672	0.005279	0.010426
	2012	0.004542	0.003183	0.007406	0.007037	0.012374	0.008580	0.005616	0.010116	0.011967	0.006135	0.004347	0.006187	0.007291	0.004637	0.008104
	2013	0.003594	0.002682	0.007471	0.006647	0.006535	0.004133	0.010400	0.018900	0.010303	0.016668	0.007647	0.006448	0.008452	0.004241	0.011144
Lake Tahune	**2000**	0.004410	0.004448	0.004090	0.004510	0.013465	0.006123	0.009719	0.005632	0.011733	0.012071	0.002600	0.008229	0.007253	0.005696	0.007158
	2001	0.002568	0.001743	0.008135	0.006037	0.002997	0.012250	0.005229	0.014106	0.006603	0.010916	0.007880	0.006861	0.007110	0.003724	0.010528
	2002	0.006416	0.004339	0.004374	0.002693	0.004097	0.016527	0.013161	0.008855	0.015700	0.010210	0.005283	0.005352	0.008084	0.005369	0.012848
	2003	0.003994	0.001589	0.007339	0.005310	0.005632	0.011933	0.011113	0.014116	0.017067	0.006929	0.002040	0.005097	0.007680	0.003560	0.012387
	2004	0.010513	0.003497	0.003865	0.004730	0.011819	0.016913	0.011306	0.009039	0.008433	0.006655	0.006893	0.004632	0.008191	0.006214	0.012419
	2005	0.005355	0.005561	0.003242	0.006043	0.009826	0.004353	0.010739	0.013094	0.007343	0.012155	0.007807	0.013197	0.008226	0.008038	0.009395
	2006	0.003416	0.003675	0.003358	0.014263	0.008645	0.004670	0.008035	0.006823	0.010180	0.007445	0.003583	0.004700	0.006566	0.003930	0.006509
	2007	0.007465	0.001836	0.006939	0.002313	0.013458	0.003373	0.006439	0.012629	0.009260	0.011810	0.001123	0.006332	0.006915	0.005211	0.007480
	2008	0.001361	0.006228	0.005065	0.005457	0.005816	0.008107	0.007755	0.008026	0.012567	0.005055	0.006553	0.007055	0.006587	0.004881	0.007963
	2009	0.005661	0.004411	0.007216	0.006777	0.008881	0.007110	0.012652	0.021094	0.011453	0.004206	0.005120	0.005990	0.008381	0.005354	0.013619
	2010	0.001923	0.003768	0.006474	0.007560	0.006103	0.007590	0.006187	0.011335	0.012717	0.006897	0.007333	0.007648	0.007128	0.004446	0.008371
	2011	0.005977	0.006743	0.007319	0.006467	0.005448	0.011970	0.011239	0.008671	0.009647	0.007687	0.009790	0.003681	0.007887	0.005467	0.010627
	2012	0.004703	0.003272	0.007510	0.007210	0.012419	0.008770	0.005797	0.010529	0.012240	0.006119	0.004587	0.006445	0.007467	0.004807	0.008365
	2013	0.003777	0.002764	0.007561	0.006807	0.006590	0.004297	0.010661	0.019348	0.010527	0.016300	0.007583	0.006677	0.008574	0.004406	0.011435
Square Tarn	**2000**	0.001952	0.002145	0.003077	0.003453	0.008590	0.004120	0.006223	0.003774	0.009897	0.006316	0.001210	0.008368	0.004927	0.004155	0.004706
	2001	0.001158	0.001486	0.004839	0.004250	0.001945	0.008500	0.003139	0.009055	0.002880	0.008616	0.004390	0.004029	0.004524	0.002224	0.006898
	2002	0.004200	0.002214	0.003042	0.001600	0.001368	0.012210	0.007332	0.006829	0.011390	0.006194	0.003580	0.004400	0.005363	0.003605	0.008790
	2003	0.001829	0.001225	0.003955	0.003397	0.003468	0.006680	0.006035	0.009355	0.011687	0.004426	0.001403	0.003452	0.004743	0.002169	0.007357
	2004	0.006197	0.002762	0.001919	0.003443	0.006684	0.009650	0.007948	0.007313	0.004910	0.003939	0.004100	0.003684	0.005212	0.004214	0.008304
	2005	0.003752	0.003696	0.002103	0.002210	0.005590	0.002113	0.004935	0.007735	0.004377	0.007474	0.003713	0.007129	0.004569	0.004859	0.004928
	2006	0.003410	0.002386	0.001765	0.008833	0.005432	0.003263	0.006348	0.005277	0.006830	0.005716	0.003627	0.002487	0.004615	0.002761	0.004963
	2007	0.005748	0.000439	0.002335	0.002120	0.006539	0.002720	0.003258	0.008700	0.005270	0.008310	0.000677	0.004681	0.004225	0.003623	0.004893
	2008	0.000787	0.004379	0.002810	0.002737	0.001952	0.005940	0.004868	0.006652	0.007737	0.004619	0.004150	0.004697	0.004277	0.003288	0.005820
	2009	0.003981	0.003586	0.004697	0.004900	0.005284	0.008533	0.006158	0.011297	0.008117	0.004203	0.003860	0.003368	0.005665	0.003645	0.008663

APPENDIX B: RAW PLANT CARBON DATA

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Swallow Lagoon	2000	333.08	335.70	336.52	334.95	330.10	325.42	321.07	317.60	315.67	314.01	312.50	314.16	324.23	327.65	321.36
	2001	316.58	318.27	320.09	320.71	319.84	317.12	312.86	309.57	308.41	308.28	308.81	311.75	314.36	315.53	313.18
	2002	316.28	319.46	320.41	321.34	320.48	317.39	315.44	312.38	311.26	312.20	313.88	318.11	316.55	317.95	315.07
	2003	323.46	325.02	325.32	325.95	323.65	320.94	316.43	314.00	315.32	318.31	323.74	327.89	321.67	325.46	317.12
	2004	331.84	334.89	336.15	336.28	332.93	326.13	319.08	312.65	306.86	303.87	305.16	306.68	321.04	324.47	319.28
	2005	309.50	311.23	311.11	308.54	305.07	300.50	294.24	292.77	293.82	295.72	299.34	303.13	302.25	308.62	295.84
	2006	312.91	318.91	320.50	320.82	320.21	316.69	310.47	307.23	306.18	308.49	310.88	312.38	313.81	314.73	311.46
	2007	313.52	314.96	316.60	318.99	317.95	312.58	308.78	307.34	304.86	306.08	307.89	309.18	311.56	312.55	309.56
	2008	307.79	308.99	309.86	310.70	311.85	307.96	304.75	304.01	304.96	307.06	311.11	313.38	308.70	310.72	305.57
	2009	318.39	320.41	321.50	317.88	312.93	307.05	303.31	303.61	305.14	308.58	313.25	313.38	312.12	317.39	304.66
	2010	312.49	312.05	309.11	306.67	304.28	300.67	296.46	294.55	293.70	292.75	296.46	298.11	301.44	307.55	297.22
	2011	297.96	301.35	303.34	302.61	301.75	299.43	297.52	298.20	298.40	300.32	304.35	305.90	300.93	301.74	298.38
	2012	309.06	309.99	309.92	309.14	306.85	302.31	296.76	295.12	295.57	296.35	299.09	302.96	302.76	307.34	298.06
	2013	305.04	305.32	304.76	305.28	303.80	298.79	292.73	290.58	291.16	292.62	295.87	299.96	298.83	303.44	294.04
Blue Lake	2000	332.59	334.89	335.42	333.85	329.24	324.83	320.66	317.37	315.48	313.67	312.22	313.72	323.66	327.07	320.95
	2001	315.83	317.30	319.16	319.76	319.07	316.47	312.29	309.00	307.81	307.47	307.77	310.40	313.53	314.51	312.59
	2002	314.41	317.12	317.80	318.74	318.31	315.39	313.48	310.43	309.63	310.53	312.04	315.89	314.48	315.81	313.10
	2003	320.81	322.17	322.81	323.56	321.50	319.13	314.68	312.47	313.90	316.88	322.12	325.94	319.66	322.97	315.42
	2004	329.45	332.29	333.56	333.86	330.77	324.21	317.33	310.93	305.15	301.87	302.93	304.31	318.89	322.02	317.49
	2005	306.97	308.50	308.14	305.52	302.31	298.20	292.38	291.14	292.33	294.22	297.59	303.21	300.04	306.23	293.91
	2006	310.61	316.25	317.86	318.16	317.73	314.50	308.50	305.44	304.67	306.94	309.15	310.60	311.70	312.49	309.48
	2007	314.14	319.71	325.32	331.14	333.34	330.64	328.93	329.92	330.30	335.36	341.33	347.28	330.62	327.04	329.83
	2008	349.52	354.14	358.52	361.71	364.51	361.46	359.21	360.28	363.72	368.83	376.33	384.78	363.58	362.81	360.32
	2009	393.10	399.21	403.43	402.93	401.65	397.49	393.87	394.37	396.44	400.08	404.33	403.86	399.23	398.72	395.24
	2010	402.20	400.55	395.37	391.90	389.45	384.77	379.03	375.83	374.29	372.39	375.74	377.37	384.91	393.37	379.88
	2011	377.88	383.26	386.92	387.26	386.93	384.28	382.87	384.31	386.94	392.18	395.59	393.31	386.81	384.82	383.82
	2012	392.69	390.26	387.00	383.24	377.91	370.52	362.46	358.18	355.89	353.99	353.89	354.73	370.06	379.23	363.72
	2013	353.83	352.12	349.66	348.54	345.46	338.86	331.51	327.85	326.81	326.56	328.14	330.59	338.33	345.51	332.74
18 Mile Swamp	2000	332.59	334.89	335.42	333.85	329.24	324.83	320.66	317.37	315.48	313.67	312.22	313.72	323.66	327.07	320.95
	2001	315.83	317.30	319.16	319.76	319.07	316.47	312.29	309.00	307.81	307.47	307.77	310.40	313.53	314.51	312.59
	2002	314.41	317.12	317.80	318.74	318.31	315.39	313.48	310.43	309.63	310.53	312.04	315.89	314.48	315.81	313.10
	2003	320.81	322.17	322.81	323.56	321.50	319.13	314.68	312.47	313.90	316.88	322.12	325.94	319.66	322.97	315.42
	2004	329.45	332.29	333.56	333.86	330.77	324.21	317.33	310.93	305.15	301.87	302.93	304.31	318.89	322.02	317.49
	2005	306.97	308.50	308.14	305.52	302.31	298.20	292.38	291.14	292.33	294.22	297.59	303.21	300.04	306.23	293.91
	2006	310.61	316.25	317.86	318.16	317.73	314.50	308.50	305.44	304.67	306.94	309.15	310.60	311.70	312.49	309.48
	2007	314.14	319.71	325.32	331.14	333.34	330.64	328.93	329.92	330.30	335.36	341.33	347.28	330.62	327.04	329.83
	2008	349.52	354.14	358.52	361.71	364.51	361.46	359.21	360.28	363.72	368.83	376.33	384.78	363.58	362.81	360.32
	2009	393.10	399.21	403.43	402.93	401.65	397.49	393.87	394.37	396.44	400.08	404.33	403.86	399.23	398.72	395.24
	2010	402.20	400.55	395.37	391.90	389.45	384.77	379.03	375.83	374.29	372.39	375.74	377.37	384.91	393.37	379.88
	2011	377.88	383.26	386.92	387.26	386.93	384.28	382.87	384.31	386.94	392.18	395.59	393.31	386.81	384.82	383.82
	2012	392.69	390.26	387.00	383.24	377.91	370.52	362.46	358.18	355.89	353.99	353.89	354.73	370.06	379.23	363.72
	2013	353.83	352.12	349.66	348.54	345.46	338.86	331.51	327.85	326.81	326.56	328.14	330.59	338.33	345.51	332.74
Pungbougal Lagoon	2000	189.16	200.16	209.41	220.04	213.46	197.58	185.63	178.18	169.20	157.96	148.74	152.87	185.20	180.73	187.13
	2001	168.44	185.97	196.89	192.38	176.20	161.97	153.18	150.70	150.63	149.52	145.67	144.78	164.69	166.39	155.29
	2002	146.21	146.09	146.81	144.38	140.57	133.03	126.47	124.05	128.17	127.62	123.51	123.81	134.23	138.70	127.85
	2003	130.04	127.86	126.86	123.90	121.37	121.07	122.36	126.14	125.57	124.72	127.86	134.76	126.04	130.89	123.19
	2004	141.55	148.88	149.93	145.24	136.36	129.34	126.22	125.13	124.50	124.00	134.47	152.41	136.50	147.61	126.90
	2005	165.28	167.84	162.79	155.45	145.12	137.28	131.49	134.02	142.55	147.13	151.24	156.37	149.71	163.16	134.26
	2006	161.13	167.52	174.74	174.80	164.59	150.92	137.92	131.91	131.14	128.94	125.84	120.75	147.52	149.80	140.25
	2007	116.88	113.59	113.01	111.96	107.69	101.74	96.85	95.01	97.95	101.03	103.25	111.10	105.84	113.85	97.87
	2008	117.63	127.07	136.00	132.71	126.72	118.52	111.53	110.48	119.05	129.87	132.06	135.07	124.73	126.59	113.51
	2009	139.48	141.81	147.00	146.86	139.22	133.18	130.27	133.66	138.58	139.47	134.60	125.01	137.43	135.43	132.37
	2010	122.43	126.78	134.85	142.52	138.43	128.29	119.81	117.32	124.00	133.96	143.66	148.59	131.72	132.60	121.81
	2011	160.49	168.98	172.87	176.48	172.32	159.87	147.45	136.44	130.81	132.08	134.90	141.06	152.81	156.84	147.92
	2012	159.58	175.67	185.77	185.77	175.07	162.76	153.70	150.48	151.47	149.30	145.74	143.94	161.60	159.73	155.65
	2013	147.89	163.14	176.15	178.78	170.96	159.44	151.74	149.24	148.20	145.39	142.74	145.62	156.61	152.22	153.47

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Whynot Billabong	2000	149.25	147.87	147.27	146.51	142.52	137.76	133.73	130.42	126.07	120.33	118.52	122.57	135.24	139.90	133.97
	2001	125.87	132.25	133.95	130.46	125.27	120.57	117.41	121.83	130.82	133.13	130.40	125.91	127.32	128.01	119.94
	2002	121.60	116.93	112.85	109.60	105.71	101.34	97.41	93.97	91.94	90.09	88.25	86.41	101.34	108.31	97.57
	2003	85.01	83.45	83.31	83.70	84.86	84.08	84.78	85.91	88.18	90.31	92.99	98.61	87.10	89.02	84.93
	2004	103.97	111.65	113.84	114.20	114.02	114.98	115.89	116.07	117.09	119.02	121.07	127.46	115.77	114.36	115.65
	2005	134.09	135.25	131.47	126.85	122.48	118.62	124.76	137.41	138.27	135.74	135.40	134.60	131.24	134.64	126.93
	2006	132.21	132.33	133.66	129.81	124.05	118.44	113.15	112.29	111.19	109.18	107.14	104.66	119.01	123.07	114.63
	2007	105.55	104.24	102.03	100.07	97.98	96.12	94.73	93.14	92.34	91.03	89.36	93.23	96.65	101.01	94.66
	2008	104.72	123.15	135.23	130.34	122.40	115.36	109.44	107.60	113.29	118.61	116.14	114.76	117.59	114.21	110.80
	2009	111.10	109.69	106.27	101.27	96.85	96.90	101.36	104.13	103.87	101.74	97.49	92.16	101.90	104.32	100.80
	2010	92.98	95.43	106.62	117.13	115.38	109.07	103.04	102.87	112.29	127.44	138.95	147.76	114.08	112.06	104.99
	2011	147.61	139.11	130.13	122.24	114.88	106.99	100.96	97.67	99.85	109.36	113.40	113.95	116.35	133.56	101.87
	2012	119.04	122.85	125.78	125.65	123.97	121.69	121.17	125.58	128.51	126.15	121.97	116.64	123.25	119.51	122.81
	2013	112.39	111.34	112.33	113.55	110.65	107.71	104.85	102.58	101.28	100.84	100.55	99.69	106.48	107.81	105.05
Booberoi Lagoon	2000	189.71	194.22	196.44	199.21	196.20	188.36	183.19	179.91	173.52	164.45	155.88	156.72	181.48	180.22	183.82
	2001	168.85	180.13	187.59	188.90	182.24	174.85	168.40	165.72	167.05	167.25	163.81	163.13	173.16	170.70	169.65
	2002	163.80	161.93	159.43	156.07	151.89	145.29	138.86	133.03	130.49	127.89	124.53	122.54	142.98	149.42	139.06
	2003	123.11	121.18	120.18	119.51	119.39	119.59	122.25	128.96	131.59	131.13	131.82	132.10	125.07	125.46	123.60
	2004	134.43	142.54	150.50	157.56	157.48	155.05	154.42	153.24	150.94	149.69	154.13	163.22	151.93	146.73	154.24
	2005	169.21	169.01	164.91	158.56	151.29	145.26	144.95	156.06	166.87	166.80	168.32	170.26	160.96	169.50	148.75
	2006	168.77	167.94	171.09	173.44	168.60	160.88	154.40	150.87	149.08	146.37	141.87	135.88	157.43	157.53	155.38
	2007	129.79	123.20	117.91	113.67	109.28	103.94	97.88	92.44	88.56	87.65	86.46	91.31	103.51	114.77	98.09
	2008	100.40	113.73	126.69	130.78	127.54	118.46	107.59	103.76	113.55	131.12	135.34	131.15	120.01	115.10	109.94
	2009	128.27	124.60	122.52	117.89	110.07	105.14	105.74	117.66	131.06	130.38	123.86	111.76	119.08	121.55	109.51
	2010	108.61	109.75	113.32	117.67	113.27	104.15	97.36	96.23	101.08	107.46	113.97	117.41	108.35	111.92	99.25
	2011	122.97	124.59	126.15	127.55	122.19	111.65	103.23	100.01	100.89	101.12	101.17	103.50	112.09	117.02	104.96
	2012	112.06	118.96	125.94	129.61	126.97	122.57	120.29	122.41	127.04	128.02	126.65	124.34	123.74	118.45	121.76
	2013	124.25	131.18	139.89	145.13	144.05	139.52	137.58	139.30	139.49	138.91	137.65	138.07	137.92	131.17	138.80
Macintyre Downs Bill:	2000	147.13	145.62	144.38	144.30	141.19	135.78	131.86	128.31	122.35	115.32	110.34	111.30	131.49	134.69	131.99
	2001	115.90	122.23	124.20	121.53	117.23	114.88	113.72	116.37	123.85	127.79	124.74	119.01	120.12	119.05	114.99
	2002	115.05	110.22	105.92	101.87	97.59	93.11	89.10	85.44	83.68	82.61	80.88	79.02	93.71	101.43	89.22
	2003	77.82	76.35	76.34	76.46	77.36	76.68	77.33	79.88	82.29	83.10	83.47	85.26	79.36	79.81	77.96
	2004	88.08	92.35	94.43	97.36	100.65	104.54	108.60	110.32	111.46	113.63	114.90	119.70	104.67	100.04	107.82
	2005	126.63	129.87	126.88	121.41	115.96	111.01	114.76	129.11	134.79	132.17	130.23	125.23	124.84	127.24	118.29
	2006	121.53	120.70	122.41	120.90	115.86	110.21	105.11	106.78	109.18	107.44	103.61	99.07	111.90	113.77	107.37
	2007	97.78	95.64	91.98	88.86	86.17	83.69	81.45	79.63	78.74	78.67	79.61	83.74	85.50	92.38	81.59
	2008	89.45	100.18	110.68	111.75	107.57	102.17	98.04	102.36	115.44	124.57	121.83	118.48	108.54	102.70	100.86
	2009	113.98	111.95	109.24	104.63	99.91	97.87	100.33	106.77	110.88	110.32	104.95	97.67	105.71	107.87	101.66
	2010	95.31	96.11	102.24	108.52	107.62	101.59	95.66	99.97	115.47	129.55	132.95	131.58	109.71	107.67	99.07
	2011	131.38	127.12	121.47	116.18	110.36	105.10	101.73	98.82	100.03	105.32	107.08	107.38	111.00	121.96	101.88
	2012	112.43	116.77	120.26	121.25	120.47	118.78	119.35	125.48	131.12	129.84	124.67	117.84	121.52	115.68	121.20
	2013	112.38	111.31	112.76	114.53	113.01	111.02	110.29	109.91	107.73	105.70	103.47	100.51	109.38	108.07	110.41
Bishop Swamp	2000	441.59	449.16	451.52	448.47	442.35	435.34	427.06	422.10	422.12	424.76	425.95	432.76	435.26	441.17	428.17
	2001	444.20	449.95	453.21	455.83	453.48	448.10	442.99	439.71	441.00	448.74	455.54	462.77	449.63	452.31	443.60
	2002	474.92	481.66	488.13	488.91	486.35	480.34	475.26	471.66	471.00	474.55	478.97	483.55	479.61	480.04	475.75
	2003	488.65	487.58	484.75	482.37	476.99	470.38	462.16	457.27	457.97	459.77	466.98	477.06	472.66	484.43	463.27
	2004	487.07	493.33	493.08	493.18	491.07	483.28	474.11	466.76	466.30	470.79	474.77	478.64	481.03	486.35	474.72
	2005	488.65	497.84	504.30	503.95	497.52	489.11	479.31	477.75	479.58	485.04	493.69	505.64	491.86	497.38	482.06
	2006	514.86	521.26	523.98	526.52	525.13	517.66	508.05	501.52	501.79	509.01	513.88	520.90	515.38	519.01	509.08
	2007	524.27	525.89	526.03	527.14	522.98	514.12	502.88	496.24	491.55	495.46	498.24	500.28	510.42	516.81	504.41
	2008	505.02	509.98	517.80	520.05	514.89	504.59	496.30	491.24	489.82	493.67	497.45	505.21	503.84	506.74	497.37
	2009	517.23	524.38	523.77	516.38	504.12	487.51	475.06	470.60	472.54	478.85	485.75	497.54	496.14	513.05	477.72
	2010	503.27	510.49	512.13	514.19	511.19	500.52	489.57	482.22	479.68	477.40	478.07	477.94	494.72	497.24	490.77
	2011	482.54	489.11	487.26	485.59	481.28	472.09	462.57	455.96	454.52	451.96	450.86	452.34	468.84	474.66	463.54
	2012	461.16	463.61	465.88	464.40	459.54	450.59	440.75	435.81	437.66	442.96	445.96	452.47	451.73	459.08	442.38
	2013	460.65	464.25	463.08	463.42	461.32	453.07	443.91	440.44	442.87	448.37	452.03	458.96	454.36	461.29	445.81

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Lake Moira	2000	195.04	163.79	162.97	159.52	160.03	158.42	157.16	158.31	160.02	162.54	166.76	172.77	164.78	177.20	157.96
	2001	171.05	168.03	164.47	161.25	163.18	161.36	161.09	162.74	164.60	165.24	166.94	163.23	164.43	167.44	161.73
	2002	158.80	156.27	154.99	152.31	147.96	144.86	142.44	139.03	134.85	132.00	128.44	125.20	143.10	146.76	142.11
	2003	123.75	121.81	122.72	121.23	123.33	125.07	124.92	127.88	134.74	143.55	149.83	156.24	131.26	133.94	125.96
	2004	158.56	154.88	151.03	146.99	142.38	140.65	140.08	140.64	145.10	150.75	155.22	159.87	148.68	157.77	140.46
	2005	164.35	166.12	172.76	169.49	164.11	159.07	158.46	161.60	166.15	171.58	176.44	179.66	167.48	170.04	159.71
	2006	175.57	170.68	167.37	162.45	159.96	156.01	154.75	157.48	160.07	157.63	153.03	148.74	160.31	165.00	156.08
	2007	143.86	139.27	136.04	132.88	132.96	135.87	138.63	144.90	145.99	143.78	137.72	133.40	138.78	138.84	139.80
	2008	131.25	131.84	130.46	125.87	121.48	118.65	116.75	118.29	122.89	122.24	119.66	122.16	123.46	128.42	117.90
	2009	123.18	118.64	113.36	108.67	106.25	104.52	108.24	116.54	120.02	124.83	121.44	119.55	115.44	120.46	109.77
	2010	117.29	113.95	115.49	117.57	116.61	115.70	116.33	121.07	131.90	149.07	162.77	170.95	129.06	134.06	117.70
	2011	176.67	180.58	184.83	185.50	183.42	179.71	176.27	177.00	182.68	187.94	186.57	184.97	182.18	180.74	177.66
	2012	180.88	178.24	179.56	184.77	183.22	179.48	175.95	174.72	176.06	179.35	181.03	177.09	179.20	178.74	176.71
	2013	171.62	166.78	165.87	161.73	156.35	153.29	153.15	153.05	157.31	163.39	164.43	163.63	160.90	167.34	153.16
2 Carp Billabong	2000	185.70	182.11	177.82	173.93	170.56	167.48	166.12	169.92	178.68	192.09	205.46	206.82	181.39	191.54	167.84
	2001	199.98	193.40	187.46	181.35	174.84	168.40	166.22	169.41	179.22	188.57	195.03	189.96	182.82	194.45	168.01
	2002	184.08	178.01	172.92	170.37	166.19	160.47	158.21	159.42	161.27	163.33	158.69	152.76	165.48	171.61	159.37
	2003	146.26	140.24	135.18	133.77	139.06	143.00	145.01	150.84	162.12	177.36	177.93	174.54	152.11	153.68	146.28
	2004	172.01	168.33	164.55	160.10	154.38	150.13	151.34	155.39	167.86	174.93	169.57	164.75	162.78	168.36	152.29
	2005	161.00	162.18	164.57	160.91	156.24	151.05	147.79	153.00	166.21	183.22	199.35	203.73	167.44	175.64	150.61
	2006	199.64	195.22	189.74	182.01	175.51	169.75	165.47	166.67	166.69	166.16	160.53	154.08	174.29	182.98	167.30
	2007	147.41	140.77	134.81	130.15	129.00	132.07	136.85	145.49	150.11	148.42	143.39	138.93	139.80	142.37	138.13
	2008	134.75	132.14	128.88	124.85	120.63	116.35	113.81	120.46	131.15	133.47	130.13	127.04	126.14	131.31	116.88
	2009	123.75	118.97	114.38	109.70	105.93	103.71	106.95	116.02	131.91	149.68	149.18	142.00	122.68	128.24	108.90
	2010	135.33	130.22	130.96	132.64	128.68	126.70	126.76	129.52	138.38	153.32	167.66	177.51	139.81	147.69	127.66
	2011	185.10	188.75	197.06	199.05	193.57	186.97	180.81	181.47	189.63	197.10	197.69	196.03	191.10	189.96	183.09
	2012	193.84	191.75	189.67	190.13	189.40	187.66	185.10	187.85	195.98	202.28	201.82	197.99	192.79	194.53	186.87
	2013	194.13	190.85	187.61	185.03	180.24	177.13	177.26	179.46	189.39	198.63	195.05	191.20	187.18	192.06	177.95
Dairy Billabong	2000	172.53	166.10	160.44	157.49	154.55	150.76	148.61	151.55	156.76	169.25	183.29	188.49	163.32	175.71	150.30
	2001	185.15	180.01	174.88	169.13	163.81	158.07	156.44	160.04	169.43	178.17	182.34	175.19	171.05	180.12	158.18
	2002	167.60	162.82	158.99	157.82	155.22	150.43	148.02	148.92	150.69	151.03	145.53	139.64	153.06	156.69	149.12
	2003	133.88	128.55	124.85	123.08	126.44	129.98	132.26	138.59	150.39	167.72	174.74	174.93	142.12	145.79	133.61
	2004	174.24	168.94	162.37	154.58	146.87	142.50	143.11	147.15	160.75	169.84	164.30	158.42	157.76	167.20	144.25
	2005	155.54	159.81	167.57	162.24	155.29	148.17	142.49	144.65	157.13	178.29	197.90	206.48	164.63	173.94	145.10
	2006	199.08	188.24	176.58	166.33	158.61	150.48	144.88	146.75	151.07	149.21	142.46	135.57	159.10	174.30	147.37
	2007	128.73	122.62	117.77	113.57	110.88	112.92	117.28	126.68	137.26	137.07	133.63	128.91	123.94	126.75	118.96
	2008	124.72	123.84	119.82	115.65	111.75	108.44	106.32	111.46	125.06	127.75	124.57	123.94	118.61	124.17	108.74
	2009	121.56	115.53	109.97	105.21	101.98	100.18	103.03	111.88	130.56	152.08	150.72	143.52	120.52	126.87	105.03
	2010	136.66	130.02	131.07	134.75	130.50	127.64	126.86	129.09	138.82	160.00	178.95	192.86	143.10	153.18	127.86
	2011	201.36	203.41	209.10	211.23	206.53	200.04	194.67	196.05	206.12	217.52	219.82	217.89	206.98	207.55	196.92
	2012	213.03	208.55	204.57	203.58	201.09	197.54	193.67	195.04	204.12	213.78	212.72	206.91	204.55	209.50	195.42
	2013	200.93	195.10	188.29	183.22	176.97	173.07	172.32	174.00	184.87	199.06	197.16	192.21	186.43	196.08	173.13
Lake Spicer	2000	185.65	195.76	203.33	204.09	197.82	188.09	180.07	174.47	173.13	175.37	185.85	202.55	188.85	194.65	180.88
	2001	217.67	228.65	234.05	231.76	227.47	220.10	212.73	207.35	205.94	209.38	216.07	225.11	219.69	223.81	213.39
	2002	232.43	241.94	247.49	247.92	242.87	233.65	223.15	215.05	212.46	213.54	217.63	226.91	229.59	233.76	223.95
	2003	239.50	248.52	252.27	249.67	243.11	233.30	224.08	216.13	212.92	214.18	221.52	233.81	232.42	240.61	224.50
	2004	241.86	246.16	243.99	236.39	224.10	210.33	198.70	190.10	188.08	189.10	193.67	202.99	213.79	230.34	199.71
	2005	211.83	217.37	218.65	216.69	208.69	199.15	190.28	181.84	179.30	181.34	189.53	202.41	199.76	210.54	190.42
	2006	216.06	228.05	234.10	231.46	223.29	215.20	206.42	200.29	199.37	204.19	213.39	226.41	216.52	223.51	207.31
	2007	237.98	247.17	252.41	250.96	245.11	235.82	227.65	220.27	217.38	216.06	223.06	234.81	234.06	239.99	227.91
	2008	248.31	258.96	262.62	257.09	247.99	237.40	226.69	217.70	211.45	207.41	212.29	222.44	234.20	243.24	227.26
	2009	232.17	239.87	240.49	234.57	224.14	212.07	201.29	191.62	185.76	187.47	196.94	205.02	212.62	225.69	201.66
	2010	213.29	220.51	222.13	216.52	206.26	195.68	185.00	175.78	169.98	169.43	174.82	182.41	194.32	205.41	185.49
	2011	187.85	189.79	190.05	187.33	181.29	172.64	164.67	159.00	157.98	163.32	170.80	181.99	175.56	186.55	165.44
	2012	196.80	207.07	209.75	206.06	198.69	189.49	181.34	175.06	173.19	175.35	181.20	191.29	190.44	198.39	181.97
	2013	202.66	213.69	219.77	216.69	209.77	200.97	192.61	185.07	182.90	182.67	186.06	195.04	198.99	203.79	192.88

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Lake Dove	2000	221.77	231.13	237.62	237.47	231.34	222.04	213.41	206.87	203.98	203.05	208.64	223.32	220.05	225.41	214.11
	2001	235.17	243.72	248.09	246.34	241.77	233.28	224.83	218.23	215.20	217.37	222.70	231.06	231.48	236.65	225.45
	2002	239.24	247.64	253.36	254.43	249.93	241.32	231.19	223.74	222.00	223.79	231.32	243.40	238.45	243.43	232.08
	2003	257.28	269.06	274.99	273.93	268.64	259.24	249.80	241.69	239.23	241.63	250.75	264.24	257.54	263.53	250.24
	2004	277.79	285.89	287.61	283.67	275.14	264.00	252.60	243.80	240.85	241.94	246.00	257.05	263.08	273.58	253.47
	2005	270.22	279.52	285.05	284.64	277.78	267.31	256.66	247.27	242.78	243.31	249.01	259.90	263.62	269.88	257.08
	2006	274.65	287.32	294.15	291.45	282.80	274.10	263.67	256.46	254.90	259.37	267.74	281.40	274.00	281.12	264.74
	2007	294.28	304.77	311.12	311.30	303.99	292.24	280.70	269.46	263.40	260.12	265.43	276.27	286.09	291.77	280.80
	2008	289.78	299.84	303.01	295.29	283.58	270.21	256.48	244.31	236.93	235.77	242.92	249.86	267.33	279.83	257.00
	2009	259.75	268.46	269.78	263.25	253.19	240.87	228.47	217.38	211.13	214.09	225.92	237.10	240.78	255.10	228.90
	2010	250.39	261.52	268.11	264.50	255.88	246.30	236.42	228.15	223.18	224.78	233.71	245.91	244.90	252.61	236.96
	2011	258.48	266.52	272.23	271.49	264.49	254.06	243.11	234.81	232.94	236.37	241.23	250.65	252.20	258.55	244.00
	2012	263.19	270.76	271.63	266.60	258.15	247.47	237.34	229.10	224.50	224.71	229.40	238.75	246.80	257.57	237.97
	2013	249.78	259.28	264.31	260.78	253.37	243.74	234.10	224.95	220.88	220.37	225.10	234.07	240.89	247.71	234.26
Lake Basin	2000	172.80	181.50	188.69	189.58	184.10	175.61	168.83	163.79	162.56	163.61	171.58	184.56	175.60	179.62	169.41
	2001	195.92	204.17	208.24	205.55	201.32	194.30	187.65	182.54	180.78	182.98	187.97	195.88	193.94	198.66	188.16
	2002	202.28	210.62	215.66	216.45	212.96	205.78	197.46	191.52	190.37	192.18	195.32	203.24	202.82	205.38	198.25
	2003	214.27	221.83	225.03	223.14	217.56	209.14	201.57	194.99	192.52	193.93	200.29	211.18	208.79	215.76	201.90
	2004	218.18	220.70	218.24	211.44	201.25	190.23	180.46	172.76	170.61	172.87	177.48	185.81	193.34	208.23	181.15
	2005	194.37	199.98	200.93	198.57	191.47	182.98	175.13	167.48	164.78	166.26	172.87	182.21	183.09	192.19	175.20
	2006	192.03	201.51	205.61	202.77	195.48	187.96	179.96	174.29	172.86	176.87	184.42	194.91	189.06	196.15	180.73
	2007	209.46	226.52	238.33	241.45	238.79	231.49	225.77	221.15	222.99	226.28	240.06	257.23	231.63	231.07	226.14
	2008	274.96	289.22	296.28	294.70	286.85	276.11	265.34	256.80	251.44	248.59	254.61	266.50	271.78	276.89	266.08
	2009	279.81	291.67	295.29	291.91	283.66	272.95	262.67	253.43	248.67	252.33	265.30	277.77	272.95	283.08	263.02
	2010	289.76	300.23	304.36	298.84	287.14	275.11	262.18	250.52	244.14	244.76	251.77	261.63	272.54	283.87	262.60
	2011	268.28	271.10	273.30	270.26	262.38	250.89	240.27	232.51	231.23	236.39	241.14	247.06	252.08	262.15	241.22
	2012	256.22	262.04	261.27	255.04	245.55	234.83	224.94	216.57	212.62	212.26	215.91	223.55	235.07	247.27	225.45
	2013	232.07	239.95	243.59	239.08	231.25	221.89	213.05	204.96	201.53	199.99	202.44	209.58	219.95	227.20	213.30
Lake Gwendolyn	2000	214.73	223.13	227.69	226.02	219.86	210.47	202.94	197.41	195.64	196.12	206.37	222.33	211.89	220.06	203.60
	2001	235.78	245.38	249.83	247.41	243.07	235.40	227.59	221.90	220.29	223.45	230.35	238.99	234.95	240.05	228.30
	2002	245.10	254.13	259.60	260.21	255.46	246.67	236.76	229.68	227.55	230.03	234.55	244.85	243.72	248.03	237.70
	2003	257.74	267.32	272.43	271.08	265.94	265.94	248.29	241.61	238.86	240.80	248.38	261.94	256.70	262.34	251.95
	2004	271.32	277.94	278.08	272.12	263.07	252.09	241.34	233.02	230.14	232.21	238.59	249.51	253.29	266.26	242.15
	2005	260.49	268.45	272.21	271.29	263.92	253.94	244.34	234.47	231.21	232.81	238.90	249.59	251.80	259.51	244.25
	2006	261.48	270.85	274.80	271.51	262.76	253.27	242.96	235.76	233.38	237.34	245.70	257.21	253.92	263.18	244.00
	2007	269.45	281.32	288.69	288.80	284.34	275.48	267.71	260.82	260.09	261.18	272.82	288.39	274.92	279.72	268.00
	2008	304.99	318.02	322.22	318.81	311.02	300.55	289.74	281.63	276.66	274.85	282.21	294.55	297.94	305.85	290.64
	2009	308.07	319.73	322.91	318.45	310.06	299.10	288.13	278.02	273.07	276.61	289.37	299.78	298.61	309.19	288.42
	2010	309.10	317.37	317.93	309.94	297.26	283.84	269.68	256.11	247.42	246.02	250.84	258.18	280.31	294.88	269.88
	2011	262.56	261.09	258.21	252.57	243.55	231.86	221.13	213.06	210.88	214.94	221.32	231.05	235.19	251.57	222.02
	2012	244.06	252.74	254.54	250.54	242.67	232.31	223.10	215.79	213.12	214.65	220.49	231.18	232.93	242.66	223.73
	2013	241.67	251.72	257.31	254.05	247.39	238.43	229.36	221.31	218.61	218.05	221.66	230.47	235.84	241.29	229.70
Godwin Tarn	2000	219.31	229.19	237.08	237.33	231.38	221.97	213.96	207.72	205.39	206.51	215.77	231.81	221.45	226.77	214.55
	2001	244.10	253.94	259.17	257.80	253.55	245.57	237.02	231.18	230.00	233.52	240.06	248.18	244.51	248.74	237.92
	2002	255.03	263.99	269.29	270.00	265.64	256.74	246.54	239.19	236.80	238.75	245.08	257.12	253.68	258.71	247.49
	2003	271.24	281.60	286.18	284.30	278.55	269.24	259.82	252.57	249.57	250.92	258.61	271.68	267.86	274.84	260.54
	2004	281.98	287.67	285.85	278.33	267.34	254.70	242.77	233.06	229.62	231.71	237.58	248.89	256.63	272.85	243.51
	2005	258.98	266.36	269.77	268.40	261.25	250.88	240.25	230.10	226.17	227.16	233.64	244.03	248.08	256.46	240.41
	2006	256.51	266.77	271.98	268.59	259.49	250.32	240.19	233.20	232.29	237.51	245.50	257.91	251.69	260.40	241.24
	2007	273.74	289.82	299.33	301.05	296.19	286.14	276.21	267.71	265.88	268.07	281.58	298.91	283.72	287.49	276.69
	2008	316.32	328.70	333.71	329.22	319.91	307.82	295.10	284.64	278.48	276.21	283.41	294.88	304.03	313.30	295.85
	2009	308.05	317.18	318.18	312.18	301.02	286.80	273.23	260.74	252.65	253.76	265.28	275.73	285.40	300.32	273.59
	2010	286.67	295.92	298.22	290.85	278.01	264.40	250.32	237.95	229.42	227.87	234.41	244.77	261.57	275.79	250.89
	2011	255.19	259.28	260.12	256.66	249.82	239.74	229.65	222.65	220.90	226.04	233.25	242.02	241.28	252.16	230.68
	2012	254.38	262.36	262.60	257.31	248.73	237.71	227.88	219.71	216.03	216.65	221.33	230.51	237.93	249.08	228.43
	2013	240.48	249.57	254.42	250.38	243.02	233.45	223.90	215.41	211.56	210.69	215.14	223.94	231.00	237.99	224.25

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average (Year)	Average (Summer)	Average (Winter)
Lake Rolleston	2000	172.68	180.95	188.34	189.21	183.88	175.73	168.90	163.98	162.34	163.04	170.70	183.24	175.25	178.96	169.54
	2001	193.76	201.39	205.86	203.90	200.26	194.04	187.73	182.79	181.20	183.43	188.17	195.43	193.16	196.86	188.18
	2002	200.54	207.57	211.81	212.37	208.58	201.03	192.11	185.01	182.74	183.56	186.38	193.53	197.10	200.55	192.72
	2003	203.52	210.26	213.33	211.99	206.74	198.49	190.97	184.31	181.87	182.72	188.72	199.21	197.68	204.33	191.26
	2004	206.58	209.69	207.84	202.08	192.25	181.04	171.51	164.25	162.37	163.28	166.82	174.67	183.53	196.98	172.27
	2005	182.58	186.30	186.09	183.27	175.89	167.52	159.81	152.83	150.38	151.34	157.64	166.17	168.32	178.35	160.05
	2006	175.44	185.07	189.61	187.66	181.54	175.32	168.26	163.80	163.47	167.79	175.23	185.51	176.56	182.00	169.13
	2007	197.59	209.15	216.86	217.68	213.58	205.99	199.35	193.06	190.93	192.27	203.02	215.99	204.62	207.58	199.47
	2008	230.04	241.14	244.91	239.85	231.52	221.50	211.47	203.24	198.00	196.02	203.06	214.68	219.62	228.62	212.07
	2009	227.35	235.79	236.24	231.68	223.22	213.18	203.66	195.16	190.43	192.79	204.34	214.35	214.02	225.83	204.00
	2010	223.38	229.82	230.73	221.13	206.71	194.31	183.10	173.35	167.44	166.49	171.86	179.57	195.66	210.92	183.59
	2011	186.22	181.62	193.49	192.30	187.10	178.97	170.97	165.17	164.13	169.72	176.10	184.08	179.16	183.98	171.71
	2012	194.29	201.17	202.39	198.79	191.93	183.41	175.61	169.30	166.84	167.84	172.64	181.06	183.77	192.17	176.11
	2013	189.47	197.53	202.29	199.50	193.50	185.69	178.27	171.48	168.97	168.03	170.82	178.10	183.64	188.37	178.48
Lake Vera	2000	177.64	186.41	193.22	193.94	188.74	180.14	172.89	167.48	166.14	167.97	177.41	191.99	180.33	185.34	173.50
	2001	203.82	212.19	215.91	213.60	209.26	202.30	195.01	189.81	188.99	192.49	199.33	207.33	202.50	207.78	195.71
	2002	213.76	222.01	226.76	226.64	221.86	213.44	204.46	198.24	196.79	198.98	204.04	213.45	211.70	216.41	205.38
	2003	224.35	231.53	233.82	230.36	223.11	213.27	204.27	197.21	194.11	194.82	201.57	213.20	213.47	223.03	204.91
	2004	221.65	225.67	223.17	215.99	206.65	196.17	186.31	178.59	176.30	178.18	184.07	194.92	198.97	214.08	187.02
	2005	204.45	211.76	214.52	212.94	205.64	196.25	187.27	178.70	176.57	178.58	185.03	195.61	195.61	203.94	187.41
	2006	207.13	217.64	222.65	219.93	212.20	204.30	195.68	189.88	188.70	193.11	200.22	210.74	205.18	211.84	196.62
	2007	223.79	236.40	244.06	244.54	239.76	230.83	222.58	215.22	212.26	212.35	223.17	237.80	228.56	232.66	222.88
	2008	252.57	263.72	267.61	262.78	253.34	241.66	229.84	219.68	213.77	210.39	215.85	226.39	238.13	247.56	230.39
	2009	238.96	248.56	249.41	244.36	235.79	224.80	214.15	204.44	200.08	203.91	217.41	228.69	225.88	238.74	214.46
	2010	239.44	248.56	251.19	245.04	234.35	223.39	212.08	202.23	195.47	194.75	202.05	212.75	221.78	233.58	212.57
	2011	219.90	222.20	223.18	220.41	214.36	205.03	196.09	189.91	188.25	193.07	200.41	209.89	206.89	217.33	197.01
	2012	221.98	229.71	230.29	225.26	217.21	207.14	198.24	190.84	187.72	188.88	194.07	204.08	207.95	218.59	198.74
	2013	213.95	222.52	226.96	222.97	215.76	206.68	197.81	189.94	187.33	186.70	190.57	199.07	205.02	211.85	198.14
Lake Tahune	2000	199.83	223.02	227.65	226.04	220.05	210.84	203.26	197.73	196.27	197.64	207.96	224.25	211.21	215.70	203.94
	2001	237.84	247.37	251.73	249.45	244.94	237.06	228.96	223.27	221.77	224.91	232.12	240.73	236.68	241.98	229.76
	2002	247.70	256.89	262.72	263.29	258.47	249.49	239.47	232.41	230.56	233.24	238.65	249.11	246.83	251.24	240.46
	2003	262.00	271.53	276.53	274.96	269.49	260.26	251.34	244.43	241.25	242.91	251.09	264.62	259.20	266.05	252.01
	2004	274.63	281.13	281.01	274.93	265.78	254.59	243.62	235.12	232.40	234.36	240.78	251.74	255.86	269.17	244.44
	2005	262.46	270.54	274.13	272.85	265.04	254.89	244.98	234.76	231.34	232.77	238.92	249.14	252.65	260.71	244.88
	2006	260.36	269.76	273.83	270.39	261.41	251.88	241.48	234.34	232.28	236.49	245.09	256.99	252.86	262.37	242.57
	2007	268.39	278.36	283.93	282.25	275.78	265.32	255.63	246.69	242.21	240.42	249.80	262.93	262.64	269.89	255.88
	2008	276.11	286.10	288.90	283.30	273.19	260.83	248.25	237.40	230.86	226.52	231.22	241.27	257.00	267.83	248.82
	2009	252.44	261.36	261.87	256.13	247.10	235.83	224.96	215.12	210.44	213.57	226.41	237.44	236.89	250.41	225.31
	2010	247.50	256.25	258.55	252.05	241.23	230.14	218.65	208.56	201.55	200.54	207.17	217.18	228.28	240.31	219.12
	2011	223.96	226.06	227.14	224.41	218.49	209.30	200.53	194.39	192.60	197.40	205.28	215.93	211.29	221.99	201.41
	2012	229.51	238.56	240.15	236.27	228.98	219.15	210.49	203.51	200.99	202.39	208.40	219.33	219.81	229.13	211.05
	2013	229.99	239.71	245.24	241.93	235.43	226.61	217.76	210.03	207.62	207.31	211.54	220.49	224.47	230.06	218.13
Square Tarn	2000	173.97	185.52	191.24	190.51	184.97	176.60	169.67	164.35	163.20	167.01	177.25	193.16	178.12	184.22	170.21
	2001	206.96	217.32	222.47	220.22	215.11	207.19	198.74	193.19	191.73	195.44	203.45	213.43	207.10	212.57	199.71
	2002	221.55	231.13	235.56	234.12	227.48	217.81	208.40	201.58	198.20	199.24	205.06	215.02	216.26	222.57	209.26
	2003	227.20	234.62	235.37	229.56	221.10	210.75	201.43	194.84	192.40	194.65	202.57	215.06	213.30	225.63	202.34
	2004	223.00	227.33	223.79	214.24	203.03	191.91	182.04	173.75	171.39	176.07	182.98	193.69	196.94	214.68	182.57
	2005	202.81	207.22	206.93	202.22	192.61	181.46	171.24	162.10	159.99	163.52	170.96	183.27	183.69	197.77	171.60
	2006	196.52	206.26	210.84	207.21	198.26	189.22	179.78	173.49	172.86	179.04	187.52	202.05	191.92	201.61	180.83
	2007	218.63	232.43	239.30	238.41	231.34	221.07	211.83	204.45	202.77	204.39	212.02	226.92	220.30	225.99	212.45
	2008	243.61	255.94	260.56	256.93	248.72	238.11	228.22	221.02	217.38	219.16	228.89	240.74	238.27	246.76	229.12
	2009	254.79	267.34	270.43	265.91	257.69	246.95	236.06	226.33	222.36	225.80	237.02	247.57	246.52	256.57	236.45
	2010	260.06	272.93	277.84	274.48	265.01	254.48	243.40	234.58	230.08	232.96	241.85	254.01	253.47	262.33	244.15
	2011	262.18	264.00	264.61	260.48	252.92	242.01	231.48	222.66	218.27	222.90	228.97	237.19	242.31	254.46	232.05
	2012	248.01	254.67	252.34	245.07	235.09	223.46	213.18	204.39	200.51	201.49	205.97	215.36	224.96	239.35	213.68
	2013	224.05	231.61	234.26	227.57	218.75	208.60	198.68	190.28	187.23	187.45	191.35	199.83	208.31	218.50	199.19

APPENDIX B: RAW VEGETATION FRACTION DATA

		Average (Year)	Average (Summer)	Average (Winter)		Average (Year)	Average (Summer)	Average (Winter)
Swallow Lagoon	2000	76.00	NA	89.00	Blue Lake	75.50	NA	90.25
	2001	74.00	81.00	90.00		73.50	80.25	88.50
	2002	75.00	79.00	71.00		70.00	79.00	70.00
	2003	65.00	77.00	87.00		75.25	70.67	87.00
	2004	67.00	51.00	NA		75.25	76.25	87.33
	2005	68.00	64.00	82.00		75.00	77.00	89.25
	2006	72.00	70.00	87.00		74.75	80.25	90.25
	2007	73.00	70.00	82.00		74.75	79.25	88.25
	2008	74.00	77.00	86.00		74.50	81.25	91.50
	2009	73.00	79.00	86.00		73.00	82.75	91.50
	2010	73.00	75.00	86.00		74.75	79.50	91.50
	2011	NA	80.00	90.00		NA	85.25	91.00
	2012	71.00	77.00	73.00		72.50	82.50	77.33
	2013	71.00	69.00	77.00		72.50	69.50	78.00
18 Mile Swamp	2000	84.33	NA	90.00	Pungbougal Lagoon	13.13	NA	3.00
	2001	84.67	82.00	90.33		13.00	23.38	11.75
	2002	80.67	80.33	91.00		12.13	9.13	9.25
	2003	83.00	72.67	90.50		23.75	18.00	32.88
	2004	83.00	79.50	88.50		21.25	24.00	12.25
	2005	86.00	78.67	91.50		18.75	13.50	25.50
	2006	85.50	81.00	91.50		14.25	24.50	15.88
	2007	83.00	80.33	88.50		16.38	2.75	24.25
	2008	85.50	78.33	91.00		24.38	29.13	30.75
	2009	83.00	83.00	91.50		25.88	29.38	45.63
	2010	86.00	80.33	91.00		40.25	15.25	42.63
	2011	86.50	86.00	94.00		24.00	35.13	22.25
	2012	75.00	83.00	80.00		27.25	33.63	32.75
	2013	73.67	72.33	78.33		21.50	22.25	17.13

		Average (Year)	Average (Summer)	Average (Winter)		Average (Year)	Average (Summer)	Average (Winter)
Whynot Billabong	2000	39.50	NA	38.00	Booberoi Lagoon	29.38	NA	28.15
	2001	52.00	51.00	49.00		38.54	39.23	37.92
	2002	41.50	53.50	44.00		23.31	33.15	25.92
	2003	35.50	36.00	48.00		23.15	15.31	32.38
	2004	39.50	30.00	40.50		34.00	28.69	28.92
	2005	36.50	43.00	44.50		25.23	30.00	34.15
	2006	30.00	34.00	37.00		26.00	26.38	32.23
	2007	23.50	17.50	29.00		20.77	11.31	23.92
	2008	35.50	44.50	34.00		28.85	45.46	30.23
	2009	29.00	30.50	40.00		25.77	24.08	36.31
	2010	34.00	21.00	28.00		33.69	21.46	31.31
	2011	35.50	58.00	21.50		32.46	42.85	30.69
	2012	40.00	51.00	39.00		38.38	52.46	36.69
	2013	41.50	30.00	49.50		37.69	31.15	42.08
MacIntyre Downs Bill	2000	41.80	NA	45.40	Bishop Swamp	91.00	NA	94.00
	2001	45.80	55.00	49.60		89.00	88.00	92.00
	2002	29.40	49.20	24.40		84.00	85.00	92.00
	2003	23.60	5.40	43.80		84.00	79.00	91.00
	2004	32.40	30.40	26.00		90.00	87.00	95.00
	2005	28.80	37.60	37.40		88.00	85.00	95.00
	2006	26.20	43.00	24.40		89.00	88.00	93.00
	2007	10.80	7.80	12.00		89.00	83.00	96.00
	2008	27.20	32.40	28.00		91.00	NA	96.00
	2009	21.80	29.60	34.60		89.00	85.00	97.00
	2010	29.40	21.20	18.20		90.00	88.00	94.00
	2011	30.80	47.80	20.60		91.00	91.00	95.00
	2012	31.60	36.00	31.80		NA	88.00	NA
	2013	34.60	26.80	37.20		71.00	71.00	NA

		Average (Year)	Average (Summer)	Average (Winter)		Average (Year)	Average (Summer)	Average (Winter)
Lake Moira	2000	55.76	NA	50.38	2 Carp Billabong	54.50	NA	80.00
	2001	47.50	41.25	57.18		30.75	15.50	70.00
	2002	47.65	47.82	53.44		34.25	1.00	58.75
	2003	52.20	40.57	58.76		34.00	2.25	89.00
	2004	46.77	50.80	50.12		29.50	13.25	75.75
	2005	50.16	46.06	53.53		44.25	18.00	56.50
	2006	44.38	43.90	46.36		29.75	13.25	62.25
	2007	41.88	31.31	59.53		28.25	0.25	NA
	2008	35.79	20.21	33.79		31.00	10.25	86.00
	2009	37.41	10.88	35.65		30.00	3.00	77.00
	2010	44.17	28.21	59.85		48.00	4.25	72.50
	2011	46.21	38.42	52.35		58.50	48.50	68.25
	2012	48.67	42.89	46.83		54.00	18.75	75.25
	2013	51.73	47.47	55.65		49.00	17.75	71.50
Dairy Billabong	2000	73.13	NA	84.00	Lake Spicer	80.77	NA	87.75
	2001	66.50	54.00	76.00		80.69	78.00	89.00
	2002	59.38	41.75	76.75		81.56	79.39	NA
	2003	65.00	29.50	84.75		82.06	76.17	82.50
	2004	59.00	48.13	73.50		79.72	75.22	78.38
	2005	63.38	48.88	67.63		80.28	77.33	84.69
	2006	56.25	44.13	74.25		82.00	75.56	83.29
	2007	58.75	28.63	82.75		80.72	78.22	82.44
	2008	56.63	41.75	74.88		75.57	74.44	83.89
	2009	55.50	35.50	81.00		80.61	74.94	86.11
	2010	69.88	38.25	86.00		80.39	75.31	79.94
	2011	74.38	60.50	81.50		82.50	76.11	88.06
	2012	60.50	52.00	65.33		70.82	75.11	72.00
	2013	60.88	46.33	72.50		70.35	67.89	72.75

		Average (Year)	Average (Summer)	Average (Winter)		Average (Year)	Average (Summer)	Average (Winter)
Lake Dove	2000	73.42	NA	79.88	Lake Basin	80.67	NA	NA
	2001	74.22	74.83	81.50		84.00	74.33	93.50
	2002	70.00	72.80	NA		79.83	76.00	89.00
	2003	69.45	72.04	NA		77.00	73.50	86.33
	2004	70.00	70.39	70.00		77.33	73.00	82.50
	2005	68.32	70.79	69.10		76.83	72.33	84.67
	2006	69.88	69.90	66.33		74.67	65.50	84.00
	2007	69.13	69.04	67.75		74.83	70.50	83.50
	2008	NA	70.46	69.60		76.50	68.00	80.17
	2009	69.42	68.79	77.22		75.00	69.83	83.50
	2010	69.14	69.25	68.53		76.50	71.50	81.17
	2011	72.45	72.38	NA		78.00	73.17	87.00
	2012	66.33	71.90	60.17		67.83	71.17	76.80
	2013	67.22	65.00	71.50		66.33	62.00	67.25
Lake Gwendolyn	2000	NA	NA	NA	Godwin Tarn	80.00	NA	NA
	2001	NA	60.80	NA		NA	83.09	NA
	2002	NA	NA	NA		79.50	82.00	NA
	2003	43.50	58.00	32.00		75.14	79.90	71.50
	2004	43.00	41.00	NA		76.00	80.56	NA
	2005	44.50	54.67	56.00		74.80	79.82	NA
	2006	51.00	56.50	43.75		76.20	81.20	79.20
	2007	47.67	54.20	45.33		75.44	79.45	63.33
	2008	NA	50.33	NA		NA	79.00	52.67
	2009	44.00	45.00	NA		76.25	76.50	NA
	2010	42.00	51.80	37.00		77.44	80.50	75.80
	2011	NA	58.25	NA		79.91	79.73	72.00
	2012	56.00	54.50	NA		72.71	79.09	NA
	2013	58.67	51.60	NA		72.90	70.73	NA

		Average (Year)	Average (Summer)	Average (Winter)		Average (Year)	Average (Summer)	Average (Winter)
Lake Rolleston	2000	77.43	NA	87.50	Lake Vera	NA	NA	NA
	2001	80.00	78.16	86.50		NA	86.77	NA
	2002	80.16	76.67	89.50		87.00	88.25	NA
	2003	80.71	77.32	87.29		84.11	87.64	83.63
	2004	78.87	74.90	84.93		84.57	82.00	90.00
	2005	77.71	76.52	79.61		82.38	85.00	83.50
	2006	78.56	75.03	83.84		86.00	80.27	88.30
	2007	77.72	74.50	83.53		84.00	88.08	79.57
	2008	70.50	72.00	85.21		NA	84.38	76.80
	2009	76.93	72.81	82.88		85.13	83.13	83.00
	2010	78.06	75.43	84.52		83.13	86.18	79.00
	2011	80.38	73.78	85.56		84.33	81.75	85.27
	2012	68.70	73.06	71.56		74.00	82.92	NA
	2013	68.43	66.30	69.00		76.50	74.08	76.00
Lake Tahune	2000	NA	NA	NA	Square Tarn	NA	NA	NA
	2001	NA	67.50	NA		84.00	89.00	NA
	2002	NA	NA	NA		84.00	NA	NA
	2003	52.50	64.00	39.50		NA	90.00	NA
	2004	43.00	55.50	NA		77.00	86.00	NA
	2005	54.50	54.50	NA		86.00	88.00	81.00
	2006	50.00	62.00	43.50		85.00	88.00	84.00
	2007	52.00	57.50	35.00		87.00	79.00	59.00
	2008	NA	56.50	NA		86.00	80.00	NA
	2009	44.00	60.50	NA		NA	89.00	NA
	2010	48.00	52.00	57.00		NA	84.00	90.00
	2011	68.00	62.00	56.00		84.00	87.00	80.00
	2012	NA	56.50	NA		NA	80.00	NA
	2013	62.00	57.00	NA		NA	70.00	NA