LATE PLEISTOCENE TO MID-HOLOCENE CLIMATE VARIABILITY IN IRELAND: EVIDENCE FROM OSTRACOD GEOCHEMISTRY

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In Partial Fulfillment of the Requirements
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Saskatoon

Shawn Michael McKenzie

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ABSTRACT

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by

Shawn Michael McKenzie

Department of Geological Sciences
University of Saskatchewan
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Examining Committee:

Dr. J.B. Merriam	Chair of Graduate Committee
Dr. W.P. Patterson	Supervisor, Department of Geological Sciences
Dr. C. Holmden	Department of Geological Sciences
Dr. B.M. Eglington	Department of Geological Sciences
Dr. Jill Johnstone	External Reviewer

Late Pleistocene to Mid-Holocene Climate Variability in Ireland: Evidence from Ostracod Geochemistry

Stable isotope values of ostracod calcite provide a record of variation in $\delta^{18}O_{(H_2O)}$ values and water temperature from the late glacial to mid-Holocene in Western Ireland. Lough Monreagh, located in County Clare, Western Ireland, contains marl sediment that includes pristine ostracod calcite whose $\delta^{18}O$ and $\delta^{13}C$ values were evaluated. These values were used relative to modern ecological requirements to derive a paleoenvironmental record for Lough Monreagh that includes water temperature, eutrophication, water depth, as well as terrestrial vegetation and weathering within the lake's watershed. $\delta^{13}C$ values of ostracod calcite presented herein suggest a significant increase in terrestrial vegetation beginning during the Allerød (13,600 cal year B.P.) and extending through to the mid-Holocene (6,997 cal year B.P.). Marl and ostracod $\delta^{18}O$ values record variability in temperature and precipitation $\delta^{18}O_{(H_2O)}$ values that are in turn forced by variation in atmospheric and oceanic circulation. Water temperatures presented herein were calculated from $\delta^{18}O$ values of ostracod calcite and marl, constrained by temperature preference and tolerance ranges of ostracod species, yielding the highest resolution temperature record covering this period to date. Over 4,700 ostracods representing all three freshwater superfamilies were counted and identified to evaluate the trophic stage of the lake. The lake was characterized as a clear-, cold-water (~8ºC summer water temperature), low-nutrient environment during the Allerød, then freezes abruptly during the Younger Dryas as evidenced by black clay deposits aged 12,800 to 11,300 cal yr B.P. Following the Younger Dryas, transitional warming and increasing terrestrial vegetation are evidenced by decreasing $\delta^{13}C$ values of ostracoda and faunal transition to phytophyllic species. Summer water temperatures warm to >16ºC, with ostracod species suggesting a shallow-water, fen- and macrophyte-rich environment with abundant plant life in and around the lake by ~8,000 cal yr B.P.

Keywords: Late Glacial, Younger Dryas, Holocene, ostracods, limnocytherids, candonids, stable isotopes, carbon, oxygen, atmospheric circulation, bedrock weathering, vegetation mass rates, Ireland

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CHAPTER 1. INTRODUCTION

1.1 Thesis and Project Overview

The purpose of this study was to describe both qualitatively and quantitatively the changing climate variability of the ancient lake Lough Monreagh (14,500 to 7,000 kyr B.P.) located in western Ireland based on ostracod evidence. The primary proxies used include ostracod populations, carbon and oxygen isotopes of their calcite ($CaCO_3$) shells, oxygen isotopes of the accompanying lake sediment, chemical composition of the sediment, and stratigraphy of the lake sediment. This research yields very high-resolution changes in water temperature and vegetation in the Lough Monreagh region on centennial time scales, while illustrating a convincing model of ostracod faunal and carbon isotope relationships within their environment. This work is a significant contribution to science through its resolution that lends understanding of climate mechanisms in the North Atlantic region, which assists in interpreting current and predicting future climate changes.

The effects of changing temperature, precipitation, and atmospheric circulation influence ecosystems and societies. For instance, indigenous populations in high-latitude regions began to experience significant adverse impacts related to climate change (Schneider et al., 2007). Increased temperatures have resulted in the removal of ice cover and coastal erosion. Additionally, freshwater wells in the North American Arctic are warming, posing risks to human health by promoting transmission of diseases (Martin et al., 2005). Geographic translocation of ecosystems are also likely to alter traditional uses of natural resources and lifestyles. Reduction in Arctic sea-ice habitat may force the extinction of ice-dependent species such as walrus and polar bears (Schneider et al., 2007).

Due to the possible effects of climate change/global warming on our society, efforts are being made to characterize climate of the recent past in order to better predict climates in the future. This is particularly important because the instrumental record is too short to predict long-term future climate change. Traditionally, climate change is predicted using models that are tuned to proxy data. Thus, accuracy of model output is constrained by the veracity of boundary conditions derived from proxy data. In recent decades efforts to generate proxy-based reconstructions of North Atlantic climate variability have increased in an attempt to ascertain the potential effects of global warming on ecosystems and society and to identify long-term climate cycles and prehistoric climate events. A better understanding of climate variability will permit scientists to better evaluate whether the recent warming is due to global warming, or natural climate change.

The lakes of Western Ireland display a number of characteristics that are ideal for proxy paleoclimate reconstructions: 1) sediment cores taken from these lakes display varves, thus the sediment layers are undisturbed through time; 2) Ireland's location intermediate to the Icelandic Low and Azores High in the North Atlantic is ideal for evaluating temporal variability in climate modes (North Atlantic Oscillation) and the ocean circulation (Atlantic Multi-decadal Oscillations, thermohaline circulation) that have been demonstrated to influence climate (e.g. Hubeney et al., 2006; Diefendorf et al., 2006) and; 3) Ireland's distance from mainland Europe limits continental climate effects. Changes in Western Ireland's climate should be reflected in the aquatic ecosystems of its lakes. Climate variability characterized in Western Ireland has been used to infer changing conditions throughout the North Atlantic coastal regions (western Europe and eastern North America).

Ostracoda are small (1-2mm), aquatic, bivalved crustaceans. Population densities of individual species vary with changes in their ecosystems (Ito et al., 2003; Xia et al., 1999a; 1999b). Certain species of ostracoda are extremely sensitive to water temperature, eutrophication or nutritional stage of the lake system, and the availability of certain resources (such as the characteristics of the benthos substrate or plant taxa avaliable). Ostracod carapaces are preserved in the lake sediment such that, when identified by species, can be used to reconstruct the faunal community at the time of deposition. Due to their minute size and relatively short lifespan (seasonal to 3 years), species are quickly eliminated from ecosystems as environmental conditions change, thus, species have been used to identify lake stage evolution through time (e.g. Boomer, 2002). Lake environmental change may equate in part to climate change. For example, an increase in nutrition could be linked to an increase in terrestrial vegetation that is in turn related to climate change. The lakes of Western Ireland are sufficiently populated with ostracoda to obtain a high-resolution faunal census record. This thesis will address the impacts of climate change on lake eutrophication using ostracod faunal tracers while establishing a climate record in Western Ireland.

The bivalved carapaces of ostracoda are constructed of calcite ($CaCO_3$) (Turpen and Angell, 1971). Carbon and oxygen isotope values extracted from ostracod calcite record environmental conditions during calcification, both within and external to the lake. Because ostracods calcify relatively quickly (within hours) (Rosenfeld, 1982), each valve is a record of the environmental conditions at that point in time. Ostracod valves are shed during ecdysis as the organism grows and the valves accumulate as sediment. Because lakes in Western Ireland are saturated with respect to carbonate, as evidenced by biologically induced calcitic sediment (marl), the ostracod calcite recovered is primary (uncrystallized). A single ostracod can molt up to nine times in its life cycle (Delorme, 1989; Meisch, 2000) and with sufficient populations, enough material is available to obtain temporal high-resolution carbon and oxygen isotope data.

The duration of the record presented in the following manuscripts spans almost 8,500 years from ~15,500 to ~7,000 cal years B.P. Notable climate events include the Allerød thermal oscillation at the close of the Pleistocene, the Younger Dryas cooling event, and significant climate variability during the early Holocene (Pre-Boreal cooling event, Boreal chronozone and Holocene Hypsithermal). Ostracods have been utilized in the past as a reliable paleoenvironmental proxy (e.g. Boomer, 2002; Xia et al. 1997b; von Grafenstein et al. 1992; 1994; 1998), but these records are generally low-resolution, with a multi-centennial sample spacing through the Holocene. The research presented herein generated the highest resolution ostracod-derived environmental climate record for the Late Pleistocene to Early- and Mid-Holocene to date.

1.2 Organization

This research focuses on the investigations of lake evolution and climate variability based on a multiproxy record extracted from a lacustrine sediment core collected from Lough Monreagh, Western Ireland. The thesis is divided into two portions, both of which are articles written in peer-review publication format, each with their own separate introductions, and as such, some information presented in chapters may be repeated. Chapters 2 and 3 are the author's own research, including methods, data analysis, and interpretations using the authors own ideas under the guidance of the author's supervisor. Chapter 2 presents the ostracod faunal record and carbon isotope values of the ostracod valves, in combination with loss on ignition of the bulk sediment to identify a lake eutrophication and terrestrial vegetational variability change record and it's relevance to climate change. Chapter 3 presents oxygen isotope values of ostracod valves and presents an illustration of decadal and multidecadal climate variability in the record. Additionally, theoretical lake water temperatures are investigated combining bulk sediment with ostracod oxygen isotope values. Chapter 4 contains contributions of thesis including summaries of manuscripts, ecological and climate descriptions, caveats, a note about resolution, and concluding remarks.

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CHAPTER 2. LATE GLACIAL TO MID-HOLOCENE (15,500 TO 7,000 CAL YEARS BP) ENVIRONMENTAL VARIABILITY: EVIDENCE OF LAKE EUTROPHICATION AND VARIATION IN VEGETATION FROM OSTRACOD FAUNAL SUCCESSION AND CARBON ISOTOPE VALUES OF LOUGH MONREAGH, IRELAND*

2.1 Abstract

Calcitic ostracod shells extracted from an 8.67m core recovered from Lough Monreagh, western Ireland, provide evidence for significant, long-term eutrophication and increased terrestrial vegetation from the Late Glacial to the Mid-Holocene. We characterized faunal assemblages, determined $\delta^{13}C$ values of the ostracod calcite, as well as the percentages of carbonate, organic carbon, and siliclastic material in the sediment to provide a high-resolution record of the lacustrine and terrestrial ecosystems. Following deglaciation, Bølling and Allerød age (15,500-12,800 cal yr B.P.) sediment was dominated by the benthic, cool-water, oligotrophic ostracod *Limnocytherina sanctipatricii*, that exhibit high $\delta^{13}C$ values that approach those of the surrounding bedrock. We interpret these high carbon isotope values to be forced by DIC supplied to the lake from a landscape of carbonate bedrock devoid of substantial vegetation. The Younger Dryas (12,800-11,500 cal yr B.P.) was represented by a 6cm-thick black clay section deficient in ostracod shells but containing silicilastics. The absence of carbonate suggests that the lake may have been ice covered during the Younger Dryas thereby halting biological productivity. A rapid decrease in $\delta^{13}C$ values and the high concentration of *Candona* species at 10,500 cal yr B.P. signifies increasing vegetation and eutrophication in the Lough Monreagh basin. Mid-Holocene age sediment following 8,300 cal yr B.P. contained considerable numbers of littoral, warm-water, eutrophic, and phytophyllic *Metacypris cordata* with relatively low $\delta^{13}C$ values. These results suggest significant terrestrial vegetation that supplies dissolved organic matter, particulate

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organic matter, plant debris, and subsequently DIC that all have relatively low $\delta^{13}C$ values. This decrease in carbon isotope values is also associated with increased eutrophication and high rates of aquatic vegetative production.

2.2 Introduction

This research is justified because concerns over anthropogenic forcing of climate due to increased greenhouse gas emissions require novel efforts to better understand the impact of global warming on earth's ecosystems. Due to the relatively short duration of instrumental records, preanthropogenic climate and environmental changes must be characterized to compare to modern trends. Therefore, high-resolution environmental reconstructions must be prioritized that preserve centennial variability. Records such as this study are critical to further our understanding of natural regional climate dynamics.

The cosmopolitan distribution of freshwater ostracods permits characterization of lacustrine environments throughout Western Europe by faunal assemblages of ostracods (e.g. Meisch 2000, Absolon 1973). The composition and relative abundance of species have been used as a qualitative measure for freshwater ecosystem health (Boomer 2002; Meisch 2000). The primary objective of the research herein is to generate a carbon isotope record of carbon cycling for Western Ireland tuned with species-specific ostracod ecological requirements.

This research supports these efforts by presenting a high-resolution quantitative and qualitative record for a past environment using ostracodal fauna-based reconstruction, while introducing a new model using $\delta^{13}C$ values of ostracods. The results and interpretation provided in this study could be compared to other proxy studies in western Ireland, to corroborate a complete model for preanthropogenic environmental change in the North Atlantic region.

2.3 Study Area and Background

Ireland has a temperate maritime climate moderated by the waters of the North Atlantic Drift that yield air temperatures ranging between 2.5 and 19.0°C, with a mean annual temperature of 9.5°C. Humidity usually ranges from 70-90% with the maximum rainfall (~2800mm) on the western coast in winter (MET 2003). Lough Monreagh is located in Contae an Chláir, about 20km from the Atlantic coast, 23m above sea level, and approximately 4km southeast of the town of Gort (*An Gort*) at 53˚01'55"N, 08˚53'55"W (Figure 2.1A, B). Bedrock geology of the region is dominantly Lower Carboniferous Viséan limestone with nearby topography including the Slieve Aughty Mountains (*Sliabh Eachtai*) and Burren Highlands that reach 400m elevation. Well-buffered by the marine carbonate bedrock geology of the region (Mitchell et al. 1996), biomineralized carbonate production by *Chara* spp. within these lakes generates thick sequences of calcitic mud known as marl, that is often superseded by peat deposits (Diefendorf et al. 2007). Modern Lough Monreagh consists of blanket bog with several small open bodies of water. Many Western Irish lakes have short residence times (Diefendorf et al. 2005; 2007; Tibert et al. 2007), and Lough Monreagh has a small catchment area (2-3km^2). Lakes in western Ireland are ideal for the study of paleoclimate due to their ability to preserve proxies related to changes of the North Atlantic ocean currents and the North Atlantic Oscillation, both of which are believed to be responsible for significant variability in climate for the western European, North Atlantic, and eastern North American regions. Additionally, cores taken from Irish lakes often contain laminations (varves) (e.g. Diefendorf et al. 2007; Tibert et al. 2007; visual observation), indicative of sedimentation unaltered by bioturbation. Therefore, the ostracod valves preserved in the marl of Lough Monreagh can yield an ideal unaltered time series proxy record.

Carbon isotopes are atoms of carbon with different atomic masses and stable carbon consists of two mass values: carbon-12 and carbon-13. Carbon isotope ratios express the relative abundance of carbon-13 to carbon-12 in a sample using the notation δ^{13}C and are calculated as:

$$\delta^{13}C = \frac{^{13}C}{^{12}C} \qquad \text{(Eq. 1)}$$

δ^{13}C values are compared to standard VPDB (Vienna PeeDee Belemnite) ‰ (per mille) for international comparison and are related in the following equation:

$$\delta^{13}C_{(VPDB)}‰ = \frac{\frac{^{13}C}{^{12}C}sample}{\frac{^{13}C}{^{12}C}VPDB} \text{ x } 1000 ‰ \qquad \text{(Eq. 2)}$$

2.4 Methods

The Lough Monreagh core (8.67m) was collected using a Livingstone square-rod piston-coring device (Wright 1967, 1991). Cores were split and sampled at 5cm increments at the University of Mary Washington and were analyzed for total weight percent carbon and $CaCO_3$ using loss on ignition methods modified from Dean (1974).

The lower 5.5m of core was sampled (1.0cm^{-3} sediment sample size) at 2cm resolution for ostracods and at 1mm resolution for marl. Higher resolution ostracod sampling (1cm) was performed from 7.410-7.640m, encompassing the brown band through the black clay. Sampling at 0.5cm resolution with a smaller sediment sample size (~0.5cm^{-3}) was performed in the oldest facies containing ostracod valves (8.360-8.430m). Samples were soaked in a mild solution of triclosan and water to disaggregate the sediment. Adult (late) instar ostracod valve components were separated by stereomicroscope under 30x magnification and manually extracted from the sediment. Ostracods were identified and classified using the taxonomic scheme of Meisch (2000). Left valves of each species were counted to obtain organism count for genera and species present per sample.

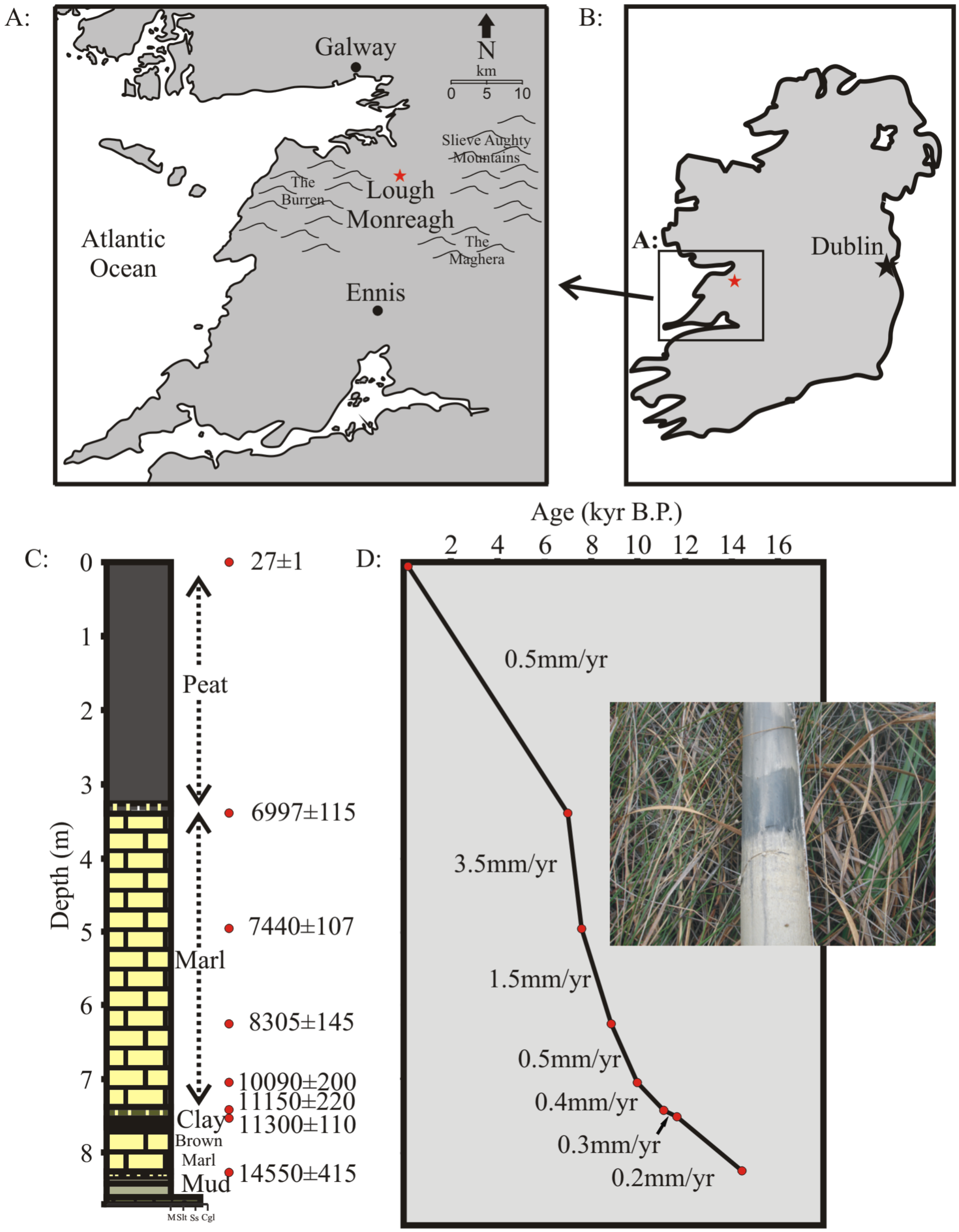


Figure 2.1. Field location map of Lough Monreagh A: study site in western Ireland and B: Ireland. C: Core stratigraphic log and D: sedimentation rates of units for the Lough Monreagh lake core. Photo insert shows 6cm black clay horizon at 7.54-7.60 m depth.

Ostracod valves of *Limnocytherina sanctipatricii* (core depth >7.171m age >11.0kyr B.P.), *Paracandona euplectella* (depth and age interval 7.171-6.250m 11.0-8.3kyr B.P.), and *Metacypris cordata* (depth <6.250m age <8.3kyr B.P.) were carefully cleaned with a sable hair artist's paintbrush and selected for stable oxygen and carbon isotope analysis. Ostracod valves were roasted *in vacuo* at 200°C to remove volatiles that may influence isotope values. $\delta^{13}C$ values were obtained using a Kiel IV carbonate preparation device directly coupled to a Thermo-Finnigan MAT 253 SIRMS in the Saskatchewan Isotope Laboratory. Thirty to fifty microgram samples equating to four to eight ostracod valves (dependent on species and variability in size of adult valves) were reacted with 103% anhydrous phosphoric acid for three minutes at 70ºC. Carbon values were reported in standard delta per mille (‰) notation relative to NBS-19 VPDB standards loaded in each run.

Age control was provided by ^{14}C AMS ages obtained from plant macrofossil material from eight intervals in the core that were analyzed at either the Gliwice (Poland) Radiocarbon Laboratory or the University of Pittsburgh (USA). Ages of aquatic plant macrofossil material (gyrogonites) were corrected for atmospheric ^{14}C using CALIB 4.3 software to obtain calendar years (Stuiver et al. 1998). Additionally, calendar dates obtained from aquatic plant material were corrected for Carboniferous bedrock reservoir effect present in the water.

2.5 Results

2.5.1 Facies descriptions and composition

Percentages of organic carbon, carbonate, and noncombustible components are presented in figure 2.3A and B. The prominent lithologies of the Lough Monreagh core consist of two major units (Fig. 2.3C). The first unit is a light tan laminated carbonate mud known as marl and consists of >80% carbonate content within which ostracods, charophytes (present as calcite encrusted stems and gyrogonites), gastropods, and mollusks are very abundant. This marl sediment is the result of the biologically induced precipitation of calcite out of the carbonate saturated lake water through cations supplied by *Chara* spp. (e.g. Diefendorf et al. 2007). Marl is overlain by the second major unit, humic peat with a high organic carbon content (>80%). Neither microfaunal nor macrofaunal components were observed within the peat unit. The marl unit contains a 6cm band of black clay with quartz grains, noncombustible content that does not contain microfaunal or macrofaunal content. The transition from marl to peat units occurs at 3.42m (6,997 cal yr B.P.) in the Lough Monreagh core (Table 2.1). The ages in fig 2.1C are calendar years corrected for aquatic reservoir carbon. The sedimentation rates were determined by using depth points in the core (mm) with known ages and divided by the amount of time between those points (years) to obtain mm/yr sedimentation rates. Ages were interpolated to all sample points between age points in the core based on decompressed depth of each sample.

Table 2.1. List of AMS radiocarbon dates from Lough Monreagh. Strat position was the decompressed depth (m) of the sample. Material abbreviations: MON indicates sample came from Lough Monreagh core. Twig indicates terrestrial twig and Plant was a terrestrial leaf. Gyro indicates gyrogonite (aquatic macrophyte). Uncorrected age indicates the ^{14}C date obtained from the sample. Corrected ages are ^{14}C ages corrected for atmospheric ^{14}C standard procedure (Stuiver et al. 1998).

Strat. Position (m)	Material	Uncorrected age	Corrected age
0.00	MON Twig	50±0.5	27±1
3.380	MON Gyro	7890±45	6997±115*
4.943	MON Plant	7420±20	7440±107
6.227	MON Gyro	8120±50	8305±145*
7.037	MON Gyro	9560±50	10090±200*
7.415	MON Gyro	10530±60	11150±220*
7.463	MON Gyro	10640±50	11300±110*
8.250	MON Gyro	14590±70	14550±415*

*These samples had to be corrected an additional 850 years because of residual reservoir carbon in the aquatic macrophytes.

2.5.2 Microfossil distributions

A total of 4,755 ostracods were recovered from 287 samples extracted from the Lough Monreagh core. Seven species of ostracoda from four freshwater families were identified and are classified as follows to facilitate discussion: 1) limnocytherids (*Metacypris cordata* and *Linmocytherina sanctipatricii*); 2) darwinulids (*Darwinula stevensoni*); 3) candonids (*Candona candida*, *Fabaeformiscandona protzi*, *Paracandona euplectella*, *Cyclocypris ovum*, and *Candona* sp.); and 4) cyprids (*Cypria* sp. and *Heterocypris* sp.).

The marl unit contains a relatively abundant population of Limnocytheridae ostracods including *Limnocytherina sanctipatricii* and *Metacypris cordata* (figure 2.2). These two species of limnocytherids never occur together in the same core sample, with *Limnocytherina sanctipatricii* only present in the basal marl sediment at ages >11,000 cal yr B.P. and Metacypris cordata in marl sediment at ages <8,300 cal yr B.P. When *Limnocytherina sanctipatricii* was present, it usually constituted >80% of the population observed in the sample. The other limnocytherid *Metacypris cordata* appears at 8,300 cal yr B.P. and persists to the peat transition at 6,997 cal yr B.P. Much like *Limnocytherina sanctipatricii*, *Metacypris cordata* was the dominant ostracod present when it occured in samples. The 2,700-year gap following the extinction on *L. sanctipatricii* in Lough Monreagh and the appearance of *M. cordata* was populated by candonids and cyprids. Darwinulids occured in strata with a similar range as *M. cordata*.

2.5.3 $\delta^{13}C$ values

Carbon isotope values of Lough Monreagh ostracod calcite are presented relative to calibrated age (figure 2.3C), core lithology, and LOI results to facilitate interpretation. Ostracod $\delta^{13}C$ values range from +3 to -9‰ VPDB along the length of the core. The highest values (1 to 3‰) occur prior to and just following the black clay band (12,800 to 11,000 cal yr B.P.). Values decrease substantially through the early Holocene to -9‰ with major excursions occurring at 10,000 and 8,300 cal yr B.P. It is worthy to note that values from individual species of Limnocytheridae ostracod valves have similar values (0 to +3‰ for *Limnocytherina sanctipatricii* and -5 to -9‰ for *Metacypris cordata*) while values of the candonid *Paracandona euplectella* are more variable (+2 to -6‰).

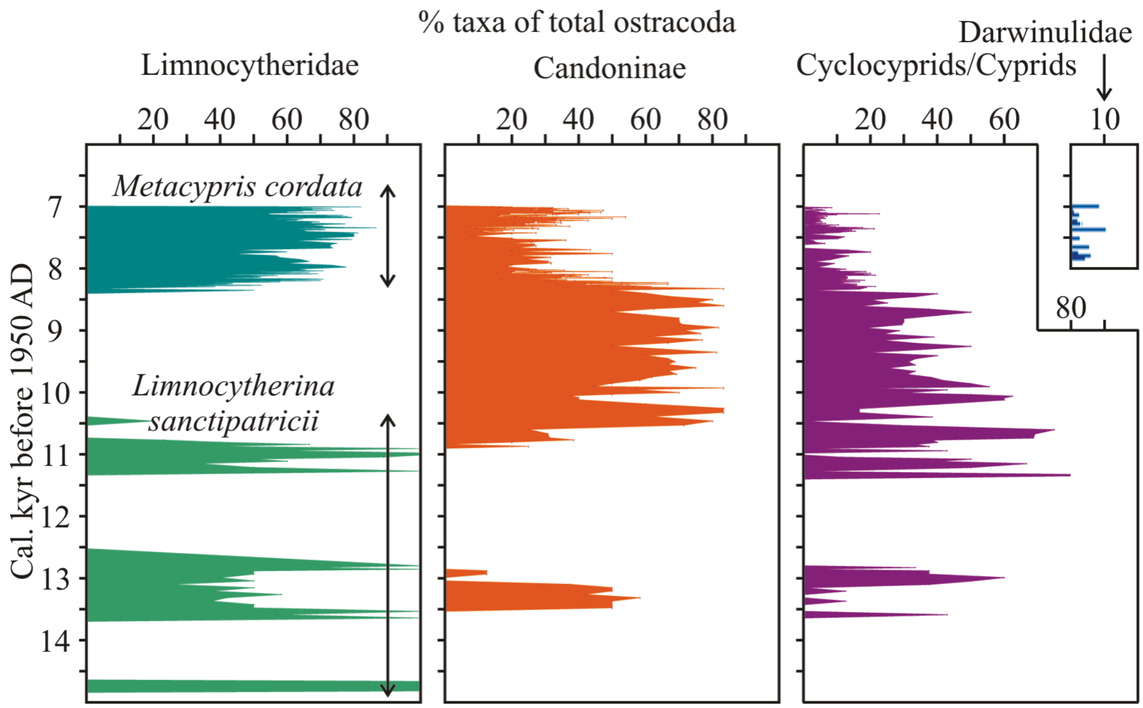
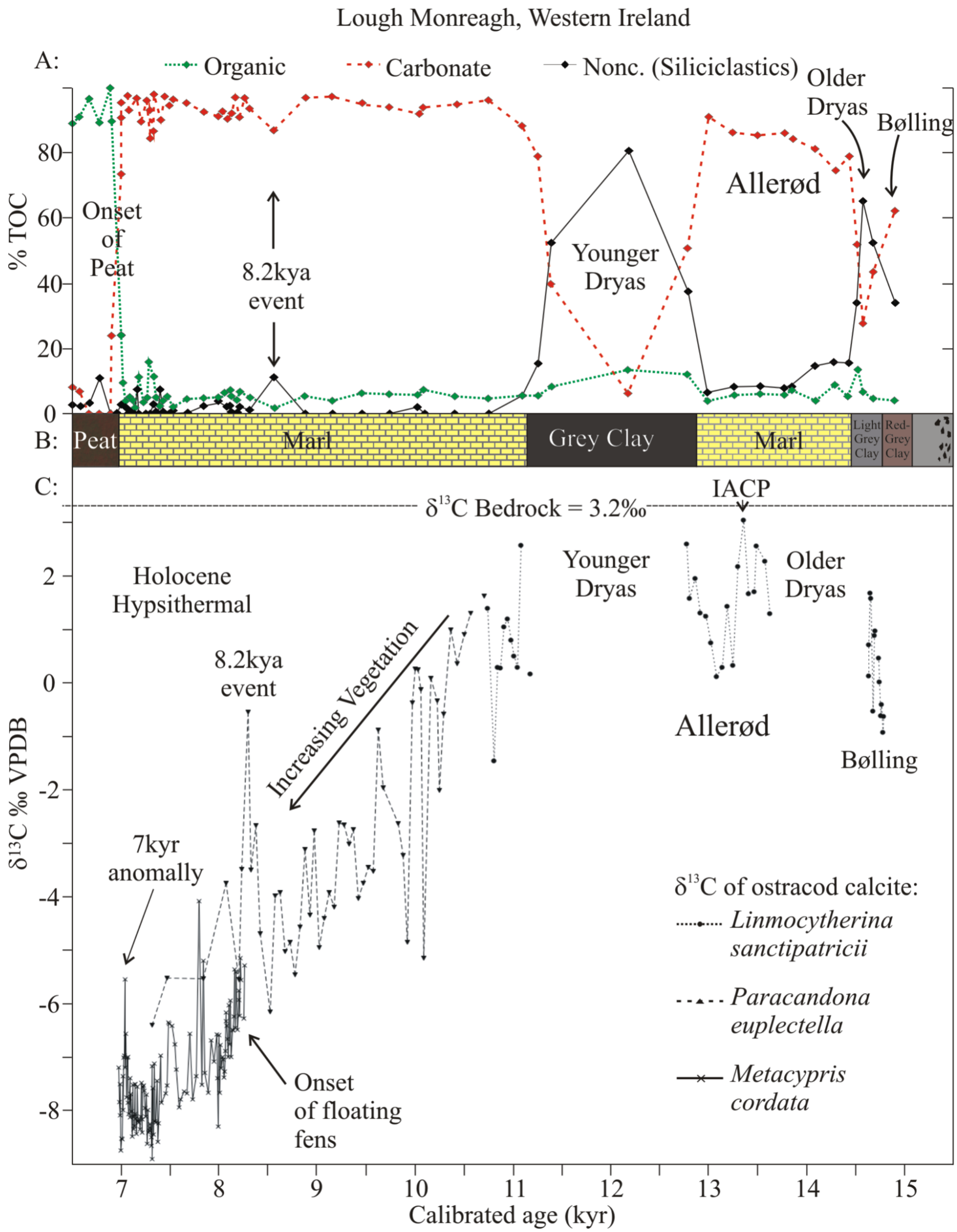


Figure 2.2. Ostracod census counts from the marl sediment core extracted from Lough Monreagh. These three plots display calendar years on the y-axis and families of ostracod abundances present are represented on the x-axis. The inset in the upper right plots Darwinulids with age (y-axis) corresponding to the other three plots.



Text-Figure 2.3. Composite plot of loss on ignition, stratigraphic units, and $\delta^{13}C$ values of ostracod calcite vs. calibrated age from Lough Monreagh. Note that high carbonate coincides to marl and the black clay contains high noncombustible content.

2.6 Discussion

2.6.1 $\delta^{13}C$ values

It has been proven that ostracods precipitate calcite with carbon isotope values $\delta^{13}C$ close to those of the ambient host water (Keatings et al. 2002; von Grafenstein et al. 1999) with little additional fractionation (von Grafenstein et al. 1999). However, in reality this model is complicated by other factors that influence the $\delta^{13}C$ values of ostracod calcite such as diet and respiration that in turn correspond to lake productivity and water temperature respectively. Therefore, the ostracod $\delta^{13}C$ values presented here represent variability in $\delta^{13}C$ values of DIC, diet, and ostracod metabolism. These are influenced by DIC derived from bedrock with high $\delta^{13}C$ values (3.2‰$_{VPDB}$) and degrading plant material within the lake's water-shed that result in DIC with low $\delta^{13}C$ values -22 to -27‰$_{VPDB}$ that is supplied to the lake water DIC reservoir (Diefendorf et al. 2007). Therefore the ostracod $\delta^{13}C$ time series presented provides a record of variation in the lake carbon budget, that includes changing vegetation in and around the lake basin with high $\delta^{13}C$ values representing limited terrestrial vegetation and low values correspond to increased vegetation (Fig. 2.4). These factors can however be further constrained by consideration of published ecological requirements of the ostracod fauna (e.g. Boomer 2002). The 12‰ shift in ostracod $\delta^{13}C$ values presented here had not been observed to date in Western Europe.

2.6.2 Ostracod faunal signatures

Ostracods are common throughout the two marl units of the core (Fig. 2.3B). *Limnocytherina sanctipatricii* (Brady and Robertson 1869) is a cold-stenothermic species that currently inhabits deep profundal zones at temperatures of 4-5°C (Schwalb 2002; von Grafenstein 1994). Löffler (1969) suggests that water temperatures of 15°C are too high for this taxon. It is a pioneer species and an indicator of first-stage lakes with sparse aquatic productivity (Löffler 1997). This ostracod currently resides at depths of 186 and 250m of Lake Constance (Bodensee), a monomictic alpine lake on the border between

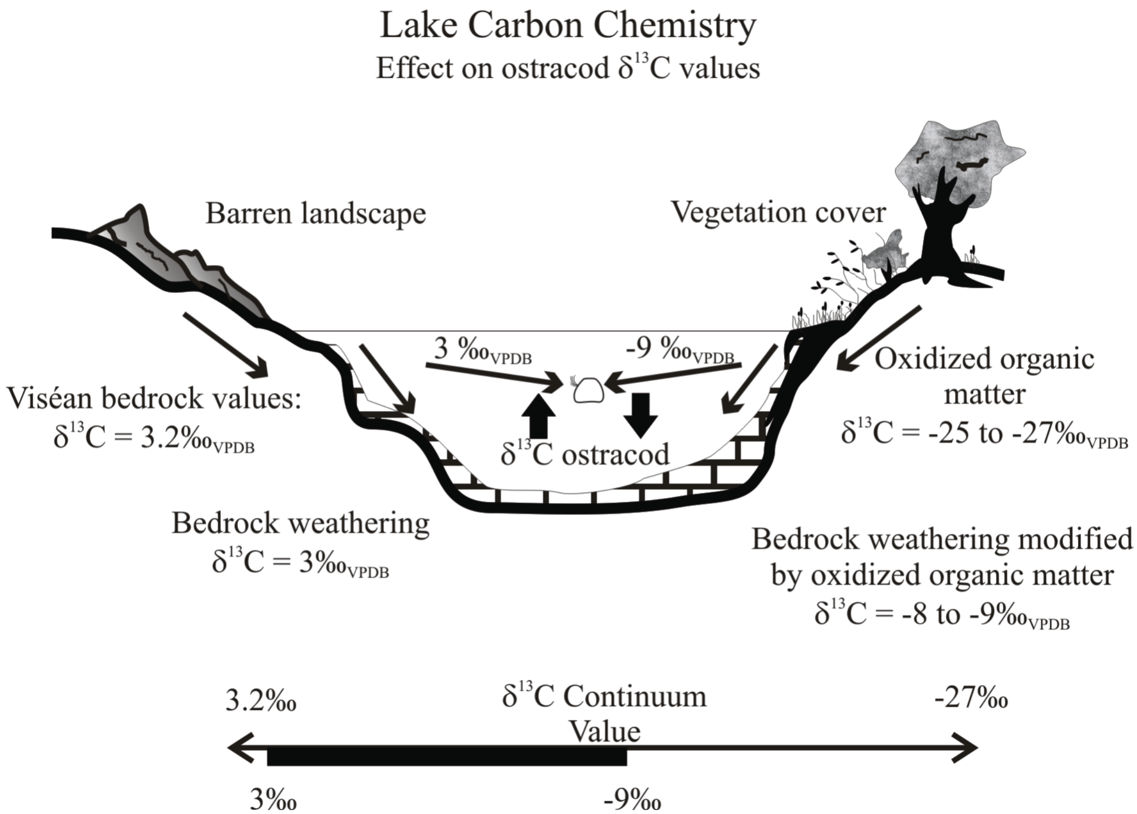


Figure 2.4. Carbon cycle illustration for freshwater lake systems based on the effects of bedrock vs. organic detritus effects on $\delta^{13}C$ ostracod values. Lake DIC is derived from bedrock with high $\delta^{13}C$ values (3.2‰$_{VPDB}$) and degrading plant material (-22 to -27‰$_{VPDB}$) that is supplied to the lake water DIC reservoir. Ostracod $\delta^{13}C$ variability from Lough Monreagh reflect bedrock (3.0‰$_{VPDB}$) and organic detritus (-9‰$_{VPDB}$) effects in the lake carbon budget.

Germany, Switzerland, and Austria (Löffler 1969; Schwalb 2002). It is also been reported in lakes in Greenland (Griffiths and Evans 1995). Scharf (1980, 1993) suggests *Limnocytherina sanctipatricii* is also very sensitive to the trophic level of their environment as they were observed in two oligotrophic Eifelian lakes (Weinfeldermaar and Pulvermaar) in western Germany but in adjacent slightly eutrophic lakes only subfossils of this species were found. Previous publications suggest modern *Limnocytherina sanctipatricii* appear to be restricted to the central European Alps and Scandinavia; and the lack of *Limnocytherina sanctipatricii* reported in publications from locations in southern Europe, southern Russia, and the Ukraine suggest very specific ecological conditions required by this limnocytherid: clean-bottom, clear-water, cold-stenothermal, deep-water lakes. The ecological parameters outlined here for *Limnocytherina sanctipatricii* agree well with the $\delta^{13}C$ values of this species reported in this study. High $\delta^{13}C$ values similar to bedrock correspond to minimal terrestrial vegetation adjacent to Lough Monreagh (Fig. 2.3C).

Metacypris cordata (Brady and Robertson 1870) is considered a warm-water stenothermic species, with a preference for water temperatures of 14-20°C (Hiller 1972). This ostracod is also described as a "fen-car" species that clings to reeds and other littoral plants (Robinson 1980; Meisch 2000; Danielopol et al. 1996). In Lake Caldarusani, Romania, this taxon was observed in/on floating islands of fen vegetation including *phragmites*, *Typha*, and *Carex* (Danielopol and Vespremeanu 1964), and in rootmasses of floating fens (alkaline wetlands) in Skelsmergh Tarn of the English Lake District (Meisch 2000). We observed this species in the littoral zone of modern vegetation-choked Toole's Lough in Ireland, located a few km southeast of Lough Monreagh, thereby confirming that *Metacypris cordata* is a phytophylic species. Carbon values of *Metacypris cordata* are much lower than *Limnocytherina sanctipatricii*, probably due to water DIC dominantly sourced from oxidized terrestrial organic material.

Members of the Candoninae subfamily (Superfamily Cypridoidea) reside in a wide range of environments at varying temperature (Horne 2007), nutrition, and salinity levels (e.g. Meisch 2000) without a specific range of optimal productivity. The Candona group observed in Lough Monreagh (*Paracandona euplectella*, *Candona candida, Fabaeformiscandona protzi*, and *Cyclocypris ovum*), henceforth referred to as Candona spp. do not appear to have specific environmental requirements for productivity. In fact, Candona spp. ostracoda have been reported from nearly every country in Western Europe (e.g. Meisch 2000), thus, limnocytherids are more sensitive to environmental variability. $\delta^{13}C$ values of *Paracandona euplectella* display a significantly larger range in $\delta^{13}C$ values than either of the two limnocytherids, suggesting that *P. euplectella* and other candonid species remain productive despite significantly greater environmental variability than the limnocytherids could tolerate.

2.6.3 Late Glacial environment

The last glacial maximum occurred at ~22,000 cal yr B.P., followed by rapid deglaciation starting ~17,400 cal yr B.P. on the British Isles (Bowen 2002). The termination of glaciation is marked at Lough Monreagh as a transition from characteristically dark grey clay and gravel (Watts, 1985) to marl, a transition observed previously throughout the region (Diefendorf 2007; O'Connell et al. 1999). Results of Lambeck (1996) who used three layer models of the rheological response of the Earth to changing surface loads suggest the Lough Monreagh area was completely deglaciated between 18,000 and 15,000 cal yr B.P., in agreement with our record with sedimentation initiated at ~15,500 and pioneering ostracoda appearing ~14,850 cal yr B.P. Following deposition of the dark grey clay and gravel, the Bølling warm interstadial was the first event recorded by the ostracoda from Lough Monreagh, indicating that the lake was ice-free during the Bølling. Gyrogonites present in these strata that further suggest ice-free conditions as *Chara* are present and productive. *Limnocytherina sanctipatricii* with carbon values ranging from 0 to $2‰_{VPDB}$ that suggest clear, cold waters at 4-5°C, sparse terrestrial vegetation, and DIC $\delta^{13}C$ values dominated by bedrock $\delta^{13}C$. Ostracod $\delta^{13}C$ values fluctuate during the Bølling suggesting variation in productivity rates or bedrock weathering, concomitant with variable climate reported from nearby Lough Inchiquin (Diefendorf et al. 2005; 2007). Ostracods are common while total carbonate content is high but are absent when carbonate content sharply decreases, likely related to cooling that halted carbonate production in the lake following the Bølling. This shutdown may also be forced by increasingly arid conditions characteristic of the Older Dryas that may have dried the lake basin.

We suggest several possible mechanisms for the relatively high $\delta^{13}C$ values observed in the Limnocytherids. Firstly, given their relatively small size, their volume to surface area ratio coupled with the low metabolic rate at their preferred temperatures would limit the influence of metabolic carbon relative to DIC on the $\delta^{13}C$ value of their shell. Secondly, in a study of carbon limited subarctic lakes, Gu and Alexander (1996) noted that some cyanobacteria were able to fix carbon directly from the atmosphere, generating organic tissue with values that were 9 to 16‰ higher than subsurface algae. Any ostracod feeding on this cyanobacterial scum would generate a calcite shell with values intermediate between water DIC and diet with higher values than those generated during periods in which the lake was not carbon limited. Lastly, some ostracods have been observed to collect carbonate grains presumably to assist with shell production, thereby incorporating a significant carbonate $\delta^{13}C$ component from the marl (unpubl. data) that is observed to display $\delta^{13}C$ values higher than those of the bedrock.

Ostracods returned to the lake at the onset of the Allerød at 13,600 cal yr B.P. and persist to the onset of the Younger Dryas at 12,800 cal yr B.P., illustrated in Fig. 2.5A. Carbonate content increases with a lower density of gyrogonites than observed during the Bølling. *Limnocytherina sanctipatricii* dominates the ostracod population, exhibiting higher $\delta^{13}C$ values higher than those of the Bølling, suggesting that Allerød temperatures were not as high as during the Bølling. Struiver et al. (1995) suggests it was warmer earlier in the Late Glacial (Bølling) than the Allerød.

The increase in carbon values seen at 13,400 cal yr B.P. may reflect the previously identified intra-Allerød cold period (IACP) seen by Leng and Marshall (1992) using North Atlantic foraminifera occurring at 12 kyr B.P. suggesting cool-down conditions occurred at this time. In our record, this cool-down is signaled by decreased vegetation productivity in Ireland. The IACP has been identified before in Ireland (Diefendorf et al. 2005) and England (Marshall et al. 2002) using $\delta^{18}O$ values of calcite between 13,900 to 13,750 cal yr. B.P. The differences in timing are likely related to different age models, as suggested in Diefendorf et al. (2005).

Our population data suggest cooling occurred ~80 years prior to the onset of the Younger Dryas as is evidenced by the termination of the candonids, cyclocyprids, and cyprids while *Limnocytherina sanctipatricii* persists. Additionally, $\delta^{13}C$ values increase

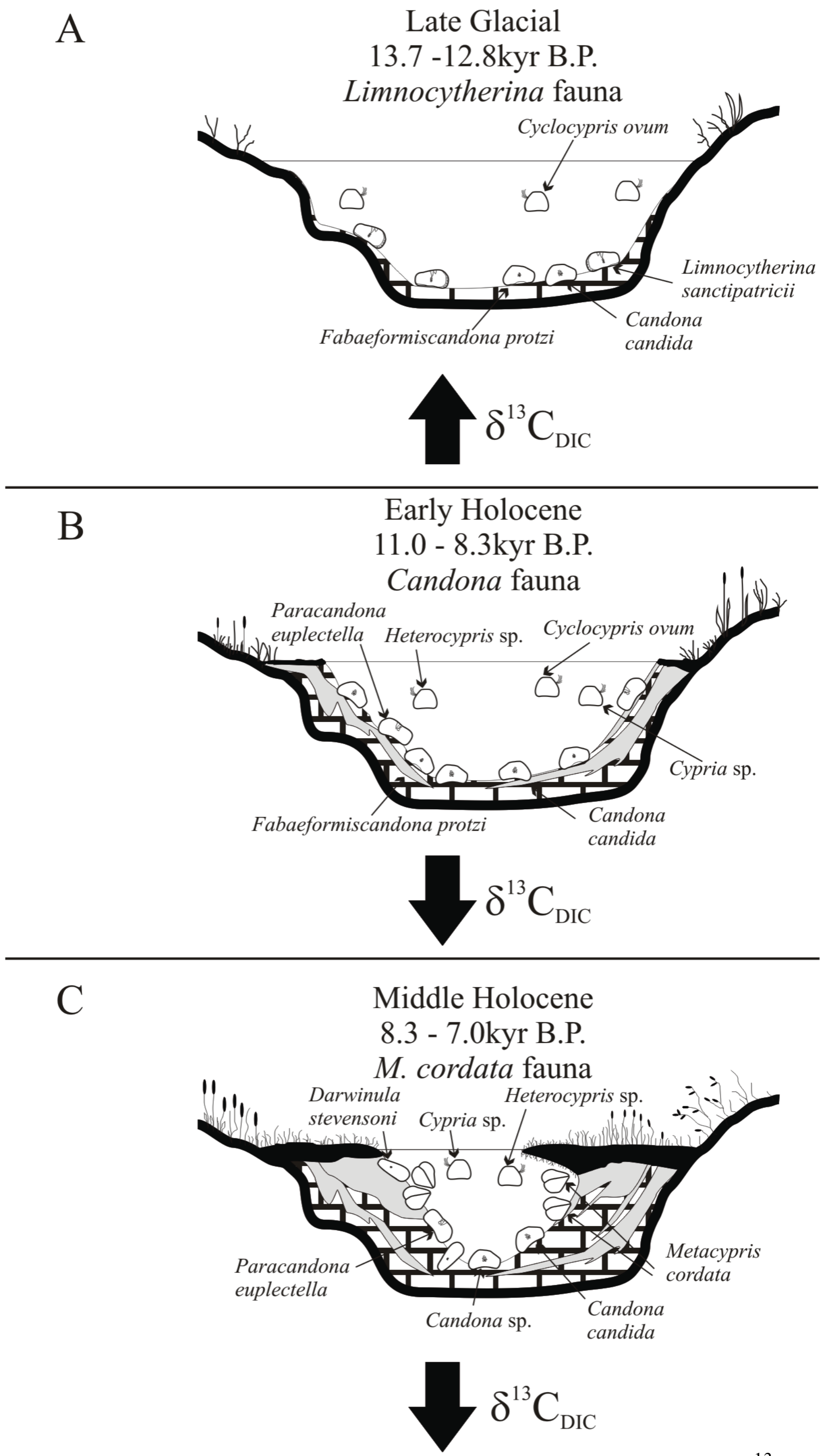


Figure 2.5. Theoretical model of ostracod faunal community – $\delta^{13}C$ values – environmental relationships for the A: Late Glacial (Allerød), B: Early Holocene, and C: Mid-Holocene.

significantly during this time. This means that aquatic vegetation was reduced at this time, reversing the increasing trophic advancement in the lake during the century prior to the Younger Dryas.

We speculate based on multiple proxy data that the cooling occurring during the ~80 years just prior to the Younger Dryas may have been the result of glacial meltwater bursts into the North Atlantic Ocean (e.g. Jones et al., 2002; Alley et al., 1993), shutting down the North Atlantic warm water circulation. During the Younger Dryas, polar waters advanced southwards into the North Atlantic potentially to 53ºN (Ruddiman et al. 1977) while foraminifera proxy records suggest summer mean sea surface temperatures were reduced to 10ºC adjacent to western Ireland (Duplessy et al. 1996) which forced cooling, aridity, and windier climate at Lough Monreagh. The onset of the Younger Dryas (12,800 cal yr B.P.) at Lough Monreagh was detrimental to the Lough Monreagh ecosystem, as the remaining ostracod species *L. sanctipatricii* that flourished during at the end of the Allerød were terminated.

The Younger Dryas is manifested in our record as a significant decrease in total carbonate from ~80% in the Allerød to <10%, at the onset of the ostracod deficient black clay layer identified here and at other locations in Ireland (e.g. Diefendorf et al. 2005). As was mentioned previously, ostracods were restricted to the overlying and underlying marl units in this core and they were not observed in the black clay section (Fig. 2.3B). The black clay horizon with pitted silicate grains was likely deposited in a low energy aquatic environment, perhaps under occasional/persistent ice cover.

2.6.4 Holocene Environment

Following the Younger Dryas, sediment transitioned rapidly to marl containing ostracods (*Limnocytherina sanctipatricii*) and gyrogonites suggested *Chara* productivity increased immediately after the Younger Dryas. $\delta^{13}C$ values of *Limnocytherina sanctipatricii* are high, suggesting limited transport of terrestrial organic matter to the lake basin. At 10,800 cal yr B.P., *Limnocytherina sanctipatricii* are succeeded by Candona spp. ostracoda, rare prior to the Younger Dryas, that come to dominate the population. At this faunal change, carbon values also begin a long-term decrease that we interpret as a record of the establishment of significant terrestrial vegetation. Despite the tolerance of Candona spp. to wide ranging environmental conditions, the disappearance of the limnocytherid suggests that the lake became meso-oligotrophic—an environment too rich in nutrients for the survival of limnocytherids. $\delta^{13}C$ values of *Paracandona euplectella* display rapid excursions of 4-6‰ from ~10,200 to ~8,000 cal yr B.P. suggestive of rapid variation in conditions, perhaps an explanation for dominance by the tolerant Candona spp. A lower-resolution ostracod carbon record from nearby Lough Corrib (Tibert et al. 2007) does not display the variability observed in the Lough Monreagh core, likely due to the difference in resolution. Another possible cause of these excursion could be related to diet variability due to a change in the plant taxa in the region, particularly because *Paracandona euplectella* is described as an omnivore (Haury 1986), it is not entirely dependent on one type of food source. The changing vegetation types may be due to sudden regional sea surface temperature changes brought about by variability in the North Atlantic Drift.

The well-known "8.2kyr cold event" is present in our sediment record as a significant 6‰ increase in carbon isotope values at 8,300 cal yr. B.P. perhaps as a result of rapid decreased terrestrial vegetation in Ireland. This interval is also characterized by a high density of gyrogonites in strata containing slightly lower total carbonate content, signaling that a decreased carbonate saturation within the sediment pile, or that calcite production may have decreased at ~8.2kyr.

Following the 8.2kyr excursion, the limnocytherid *Metacypris cordata* and the darwinulid *Darwinula stevensoni* appear, signifying major environmental and community changes (Fig. 2.5C). Appearance of these fauna suggests that the lake has become a eutrophic and alkaline fen in which aquatic vegetative productivity is higher than during any prior interval. Additionally, lower $\delta^{13}C$ values suggest that terrestrial vegetation within the lake's watershed has been fully reestablished. Based on our concomitant $\delta^{18}O$ values (Chapter 3), summer water temperatures reach 14 to 20°C, likely on the warmer end of the range, as *Darwinula stevensoni* has been reported to favor waters of 19°C during their reproductive stage (Ito et al. 2003). The transition within ostracod populations from candona species to *Metacypris cordata* has been observed in other Western European studies (this transition has been labeled "Candona-*cordata*" in these studies) and described as marking the onset of Holocene (Hypsithermal) warming and more humid conditions (Absolon 1973). The example of the Candona-*cordata* transition here at Lough Monreagh is most striking, as *Metacypris cordata* appears and becomes the dominant member of the population within ~100 years (Figure 2.2).

The sudden onset of peat occurs at 6,997 cal yr. B.P., representing transition of the forested alkaline fen to the modern blanket bog. We speculate the disappearance of the forests may be linked to tree-cutting land-clearing practices of Neolithic peoples, resulting in a reduction in envirotranspiration (Moore, 1975; 1993; Ahlberg et al 2001). Because this sequence of events occurs while it is already humid and warm, the peat subsequently spreads over the wet soils quickly, leading to bog progradation onto the lake, thereby converting the littoral zone into an acidic environment, limiting preservation of fen ostracodal calcite. The ostracod faunal record suggests that regional warming occurred first, promoting increased land-clearing by the proto-Irish.

2.7 Conclusions

Lough Monreagh ostracodal calcite provides an archive of information on lacustrine environmental and landscape changes from the Late Glacial Bølling-Allerød interstadial oscillation to the mid-Holocene using species population, sediment chemistry, and $\delta^{13}C$ values. The faunal signature results of this study conform to those of transitional, small European water bodies previously published (e.g. Griffiths and Evans 1995; Boomer 2002). $\delta^{13}C$ values of ostracod calcite represent a combination of DIC, metabolic contribution, and diet variability, though the specific effects of diet and respiration on $\delta^{13}C$ calcite values remain unquantified. We recognize the following temporal trends in our record:

1) Late glacial Lough Monreagh sediment records the Bølling and Allerød interstadals, characterized by the oligotrophic, profundal, cold-water ostracod *Limnocytherina sanctipatricii*, that suggests a landscape of exposed bedrock barren of vegetation. Weathering of the carbonate bedrock dominates the carbon budget of the lake DIC. We find no evidence of ostracods or other organisms in Lough Monreagh during the cold Younger Dryas interval. Climate conditions

abruptly warmed following the Younger Dryas and organisms returned immediately to Lough Monreagh.

2) The Late Glacial/Early Holocene boundary is characterized as a transitional environment characterized by increasing vegetation, that fosters diversification of ostracod fauna by increasing phytophylic species as observed in the Candona fauna within the sediment.

3) During the Holocene, warming continues, as indicated by the appearance and dominance of the eutrophic, littoral, warm-water ostracod *Metacypris cordata*. Lake water DIC was subsequently dominated by carbon supplied by breakdown of increasingly abundant and diverse terrestrial vegetation. $\delta^{13}C$ values decrease during the Holocene as terrestrial vegetative biomass and its influence continue to increase. The lake transforms into a blanket bog approximately 7,000 years ago.

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Figure Captions

Figure 2.1. Field location map of Lough Monreagh A: study site in western Ireland and B: Ireland. C: Core stratigraphic log and D: sedimentation rates of units for the Lough Monreagh lake core. Photo insert shows 6cm black clay horizon at 7.54-7.60 m depth.

Figure 2.2. Ostracod census counts from Lough Monreagh. Note the separation between two limnocytherid taxa, perhaps an indication of the different preferred environments as these species never occur together. Additionally, note the lack of any organisms in the black clay horizon aged 12,500 to 11,800 cal yr. B.P.

Figure 2.3. Composite plot of loss on ignition, stratigraphic units, and $\delta^{13}C$ values of ostracod calcite vs. calibrated age from Lough Monreagh. Note that high carbonate coincides to marl and the black clay contains high noncombustible content.

Figure 2.4. Carbon cycle illustration for freshwater lake systems based on the effects of bedrock vs. organic detritus effects on $\delta^{13}C$ ostracod values. Lake DIC is derived from bedrock with high $\delta^{13}C$ values (3.2‰$_{VPDB}$) and degrading plant material (-22 to -27‰$_{VPDB}$) that is supplied to the lake water DIC reservoir. Ostracod $\delta^{13}C$ variability from Lough Monreagh reflect bedrock (3.0‰$_{VPDB}$) and organic detritus (-9‰$_{VPDB}$) effects in the lake carbon budget.

Figure 2.5. Theoretical model of ostracod ecosystems – $\delta^{13}C$ values – environmental relationships for the A: late glacial (Allerød), B: early Holocene, and C: middle Holocene

CHAPTER 3. LATE GLACIAL TO MID-HOLOCENE CLIMATE VARIABILITY FROM WESTERN IRELAND: EVIDENCE FROM OXYGEN ISOTOPE VALUES OF MARL AND LACUSTRINE OSTRACODA*

3.1 Abstract

Ostracod and marl calcite were extracted from an 8.67m core recovered from Lough Monreagh, western Ireland, providing evidence for significant, rapid, and long-term summer water temperature variability from the Late Glacial (13,670 cal yr B.P.) to the Mid-Holocene (7,000 cal yr B.P.). We identified the ostracod faunal assemblage and determined $\delta^{18}O$ values of both ostracod summer forms and marl to provide a high-resolution lake water temperature record for the Late Glacial to Mid-Holocene period in Ireland. Here we present a new multi-millennial proxy record of lacustrine temperature variability and use it to elucidate climate variability in North Atlantic climate. Climate perturbations in our record include the Younger Dryas during which ostracoda were absent, and the onset of the mid-Holocene Hypsithermal which was identified by faunal change and increased temperatures. Our record of water temperature variability from the Late Glacial to the Mid-Holocene quantifies high-resolution climate during this period.

3.2 Introduction

Reconstruction of paleoclimate coupled with modeling of past climates permits more realistic predictions of future climatic events, thereby increasing our ability to mitigate anthropogenic forcing of such future environmental changes. This paper presents a detailed temporal record of variation in $\delta^{18}O$ values of ostracods and marl from a sediment core recovered from Lough Monreagh in County Claire (*Contae an Chláir*), western Ireland to reconstruct a temporal record variation in temperature and $\delta^{18}O_{(H_2O)}$ values of water for the Late Glacial to the Mid-Holocene. Ireland is well positioned near the center of the nodes of the North Atlantic Oscillation (NAO) for development of

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climate records for the North Atlantic. Because the NAO is a dominant climate mechanism of eastern North America and western Europe, its influence extends well beyond the North Atlantic region. Evidence for changing meteorological and oceanic conditions, such as the NAO, migration of the Circumpolar Vortex (CPV), and the vigor of the Atlantic Multidecadal Oscillation (AMO) can be quantified using proxy records of precipitation and temperature from the lake sediment of western Ireland.

Lacustrine biomineralized calcite (marl) has been established as an excellent climatic proxy (e.g. Leng and Marshall, 2004, Hammarlund et al., 2001), with the lakes of Ireland being particularly well-suited for these studies due to preservation of laminated sediment. Lake sediment disturbance is further minimized by blanket bog progradation generating peat that acts as a protective cap. Furthermore, Ireland's maritime location is particularly sensitive to perturbations of the AMO, CPV, and NAO variability, which would be recorded by Irish lake sediment. Ireland's climate is moderated by the North Atlantic Ocean (Jordan, 1997) and the North Atlantic Drift which reduce thermal seasonal extremes, and generate higher temperatures relative to other landmasses at similar latitudes. Changes in the shape, latitude, and intensity of the NAO and CPV reflect changes in Earth's heat budget and air temperatures over time as well as the dispersal of weather-related phenomena such as storms (e.g. Hurrell, 1995; Kirby et al., 2002).

The purpose of this study is to generate a high-resolution water temperature record for the late Glacial and Mid-Holocene which would infer climate variability in Ireland. Our stable isotope record spans approximately 7 thousand years, from 13,670 to 7,000 cal yr B.P., and exhibits evidence of four significant Late Glacial to Mid-Holocene climatic events: the Allerød Interstadial warming, Younger Dryas cooling, the Holocene Hypsithermal warm period, and the 8,200 cal yr B.P cooling. Additionally, two previously undescribed cooling events, each lasting 100 years, were observed. A detailed analysis of ostracod abundance and species variability throughout the core provides a complementary record of environmental change, aiding in the interpretation of our temporal record of water temperatures. Identification of thermally-sensitive ostracod species with well-characterized thermal tolerances allows us to calculate $\delta^{18}O_{(H_2O)}$ values of the host water. $\delta^{18}O_{(H_2O)}$ values calculated from ostracods are coupled with marl $\delta^{18}O_{(CaCO_3)}$ values over the same intervals, quantifying a temporal record of water temperature variability with decadal resolution.

3.3 Study Site and Background

Ireland has a temperate maritime climate moderated principally by the waters of the North Atlantic Drift. Consequently, air temperatures range between 2.5 and 19.0°C, around a mean annual temperature of 9.5°C. Humidity usually ranges from 70-90% with heavy rainfall (~2800mm) along the western coast in winter (MET, 2003). Lough Monreagh is located in Contae an Chláir along the west coast about 20km from the Atlantic Ocean, 23m above sea level, and approximately 4km southeast of the town of An Gort (text-figure 1-A, B) at 53˚01'55"N, 08˚53'55"W. Bedrock geology of the region is largely pure Lower Carboniferous Viséan limestone that was deposited in shallow equatorial seas (Moles and Moles, 2002) with nearby topography (the Slieve Aughty Mountains and Burren Highlands) reaching ~400m elevation. Lakes in western Ireland are well-buffered by the marine carbonate bedrock geology of the region (Mitchell et al., 1996). Biomineralized carbonate production by *Chara spp.* algae within Lough Monreagh generated thick sequences of marl (calcite content >80%), which were overlaid by a thick peat deposit. Modern Lough Monreagh consists of blanket bog with several small open bodies of water, within a small catchment area (2-3km^2). Due to high rainfall, lakes in Western Ireland have short residence times (Diefendorf et al. 2005; 2007; Tibert et al. 2007).

The Global Network for Isotopes in Precipitation (GNIP) monitors precipitation $\delta^{18}O_{(precip)}$ values from a hydrological research station in Valentia in southwestern Ireland. $\delta^{18}O_{(precip)}$ values at Valentia range from -6.0‰ VSMOW in winter to -4.0‰ VSMOW in summer. $\delta^{18}O$ values of the surface waters of Ireland were evaluated previously to assist in selection of the most appropriate lakes for the development of sediment-based paleoclimate records (Diefendorf and Patterson, 2005). Lakes in the Burren region yield $\delta^{18}O_{(H_2O)}$ values range between -4.1 and -6.1‰ VSMOW during the summer months (Diefendorf and Patterson, 2005). During the summer of 2007, Lough Monreagh yielded a mean $\delta^{18}O_{(H_2O)}$ value of -5.2‰ VSMOW, similar to mean precipitation values observed at the Valentia station, suggesting this lake is ideal to develop a sediment-based paleoclimate record.

Ostracods are small, bivalved micro-crustaceans that occupy most natural aquatic systems. Ostracods encountered in Irish sediments generally measure <1mm long posterior to anterior. These organisms precipitate two low-magnesium calcite valves at phosphatic granular epidermis points (Robinson, 1980), one on each side of the organism, that together form a protective carapace around the animal. During their larval development, limnic ostracods produce up to nine calcite carapaces that the organism sheds during molting (von Grafenstein et al., 1994). These shells preserved in the marl record water temperature and $\delta^{18}O_{(H_2O)}$ values as shell $\delta^{18}O_{(CaCO_3)}$ values. The most common ostracod taxa in Burren lakes include limnocytherids and candonids (Tibert et al., 2007; Meisch, 2000), both of which appear in high abundance to determine environmental characteristics of their paleoenvironment including temperature and vegetative productivity rates.

3.4 Methods

The Lough Monreagh core (8.67m) was collected in spring of 2006 (Fig. 2.1) using a Livingstone square-rod piston-coring device (Wright 1967, 1991). Cores were split and sampled at 5cm increments at the University of Mary Washington and these samples were analyzed for total weight percent carbon and $CaCO_3$ using loss on ignition methods modified from Dean (1974).

At the Saskatchewan Isotope Laboratory marl sediment was extracted from the moist core at 1mm resolution except within the 6cm interval of black clay, where 1cm resolution was obtained. Macrofossils and microfossils and visible organics were removed under 30x magnification. The lower 5.5m of core was sampled (1.0cm^{-3} sediment sample size) at 2cm resolution for ostracod valves. Higher resolution sampling (1cm) was conducted from 7.410-7.640m, encompassing the brown band through the 6 cm-thick black clay section. Samples were soaked in a mild solution of triclosan and water to disaggregate the sediment. Adult (late) instar ostracod valve components were separated by stereomicroscope under 30x magnification and extracted from the sediment. Ostracods were identified and classified using the taxonomic scheme of Meisch (2000).

Left valves of each species were counted to obtain organism count for genera and species present per sample.

Ostracod valves of the three most common species were analyzed for stable isotope values. *Limnocytherina sanctipatricii* (core depth >7.171m age >11,007 cal yr B.P.), *Paracandona euplectella* (depth and age interval 7.171 - 6.250m 11,007 - 8,305 cal yr B.P.), and *Metacypris cordata* (depth <6.250m age <8,305 cal yr B.P.) were carefully cleaned with a sable hair artist's paintbrush and selected for $\delta^{13}C_{(CaCO_3)}$ and $\delta^{18}O_{(CaCO_3)}$ analyses. Ostracod valves and marl samples were separately roasted *in vacuo* at 200°C to remove volatiles that may influence isotope values. Stable oxygen isotope values were obtained from both ostracod and marl samples separately using a Kiel IV carbonate preparation device directly coupled to a Finnegan MAT 253 SIRMS in the Saskatchewan Isotope Laboratory. Thirty to fifty microgram samples equating to four to eight ostracod valves (dependent on species and variability in size of adult valves) were reacted with 103% anhydrous phosphoric acid for three minutes at 70ºC. For marl, 1cm resolution in the black clay band was necessary to provide enough carbonate material to meet the minimal CO_2 mass required by the instrument. Oxygen values for both ostracods and marl were reported in standard delta per mille (‰) notation relative to NBS-19 VPDB standards loaded in each run.

The ^{14}C AMS ages were obtained from plant macrofossil material from eight points in the core and were performed at both the Gliwice (Poland) Radiocarbon Laboratory and at the University of Pittsburgh (USA) (Table 2.1). Ages of aquatic plant macrofossil material (gyrogonites) were corrected for the Carboniferous bedrock reservoir effect present in the water and converted to calendar years using CALIB 4.3 (Stuiver et al., 1998).

3.5 Results and Water Temperature Calculation

3.5.1 Facies Description and Composition

Core stratigraphy and sedimentation rates are presented in Figure 2.1C and 2.1D respectively. The Lough Monreagh core consist of two major units: 1) light tan laminated carbonate mud; and 2) Humic peat. The laminated carbonate consisted of >80% carbonate content within which ostracods, charophytes (evidenced by tubular structural textures in the marl and also gyrogonites), gastropods, and mollusks were very abundant. Neither microfaunal nor macrofaunal components were observed within the peat unit. The marl unit contained a 6cm band of black clay with quartz grains, with no microfaunal or macrofaunal content. The transition from marl to peat units occured at 3.42m (6,997 cal yr B.P.).

3.5.2 Ostracod Faunal and Marl $\delta^{18}O_{(CaCO_3)}$ Values

A total of 4,755 ostracods from 287 sediment samples were extracted and identified to the generic and in most cases, the species level. Seven species of ostracoda from four freshwater families were identified and are classified as follows to facilitate discussion: 1) limnocytherids (*Metacypris cordata* and *Linmocytherina sanctipatricii*); 2) darwinulids (*Darwinula stevensoni*); 3) candonids (*Candona candida*, *Fabaeformiscandona protzi*, *Paracandona euplectella*, *Cyclocypris ovum*, and *Candona* sp.); and 4) cyprids (*Cypria* sp. and *Heterocypris* sp.). Unidentified species of cyprids, heterocyprids and candonids are grouped by genera. The Lough Monreagh marl unit contains a relatively abundant population of Limnocytheridae ostracods including *Limnocytherina sanctipatricii* and *Metacypris cordata* (Fig. 2), two limnocytherids that never occur together. *Limnocytherina sanctipatricii* only occurs in the basal sediment with age >11,007 cal yr B.P. of the Lough Monreagh core, that includes sediment just prior to and after the black clay band. When *Limnocytherina sanctipatricii* is present, it usually constitutes >80% of the population of that particular sample. The other limnocytherid *Metacypris cordata* is introduced at 8,305 cal yr B.P. and persists to the peat transition at 6,997 cal yr B.P. Much like *Limnocytherina sanctipatricii*, *Metacypris cordata* is the dominant ostracod present when it occurs in the sample. The 2,700-year gap following the extinction on *L. sanctipatricii* in Lough Monreagh and the appearance of *M. cordata* is characterized by candonids and cyprids. Darwinulids occur in strata with a similar range as *M. cordata*.

Marl $\delta^{18}O_{(CaCO_3)}$ values obtained from 3,186 samples recovered at 1mm intervals from the entire marl sediment sequence were time-averaged over the interval of each ostracod sample for the calculation of temperatures. $\delta^{18}O_{(CaCO_3)}$ VPDB values obtained from *Limnocytherina sanctipatricii* and *Paracandona euplectella* display high frequency

2‰ shifts during Allerød and post-Younger Dryas sedimentation (Fig. 3.1). A rapid 2‰ decrease in marl $\delta^{18}O_{(CaCO_3)}$ values observed at 8,305 cal yr B.P., coincides with decreasing values obtained from *Metacypris cordata*. The gap in the results from 12,710- to 11,596 cal yr B.P. is due to lack of ostracods in the black clay horizon.

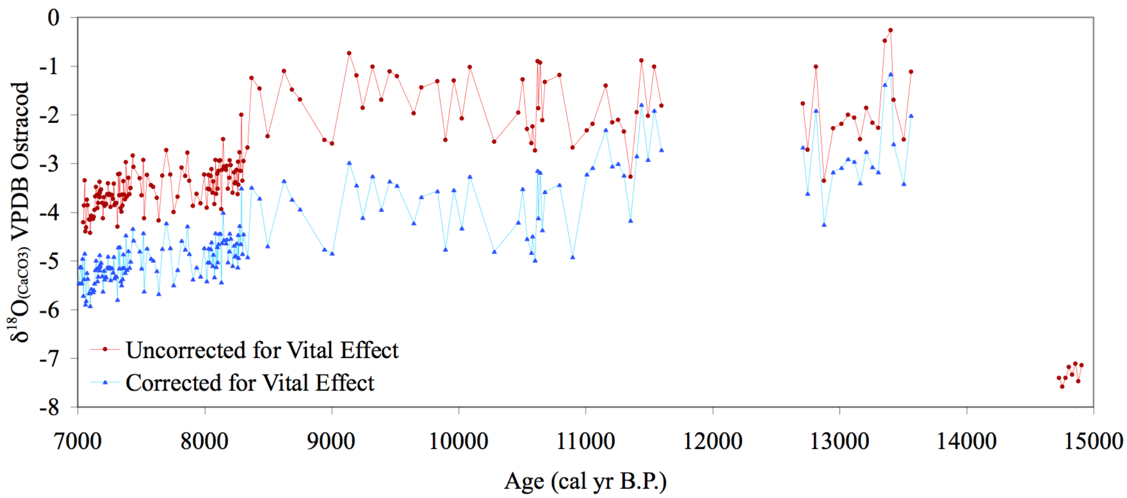

Figure 3.1. $\delta^{18}O_{(CaCO_3)}$ ostracod values uncorrected for vital effect (red data) and corrected for vital effect (blue data) from Lough Monreagh.

3.5.3 Vital Effects on Ostracod $\delta^{18}O_{(CaCO_3)}$ Values

Biological processes that override the environmental signal were first outlined in mollusks (Urey et al., 1951). Epstein and colleagues (1951) also noted that biogenic minerals are not deposited in isotopic equilibrium because of "the presence of a physiological effect in the case of certain groups of animals…" (Epstein et al., 1951). In the geochemical community, the "physiological effect" has since become known as the vital effect (e.g. Keatings et al. 2002; Holmes and Chivas 2002). Vital effects complicate paleoenvironmental oxygen isotope studies because the original environmental signal being modified or partially erased by the organism. Causes of nonequilibrium biomineralization are not completely understood (Holmes, 2001) but some speculation may be made here. Most organisms that precipitate biomineralized calcite have been observed to calcify the mineral within or between cells (Lowenstam and Weiner, 1989; Simkiss and Wilbur, 1989). Weiner and Dove (2003) suggest that cells transport all the raw material ions to the calcification site, which may be remote from the source of the ions such as the host environment. Additionally, these ions are often temporarily stored in membrane-bound vesicles and re-dissolved. It is reasonable to speculate that equilibrium may not be maintained between the resulting biomineralized calcite and the ambient host water (Weiner and Dove, 2003).

Until recently, some groups of animals known to exhibit vital effects have been simply avoided for reconstructing climate, but ongoing research attempts to quantify the oxygen vital effect induced by ostracoda from all three freshwater superfamilies: Cytheroidea; Cyproidea; and Darwinuloidea. Ostracoda cultured in controlled conditions induce fractionation of oxygen isotopes (e.g. Xia et al., 1997; Keatings et al., 2002). In addition, this fractionation is also observed in natural settings as elevated oxygen isotope values of the ostracod calcite compared to the oxygen value of the host water. Other groups have quantified vital effects for the three taxa whose oxygen isotope values are used to reconstruct the water temperature of Lough Monreagh (von Grafenstein et al., 1999; Schwalb, 2002; Holmes and Chivas, 2002)

Ten members of the Candonidae family, one Limnocytherid (*Limnocythere inopinata*), and other species from avaliable taxa were rigorously sampled and tested from two south German (Bavarian) lakes, Starnberger See and Ammersee, for seasonal oxygen vital effects (von Grafenstein et al. 1999). Ostracods and water were obtained over the course of one year at 14-day intervals from two depths (5 and 20m) in each of the two lakes with differing $\delta^{18}O$ water values. Grafenstein measured water temperature (recorded from 4 to 21°C during the study) and water isotope values ($\delta^{2}H$, $\delta^{18}O$) were measured throughout the year to determine the isotope value of theoretical calcite forming under these conditions on the basis of calibrated equations of oxygen isotope fractionation $\alpha = 1.0412$ from Friedman and O'Neil, 1977. These theoretical values were then compared to $\delta^{18}O$ values obtained from the ostracod calcite. Seasonal temperatures or $\delta^{18}O$ water variations of could not explain disagreements of ostracod calcite values from the theoretical calcite values in the deeper sampling sites. Therefore, no taxa formed their shells at isotopic equilibrium. Vital effects were reported to be nearly the same for all valves of a taxon and temperature independent. Vital effect values for all candonids tested were remarkably similar at +2.2 ±1.5‰ from the theoretical calcite value while *Limnocythere inopinata* vital effect is reported at 0.73 ±0.23‰. This means that the uncorrected values obtained from candonids are 2.2‰ higher than correct values.

In addition, mean water temperatures during calcification are readily correlated in the valve $\delta^{18}O$ if corrected for the vital effect (von Grafenstein et al. 1999).

Valves of *Limnocytherina sanctipatricii* were obtained from a core taken from the sediment surface at 186m depth in Lake Constance (Schwalb, 2002), located on the German-Austrian border. Water temperatures 1m above the sediment surface varied between 4-5°C annually (IGKB, 1998). Modern bottom water $\delta^{18}O$ values and temperatures should yield theoretical $\delta^{18}O_{calcite}$ values of approximately -8.8‰ VPDB based on fractionation factors and calibrated equations from Friedman and O'Neil (1977). This theoretical value was compared to -7.8 to -8.0‰ VPDB for *Limnocytherina sanctipatricii* in the bottom waters (Schwalb, 2002), suggesting an offset of around +0.8 to +1.0‰, an offset value similar to those of *Limnocythere inopinata* from southern German lakes (von Grafenstein et al., 1999). It is currently unknown if other members of the *Limnocytherina*-*Limnocythere* genera have vital effects in the range of +0.8 to +1.0‰ but this vital effect value has been accepted by others (Tibert et al., 2007) in stable oxygen isotope reconstructions. A vital effect value of +1.5 ±0.7‰ has been estimated for *Metacypris cordata* (Holmes and Chivas, 2002; Keatings, 1999).

Vital effects appear to be constant for all instars within a species and are temperature independent. Oxygen isotope values of *Limnocytherina sanctipatrii*, *Paracandona euplectella*, and *Metacypris cordata* corrected for the vital effects are presented in Figure 3.1.

3.5.4 $\delta^{18}O_{(H_2O)}$ Values of Lough Monreagh (13,561-to 6,997 cal yr B.P.)

Derivation of water $\delta^{18}O_{(H_2O)}$ values of the ostracod host water requires knowledge of thermal tolerance and preference for ostracods. With temperature of calcification constrained by thermal tolerance and $\delta^{18}O_{(CaCO_3)}$ values determined in the laboratory, the $\delta^{18}O_{(H_2O)}$ value can be calculated. For instance, *Limnocytherina sanctipatricii* is a cold-stenothermic species that is found in deep profundal zones of modern Alpine lakes of central Europe where the temperatures are consistently 4-5°C (Schwalb, 2002; von Grafenstein et al., 1994). By contrast, *Metacypris cordata* is considered a warm-water stenothermic species populating forested alkali fen environments, with optimum productivity at water temperatures of 14-20°C (Hiller, 1972; Danielopol et al., 1996). *Paracandona euplectella*, like most of the *Candona spp*. observed in this study are much more problematic for use in determining summer aquatic temperatures due to the lack of information about their life cycle and their very wide distribution in nearly every meso- to eutrophic environment in every ecozone in Europe (Meisch, 2000). In lakes such as Toole's Lake in western Ireland, candonids are common in the upper 1m littoral zone on the benthos sediment where I observed wind-driven turnover. Thus, I speculate that temperature may vary between minima of ~7°C and maxima ~13°C. Ostracod $\delta^{18}O_{(CaCO_3)}$ values and thermal preferences are thus used to calculate the $\delta^{18}O_{(H_2O)}$ value of the lake using the Kim and O'Neil equation (1997) to derive the fractionation factor $\alpha_{(CaCO_3\text{-}H_2O)}$ using the species temperature T in Kelvin:

$$10^3 \ln \alpha_{(CaCO_3\text{-}H_2O)} = 18.03(10^3/T) - 32.42 \qquad \text{(Eq. 3)}$$

Mean values of $\alpha_{(CaCO_3\text{-}H_2O)}$ for *Limnocytherina sanctipatricii* are 1.033, for *Paracandona euplectella* the $\alpha_{(CaCO_3\text{-}H_2O)}$ value was 1.031, and for *Metacypris cordata*, 1.030.

The $\alpha_{(CaCO_3\text{-}H_2O)}$ values were then converted to $\delta^{18}O_{(H_2O)}$ values using measured $\delta^{18}O_{(CaCO_3)}$ values:

$$\alpha_{CaCO3-H2O} = \frac{1\,000 + \delta_{CaCO3}}{1\,000 + \delta_{H2O}} \qquad \text{(Eq. 4)}$$

$\delta^{18}O_{(H_2O)}$ values V-SMOW (figure 3.2) calculated from ostracod calcite at the maximum, minimum, and mean thermal tolerances are combined with $\delta^{18}O_{(CaCO_3)}$ from contemporaneous time-averaged marl samples to calculate water temperatures (figure 3.3).

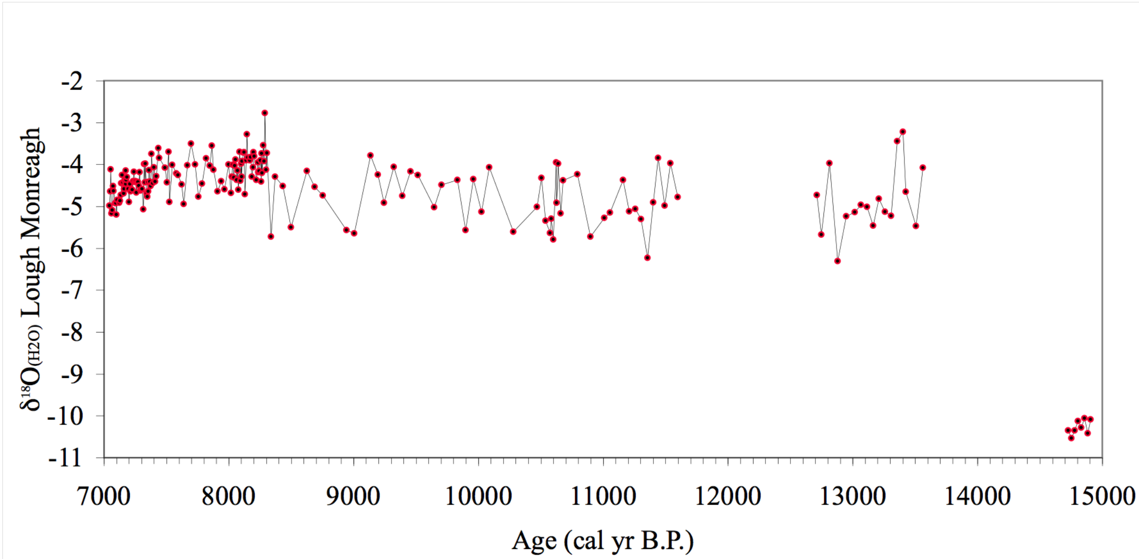

Figure 3.2. $\delta^{18}O_{(H_2O)}$ values VSMOW of Lough Monreagh lake paleowater determined using $\delta^{18}O_{(CaCO_3)}$ and thermal preferences of the species identified instars calculated through the Kim and O'Neil (1997) equation.

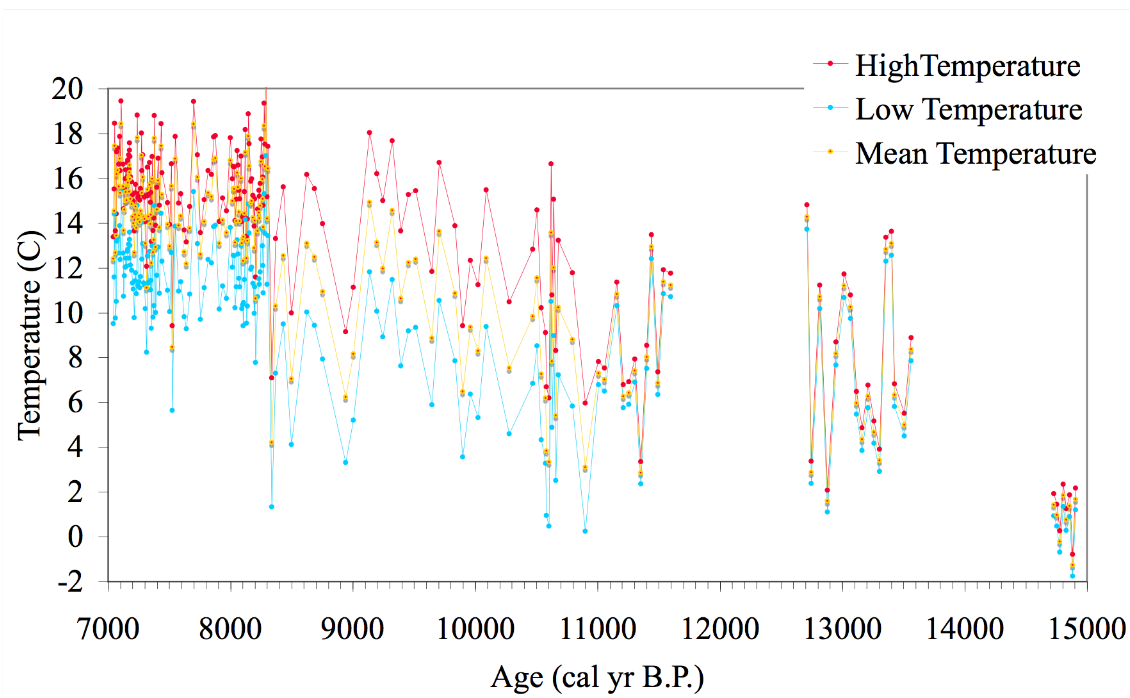

Figure 3.3. Lough Monreagh lake water temperatures calculated from contemporaneous time-averaged marl $\delta^{18}O_{(CaCO_3)}$values. The red line represents upper limit of probable temperature range while the blue line illustrates the lower limit of the probable temperature range. Mean temperatures were calculated as the mean of maxima and minima temperatures.

3.6 Discussion

Two factors influence $\delta^{18}O_{(CaCO_3)}$ ostracod values: $\delta^{18}O_{(H_2O)}$, and temperature. It is apparent from figure 3.2 that $\delta^{18}O_{(H_2O)}$ values of Lough Monreagh vary considerably from the Late Glacial. $\delta^{18}O_{(CaCO_3)}$ values of the oldest ostracods (>14,500 cal year B.P.) in this record are 5‰ lower than those occuring later in the Late Glacial (13,500 to 12,700 cal year B.P.) despite representing the same species (*Limnocytherina sanctipatricii*). Similar changes during this portion of the Late Glacial 15,000 to 13,000 cal year B.P. have been observed before in $\delta^{18}O_{(CaCO_3)}$ ostracod values of Bavarian (German) lakes in central Europe (von Grafenstein et al., 1994). Grafenstein attributed variability in $\delta^{18}O_{(CaCO_3)}$ ostracod value changes to localized Alpine glacial meltwater bursts with lower $\delta^{18}O_{(H_2O)}$ values. Lough Monreagh $\delta^{18}O_{(H_2O)}$ values >14,500 cal yr B.P. reflects low $\delta^{18}O_{(H_2O)}$ value glacial meltwaters following the deglaciation of northeastern and southwestern Ireland 18,000 to 15,000 cal yr B.P. (Lambeck, 1996). It is likely glacial meltwater strongly affected $\delta^{18}O_{(H_2O)}$ values in the Late Glacial >14,500 cal years B.P.

The remainder of the time series displays sustained 2-3‰ $\delta^{18}O_{(H_2O)}$ variability (fig 3.2), which suggests that Rayleigh distillation was relatively constant from 14,000 to 7,000 kyr B.P. Water temperature values for the Mid-Holocene are higher than the values immediately following the Younger Dryas. These increased water temperatures could translate to increased air temperatures. Water temperatures yielded from $\delta^{18}O_{(CaCO_3)}$ marl values from Lough Monreagh are in substantial agreement with ostracod thermal tolerance values obtained from other studies (e.g. von Grafenstein et al, 1994; Schwalb, 2002; Meisch 2000) suggesting $\delta^{18}O_{(CaCO_3)}$ ostracod values faithfully record water temperature variability in the lake. While there is general consensus that temperatures were elevated during the early to mid Holocene, our time series demonstrates both water temperature values and variability, which are essential for quantitative climate interpretations. For instance we recognize an overall increase in water temperatures during the early Holocene, culminating at about 8,000 cal yr B.P. that may be related to the onset of the Holocene Hypsithermal. The termination of our record at 6,997 cal year B.P. is likely due to the transition of the lake to the modern blanket bog.

3.7 Conclusions

I have demonstrated that ostracod geochemistry has the potential to quantify water temperature changes in lakes using thermal tolerances and the relationship between $\delta^{18}O_{(CaCO_3)}$ of contemporaneous ostracods and marl to derive $\delta^{18}O_{(H_2O)}$ values and water temperatures. These water temperature changes could relate to North Atlantic regional climate change. The results presented here have the potential to improve North Atlantic climate interpretations from proxy $\delta^{18}O_{(CaCO_3)}$ values. We identify an 8°C water temperature increase beginning from the onset of the Holocene following the Younger Dryas excursion to the end of our record at 6,997 cal yr B.P. We also identify the onset of the mid-Holocene Hypsithermal at ~8,000 cal year B.P. We link ostracod $\delta^{18}O_{(CaCO_3)}$ values to faunal environmental relationships to provide convincing arguments for regional climate change from the Late Glacial through the Mid-Holocene.

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Figure Captions

Figure 3.1. $\delta^{18}O_{(CaCO_3)}$ ostracod values uncorrected for vital effect (red data) and corrected for vital effect (blue data) from Lough Monreagh.

Figure 3.2. $\delta^{18}O_{(H_2O)}$ values VSMOW of Lough Monreagh lake paleowater determined using $\delta^{18}O_{(CaCO_3)}$ and thermal preferences of the species identified instars calculated through the Kim and O'Neil (1997) equation.

Figure 3.3. Lough Monreagh lake water temperatures calculated from contemporaneous time-averaged marl $\delta^{18}O_{(CaCO_3)}$values. The red line represents upper limit of probable temperature range while the blue line illustrates the lower limit of the probable temperature range. Mean temperatures were calculated as the mean of maxima and minima temperatures.

CHAPTER 4. CONTRIBUTIONS OF THESIS

4.1. Summaries of Manuscripts

Both manuscripts (Chapters 2 and 3) presented in this thesis are directly related to each other in that they utilize stable isotope geochemistry of ostracoda to characterize the paleoclimate of Ireland during the Late Glacial to the Mid-Holocene.

Chapter 2 provided the highest resolution ostracod-derived proxy time series to date. This time series integrated carbon isotope values of ostracod calcite with loss on ignition of the bulk organic material and ostracod faunal assemblages to identify the response of lake water DIC to changes in the vegetative mass rates in the lake's watershed. Late Glacial Lough Monreagh was a cool-water, oligotrophic system with the aquatic DIC control dominated by bedrock erosion and hosted in an environment with limited terrestrial vegetation as evidenced by the prevalence of *Limnocytherina sanctipatricii* in the ostracod community and relatively high $\delta^{13}C_{(CaCO_3)}$ values of the ostracod shell. The Younger Dryas is manifested in the lake record as an ostracod deficient black clay section, signifying low energy and anoxic conditions associated with continuous ice cover. During the Holocene, terrestrial vegetation and productivity rates increased and lake DIC shifts to include increased amounts of oxidized organic detritus as evidenced by lower $\delta^{13}C_{(CaCO_3)}$ values. Further, the appearance of *Metacypris cordata* provided evidence of increasing lake eutrophication and warm-water alkali fen environmental conditions in the lake during the Holocene.

Chapter 3 provides a high-resolution archive of paleoclimate from the Late Glacial and Mid-Holocene. I have demonstrated that ostracod geochemistry has the potential to quantify water temperature changes in freshwater ecosystems using species-specific thermal tolerance along with the relationship between $\delta^{18}O_{(CaCO_3)}$ of contemporaneous ostracods and marl to derive $\delta^{18}O_{(H_2O)}$ and water temperatures. The results presented here have the potential to improve North Atlantic climate interpretations from proxy $\delta^{18}O_{(CaCO_3)}$ values. I identified water temperature increased beginning from the onset of the Holocene following the Younger Dryas excursion to the end of the record at 6,997 cal yr B.P. I identified the onset of the Mid-Holocene Hypsithermal to occur at about 8,000 cal year B.P. I linked ostracod $\delta^{18}O_{(CaCO_3)}$ values to faunal environmental relationships and provided convincing arguments for regional climate change from the Late Glacial through the Mid-Holocene.

4.2. Ecosystem and Climate

In the Late Glacial, Lough Monreagh was characterized by clear-, cool waters as evidenced by the relative abundance of the ostracod *Limnocytherina sanctipatricii*, which occupies modern Alpine and Northern Scandinavian lakes. Provided the environmental necessities of this species had not changed over the course represented in the study, environments it occupies today should be representative of what it occupied 14,500 years ago. Additional evidence include relatively high $\delta^{13}C$ values, which reflect values of DIC in the water shed, signifying the DIC was firmly controlled by bedrock erosion during this time. Water temperatures obtained during this period yield values within *Limnocytherina sanctipatricii*'s thermal tolerance with values 4-11ºC. The 6cm black clay contained material that was interpreted to be 1,200 years of extreme climate that suggested advancement of tundra southwards into the Burren region during the Younger Dryas cooling event. The Younger Dryas was preceded by about 80 years of vegetational clearing, as evidenced by increased abundance of *L. sanctipatricii* and increased $\delta^{13}C$ values.

The Early Holocene was punctuated with substantial high frequency high amplitude changes in vegetation, as was evidenced by variable $\delta^{13}C$ values of lake DIC. The faunal arrangement during this time period suggested variable nutritional content as well. The nutritional content exceeded those required by *Limnocytherina sanctipatricii* that forced this species into decline. Additionally, increased relative abundance of candonids suggested an overall increase in temperature to values higher than those tolerated by *L. sanctipatricii*, which forced this species' extinction from the lake. The species that were present in the early Holocene were tolerant of a wide range of environmental factors, which allowed them to persist during these highly variable climate changes. The $\delta^{18}O$ proxy supported the faunal proxy conclusion: that temperatures, while highly variable, were elevated during the early Holocene compared to the previous Late Glacial.

The well-known 8.2 kyr cooling event was marked in this study as a decrease in $\delta^{13}C$ and temperature, which is concomitant with previous studies (e.g. GISP; Diefendorf et al. 2007; Tibert et al; 2007). Recognizing the 8.2 kyr event was a test of this research, and its presence here suggested that these proxies do record climate accurately. Following the 8.2kyr event, Metacypris cordata dominated the faunal sequence, which suggested warm-, nutrient rich waters and a relative increase in vegetation. Summer temperatures were elevated to 14-20ºC, likely at the warmer end of the range due to the appearance of *Darwinula stevensonii*, and the temperature proxy corroborated well with thermal tolerances of these species. The onset of peat that occurred at 7,000 cal yr B.P. may be due to tree removal by early anthropogenic activities, which increased envirotransporation near the lake, but this remains highly speculative.

The ostracod faunal succession observed in this research was first seen by Absolon (1973) and reinforced by Boomer (2002), both of whom attributed this faunal succession to the "evolution" of lakes: clean bottom, clear water, low nutritional environments to murky, high nutritional, warm water containing a relative increase in organic detritus. All proxies corroborate well with the known modern ecological needs of the accompanying species. Some caveats, however, exist. For instance, the temperature of shell formation was estimated, based on values reported in previous studies. However, the constrained $\delta^{18}O_{(H2O)}$ values obtained (fig 3.2) suggested that the temperatures used are quite accurate. An additional caveat was the effect of diet and respiration on ostracod $\delta^{13}C_{(CaCO3)}$. It has not been disproven (von Grafenstein et al. 1999; Holmes and Chivas 2002) that there is an effect of diet or respiration on shell carbon values, but the presence of an oxygen vital effect leads one to suspect there could be a carbon vital effect as well. Unfortunately, this aspect was not tested in this study, and more work is needed in this topic.

4.3. Resolution

An additional value of this research was the resolution. GISP (Greenland Ice Sheet Project) and Lough Monreagh temperatures, plotted alongside each other (fig. 4.1), illustrate the resolution obtained in this research. Many climate events are potentially "missed" or not observed at lower resolution sampling. For instance, Lough Monreagh temperature temporal series suggested a warming event at about 7,240 cal yr B.P., which was not observed in the GISP data due to its resolution. Small events such as this one may be periodic, and signify a high-frequency climate cycle resulting in thermal increase. This event was a 4ºC increase in water temperature, which could be comparable to the modern warming event. To determine if these events are related, statistical analysis will be run on the time series. The high resolution provided by this research will contribute to climate studies by providing climate cycling occurring 14,000 to 7,000 cal yr B.P. These prehistoric cycles could be compared to the historic and modern instrumental records to validate long term climate cycles and their frequencies.

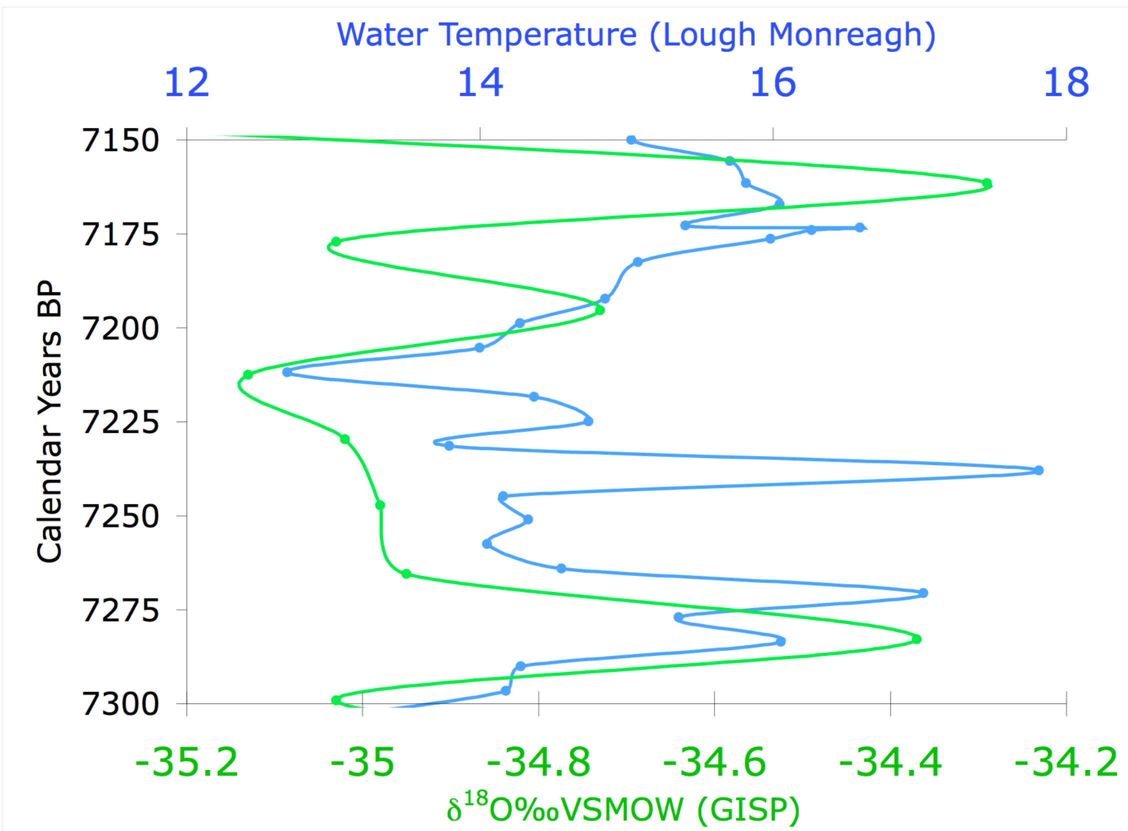

Figure 4.1. Illustration of resolution of Lough Monreagh water temperature (cyan) compared to GISP $\delta^{18}O$ ice core values (green) for the time period 7,150-7,300 cal yr B.P. Twenty-six data points from this time interval while GISP revealed nine data points.

The resolution achieved in this study was truly outstanding. As further convincement, it must be emphasized that the presence of varves in the sediment ensured that the record and its proxies were not disturbed over time. This is contradictory to the

GISP core, where compaction of material potentially led to inaccurate dating and data analysis in the older sections of the record.

4.4 Conclusion

In conclusion, I have utilized ostracod faunal signatures, $\delta^{18}O$ and $\delta^{13}C$ of their calcite shells, and determined the chemical content of the accompanying sediment in a multipoxy study to determine the paleoecology and temperature of ancient Irish Lough Monreagh. I have characterized ostracod fauna populations and determined species relative abundances that resulted in an accurate description of the paleoecosystem of the lake at various times. I have proven that $\delta^{13}C$ of ostracod shells reflect landscape DIC control and are related to landscape vegetation increases and retreats, which corroborated well to known species environmental factors. I have also demonstrated that $\delta^{18}O$ of the calcite shells record the temperature of the lake when the ostracods were living, provided both vital effect and $\delta^{18}O$ of the water were constrained. This research yielded the highest resolution record of environmental and temperature change from 14,500 to 7,000 cal yr B.P. that provided a telling argument that climate acts on long term, high frequency, and dramatic cycles. The driver of the changes, however, has not yet been determined.

4.5. References

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Figure Captions

Figure 4.1. Illustration of resolution of Lough Monreagh water temperature (cyan) compared to GISP $\delta^{18}O$ ice core values (green) for the time period 7,150-7,300 cal yr B.P. Twenty-six data points from this time interval while GISP revealed nine data points.

APPENDIX A. OSTRACODA CENSUS COUNTS FROM THE LOUGH MONREAGH CORE

		Limnocytheridae		Candonidae			Cyclocyprididae			Darw.	Census
Strat.	Age (Cal)	*L. sanc.*	*M. cord.*	*C. cand.*	*F. protzi*	*P. eupl.*	*C. ovum*	*Cypria* sp.	*Het.* sp.	*D. stev.*	Total
3.40	6997	0	12	1	0	2	0	0	1	0	16
3.42	7008	0	23	0	0	4	0	0	0	1	28
3.44	7014	0	17	0	0	5	0	0	1	2	25
3.46	7020	0	16	1	0	3	0	0	2	2	24
3.48	7025	0	18	2	0	8	0	0	0	3	31
3.50	7031	0	25	3	0	10	0	0	1	2	41
3.52	7037	0	22	0	0	8	0	0	0	0	30
3.54	7042	0	24	5	0	9	0	0	0	0	38
3.56	7048	0	25	3	0	7	0	0	2	0	37
3.58	7054	0	17	1	0	8	0	0	1	0	27
3.60	7059	0	21	0	0	9	0	0	2	0	32
3.62	7065	0	20	0	0	7	0	0	0	0	27
3.64	7071	0	18	5	0	13	0	0	1	1	38
3.66	7076	0	22	3	0	8	0	0	1	0	34
3.68	7082	0	17	3	0	7	0	0	1	0	28
3.70	7088	0	12	2	0	7	0	0	1	0	22
3.72	7093	0	15	1	0	9	0	0	0	0	25
3.74	7099	0	14	3	0	11	0	0	2	0	30
3.76	7105	0	33	2	0	11	0	0	2	0	48
3.78	7110	0	14	0	0	13	0	0	3	0	30
3.80	7116	0	17	1	0	5	0	0	7	1	31
3.82	7122	0	32	4	0	16	0	0	6	1	59
3.84	7127	0	16	2	0	10	0	0	2	0	30
3.86	7133	0	17	3	0	7	0	1	2	1	31
3.88	7139	0	28	3	0	13	0	0	2	2	48
3.90	7144	0	33	3	0	4	0	0	1	2	43
3.92	7150	0	28	2	0	11	0	0	1	1	43
3.94	7156	0	19	2	0	6	0	0	2	0	29
3.96	7161	0	25	1	0	4	0	0	1	1	32
3.98	7167	0	20	1	0	4	0	0	1	2	28
4.00	7173	0	27	1	0	9	0	0	1	1	39
4.10	7175	0	19	1	0	10	0	1	1	6	38
4.12	7176	0	16	6	0	14	0	0	1	0	37
4.14	7177	0	27	2	0	3	0	1	1	0	34
4.16	7182	0	15	1	0	3	0	0	0	0	19
4.19	7192	0	18	3	0	8	0	0	2	0	31
4.21	7199	0	18	5	0	14	0	0	1	0	38
4.23	7205	0	22	1	0	10	0	0	1	0	34
4.25	7212	0	26	4	0	10	0	0	2	0	42
4.27	7218	0	31	3	0	10	0	0	2	3	49
4.29	7225	0	18	1	0	9	0	0	1	0	29
4.31	7231	0	21	3	0	15	0	0	2	1	42
4.33	7238	0	16	2	0	7	0	0	1	0	26
4.35	7244	0	37	3	0	12	0	0	3	1	56
4.37	7251	0	30	2	0	10	0	0	1	0	43
4.39	7257	0	37	4	0	15	0	0	2	0	58

4.41	7264	0	29	1	0	11	0	0	1	1	43
4.43	7271	0	26	4	0	12	0	1	2	1	46
4.45	7277	0	28	0	0	10	0	0	2	0	40
4.47	7284	0	48	3	0	10	0	0	1	0	62
4.49	7290	0	46	3	0	12	0	0	0	2	63
4.51	7297	0	40	0	0	12	0	2	4	0	58
4.53	7303	0	16	3	0	5	0	0	0	0	24
4.56	7313	0	46	1	0	15	0	0	5	0	67
4.58	7319	0	46	1	0	14	0	1	3	0	65
4.60	7326	0	40	10	0	18	0	1	6	0	75
4.61	7329	0	16	1	0	5	0	0	1	0	23
4.64	7339	0	30	1	0	2	0	0	7	0	40
4.66	7345	0	39	0	0	3	0	0	3	0	45
4.68	7352	0	41	2	0	9	0	2	7	0	61
4.70	7358	0	10	2	0	3	0	2	2	0	19
4.72	7365	0	16	2	0	5	0	0	2	0	25
4.74	7371	0	22	0	0	3	0	1	3	2	31
4.76	7378	0	25	2	0	3	0	1	4	0	35
4.79	7388	0	24	3	0	5	0	1	2	4	39
4.82	7397	0	17	1	0	2	0	1	3	2	26
4.85	7407	0	23	2	0	4	0	2	2	2	35
4.88	7417	0	35	2	0	3	0	0	5	2	47
4.91	7427	0	13	0	0	2	0	0	1	0	16
4.93	7433	0	22	1	0	8	0	0	2	0	33
4.95	7440	0	12	0	0	3	0	0	0	0	15
4.98	7487	0	20	0	0	2	0	1	2	0	25
5.09	7519	0	13	2	0	2	0	1	1	1	20
5.10	7534	0	31	3	0	5	0	0	0	0	39
5.12	7549	0	22	5	0	8	0	0	1	0	36
5.14	7580	0	38	7	0	7	0	1	1	0	54
5.15	7597	0	24	3	0	3	0	0	2	0	32
5.16	7612	0	11	4	0	0	0	0	0	0	15
5.18	7642	0	16	4	0	2	0	0	0	0	22
5.20	7673	0	14	4	0	0	0	0	0	1	19
5.22	7703	0	10	3	0	7	0	2	1	0	23
5.24	7735	0	6	2	0	0	0	2	0	0	10
5.26	7765	0	6	4	0	3	0	1	0	0	14
5.28	7796	0	17	3	0	3	0	3	1	3	30
5.30	7826	0	11	3	0	3	0	2	0	0	19
5.32	7857	0	16	3	0	3	0	2	0	1	25
5.34	7889	0	26	4	0	8	0	1	0	0	39
5.36	7919	0	13	3	0	4	0	2	0	0	22
5.38	7950	0	22	2	0	4	0	2	0	0	30
5.40	7980	0	21	2	0	3	0	1	0	0	27
5.42	8012	0	10	2	0	2	0	2	0	0	16
5.44	8019	0	7	1	0	2	0	1	0	0	11
5.46	8027	0	21	3	0	5	0	2	1	0	32
5.48	8034	0	15	3	0	7	0	2	1	0	28
5.50	8042	0	17	2	0	3	0	2	0	0	24

5.52	8049	0	15	3	0	4	0	2	3	0	27
5.54	8057	0	7	2	0	8	0	3	0	0	20
5.56	8064	0	10	1	0	2	0	2	0	0	15
5.58	8072	0	12	1	0	6	0	3	0	0	22
5.60	8079	0	15	2	0	7	0	4	2	0	30
5.62	8087	0	18	2	0	2	0	4	0	0	26
5.64	8094	0	10	2	0	2	0	3	0	0	17
5.66	8101	0	11	1	0	9	0	2	3	0	26
5.68	8109	0	10	0	0	12	0	4	2	0	28
5.70	8117	0	24	3	0	12	0	3	0	0	42
5.72	8124	0	16	4	0	8	0	4	0	0	32
5.74	8131	0	15	2	0	11	0	4	0	0	32
5.76	8139	0	12	2	0	6	0	3	0	0	23
5.78	8147	0	17	3	0	9	0	4	0	0	33
5.80	8154	0	9	4	0	7	0	3	0	0	23
5.82	8161	0	3	2	0	2	0	1	0	0	8
5.84	8169	0	17	3	0	6	0	0	1	0	27
5.86	8176	0	17	2	0	2	0	3	0	0	24
5.88	8184	0	9	2	0	3	0	2	0	0	16
5.90	8191	0	5	2	0	2	0	2	0	0	11
5.92	8199	0	14	2	0	2	0	2	0	0	20
5.94	8206	0	10	3	0	4	0	1	0	0	18
5.96	8214	0	2	1	0	2	0	1	0	0	6
5.98	8221	0	11	2	0	4	0	2	0	0	19
6.13	8232	0	6	3	0	6	0	2	0	0	17
6.14	8236	0	4	2	0	6	0	0	0	0	12
6.16	8244	0	7	1	0	6	0	2	0	0	16
6.18	8252	0	8	1	0	7	0	3	0	0	19
6.20	8259	0	4	1	0	7	0	0	0	0	12
6.21	8263	0	4	2	0	4	0	1	0	0	11
6.22	8267	0	6	2	0	8	0	3	0	0	19
6.24	8274	0	11	0	1	6	0	3	0	0	21
6.26	8282	0	6	2	2	7	0	3	0	0	20
6.28	8290	0	3	2	3	3	0	3	0	0	14
6.30	8298	0	5	2	1	5	0	0	0	0	13
6.32	8305	0	4	1	2	6	0	2	1	0	16
6.33	8331	0	0	1	0	4	0	1	0	0	6
6.34	8356	0	1	0	0	1	0	0	0	0	2
6.36	8406	0	0	0	1	2	0	2	0	0	5
6.38	8455	0	0	1	2	3	0	3	0	0	9
6.40	8506	0	0	1	3	4	0	2	0	0	10
6.42	8556	0	0	2	1	3	0	1	1	0	8
6.44	8607	0	0	0	0	5	0	1	0	0	6
6.46	8655	0	0	0	1	4	0	2	1	0	8
6.48	8706	0	0	0	1	1	0	1	1	0	4
6.50	8757	0	0	0	2	1	0	2	0	0	5
6.52	8807	0	0	2	2	3	0	2	1	0	10
6.54	8856	0	0	4	1	2	0	2	1	0	10
6.56	8907	0	0	4	2	6	0	3	2	0	17

6.58	8957	0	0	4	1	4	0	1	1	0	11
6.60	9006	0	0	2	0	3	0	2	0	0	7
6.62	9056	0	0	2	4	7	0	2	2	0	17
6.64	9107	0	0	2	5	4	0	4	3	0	18
6.66	9158	0	0	2	4	4	0	2	1	0	13
6.68	9206	0	0	2	1	1	0	1	1	0	6
6.70	9257	0	0	0	0	3	0	2	1	0	6
6.72	9308	0	0	2	3	8	1	4	2	0	20
6.74	9358	0	0	2	4	7	2	1	0	0	16
6.76	9407	0	0	0	2	4	1	1	2	0	10
6.78	9458	0	0	3	1	4	0	2	2	0	12
6.80	9508	0	0	3	2	6	2	2	1	0	16
6.82	9557	0	0	6	3	7	4	3	1	0	24
6.84	9607	0	0	2	0	4	1	1	0	0	8
6.86	9658	0	0	2	0	4	2	1	0	0	9
6.88	9709	0	0	2	1	6	1	2	1	0	13
6.90	9757	0	0	3	2	8	3	3	2	0	21
6.92	9808	0	0	2	1	4	2	2	1	0	12
6.94	9859	0	0	0	2	1	1	2	0	0	6
6.96	9909	0	0	2	1	1	2	2	1	0	9
6.97	9934	0	0	0	2	3	0	1	0	0	6
6.98	9958	0	0	2	1	1	1	2	0	0	7
7.18	10008	0	0	3	1	3	2	1	0	0	10
7.19	10035	0	0	0	0	3	2	1	0	0	6
7.20	10061	0	0	0	1	2	2	3	0	0	8
7.21	10090	0	0	0	0	2	1	2	0	0	5
7.22	10124	0	0	0	1	1	1	2	0	0	5
7.24	10191	0	0	0	1	2	1	1	0	0	5
7.26	10261	0	0	2	2	1	1	0	0	0	6
7.28	10328	0	0	2	1	2	1	0	0	0	6
7.30	10396	0	0	2	4	2	5	0	0	0	13
7.32	10466	1	0	1	1	2	0	0	0	0	5
7.34	10533	0	0	2	1	2	2	0	0	0	7
7.36	10603	0	0	0	0	1	3	0	0	0	4
7.38	10670	0	0	0	1	3	6	3	0	0	13
7.40	10738	0	0	0	3	2	8	3	0	0	16
7.41	10771	3	0	0	2	3	3	2	0	0	13
7.42	10808	2	0	0	1	0	1	1	0	0	5
7.43	10842	2	0	0	0	0	1	0	0	0	3
7.44	10875	3	0	0	1	1	3	0	0	0	8
7.45	10909	2	0	0	0	0	0	0	0	0	2
7.46	10942	4	0	0	0	0	3	0	0	0	7
7.47	10979	4	0	0	0	0	0	0	0	0	4
7.48	11013	3	0	0	0	0	0	0	0	0	3
7.49	11046	8	0	0	0	0	1	0	0	0	9
7.50	11080	3	0	0	0	0	2	1	0	0	6
7.51	11114	3	0	0	0	0	1	1	0	0	5
7.52	11150	1	0	0	0	0	2	0	0	0	3
7.53	11213	3	0	0	0	0	2	1	0	0	6

7.54	11275	1	0	0	0	0	0	0	0	0	1
7.55	11338	0	0	0	0	0	1	0	0	0	1
7.56	11400	0	0	0	0	0	0	0	0	0	0
7.57	11698	0	0	0	0	0	0	0	0	0	0
7.58	11974	0	0	0	0	0	0	0	0	0	0
7.59	12249	0	0	0	0	0	0	0	0	0	0
7.60	12525	0	0	0	0	0	0	0	0	0	0
7.61	12800	1	0	0	0	0	0	0	0	0	1
7.62	12829	2	0	0	0	0	1	0	0	0	3
7.63	12856	2	0	0	0	0	0	0	0	0	2
7.64	12883	4	0	0	1	0	3	0	0	0	8
7.66	12936	4	0	0	1	0	3	0	0	0	8
7.68	12992	2	0	0	0	0	3	0	0	0	5
7.70	13045	2	0	0	0	0	2	0	0	0	4
7.72	13101	2	0	0	3	0	3	0	0	0	8
7.74	13155	5	0	0	3	2	0	0	0	0	10
7.76	13208	3	0	0	4	0	1	0	0	0	8
7.78	13264	7	0	0	2	3	0	0	0	0	12
7.80	13318	5	0	0	4	3	0	0	0	0	12
7.82	13371	3	0	0	2	2	1	0	0	0	8
7.84	13427	3	0	1	0	2	0	0	0	0	6
7.86	13480	3	0	1	0	2	0	0	0	0	6
7.88	13536	2	0	0	0	0	0	0	0	0	2
7.90	13590	4	0	0	0	0	3	0	0	0	7
7.92	13643	2	0	0	0	0	0	0	0	0	2
7.94	13699	0	0	0	0	0	0	0	0	0	0
7.96	13753	0	0	0	0	0	0	0	0	0	0
7.98	13808	0	0	0	0	0	0	0	0	0	0
8.00	13862	0	0	0	0	0	0	0	0	0	0
8.02	13907	0	0	0	0	0	0	0	0	0	0
8.04	13951	0	0	0	0	0	0	0	0	0	0
8.06	13996	0	0	0	0	0	0	0	0	0	0
8.08	14040	0	0	0	0	0	0	0	0	0	0
8.10	14085	0	0	0	0	0	0	0	0	0	0
8.12	14130	0	0	0	0	0	0	0	0	0	0
8.14	14174	0	0	0	0	0	0	0	0	0	0
8.16	14219	0	0	0	0	0	0	0	0	0	0
8.18	14264	0	0	0	0	0	0	0	0	0	0
8.20	14308	0	0	0	0	0	0	0	0	0	0
8.22	14353	0	0	0	0	0	0	0	0	0	0
8.24	14397	0	0	0	0	0	0	0	0	0	0
8.26	14442	0	0	0	0	0	0	0	0	0	0
8.28	14487	0	0	0	0	0	0	0	0	0	0
8.30	14531	0	0	0	0	0	0	0	0	0	0
8.32	14576	0	0	0	0	0	0	0	0	0	0
8.34	14620	0	0	0	0	0	0	0	0	0	0
8.35	14643	0	0	0	0	0	0	0	0	0	0
8.360	14665	8	0	0	0	0	0	0	0	0	8
8.365	14676	6	0	0	0	0	0	0	0	0	6

8.370	14687	5	0	0	0	0	0	0	0	0	5
8.375	14699	8	0	0	0	0	0	0	0	0	8
8.380	14710	10	0	0	0	0	0	0	0	0	10
8.385	14721	13	0	0	0	0	0	0	0	0	13
8.390	14732	14	0	0	0	0	0	0	0	0	14
8.395	14743	15	0	0	0	0	0	0	0	0	15
8.400	14754	13	0	0	0	0	0	0	0	0	13
8.405	14765	11	0	0	0	0	0	0	0	0	11
8.410	14777	12	0	0	0	0	0	0	0	0	12
8.415	14788	12	0	0	0	0	0	0	0	0	12
8.420	14799	9	0	0	0	0	0	0	0	0	9
8.425	14810	5	0	0	0	0	0	0	0	0	5
8.430	14821	4	0	0	0	0	0	0	0	0	4
8.44	14844	0	0	0	0	0	0	0	0	0	0
8.46	14888	0	0	0	0	0	0	0	0	0	0
8.48	14933	0	0	0	0	0	0	0	0	0	0
8.50	14977	0	0	0	0	0	0	0	0	0	0
8.52	15022	0	0	0	0	0	0	0	0	0	0
8.54	15067	0	0	0	0	0	0	0	0	0	0
8.56	15111	0	0	0	0	0	0	0	0	0	0
8.58	15156	0	0	0	0	0	0	0	0	0	0
8.60	15201	0	0	0	0	0	0	0	0	0	0
8.62	15245	0	0	0	0	0	0	0	0	0	0
8.64	15290	0	0	0	0	0	0	0	0	0	0
8.66	15334	0	0	0	0	0	0	0	0	0	0
Totals		244	2473	360	106	1045	98	219	188	56	4789

APPENDIX B. TOM, TC, AND WT. % REFRACTORY VALUES OF THE LOUGH MONREAGH CORE

Strat.Pos.	Age (Cal)	% TOM	% TC	% Wt. Refractory
0.00	27.00	46.75	47.23	6.02
0.04	106.07	17.14	80.09	2.77
0.08	187.21	40.00	56.82	3.18
0.13	288.97	10.64	87.04	2.32
0.18	390.73	22.06	73.53	4.41
0.23	492.49	95.35	0.00	4.65
0.29	614.88	82.54	14.43	3.03
0.38	799.15	81.48	25.25	-6.73
0.44	942.17	85.94	7.10	6.96
0.53	1126.44	80.00	18.18	1.82
0.60	1269.46	93.48	0.00	6.52
0.69	1453.73	84.62	8.74	6.64
0.76	1596.75	89.80	9.28	0.93
0.85	1781.02	86.96	9.88	3.16
0.92	1924.03	81.25	14.20	4.55
1.05	2190.81	85.71	12.99	1.30
1.10	2293.95	87.50	18.94	-6.44
1.15	2397.09	83.33	12.63	4.04
1.20	2500.23	86.96	0.00	13.04
1.25	2603.36	83.33	10.82	5.84
1.30	2706.50	80.95	21.65	-2.60
1.35	2809.64	81.08	6.14	12.78
1.40	2912.77	85.19	16.84	-2.02
1.45	3015.91	81.25	14.20	4.55
1.50	3119.05	86.96	19.76	-6.72
1.55	3222.18	84.31	13.37	2.32
1.60	3325.32	86.36	10.33	3.31
1.65	3428.46	83.33	15.15	1.52
1.70	3531.60	89.47	0.00	10.53
1.75	3634.73	83.78	12.29	3.93
1.80	3737.87	82.35	13.37	4.28
1.85	3841.01	86.49	6.14	7.37
1.90	3944.14	90.00	0.00	10.00
1.95	4047.28	85.71	6.49	7.79
2.00	4150.42	85.71	10.82	3.46
2.05	4253.56	91.30	9.88	-1.19
2.10	4356.69	84.62	34.97	-19.58
2.15	4459.83	91.30	0.00	8.70
2.20	4562.97	81.82	0.00	18.18
2.25	4666.10	91.30	0.00	8.70
2.30	4769.24	80.00	0.00	20.00
2.35	4872.38	86.67	15.15	-1.82
2.40	4975.51	84.62	17.48	-2.10
2.45	5078.65	88.46	17.48	-5.94

2.50	5181.79	91.43	6.49	2.08
2.55	5284.93	92.31	0.00	7.69
2.60	5388.06	88.89	0.00	11.11
2.65	5491.20	89.29	8.12	2.60
2.70	5594.34	94.12	8.91	-3.03
2.71	5614.96	100.00	0.00	0.00
2.75	5697.47	70.00	15.15	14.85
2.81	5821.24	96.30	0.00	3.70
2.85	5903.75	82.61	19.76	-2.37
2.91	6027.51	90.00	22.73	-12.73
2.95	6110.02	89.66	15.67	-5.33
3.08	6378.18	80.95	10.82	8.23
3.13	6481.31	89.29	8.12	2.60
3.18	6584.45	90.91	6.89	2.20
3.23	6687.59	97.06	0.00	2.94
3.28	6790.73	89.29	0.00	10.71
3.33	6893.86	100.00	0.00	0.00
3.34	6914.49	89.47	23.92	-13.40
3.38	6997.00	24.19	73.31	2.49
3.40	7002.70	9.47	90.91	-0.38
3.44	7014.09	2.82	92.83	4.35
3.48	7025.49	3.36	95.49	1.15
3.54	7042.58	3.75	93.75	2.50
3.58	7053.98	4.20	93.58	2.22
3.64	7071.07	2.94	98.04	-0.98
3.68	7082.47	4.00	92.73	3.27
3.74	7099.56	2.82	96.03	1.15
3.78	7110.95	4.20	93.58	2.22
3.84	7128.05	1.47	96.93	1.60
3.88	7139.44	3.41	95.56	1.03
3.94	7156.54	1.59	97.40	1.01
3.98	7167.93	3.12	97.66	-0.78
4.00	7173.63	2.78	97.85	-0.63
4.03	7180.75	2.83	90.05	7.12
4.07	7193.57	11.11	89.79	-0.90
4.14	7212.09	3.54	96.54	-0.08
4.19	7227.76	2.33	97.78	-0.11
4.25	7243.43	3.42	94.96	1.62
4.26	7247.70	4.65	95.14	0.21
4.31	7260.52	5.62	94.48	-0.10
4.36	7276.19	3.20	96.36	0.44
4.38	7280.46	6.10	94.24	-0.33
4.42	7293.28	15.93	84.47	-0.40
4.48	7308.95	4.76	93.80	1.44
4.49	7313.23	4.17	92.80	3.03
4.54	7326.05	11.49	86.21	2.30
4.59	7341.71	2.22	98.48	-0.71
4.61	7345.99	5.95	91.99	2.06
4.66	7361.66	3.09	93.72	3.19

4.71	7374.48	4.04	96.42	-0.46
4.72	7378.75	4.94	95.40	-0.34
4.78	7394.42	3.23	97.75	-0.98
4.82	7407.24	2.38	90.19	7.43
4.84	7411.51	4.76	94.70	0.54
4.89	7427.18	4.95	90.01	5.04
4.94	7440.00	3.42	97.13	-0.54
4.95	7460.19	5.06	97.81	-2.88
4.97	7480.38	5.56	94.70	-0.25
5.00	7527.48	2.06	96.06	1.87
5.12	7684.50	4.00	95.45	0.55
5.24	7854.98	4.55	92.98	2.48
5.36	8012.00	4.88	91.46	3.66
5.48	8049.16	6.25	92.33	1.42
5.59	8086.31	6.67	90.91	2.42
5.71	8123.47	6.74	91.93	1.33
5.83	8160.62	5.88	96.93	-2.81
5.94	8197.78	4.29	97.40	-1.69
6.05	8230.69	6.25	90.91	2.84
6.16	8267.84	3.17	97.40	-0.58
6.28	8305.00	4.76	93.80	1.44
6.39	8569.44	1.82	86.78	11.40
6.51	8883.47	5.32	96.71	-2.03
6.63	9172.71	3.90	97.40	-1.30
6.75	9461.94	5.80	95.52	-1.32
6.86	9751.18	6.10	94.24	-0.33
6.98	10040.42	5.94	92.26	1.80
7.00	10090.00	7.14	94.16	-1.30
7.12	10427.38	5.06	94.94	0.00
7.23	10764.77	4.55	96.42	-0.96
7.35	11102.15	5.56	88.38	6.06
7.41	11265.57	5.62	79.16	15.22
7.45	11400.00	8.18	39.26	52.56
7.50	12184.62	13.41	5.54	81.04
7.53	12800.00	11.94	50.88	37.18
7.63	13015.14	4.00	90.91	5.09
7.75	13274.94	6.10	85.92	7.98
7.86	13534.74	6.56	85.69	7.75
7.98	13794.54	6.06	86.09	7.85
8.01	13861.52	7.41	84.18	8.42
8.11	14084.78	4.11	80.95	14.94
8.21	14308.04	9.21	74.76	16.03
8.27	14442.00	5.62	79.16	15.22
8.29	14534.26	13.76	52.13	34.11
8.31	14579.26	6.96	27.67	65.38
8.36	14691.77	4.35	43.23	52.42
8.46	14916.79	3.83	62.10	34.08

APPENDIX C. $\delta^{13}C$ OSTRACODA, $\delta^{18}O$ OSTRACODA AND MARL, AND WATER TEMPERATURE RESULTS OF LOUGH MONREAGH

						Water Temp (celsius)		
Strat.Pos.	Age (Cal)	$\delta^{13}C$	$\delta^{18}O$	Species	$\delta^{18}O$ Marl	T. Mean	T. High	T. Low
3.40	6997	-7.45	-3.88	*M. cordata*	-4.95	15.09	16.07	12.13
3.42	7008	-7.11	-3.95	*M. cordata*	-4.97	14.82	15.81	11.87
3.44	7014	-7.76	-3.96	*M. cordata*	-4.81	14.07	15.05	11.13
3.46	7020	-8.01	-3.61	*M. cordata*	-4.54	14.42	15.40	11.47
3.48	7025	-7.43	-3.63	*M. cordata*	-4.72	15.19	16.18	12.23
3.50	7031	-8.67	-3.95	*M. cordata*	-4.85	14.30	15.28	11.36
3.52	7037	-8.44	-3.45	*M. cordata*	-4.78	16.30	17.30	13.32
3.54	7042	-8.44	-4.21	*M. cordata*	-4.70	12.42	13.39	9.51
3.56	7048	-7.27	-3.86	*M. cordata*	-4.82	14.55	15.53	11.60
3.58	7054	-7.91	-3.34	*M. cordata*	-4.92	17.44	18.45	14.44
3.60	7059	-6.92	-4.39	*M. cordata*	-4.94	12.68	13.65	9.77
3.62	7065	-6.89	-4.31	*M. cordata*	-5.03	13.44	14.42	10.51
3.64	7071	-5.46	-3.74	*M. cordata*	-5.05	16.18	17.17	13.20
3.66	7076	-7.11	-3.86	*M. cordata*	-5.20	16.35	17.35	13.37
3.70	7088	-7.67	-4.15	*M. cordata*	-5.34	15.64	16.63	12.67
3.72	7093	-6.93	-4.15	*M. cordata*	-5.61	16.87	17.87	13.87
3.74	7099	-6.91	-4.42	*M. cordata*	-5.55	15.35	16.34	12.38
3.76	7105	-7.76	-4.07	*M. cordata*	-5.86	18.44	19.45	15.41
3.82	7122	-7.31	-4.14	*M. cordata*	-5.33	15.64	16.63	12.67
3.84	7127	-8.05	-4.09	*M. cordata*	-4.86	13.67	14.65	10.74
3.86	7133	-7.60	-3.95	*M. cordata*	-4.92	14.60	15.58	11.65
3.88	7139	-7.92	-3.68	*M. cordata*	-4.73	15.00	15.98	12.04
3.90	7144	-8.40	-3.48	*M. cordata*	-4.62	15.39	16.38	12.43
3.92	7150	-7.44	-3.65	*M. cordata*	-4.71	15.03	16.02	12.07
3.94	7156	-8.03	-3.91	*M. cordata*	-5.12	15.70	16.69	12.73
3.96	7162	-8.26	-3.81	*M. cordata*	-5.04	15.82	16.81	12.84
3.98	7167	-8.20	-3.62	*M. cordata*	-4.90	16.04	17.04	13.06
4.00	7173	-7.42	-3.69	*M. cordata*	-4.83	15.40	16.39	12.43
4.00	7173	-7.42	-3.37	*M. cordata*	-4.77	16.59	17.59	13.60
4.01	7174	-8.02	-3.56	*M. cordata*	-4.89	16.26	17.26	13.28
4.01	7176	-7.98	-3.59	*M. cordata*	-4.86	15.98	16.98	13.00
4.03	7183	-8.07	-3.53	*M. cordata*	-4.60	15.08	16.06	12.12
4.07	7192	-8.35	-3.81	*M. cordata*	-4.83	14.86	15.84	11.90
4.09	7199	-7.47	-4.12	*M. cordata*	-5.02	14.27	15.25	11.33
4.12	7205	-8.11	-3.69	*M. cordata*	-4.53	14.00	14.98	11.06
4.14	7212	-8.14	-3.87	*M. cordata*	-4.42	12.69	13.66	9.77
4.16	7218	-8.07	-3.82	*M. cordata*	-4.74	14.37	15.35	11.42
4.18	7225	-8.27	-3.83	*M. cordata*	-4.83	14.74	15.72	11.79
4.21	7231	-8.02	-3.63	*M. cordata*	-4.42	13.79	14.77	10.86
4.23	7238	-7.39	-3.40	*M. cordata*	-5.06	17.81	18.82	14.80
4.25	7245	-8.33	-3.65	*M. cordata*	-4.52	14.16	15.14	11.22
4.28	7251	-8.07	-3.62	*M. cordata*	-4.53	14.33	15.31	11.38
4.30	7257	-7.47	-3.89	*M. cordata*	-4.74	14.05	15.03	11.11
4.32	7264	-7.45	-3.64	*M. cordata*	-4.60	14.56	15.54	11.61

4.35	7271	-7.54	-3.64	*M. cordata*	-5.13	17.03	18.03	14.03
4.37	7277	-7.87	-3.73	*M. cordata*	-4.86	15.36	16.34	12.39
4.39	7284	-8.02	-3.41	*M. cordata*	-4.69	16.05	17.05	13.07
4.41	7290	-7.62	-3.85	*M. cordata*	-4.75	14.28	15.26	11.33
4.44	7297	-8.54	-3.81	*M. cordata*	-4.69	14.18	15.16	11.24
4.46	7303	-7.90	-3.81	*M. cordata*	-4.45	13.10	14.07	10.18
4.49	7313	-8.32	-4.30	*M. cordata*	-4.50	11.12	12.08	8.24
4.52	7319	-8.29	-3.22	*M. cordata*	-4.38	15.50	16.49	12.53
4.54	7326	-8.23	-3.65	*M. cordata*	-4.54	14.24	15.22	11.30
4.55	7329	-8.16	-3.21	*M. cordata*	-4.11	14.29	15.28	11.35
4.59	7339	-8.41	-3.91	*M. cordata*	-5.12	15.71	16.70	12.74
4.61	7345	-8.58	-3.99	*M. cordata*	-4.82	13.96	14.94	11.02
4.62	7349	-7.08	-3.64	*M. cordata*	-4.56	14.38	15.36	11.43
4.63	7352	-8.83	-3.86	*M. cordata*	-4.31	12.21	13.18	9.31
4.66	7359	-7.50	-3.36	*M. cordata*	-4.62	15.97	16.96	12.99
4.68	7365	-8.36	-3.64	*M. cordata*	-4.19	12.70	13.68	9.79
4.70	7372	-7.04	-3.74	*M. cordata*	-4.41	13.25	14.22	10.32
4.72	7378	-8.11	-2.97	*M. cordata*	-4.62	17.79	18.79	14.77
4.76	7388	-8.13	-3.68	*M. cordata*	-4.28	12.93	13.90	10.01
4.79	7398	-7.36	-3.29	*M. cordata*	-4.26	14.61	15.60	11.66
4.83	7407	-8.50	-3.63	*M. cordata*	-4.88	15.90	16.89	12.92
4.86	7417	-8.15	-3.50	*M. cordata*	-4.30	13.81	14.79	10.88
4.92	7433	-6.88	-2.83	*M. cordata*	-4.41	17.44	18.44	14.43
4.94	7440	-7.77	-3.07	*M. cordata*	-4.18	15.26	16.25	12.30
4.98	7486	-7.59	-3.30	*M. cordata*	-4.12	13.93	14.91	10.99
4.99	7502	-7.44	-3.65	*M. cordata*	-4.26	12.96	13.93	10.04
5.00	7517	-6.26	-2.92	*M. cordata*	-4.12	15.66	16.65	12.69
5.01	7524	-6.30	-4.12	*M. cordata*	-3.73	8.47	9.41	5.64
5.02	7547	-6.34	-3.24	*M. cordata*	-4.69	16.87	17.87	13.87
5.04	7577	-6.68	-3.44	*M. cordata*	-4.26	13.91	14.89	10.97
5.06	7593	-7.15	-3.48	*M. cordata*	-4.39	14.33	15.31	11.38
5.08	7622	-7.85	-3.70	*M. cordata*	-4.26	12.72	13.69	9.81
5.09	7637	-7.70	-4.17	*M. cordata*	-4.61	12.18	13.15	9.28
5.11	7666	-7.56	-3.25	*M. cordata*	-4.03	13.76	14.73	10.82
5.13	7697	-7.60	-2.72	*M. cordata*	-4.51	18.43	19.44	15.40
5.16	7728	-6.48	-3.23	*M. cordata*	-4.51	16.06	17.05	13.08
5.18	7754	-7.71	-4.00	*M. cordata*	-4.53	12.61	13.58	9.70
5.20	7786	-7.28	-3.68	*M. cordata*	-4.53	14.06	15.04	11.12
5.22	7817	-4.00	-3.08	*M. cordata*	-4.21	15.35	16.34	12.38
5.24	7846	-7.43	-3.26	*M. cordata*	-4.35	15.18	16.16	12.21
5.26	7863	-5.12	-2.78	*M. cordata*	-4.23	16.84	17.84	13.85
5.27	7877	-7.21	-3.35	*M. cordata*	-4.81	16.89	17.89	13.90
5.29	7908	-7.58	-3.87	*M. cordata*	-4.51	13.09	14.06	10.17
5.31	7937	-6.61	-3.62	*M. cordata*	-4.49	14.14	15.12	11.20
5.33	7966	-7.00	-3.82	*M. cordata*	-4.56	13.57	14.54	10.64
5.36	7997	-6.49	-3.23	*M. cordata*	-4.67	16.81	17.80	13.81
5.38	8016	-7.31	-3.91	*M. cordata*	-4.96	14.99	15.98	12.03
5.40	8023	-8.22	-3.52	*M. cordata*	-4.69	15.54	16.53	12.57
5.42	8031	-6.51	-3.23	*M. cordata*	-4.40	15.52	16.51	12.55

5.44	8038	-7.59	-3.53	*M. cordata*	-4.18	13.13	14.11	10.21
5.47	8046	-6.69	-3.25	*M. cordata*	-4.11	14.09	15.07	11.15
5.49	8054	-7.12	-3.11	*M. cordata*	-4.43	16.24	17.23	13.25
5.51	8061	-6.91	-3.60	*M. cordata*	-4.78	15.59	16.58	12.62
5.53	8069	-6.96	-3.37	*M. cordata*	-4.31	14.48	15.46	11.53
5.56	8076	-7.30	-3.83	*M. cordata*	-4.69	14.10	15.08	11.16
5.58	8084	-7.19	-2.92	*M. cordata*	-4.19	15.99	16.98	13.01
5.60	8091	-6.80	-3.62	*M. cordata*	-4.26	13.10	14.07	10.18
5.62	8099	-6.08	-3.21	*M. cordata*	-3.89	13.28	14.26	10.36
5.63	8103	-6.24	-3.52	*M. cordata*	-3.99	12.32	13.29	9.42
5.64	8106	-6.32	-3.15	*M. cordata*	-3.85	13.38	14.35	10.45
5.67	8114	-6.58	-2.94	*M. cordata*	-3.87	14.43	15.41	11.48
5.69	8122	-6.91	-2.93	*M. cordata*	-4.45	17.16	18.16	14.16
5.71	8129	-5.94	-3.94	*M. cordata*	-4.43	12.44	13.40	9.53
5.73	8137	-6.68	-3.13	*M. cordata*	-3.79	13.21	14.19	10.29
5.76	8144	-5.86	-2.50	*M. cordata*	-4.17	17.88	18.88	14.86
5.78	8152	-6.92	-3.06	*M. cordata*	-4.45	16.54	17.54	13.55
5.82	8167	-6.41	-3.13	*M. cordata*	-4.16	14.88	15.87	11.93
5.84	8174	-6.42	-3.05	*M. cordata*	-4.10	14.99	15.97	12.03
5.87	8182	-6.16	-3.52	*M. cordata*	-4.41	14.25	15.23	11.30
5.89	8193	-5.27	-3.30	*M. cordata*	-3.89	12.89	13.86	9.98
5.91	8197	-6.37	-2.93	*M. cordata*	-3.79	14.10	15.08	11.16
5.93	8205	-5.32	-3.03	*M. cordata*	-3.13	10.64	11.60	7.77
5.98	8220	-6.40	-3.60	*M. cordata*	-4.36	13.65	14.63	10.72
6.01	8231	-5.85	-3.18	*M. cordata*	-4.12	14.47	15.46	11.53
6.02	8235	-5.67	-3.41	*M. cordata*	-4.29	14.22	15.20	11.28
6.05	8243	-6.15	-3.38	*M. cordata*	-4.39	14.78	15.76	11.82
6.07	8251	-5.06	-3.13	*M. cordata*	-4.56	16.74	17.74	13.75
6.09	8259	-5.48	-3.63	*M. cordata*	-4.89	15.96	16.95	12.98
6.10	8262	-5.67	-2.96	*M. cordata*	-4.03	15.07	16.06	12.11
6.11	8266	-6.20	-3.43	*M. cordata*	-4.23	13.82	14.80	10.89
6.14	8274	-5.25	-2.77	*M. cordata*	-4.54	18.34	19.35	15.31
6.16	8282	-4.67	-3.15	*M. cordata*	-4.53	16.52	17.52	13.53
6.18	8290	-5.93	-2.00	*M. cordata*	-4.13	20.06	21.08	17.00
6.21	8297	-6.20	-3.35	*M. cordata*	-4.23	14.20	15.18	11.26
6.23	8305	-5.21	-2.95	*M. cordata*	-4.31	16.43	17.42	13.44
6.24	8337	-0.47	-2.67	*P. euplectella*	-3.58	4.21	7.09	1.33
6.25	8369	-3.41	-1.24	*P. euplectella*	-3.54	10.30	13.31	7.30
6.27	8432	-2.58	-1.46	*P. euplectella*	-4.26	12.55	15.61	9.50
6.30	8496	-4.61	-2.44	*P. euplectella*	-4.01	7.06	9.99	4.12
6.34	8623	-6.07	-1.10	*P. euplectella*	-4.02	13.10	16.17	10.04
6.36	8687	-3.89	-1.48	*P. euplectella*	-4.27	12.49	15.55	9.44
6.39	8751	-3.83	-1.69	*P. euplectella*	-4.13	10.95	13.97	7.93
6.46	8942	-5.38	-2.51	*P. euplectella*	-3.89	6.24	9.16	3.31
6.48	9004	-4.48	-2.59	*P. euplectella*	-4.41	8.17	11.13	5.20
6.52	9136	-4.26	-0.73	*P. euplectella*	-4.05	14.92	18.03	11.82
6.55	9195	-2.69	-1.19	*P. euplectella*	-4.12	13.13	16.20	10.07
6.57	9244	-4.87	-1.86	*P. euplectella*	-4.53	11.97	15.01	8.93
6.59	9323	-4.32	-1.01	*P. euplectella*	-4.25	14.57	17.67	11.48

6.61	9391	-3.84	-1.69	*P. euplectella*	-4.07	10.64	13.66	7.63
6.64	9455	-4.11	-1.11	*P. euplectella*	-3.84	12.23	15.28	9.19
6.66	9514	-2.54	-1.20	*P. euplectella*	-3.97	12.40	15.45	9.35
6.71	9646	-2.93	-1.97	*P. euplectella*	-3.95	8.87	11.85	5.90
6.73	9705	-2.66	-1.44	*P. euplectella*	-4.47	13.62	16.70	10.55
6.77	9833	-3.66	-1.31	*P. euplectella*	-3.74	10.87	13.89	7.85
6.80	9896	-3.36	-2.51	*P. euplectella*	-3.95	6.49	9.41	3.56
6.82	9960	-3.44	-1.29	*P. euplectella*	-3.38	9.36	12.34	6.37
6.84	10024	-0.80	-2.07	*P. euplectella*	-3.92	8.29	11.25	5.32
6.86	10088	-1.87	-1.02	*P. euplectella*	-3.79	12.44	15.49	9.39
6.93	10279	-2.55	-2.55	*P. euplectella*	-4.23	7.54	10.48	4.59
7.00	10470	-0.29	-1.95	*P. euplectella*	-4.15	9.83	12.83	6.84
7.01	10504	0.34	-1.27	*P. euplectella*	-3.85	11.56	14.59	8.52
7.02	10538	0.33	-2.29	*P. euplectella*	-3.91	7.27	10.22	4.33
7.04	10573	-0.04	-2.58	*P. euplectella*	-3.95	6.20	9.12	3.28
7.05	10582	-5.07	-2.24	*P. euplectella*	-3.06	3.83	6.70	0.95
7.07	10601	0.17	-2.73	*P. euplectella*	-3.44	3.34	6.20	0.48
7.10	10621	-0.25	-0.90	*P. euplectella*	-3.92	13.58	16.65	10.50
7.11	10627	-1.92	-1.86	*P. euplectella*	-3.61	7.84	10.80	4.89
7.12	10640	-0.50	-0.93	*P. euplectella*	-3.61	12.02	15.06	8.98
7.15	10659	1.08	-2.11	*P. euplectella*	-3.30	5.42	8.32	2.51
7.17	10679	0.44	-1.33	*P. euplectella*	-3.61	10.23	13.24	7.23
7.22	10794	1.39	-1.18	*P. euplectella*	-3.15	8.82	11.79	5.84
7.24	10898	1.71	-2.67	*P. euplectella*	-3.32	3.11	5.97	0.26
7.27	11008	1.48	-2.32	*L. sanctipatricii*	-3.85	7.31	7.82	6.80
7.28	11054	-1.37	-2.19	*L. sanctipatricii*	-3.65	7.02	7.53	6.51
7.31	11159	0.38	-1.40	*L. sanctipatricii*	-3.73	10.83	11.36	10.31
7.32	11209	0.37	-2.16	*L. sanctipatricii*	-3.45	6.27	6.78	5.77
7.33	11256	1.14	-2.10	*L. sanctipatricii*	-3.43	6.42	6.93	5.91
7.34	11302	1.29	-2.34	*L. sanctipatricii*	-3.90	7.42	7.93	6.91
7.35	11354	0.89	-3.27	*L. sanctipatricii*	-3.77	2.87	3.36	2.37
7.37	11401	0.59	-1.94	*L. sanctipatricii*	-3.64	8.03	8.54	7.52
7.38	11439	0.38	-0.89	*L. sanctipatricii*	-3.68	12.95	13.48	12.41
7.39	11491	2.66	-2.02	*L. sanctipatricii*	-3.45	6.86	7.37	6.35
7.40	11538	1.56	-1.01	*L. sanctipatricii*	-3.46	11.38	11.91	10.86
7.43	11597	0.26	-1.81	*L. sanctipatricii*	-4.23	11.24	11.76	10.71
Younger Dryas								
7.52	12710	2.69	-1.77	*L. sanctipatricii*	-4.85	14.27	14.81	13.74
7.54	12747	1.67	-2.72	*L. sanctipatricii*	-3.22	2.89	3.38	2.39
7.56	12813	2.05	-1.01	*L. sanctipatricii*	-3.31	10.71	11.23	10.19
7.59	12877	1.40	-3.35	*L. sanctipatricii*	-3.55	1.60	2.09	1.11
7.61	12948	1.33	-2.27	*L. sanctipatricii*	-4.00	8.17	8.69	7.66
7.63	13015	0.83	-2.18	*L. sanctipatricii*	-4.59	11.20	11.73	10.68
7.66	13066	0.21	-2.00	*L. sanctipatricii*	-4.20	10.26	10.78	9.74
7.68	13114	0.38	-2.06	*L. sanctipatricii*	-3.28	5.97	6.47	5.46
7.71	13161	1.52	-2.50	*L. sanctipatricii*	-3.35	4.36	4.86	3.86
7.73	13209	0.42	-1.86	*L. sanctipatricii*	-3.15	6.27	6.77	5.76
7.76	13257	2.26	-2.17	*L. sanctipatricii*	-3.09	4.68	5.18	4.17
7.78	13305	3.14	-2.27	*L. sanctipatricii*	-2.90	3.42	3.91	2.92

7.81	13355	1.75	-0.48	*L. sanctipatricii*	-3.25	12.83	13.36	12.30
7.83	13401	1.80	-0.26	*L. sanctipatricii*	-3.09	13.10	13.63	12.57
7.84	13425	2.64	-1.69	*L. sanctipatricii*	-3.00	6.32	6.83	5.82
7.88	13505	2.37	-2.51	*L. sanctipatricii*	-3.51	5.00	5.50	4.50
7.90	13562	1.39	-1.12	*L. sanctipatricii*	-2.89	8.38	8.89	7.86
Older Dryas								
8.36	14727	0.80	-7.40	*L. sanctipatricii*	-7.56	1.43	1.92	0.94
8.37	14753	1.67	-7.58	*L. sanctipatricii*	-7.64	0.97	1.46	0.48
8.38	14778	-0.45	-7.40	*L. sanctipatricii*	-7.18	-0.21	0.28	-0.69
8.39	14804	1.06	-7.18	*L. sanctipatricii*	-7.44	1.85	2.34	1.36
8.40	14829	0.50	-7.33	*L. sanctipatricii*	-7.34	0.77	1.26	0.28
8.41	14855	0.10	-7.11	*L. sanctipatricii*	-7.26	1.38	1.87	0.89
8.42	14881	-0.31	-7.47	*L. sanctipatricii*	-6.99	-1.26	-0.78	-1.74
8.43	14906	-0.53	-7.14	*L. sanctipatricii*	-7.36	1.69	2.18	1.20

APPENDIX D. $\delta^{13}C$ and $\delta^{18}O$ $CaCO_3$ BULK MARL FROM THE LOUGH MONREAGH CORE

Strat.Pos.	Age (Cal)	$\delta^{13}C$	$\delta^{18}O$
4.42	7292.68	-5.14	-4.59
4.42	7293.01	-4.10	-5.13
4.43	7293.33	-2.86	-4.75
4.43	7293.66	-3.70	-4.73
4.43	7293.99	-3.90	-4.91
4.43	7294.31	-4.13	-5.00
4.43	7294.64	-3.11	-4.68
4.43	7294.96	-2.97	-5.14
4.43	7295.29	-3.05	-4.72
4.43	7295.62	-2.27	-4.46
4.43	7295.94	-2.80	-4.64
4.44	7296.27	-3.42	-4.74
4.44	7296.59	-4.37	-4.62
4.44	7296.92	-3.86	-4.69
4.44	7297.25	-3.10	-4.71
4.44	7297.57	-4.30	-4.52
4.44	7297.90	-4.07	-4.69
4.44	7298.22	-4.82	-4.57
4.44	7298.55	-4.09	-4.70
4.44	7298.88	-4.07	-4.59
4.45	7299.20	-3.88	-4.41
4.45	7299.53	-3.72	-4.66
4.45	7299.85	-3.80	-4.61
4.45	7300.18	-3.92	-4.63
4.45	7300.51	-3.74	-4.59
4.45	7300.83	-3.41	-4.50
4.45	7301.16	-3.48	-4.56
4.45	7301.48	-3.81	-4.93
4.46	7301.81	-3.70	-4.66
4.46	7302.13	-3.66	-4.75
4.46	7302.46	-4.36	-4.67
4.46	7302.79	-5.07	-4.49
4.46	7303.11	-5.37	-4.22
4.46	7303.44	-5.03	-4.53
4.46	7303.76	-5.29	-4.60
4.46	7304.09	-4.59	-4.51
4.46	7304.42	-4.41	-4.35
4.47	7304.74	-3.48	-4.44
4.47	7305.07	-2.66	-4.43
4.47	7305.39	-2.96	-4.45
4.47	7305.72	-3.91	-4.81
4.47	7306.05	-4.24	-4.30
4.47	7306.37	-4.40	-4.35
4.47	7306.70	-3.54	-4.45

4.47	7307.02	-4.33	-4.38
4.47	7307.35	-3.80	-4.24
4.48	7307.68	-3.96	-4.89
4.48	7308.00	-3.68	-4.70
4.48	7308.33	-3.21	-4.06
4.48	7308.65	-3.12	-4.27
4.48	7308.98	-5.05	-4.28
4.48	7309.31	-4.36	-4.09
4.48	7309.63	-4.69	-4.49
4.48	7309.96	-5.36	-4.58
4.49	7310.28	-4.03	-4.52
4.49	7310.61	-3.82	-4.72
4.49	7310.93	-2.82	-3.99
4.49	7311.26	-3.50	-3.92
4.49	7311.59	-3.22	-3.97
4.49	7311.91	-3.02	-4.17
4.49	7312.24	-3.22	-4.44
4.49	7312.56	-3.91	-4.53
4.49	7312.89	-3.95	-4.51
4.50	7313.22	-3.74	-4.45
4.50	7313.54	-3.99	-4.54
4.50	7313.87	-3.71	-4.47
4.50	7314.19	-3.22	-4.28
4.50	7314.52	-3.10	-4.21
4.50	7314.85	-3.51	-4.34
4.50	7315.17	-3.66	-4.07
4.50	7315.50	-3.58	-4.32
4.50	7315.82	-3.42	-4.16
4.51	7316.15	-3.19	-4.29
4.51	7316.48	-3.73	-4.42
4.51	7316.80	-3.98	-4.36
4.51	7317.13	-4.18	-4.61
4.51	7317.45	-4.07	-4.69
4.51	7317.78	-4.00	-4.65
4.51	7318.10	-4.71	-4.41
4.51	7318.43	-4.16	-4.80
4.51	7318.76	-4.61	-4.47
4.52	7319.08	-4.60	-4.50
4.52	7319.41	-4.26	-4.40
4.52	7319.73	-3.88	-4.22
4.52	7320.06	-4.05	-4.56
4.52	7320.39	-4.03	-4.53
4.52	7320.71	-3.70	-4.88
4.52	7321.04	-4.72	-4.71
4.52	7321.36	-3.15	-3.95
4.53	7321.69	-3.72	-4.43
4.53	7322.02	-4.45	-5.33
4.53	7322.34	-5.93	-4.73
4.53	7322.67	-6.43	-4.89

4.53	7322.99	-6.67	-4.35
4.53	7323.32	-5.79	-4.74
4.53	7323.65	-6.22	-4.61
4.53	7323.97	-3.58	-4.16
4.53	7324.30	-2.89	-4.57
4.54	7324.62	-3.63	-4.10
4.54	7324.95	-4.31	-3.91
4.54	7325.28	-3.50	-4.20
4.54	7325.60	-3.02	-4.29
4.54	7325.93	-4.40	-4.89
4.54	7326.25	-4.17	-4.43
4.54	7326.58	-4.26	-4.48
4.54	7326.90	-4.19	-4.19
4.54	7327.23	-3.88	-4.50
4.55	7327.56	-3.88	-4.61
4.55	7327.88	-3.17	-4.62
4.55	7328.21	-2.92	-4.18
4.55	7328.53	-3.31	-4.16
4.55	7328.86	-4.04	-4.17
4.55	7329.19	-3.61	-4.15
4.55	7329.51	-3.72	-3.91
4.55	7329.84	-4.51	-4.39
4.56	7330.16	-3.12	-4.60
4.56	7330.49	-4.13	-4.29
4.56	7330.82	-4.57	-4.02
4.56	7331.14	-4.04	-4.17
4.56	7331.47	-4.94	-4.49
4.56	7331.79	-4.40	-4.52
4.56	7332.12	-4.46	-4.92
4.56	7332.45	-5.11	-5.10
4.56	7332.77	-4.23	-5.19
4.57	7333.10	-5.44	-4.52
4.57	7333.42	-4.93	-4.84
4.57	7333.75	-4.55	-4.75
4.57	7334.08	-4.67	-5.01
4.57	7334.40	-5.34	-4.74
4.57	7334.73	-5.17	-4.74
4.57	7335.05	-5.56	-4.72
4.57	7335.38	-5.58	-4.94
4.57	7335.70	-5.30	-4.89
4.58	7336.03	-5.17	-4.82
4.58	7336.36	-4.67	-5.02
4.58	7336.68	-3.83	-4.97
4.58	7337.01	-3.83	-4.88
4.58	7337.33	-3.21	-4.46
4.58	7337.66	-3.74	-4.39
4.58	7337.99	-4.07	-4.73
4.58	7338.31	-4.12	-4.47
4.59	7338.64	-4.75	-4.72

4.59	7338.96	-5.05	-5.05
4.59	7339.29	-5.12	-5.33
4.59	7339.62	-5.05	-4.98
4.59	7339.94	-5.13	-5.16
4.59	7340.27	-4.83	-5.13
4.59	7340.59	-4.17	-4.68
4.59	7340.92	-4.35	-4.75
4.59	7341.25	-3.23	-5.06
4.60	7341.57	-2.13	-4.96
4.60	7341.90	-3.33	-4.40
4.60	7342.22	-3.13	-4.44
4.60	7342.55	-3.56	-4.58
4.60	7342.88	-4.80	-5.23
4.60	7343.20	-4.61	-4.99
4.60	7343.53	-3.84	-4.78
4.60	7343.85	-3.86	-4.98
4.60	7344.18	-3.62	-4.89
4.61	7344.50	-4.08	-5.29
4.61	7344.83	-4.03	-4.80
4.61	7345.16	-4.66	-4.60
4.61	7345.48	-4.02	-5.02
4.61	7345.81	-4.88	-4.77
4.61	7346.13	-4.91	-4.84
4.61	7346.46	-4.28	-4.90
4.61	7346.79	-3.91	-5.19
4.61	7347.11	-3.49	-4.88
4.62	7347.44	-4.60	-4.34
4.62	7347.76	-4.53	-4.34
4.62	7348.09	-4.50	-4.52
4.62	7348.42	-4.51	-4.89
4.62	7348.74	-4.59	-4.36
4.62	7349.07	-4.31	-4.36
4.62	7349.39	-4.30	-4.24
4.62	7349.72	-3.92	-4.37
4.63	7350.05	-3.67	-4.16
4.63	7350.37	-3.91	-4.31
4.63	7350.70	-4.19	-4.15
4.63	7351.02	-2.60	-4.35
4.63	7351.35	-3.91	-4.50
4.63	7351.67	-3.97	-4.33
4.63	7352.00	-4.95	-4.23
4.63	7352.33	-4.53	-4.34
4.63	7352.65	-4.19	-4.37
4.64	7352.98	-4.74	-4.31
4.64	7353.30	-4.13	-4.23
4.64	7353.63	-4.99	-4.38
4.64	7353.96	-4.37	-3.97
4.64	7354.28	-4.66	-4.59
4.64	7354.61	-4.46	-4.35

4.64	7354.93	-4.27	-4.04
4.64	7355.26	-4.63	-4.22
4.64	7355.59	-4.64	-4.35
4.65	7355.91	-4.03	-3.98
4.65	7356.24	-4.07	-4.70
4.65	7356.56	-3.69	-4.92
4.65	7356.89	-3.60	-4.55
4.65	7357.22	-3.52	-4.59
4.65	7357.54	-3.27	-4.64
4.65	7357.87	-3.62	-4.63
4.65	7358.19	-4.00	-4.66
4.66	7358.52	-3.72	-4.66
4.66	7358.85	-3.76	-4.61
4.66	7359.17	-2.52	-4.65
4.66	7359.50	-2.31	-4.60
4.66	7359.82	-3.32	-4.55
4.66	7360.15	-4.90	-4.64
4.66	7360.47	-5.98	-4.78
4.66	7360.80	-5.84	-4.38
4.66	7361.13	-5.27	-4.75
4.67	7361.45	-6.19	-4.52
4.67	7361.78	-5.96	-4.63
4.67	7362.10	-6.08	-4.42
4.67	7362.43	-6.04	-4.27
4.67	7362.76	-5.96	-4.49
4.67	7363.08	-5.31	-4.40
4.67	7363.41	-4.09	-4.76
4.67	7363.73	-4.87	-4.29
4.67	7364.06	-5.03	-4.30
4.68	7364.39	-5.54	-3.87
4.68	7364.71	-5.40	-4.05
4.68	7365.04	-4.04	-4.20
4.68	7365.36	-4.35	-4.38
4.68	7365.69	-2.99	-5.09
4.68	7366.02	-3.46	-5.02
4.68	7366.34	-3.20	-4.88
4.68	7366.67	-4.39	-4.14
4.69	7366.99	-4.25	-4.08
4.69	7367.32	-4.35	-4.07
4.69	7367.65	-3.32	-4.28
4.69	7367.97	-3.82	-4.84
4.69	7368.30	-3.61	-4.62
4.69	7368.62	-3.37	-4.94
4.69	7368.95	-3.40	-4.82
4.69	7369.27	-4.15	-4.71
4.69	7369.60	-2.98	-4.90
4.70	7369.93	-2.85	-5.08
4.70	7370.25	-3.73	-4.75
4.70	7370.58	-3.32	-5.07

4.70	7370.90	-4.34	-4.80
4.70	7371.23	-3.70	-4.91
4.70	7371.56	-3.84	-4.59
4.70	7371.88	-4.71	-4.36
4.70	7372.21	-4.41	-4.33
4.70	7372.53	-3.75	-4.40
4.71	7372.86	-4.05	-4.61
4.71	7373.19	-4.37	-4.60
4.71	7373.51	-4.13	-4.65
4.71	7373.84	-3.89	-4.62
4.71	7374.16	-4.45	-4.55
4.71	7374.49	-4.56	-4.41
4.71	7374.82	-4.81	-4.43
4.71	7375.14	-4.15	-4.41
4.71	7375.47	-4.36	-4.76
4.72	7375.79	-4.01	-4.62
4.72	7376.12	-4.19	-4.35
4.72	7376.45	-4.51	-4.46
4.72	7376.77	-4.09	-4.89
4.72	7377.10	-4.20	-4.62
4.72	7377.42	-4.20	-4.52
4.72	7377.75	-4.11	-4.65
4.72	7378.07	-3.81	-4.40
4.73	7378.40	-4.54	-4.85
4.73	7378.73	-4.17	-4.72
4.73	7379.05	-4.32	-4.81
4.73	7379.38	-4.55	-4.48
4.73	7379.70	-5.73	-3.93
4.73	7380.03	-5.20	-4.02
4.73	7380.36	-5.11	-3.92
4.73	7380.68	-4.83	-3.94
4.73	7381.01	-3.94	-4.02
4.74	7381.33	-3.08	-4.04
4.74	7381.66	-3.59	-3.88
4.74	7381.99	-3.08	-3.83
4.74	7382.31	-3.28	-3.78
4.74	7382.64	-3.62	-4.00
4.74	7382.96	-3.81	-4.40
4.74	7383.29	-3.75	-4.39
4.74	7383.62	-3.97	-4.23
4.74	7383.94	-4.08	-4.23
4.75	7384.27	-5.35	-4.29
4.75	7384.59	-4.28	-4.11
4.75	7384.92	-5.07	-4.23
4.75	7385.25	-4.85	-4.14
4.75	7385.57	-4.89	-4.71
4.75	7385.90	-5.40	-4.25
4.75	7386.22	-4.13	-5.16
4.75	7386.55	-5.26	-4.35

4.76	7386.87	-5.01	-4.33
4.76	7387.20	-3.89	-4.46
4.76	7387.53	-3.78	-4.32
4.76	7387.85	-3.73	-4.27
4.76	7388.18	-3.62	-4.24
4.76	7388.50	-3.73	-4.18
4.76	7388.83	-3.47	-4.38
4.76	7389.16	-2.72	-4.20
4.76	7389.48	-3.23	-4.46
4.77	7389.81	-3.32	-4.34
4.77	7390.13	-3.87	-4.21
4.77	7390.46	-2.84	-4.90
4.77	7390.79	-3.81	-4.22
4.77	7391.11	-3.86	-4.35
4.77	7391.44	-3.73	-4.31
4.77	7391.76	-3.77	-4.44
4.77	7392.09	-3.96	-4.37
4.77	7392.42	-4.66	-4.32
4.78	7392.74	-4.19	-4.12
4.78	7393.07	-3.63	-4.30
4.78	7393.39	-4.48	-4.09
4.78	7393.72	-3.84	-4.31
4.78	7394.04	-3.96	-4.24
4.78	7394.37	-4.08	-4.39
4.78	7394.70	-4.04	-4.43
4.78	7395.02	-4.02	-4.12
4.79	7395.35	-4.19	-4.17
4.79	7395.67	-4.38	-4.28
4.79	7396.00	-4.42	-4.33
4.79	7396.33	-4.20	-4.01
4.79	7396.65	-5.01	-4.24
4.79	7396.98	-4.16	-4.06
4.79	7397.30	-4.09	-4.33
4.79	7397.63	-4.92	-4.24
4.79	7397.96	-4.85	-4.21
4.80	7398.28	-4.89	-4.18
4.80	7398.61	-4.65	-4.37
4.80	7398.93	-4.91	-4.53
4.80	7399.26	-5.10	-4.11
4.80	7399.59	-4.51	-4.11
4.80	7399.91	-4.21	-3.93
4.80	7400.24	-4.33	-3.78
4.80	7400.56	-5.02	-4.02
4.80	7400.89	-4.49	-4.00
4.81	7401.22	-3.81	-3.82
4.81	7401.54	-4.35	-3.79
4.81	7401.87	-2.96	-4.36
4.81	7402.19	-3.75	-4.23
4.81	7402.52	-4.00	-4.39

4.81	7402.84	-4.27	-4.37
4.81	7403.17	-4.86	-4.35
4.81	7403.50	-4.89	-4.22
4.81	7403.82	-5.11	-4.15
4.82	7404.15	-4.86	-4.57
4.82	7404.47	-4.88	-4.18
4.82	7404.80	-5.43	-4.32
4.82	7405.13	-5.03	-4.32
4.82	7405.45	-4.37	-4.53
4.82	7405.78	-4.70	-4.59
4.82	7406.10	-4.87	-5.00
4.82	7406.43	-4.87	-5.05
4.83	7406.76	-4.29	-4.73
4.83	7407.08	-3.90	-4.92
4.83	7407.41	-3.27	-5.13
4.83	7407.73	-3.54	-4.69
4.83	7408.06	-4.30	-4.33
4.83	7408.39	-3.87	-4.79
4.83	7408.71	-4.48	-4.54
4.83	7409.04	-4.04	-4.26
4.83	7409.36	-4.48	-4.32
4.84	7409.69	-4.47	-4.29
4.84	7410.02	-4.50	-4.33
4.84	7410.34	-3.36	-4.57
4.84	7410.67	-3.59	-4.47
4.84	7410.99	-4.31	-4.47
4.84	7411.32	-4.66	-4.48
4.84	7411.64	-4.62	-4.36
4.84	7411.97	-4.63	-4.34
4.84	7412.30	-4.86	-4.44
4.85	7412.62	-4.11	-4.52
4.85	7412.95	-4.04	-4.64
4.85	7413.27	-4.21	-4.89
4.85	7413.60	-4.24	-4.39
4.85	7413.93	-4.24	-4.75
4.85	7414.25	-4.16	-4.74
4.85	7414.58	-3.15	-4.44
4.85	7414.90	-3.57	-4.36
4.86	7415.23	-4.96	-4.32
4.86	7415.56	-5.82	-4.44
4.86	7415.88	-4.21	-4.27
4.86	7416.21	-4.72	-4.50
4.86	7416.53	-4.40	-4.30
4.86	7416.86	-4.68	-4.28
4.86	7417.19	-4.59	-4.26
4.86	7417.51	-4.93	-4.33
4.86	7417.84	-4.96	-4.35
4.87	7418.16	-5.02	-4.35
4.87	7418.49	-5.01	-4.56

4.87	7418.82	-4.45	-5.06
4.87	7419.14	-4.37	-4.88
4.87	7419.47	-4.77	-4.71
4.87	7419.79	-5.14	-4.61
4.87	7420.12	-5.11	-5.09
4.87	7420.44	-5.15	-4.61
4.87	7420.77	-4.69	-4.57
4.88	7421.10	-4.70	-4.51
4.88	7421.42	-4.65	-4.49
4.88	7421.75	-4.69	-4.33
4.88	7422.07	-4.76	-4.20
4.88	7422.40	-4.79	-4.28
4.88	7422.73	-4.40	-4.14
4.88	7423.05	-4.88	-4.39
4.88	7423.38	-4.54	-4.29
4.89	7423.70	-4.99	-4.23
4.89	7424.03	-4.82	-4.33
4.89	7424.36	-4.02	-4.42
4.89	7424.68	-4.66	-4.33
4.89	7425.01	-4.83	-4.28
4.89	7425.33	-5.43	-4.37
4.89	7425.66	-6.11	-4.31
4.89	7425.99	-6.20	-4.24
4.89	7426.31	-5.36	-4.31
4.90	7426.64	-5.59	-4.34
4.90	7426.96	-4.67	-4.08
4.90	7427.29	-4.85	-3.69
4.90	7427.61	-5.29	-3.62
4.90	7427.94	-4.48	-4.01
4.90	7428.27	-4.65	-3.97
4.90	7428.59	-4.22	-4.26
4.90	7428.92	-4.93	-4.24
4.90	7429.24	-4.14	-4.28
4.91	7429.57	-3.86	-4.44
4.91	7429.90	-3.82	-4.26
4.91	7430.22	-4.61	-4.21
4.91	7430.55	-4.52	-4.30
4.91	7430.87	-4.43	-4.19
4.91	7431.20	-4.95	-4.35
4.91	7431.53	-5.11	-4.29
4.91	7431.85	-4.79	-4.22
4.91	7432.18	-4.52	-4.20
4.92	7432.50	-4.72	-4.40
4.92	7432.83	-4.66	-4.32
4.92	7433.16	-4.49	-4.34
4.92	7433.48	-4.94	-4.45
4.92	7433.81	-4.40	-4.38
4.92	7434.13	-4.46	-4.27
4.92	7434.46	-4.26	-4.11

4.92	7434.79	-4.36	-4.46
4.93	7435.11	-4.65	-4.33
4.93	7435.44	-4.65	-4.34
4.93	7435.76		
4.93	7436.09		
4.93	7436.41		
4.93	7436.74	-5.17	-4.68
4.93	7437.07	-4.96	-4.74
4.93	7437.39	-4.21	-4.78
4.93	7437.72	-4.76	-4.72
4.94	7438.04	-3.63	-4.45
4.94	7438.37	-4.13	-4.48
4.94	7438.70	-4.67	-4.16
4.94	7439.02	-4.79	-4.18
4.94	7439.35	-4.55	-4.02
4.94	7439.67	-4.79	-4.12
4.94	7440.00	-4.49	-4.22
4.94	7441.55	-4.52	-4.12
4.94	7443.10	-5.00	-4.24
4.95	7444.64	-5.59	-4.26
4.95	7446.19	-6.30	-4.36
4.95	7447.74	-6.35	-4.38
4.95	7449.29	-4.66	-4.38
4.95	7450.84	-4.45	-4.56
4.95	7452.39	-4.50	-4.42
4.95	7453.93	-4.28	-4.23
4.95	7455.48	-4.51	-4.35
4.96	7457.03	-4.84	-4.51
4.96	7458.58	-4.54	-4.41
4.96	7460.13	-4.86	-4.41
4.96	7461.68	-5.06	-4.35
4.96	7463.22	-4.46	-4.51
4.96	7464.77	-4.77	-4.33
4.96	7466.32	-4.38	-4.26
4.96	7467.87	-5.02	-4.58
4.96	7469.42	-4.41	-4.51
4.97	7470.97	-4.33	-4.38
4.97	7472.51	-4.54	-4.49
4.97	7474.06	-4.58	-4.46
4.97	7475.61	-4.63	-4.19
4.97	7477.16	-3.53	-4.30
4.97	7478.71	-3.69	-4.26
4.97	7480.26	-3.94	-4.14
4.97	7481.80	-2.44	-4.17
4.97	7483.35	-4.63	-4.14
4.98	7484.90	-3.53	-4.24
4.98	7486.45	-5.36	-4.05
4.98	7488.00	-4.75	-4.22
4.98	7489.55	-4.85	-4.28

4.98	7491.09	-4.29	-4.41
4.98	7492.64	-4.19	-4.37
4.98	7494.19	-4.15	-4.34
4.98	7495.74	-4.00	-4.60
4.99	7497.29	-3.54	-4.12
4.99	7498.84	-3.60	-4.43
4.99	7500.38	-4.65	-4.44
4.99	7501.93	-3.45	-4.02
4.99	7503.48	-4.27	-4.31
4.99	7505.03	-4.58	-4.54
4.99	7506.58	-3.36	-4.32
4.99	7508.13	-2.96	-4.23
4.99	7509.67	-3.05	-4.32
5.00	7511.22	-3.71	-4.19
5.00	7512.77	-3.63	-4.36
5.00	7514.32	-3.52	-4.10
5.00	7515.87	-3.53	-4.25
5.00	7517.42	-4.01	-4.03
5.00	7518.95	-4.03	-4.19
5.00	7520.49	-3.90	-3.86
5.00	7522.02	-3.48	-3.71
5.00	7523.56	-3.41	-3.69
5.01	7525.10	-3.92	-3.88
5.01	7526.63	-3.77	-4.34
5.01	7528.17	-2.54	-4.05
5.01	7529.70	-4.41	-3.40
5.01	7531.24	-3.97	-4.65
5.01	7532.78	-3.31	-4.22
5.01	7534.31	-2.68	-4.30
5.01	7535.85	-2.73	-4.18
5.01	7537.38	-3.17	-3.78
5.02	7538.92	-3.29	-4.01
5.02	7540.46	-3.03	-4.01
5.02	7541.99	-3.71	-4.03
5.02	7543.53	-3.91	-3.81
5.02	7545.06	-4.35	-4.04
5.02	7546.60	-5.49	-4.80
5.02	7548.14	-5.77	-4.80
5.02	7549.67	-5.56	-4.72
5.03	7551.21	-6.00	-4.42
5.03	7552.74	-4.93	-4.70
5.03	7554.28	-5.81	-4.83
5.03	7555.82	-3.86	-4.02
5.03	7557.35	-4.14	-4.19
5.03	7558.89	-4.32	-4.20
5.03	7560.42	-3.86	-4.11
5.03	7561.96	-3.47	-4.20
5.03	7563.50	-3.81	-4.11
5.04	7565.03	-4.10	-4.36

5.04	7566.57	-4.73	-4.58
5.04	7568.10	-4.47	-4.14
5.04	7569.64	-4.77	-4.11
5.04	7571.18	-4.53	-4.24
5.04	7572.71	-4.52	-4.16
5.04	7574.25	-4.93	-4.18
5.04	7575.78	-4.54	-4.33
5.04	7577.32	-4.23	-4.24
5.05	7578.86	-4.07	-4.28
5.05	7580.39	-4.19	-4.31
5.05	7581.93	-3.96	-4.08
5.05	7583.46	-4.22	-4.19
5.05	7585.00	-4.12	-4.32
5.05	7586.54	-4.12	-4.10
5.05	7588.07	-3.99	-4.28
5.05	7589.61	-4.17	-4.14
5.05	7591.14	-4.54	-4.51
5.06	7592.68	-4.82	-4.15
5.06	7594.22	-4.79	-4.12
5.06	7595.75	-4.91	-4.34
5.06	7597.29	-4.79	-4.31
5.06	7598.82	-5.03	-4.28
5.06	7600.36	-4.74	-4.22
5.06	7601.90	-2.73	-5.19
5.06	7603.43	-4.40	-3.93
5.06	7604.97	-3.78	-4.13
5.07	7606.50	-3.83	-4.19
5.07	7608.04	-4.46	-4.16
5.07	7609.57	-4.04	-4.12
5.07	7611.11	-4.38	-4.26
5.07	7612.65	-3.22	-4.49
5.07	7614.18	-2.10	-4.67
5.07	7615.72	-2.86	-4.59
5.07	7617.25	-3.23	-4.57
5.08	7618.79	-3.74	-3.94
5.08	7620.33	-3.75	-4.04
5.08	7621.86	-4.33	-4.39
5.08	7623.40	-4.45	-4.53
5.08	7624.93	-3.83	-4.91
5.08	7626.47	-4.24	-4.77
5.08	7628.01	-4.22	-4.83
5.08	7629.54	-3.84	-4.73
5.08	7631.08	-3.36	-4.53
5.09	7632.61	-2.59	-4.25
5.09	7634.15	-3.02	-4.47
5.09	7635.69	-3.48	-4.56
5.09	7637.22	-3.48	-4.48
5.09	7638.76	-4.34	-4.87
5.09	7640.29	-3.13	-4.61

5.09	7641.83	-3.65	-4.78
5.09	7643.37	-3.56	-4.69
5.09	7644.90	-3.54	-4.61
5.10	7646.44	-4.33	-4.46
5.10	7647.97	-4.03	-4.38
5.10	7649.51	-4.68	-4.37
5.10	7651.05	-4.82	-4.28
5.10	7652.58	-5.15	-4.30
5.10	7654.12	-5.44	-4.32
5.10	7655.65	-5.54	-4.48
5.10	7657.19	-4.98	-4.53
5.10	7658.73	-4.87	-4.16
5.11	7660.26	-5.22	-4.42
5.11	7661.80	-3.49	-3.85
5.11	7663.33	-3.50	-4.12
5.11	7664.87	-3.84	-4.17
5.11	7666.41	-4.19	-4.10
5.11	7667.94	-4.37	-3.82
5.11	7669.48	-3.52	-4.63
5.11	7671.01	-2.78	-4.59
5.12	7672.55	-3.16	-4.73
5.12	7674.09	-3.48	-4.54
5.12	7675.62	-2.72	-4.28
5.12	7677.16	-3.11	-4.41
5.12	7678.69	-3.37	-4.61
5.12	7680.23	-4.18	-4.87
5.12	7681.77	-4.73	-5.03
5.12	7683.30	-4.87	-4.80
5.12	7684.84	-4.12	-4.24
5.13	7686.37	-4.88	-4.65
5.13	7687.91	-4.95	-4.50
5.13	7689.45	-4.27	-4.47
5.13	7690.98	-5.02	-4.59
5.13	7692.52	-4.61	-4.42
5.13	7694.05	-5.85	-4.18
5.13	7695.59	-5.47	-4.00
5.13	7697.13	-3.95	-4.46
5.13	7698.66	-3.64	-4.63
5.14	7700.20	-5.00	-4.62
5.14	7701.73	-4.19	-4.85
5.14	7703.27	-4.51	-4.60
5.14	7704.81	-5.60	-4.28
5.14	7706.34	-5.43	-4.33
5.14	7707.88	-5.33	-4.03
5.14	7709.41	-4.05	-4.73
5.14	7710.95	-4.36	-4.82
5.14	7712.49	-4.15	-4.65
5.15	7714.02	-4.52	-4.91
5.15	7715.56	-4.15	-4.58

5.15	7717.09	-4.29	-4.89
5.15	7718.63	-4.50	-4.52
5.15	7720.17	-3.96	-4.33
5.15	7721.70	-3.90	-4.60
5.15	7723.24	-4.72	-4.49
5.15	7724.77	-4.93	-4.53
5.16	7726.31	-4.21	-4.60
5.16	7727.84	-4.19	-4.57
5.16	7729.38	-4.58	-4.40
5.16	7730.92	-4.23	-4.39
5.16	7732.45	-4.29	-4.27
5.16	7733.99	-3.60	-4.41
5.16	7735.52	-4.53	-4.27
5.16	7737.06	-4.92	-4.96
5.16	7738.60	-3.39	-4.41
5.17	7740.13	-3.76	-4.38
5.17	7741.67	-4.13	-4.57
5.17	7743.20	-4.70	-4.86
5.17	7744.74	-4.17	-4.64
5.17	7746.28	-4.27	-4.68
5.17	7747.81	-4.14	-4.48
5.17	7749.35	-4.27	-4.69
5.17	7750.88	-3.57	-4.73
5.17	7752.42	-4.08	-4.69
5.18	7753.96	-5.19	-4.46
5.18	7755.49	-4.66	-4.57
5.18	7757.03	-3.23	-4.56
5.18	7758.56	-3.39	-4.67
5.18	7760.10	-2.51	-4.63
5.18	7761.64	-3.16	-4.51
5.18	7763.17	-2.81	-4.59
5.18	7764.71	-3.02	-4.30
5.18	7766.24	-3.17	-4.49
5.19	7767.78	-3.37	-4.26
5.19	7769.32	-3.34	-4.50
5.19	7770.85	-2.73	-4.40
5.19	7772.39	-2.98	-4.30
5.19	7773.92	-3.92	-4.50
5.19	7775.46	-4.54	-4.44
5.19	7777.00	-4.91	-4.26
5.19	7778.53	-5.07	-4.47
5.19	7780.07	-4.78	-4.53
5.20	7781.60	-4.01	-4.67
5.20	7783.14	-4.52	-4.58
5.20	7784.68	-4.43	-4.41
5.20	7786.21	-4.27	-4.74
5.20	7787.75	-4.32	-4.52
5.20	7789.28	-4.53	-4.73
5.20	7790.82	-4.46	-4.81

5.20	7792.36	-4.08	-4.47
5.21	7793.89	-3.66	-4.41
5.21	7795.43	-3.83	-4.37
5.21	7796.96	-3.88	-4.67
5.21	7798.50	-3.76	-4.61
5.21	7800.04	-3.35	-4.23
5.21	7801.57	-4.64	-4.26
5.21	7803.11	-4.39	-4.51
5.21	7804.64	-3.34	-4.81
5.21	7806.18	-3.44	-4.83
5.22	7807.72	-3.76	-4.63
5.22	7809.25	-3.15	-4.35
5.22	7810.79	-3.21	-4.45
5.22	7812.32	-2.36	-4.61
5.22	7813.86	-2.55	-4.68
5.22	7815.40	-3.29	-3.95
5.22	7816.93	-2.97	-4.31
5.22	7818.47	-3.04	-4.34
5.22	7820.00	-3.49	-4.36
5.23	7821.54	-4.10	-4.19
5.23	7823.08	-4.08	-4.01
5.23	7824.61	-3.89	-4.27
5.23	7826.15	-4.95	-4.22
5.23	7827.68	-4.65	-4.53
5.23	7829.22	-3.51	-4.10
5.23	7830.76	-4.23	-4.49
5.23	7832.29	-4.40	-4.41
5.23	7833.83	-2.80	-3.99
5.24	7835.36	-4.56	-4.15
5.24	7836.90	-4.01	-4.64
5.24	7838.44	-4.67	-4.35
5.24	7839.97	-4.69	-4.37
5.24	7841.51	-4.75	-4.19
5.24	7843.04	-4.19	-4.15
5.24	7844.58	-5.29	-3.93
5.24	7846.11	-4.74	-4.53
5.25	7847.65	-3.40	-4.39
5.25	7849.19	-4.17	-4.33
5.25	7850.72	-3.01	-4.30
5.25	7852.26	-2.50	-4.46
5.25	7853.79	-4.05	-4.15
5.25	7855.33	-2.78	-4.07
5.25	7856.87	-4.85	-4.65
5.25	7858.40	-4.63	-4.37
5.25	7859.94	-4.82	-4.45
5.26	7861.47	-4.71	-4.43
5.26	7863.01	-4.50	-4.55
5.26	7864.55	-4.57	-4.19
5.26	7866.08	-5.17	-4.30

5.26	7867.62	-4.22	-4.71
5.26	7869.15	-4.36	-4.83
5.26	7870.69	-4.20	-4.94
5.26	7872.23	-4.38	-4.85
5.26	7873.76	-4.10	-5.08
5.27	7875.30	-4.53	-5.07
5.27	7876.83	-4.49	-4.82
5.27	7878.37	-4.36	-4.79
5.27	7879.91	-4.04	-4.80
5.27	7881.44	-3.94	-5.18
5.27	7882.98	-4.16	-5.10
5.27	7884.51	-5.65	-5.16
5.27	7886.05	-3.94	-5.18
5.27	7887.59	-4.12	-4.82
5.28	7889.12	-4.01	-4.77
5.28	7890.66	-3.56	-4.79
5.28	7892.19	-4.36	-4.70
5.28	7893.73	-3.85	-4.92
5.28	7895.27	-4.52	-5.06
5.28	7896.80	-3.97	-4.67
5.28	7898.34	-3.77	-4.49
5.28	7899.87	-3.53	-4.41
5.29	7901.41	-4.48	-4.69
5.29	7902.95	-5.19	-4.61
5.29	7904.48	-5.25	-4.68
5.29	7906.02	-4.92	-4.74
5.29	7907.55	-4.42	-4.64
5.29	7909.09	-4.08	-4.42
5.29	7910.63	-3.78	-4.18
5.29	7912.16	-3.57	-4.24
5.29	7913.70	-3.82	-4.65
5.30	7915.23	-1.91	-4.65
5.30	7916.77	-3.68	-4.73
5.30	7918.31	-4.09	-4.54
5.30	7919.84	-4.26	-4.72
5.30	7921.38	-3.42	-4.37
5.30	7922.91	-2.30	-4.70
5.30	7924.45	-3.60	-4.70
5.30	7925.99	-3.75	-4.80
5.30	7927.52	-4.35	-4.66
5.31	7929.06	-4.64	-4.71
5.31	7930.59	-4.60	-4.69
5.31	7932.13	-4.70	-4.48
5.31	7933.67	-4.43	-4.43
5.31	7935.20	-4.17	-4.66
5.31	7936.74	-4.74	-4.40
5.31	7938.27	-4.01	-4.43
5.31	7939.81	-3.98	-4.64
5.31	7941.35	-3.47	-4.44

5.32	7942.88	-4.67	-4.37
5.32	7944.42	-4.86	-4.60
5.32	7945.95	-5.39	-4.69
5.32	7947.49	-4.67	-4.26
5.32	7949.03	-4.90	-4.63
5.32	7950.56	-5.29	-4.83
5.32	7952.10	-4.90	-4.72
5.32	7953.63	-4.86	-5.26
5.32	7955.17	-5.17	-4.69
5.33	7956.70	-4.89	-4.84
5.33	7958.24	-4.11	-4.72
5.33	7959.78	-4.59	-4.74
5.33	7961.31	-4.29	-4.55
5.33	7962.85	-4.54	-4.52
5.33	7964.38	-4.93	-4.99
5.33	7965.92	-5.56	-4.72
5.33	7967.46	-4.30	-4.04
5.34	7968.99	-4.60	-3.94
5.34	7970.53	-4.88	-4.12
5.34	7972.06	-4.63	-4.00
5.34	7973.60	-3.70	-4.03
5.34	7975.14	-4.70	-4.66
5.34	7976.67	-4.61	-4.18
5.34	7978.21	-3.93	-4.48
5.34	7979.74	-4.60	-4.07
5.34	7981.28	-3.17	-4.69
5.35	7982.82	-2.31	-4.33
5.35	7984.35	-2.74	-4.54
5.35	7985.89	-3.35	-4.79
5.35	7987.42	-3.67	-4.61
5.35	7988.96	-4.57	-4.85
5.35	7990.50	-2.63	-4.74
5.35	7992.03	-2.77	-4.75
5.35	7993.57	-4.71	-5.03
5.35	7995.10	-3.69	-4.55
5.36	7996.64	-5.20	-4.81
5.36	7998.18	-4.65	-4.81
5.36	7999.71	-2.75	-4.62
5.36	8001.25	-5.15	-4.56
5.36	8002.78	-5.78	-4.26
5.36	8004.32	-4.32	-4.83
5.36	8005.86	-3.94	-4.73
5.36	8007.39	-4.15	-4.73
5.36	8008.93	-4.91	-4.43
5.37	8010.46	-3.71	-4.57
5.37	8012.00	-4.52	-4.69
5.37	8012.39	-5.50	-4.37
5.37	8012.78	-5.38	-4.32
5.37	8013.17	-5.24	-4.04

5.37	8013.55	-3.98	-4.94
5.37	8013.94	-4.51	-4.80
5.37	8014.33	-4.26	-4.61
5.38	8014.72	-4.25	-5.17
5.38	8015.11	-4.24	-4.66
5.38	8015.50	-4.41	-5.28
5.38	8015.88	-4.52	-4.61
5.38	8016.27	-3.56	-4.59
5.38	8016.66	-3.84	-4.80
5.38	8017.05	-4.82	-4.47
5.38	8017.44	-4.12	-4.61
5.38	8017.83	-4.05	-4.78
5.39	8018.21	-4.18	-4.56
5.39	8018.60	-3.63	-4.31
5.39	8018.99	-3.16	-4.50
5.39	8019.38	-4.24	-4.06
5.39	8019.77	-4.00	-4.45
5.39	8020.16	-3.84	-4.19
5.39	8020.55	-4.20	-4.65
5.39	8020.93	-4.34	-4.60
5.39	8021.32	-4.37	-4.53
5.40	8021.71	-4.95	-4.67
5.40	8022.10	-2.74	-4.60
5.40	8022.49	-3.11	-4.81
5.40	8022.88	-3.14	-4.74
5.40	8023.26	-3.04	-4.69
5.40	8023.65	-3.78	-4.63
5.40	8024.04	-3.59	-4.38
5.40	8024.43	-3.97	-4.35
5.40	8024.82	-3.79	-4.04
5.41	8025.21	-3.52	-4.14
5.41	8025.60	-4.12	-4.10
5.41	8025.98	-4.28	-4.23
5.41	8026.37	-4.53	-4.48
5.41	8026.76	-4.20	-4.58
5.41	8027.15	-3.65	-4.16
5.41	8027.54	-3.63	-4.38
5.41	8027.93	-4.47	-4.61
5.42	8028.31	-4.46	-4.53
5.42	8028.70	-4.03	-4.55
5.42	8029.09	-4.21	-4.50
5.42	8029.48	-3.85	-4.78
5.42	8029.87	-3.49	-4.61
5.42	8030.26	-3.93	-4.37
5.42	8030.64	-4.13	-4.46
5.42	8031.03	-4.58	-4.33
5.42	8031.42	-4.75	-4.64
5.43	8031.81	-4.14	-4.20
5.43	8032.20	-3.63	-4.55

5.43	8032.59	-3.92	-4.63
5.43	8032.98	-4.13	-4.35
5.43	8033.36	-3.71	-4.35
5.43	8033.75	-3.07	-4.29
5.43	8034.14	-4.23	-4.80
5.43	8034.53	-4.07	-4.84
5.43	8034.92	-3.51	-4.74
5.44	8035.31	-4.26	-4.54
5.44	8035.69	-4.64	-4.51
5.44	8036.08	-4.03	-4.47
5.44	8036.47	-5.17	-4.51
5.44	8036.86	-4.41	-4.74
5.44	8037.25	-3.26	-4.23
5.44	8037.64	-3.48	-4.26
5.44	8038.02	-2.84	-4.37
5.44	8038.41	-3.57	-3.98
5.45	8038.80	-2.49	-4.30
5.45	8039.19	-3.45	-4.75
5.45	8039.58	-4.48	-4.51
5.45	8039.97	-2.59	-4.29
5.45	8040.36	-4.05	-4.41
5.45	8040.74	-3.57	-4.63
5.45	8041.13	-3.20	-4.78
5.45	8041.52	-3.99	-4.65
5.45	8041.91	-3.41	-4.71
5.46	8042.30	-3.91	-4.34
5.46	8042.69	-4.34	-4.22
5.46	8043.07	-3.44	-4.06
5.46	8043.46	-2.60	-4.42
5.46	8043.85	-3.39	-4.57
5.46	8044.24	-4.42	-4.60
5.46	8044.63	-4.59	-4.70
5.46	8045.02	-5.12	-4.92
5.47	8045.41	-3.77	-4.60
5.47	8045.79	-3.34	-4.00
5.47	8046.18	-4.23	-4.34
5.47	8046.57	-5.26	-3.75
5.47	8046.96	-4.06	-4.10
5.47	8047.35	-4.30	-4.10
5.47	8047.74	-4.78	-4.35
5.47	8048.12	-4.29	-4.36
5.47	8048.51	-4.33	-4.60
5.48	8048.90	-4.91	-4.49
5.48	8049.29	-4.93	-4.54
5.48	8049.68	-4.51	-4.87
5.48	8050.07	-3.85	-4.67
5.48	8050.45	-3.66	-4.28
5.48	8050.84	-2.26	-4.42
5.48	8051.23	-2.49	-4.41

5.48	8051.62	-3.53	-4.25
5.48	8052.01	-3.61	-4.45
5.49	8052.40	-2.44	-4.28
5.49	8052.79	-3.40	-3.96
5.49	8053.17	-3.95	-4.41
5.49	8053.56	-2.79	-4.51
5.49	8053.95	-3.25	-4.36
5.49	8054.34	-3.94	-3.84
5.49	8054.73	-2.28	-4.30
5.49	8055.12	-3.72	-4.77
5.49	8055.50	-2.91	-4.23
5.50	8055.89	-2.35	-4.33
5.50	8056.28	-4.32	-4.34
5.50	8056.67	-3.08	-3.98
5.50	8057.06	-3.51	-4.08
5.50	8057.45	-3.69	-4.24
5.50	8057.83	-3.62	-4.28
5.50	8058.22	-4.19	-4.27
5.50	8058.61	-5.21	-4.21
5.51	8059.00	-5.05	-4.69
5.51	8059.39	-4.55	-4.38
5.51	8059.78	-4.28	-4.81
5.51	8060.17	-3.71	-4.29
5.51	8060.55	-4.15	-4.54
5.51	8060.94	-4.76	-4.79
5.51	8061.33	-3.41	-5.08
5.51	8061.72	-3.28	-4.49
5.51	8062.11	-2.57	-4.53
5.52	8062.50	-2.74	-4.57
5.52	8062.88	-3.13	-4.37
5.52	8063.27	-3.31	-4.18
5.52	8063.66	-3.14	-3.99
5.52	8064.05	-2.36	-4.54
5.52	8064.44	-2.67	-4.31
5.52	8064.83	-1.78	-4.72
5.52	8065.21	-4.00	-4.49
5.52	8065.60	-3.91	-4.42
5.53	8065.99	-2.97	-4.68
5.53	8066.38	-4.35	-4.42
5.53	8066.77	-2.97	-4.59
5.53	8067.16	-3.83	-5.07
5.53	8067.55	-4.33	-5.12
5.53	8067.93	-4.59	-4.39
5.53	8068.32	-3.71	-4.10
5.53	8068.71	-3.69	-4.46
5.53	8069.10	-3.41	-4.25
5.54	8069.49	-4.00	-4.45
5.54	8069.88	-2.81	-4.55
5.54	8070.26	-3.37	-4.46

5.54	8070.65	-3.24	-4.33
5.54	8071.04	-2.81	-4.78
5.54	8071.43	-4.08	-5.01
5.54	8071.82	-3.38	-4.37
5.54	8072.21	-3.97	-4.48
5.55	8072.60	-3.88	-4.84
5.55	8072.98	-3.72	-5.04
5.55	8073.37	-3.78	-4.58
5.55	8073.76	-3.24	-4.76
5.55	8074.15	-3.34	-4.86
5.55	8074.54	-4.03	-4.51
5.55	8074.93	-3.45	-4.74
5.55	8075.31	-3.05	-4.82
5.55	8075.70	-5.09	-5.14
5.56	8076.09	-5.02	-4.69
5.56	8076.48	-4.01	-4.44
5.56	8076.87	-3.19	-4.80
5.56	8077.26	-3.55	-4.36
5.56	8077.64	-3.12	-4.91
5.56	8078.03	-3.84	-4.44
5.56	8078.42	-4.25	-4.65
5.56	8078.81	-3.56	-4.59
5.56	8079.20	-4.73	-4.60
5.57	8079.59	-5.34	-4.42
5.57	8079.98	-5.20	-4.24
5.57	8080.36	-3.66	-4.41
5.57	8080.75	-3.26	-4.69
5.57	8081.14	-3.71	-4.86
5.57	8081.53	-3.22	-4.51
5.57	8081.92	-4.90	-4.41
5.57	8082.31	-4.62	-4.57
5.57	8082.69	-4.69	-4.47
5.58	8083.08	-4.48	-4.56
5.58	8083.47	-3.62	-4.46
5.58	8083.86	-4.45	-4.22
5.58	8084.25	-4.74	-4.03
5.58	8084.64	-3.11	-4.45
5.58	8085.02	-3.75	-4.39
5.58	8085.41	-2.98	-4.50
5.58	8085.80	-2.68	-4.31
5.58	8086.19	-2.21	-4.12
5.59	8086.58	-3.81	-4.32
5.59	8086.97	-2.73	-4.47
5.59	8087.36	-3.72	-4.36
5.59	8087.74	-1.84	-4.18
5.59	8088.13	-4.47	-3.94
5.59	8088.52	-4.35	-4.34
5.59	8088.91	-3.53	-4.07
5.59	8089.30	-3.69	-4.71

5.60	8089.69	-2.65	-4.73
5.60	8090.07	-2.50	-4.47
5.60	8090.46	-2.74	-4.49
5.60	8090.85	-3.02	-4.58
5.60	8091.24	-4.51	-4.21
5.60	8091.63	-4.00	-3.91
5.60	8092.02	-3.51	-4.34
5.60	8092.41	-3.47	-3.85
5.60	8092.79	-3.50	-3.83
5.61	8093.18	-3.15	-3.89
5.61	8093.57	-3.35	-4.12
5.61	8093.96	-3.45	-3.65
5.61	8094.35	-3.80	-3.95
5.61	8094.74	-3.79	-3.84
5.61	8095.12	-2.66	-3.70
5.61	8095.51	-3.65	-3.82
5.61	8095.90	-3.82	-4.00
5.61	8096.29	-3.43	-3.92
5.62	8096.68	-4.14	-3.93
5.62	8097.07	-4.21	-3.81
5.62	8097.45	-3.48	-4.21
5.62	8097.84	-3.65	-3.95
5.62	8098.23	-3.11	-4.42
5.62	8098.62	-2.77	-4.22
5.62	8099.01	-3.25	-3.80
5.62	8099.40	-4.09	-3.49
5.62	8099.79	-2.33	-3.72
5.63	8100.17	-4.62	-4.42
5.63	8100.56	-3.36	-3.97
5.63	8100.95	-3.75	-4.39
5.63	8101.34	-4.46	-4.72
5.63	8101.73	-3.34	-4.45
5.63	8102.12	-3.20	-3.93
5.63	8102.50	-2.42	-3.87
5.63	8102.89	-2.92	-4.66
5.64	8103.28	-3.13	-4.05
5.64	8103.67	-3.98	-3.96
5.64	8104.06	-3.63	-4.13
5.64	8104.45	-2.67	-3.70
5.64	8104.83	-4.56	-3.80
5.64	8105.22	-4.81	-3.88
5.64	8105.61	-3.82	-4.37
5.64	8106.00	-2.50	-3.82
5.64	8106.39	-3.44	-4.21
5.65	8106.78	-2.68	-3.78
5.65	8107.17	-2.61	-3.72
5.65	8107.55	-2.70	-4.24
5.65	8107.94	-3.44	-3.95
5.65	8108.33	-2.26	-4.26

5.65	8108.72	-2.34	-3.87
5.65	8109.11	-3.02	-4.02
5.65	8109.50	-2.88	-4.01
5.65	8109.88	-3.51	-4.10
5.66	8110.27	-3.09	-4.37
5.66	8110.66	-3.43	-4.39
5.66	8111.05	-3.95	-3.99
5.66	8111.44	-3.40	-4.35
5.66	8111.83	-3.00	-3.80
5.66	8112.22	-2.45	-4.25
5.66	8112.60	-3.31	-4.24
5.66	8112.99	-2.99	-4.04
5.66	8113.38	-3.82	-3.71
5.67	8113.77	-3.45	-4.17
5.67	8114.16	-3.17	-4.01
5.67	8114.55	-2.18	-4.76
5.67	8114.93	-1.94	-4.02
5.67	8115.32	-2.50	-4.46
5.67	8115.71	-3.94	-4.93
5.67	8116.10	-2.61	-5.09
5.67	8116.49	-1.93	-5.43
5.68	8116.88	-2.54	-4.85
5.68	8117.26	-2.98	-4.62
5.68	8117.65	-3.27	-4.32
5.68	8118.04	-1.61	-3.24
5.68	8118.43	-3.20	-4.07
5.68	8118.82	-2.52	-3.29
5.68	8119.21	-1.55	-3.77
5.68	8119.60	-2.70	-4.13
5.68	8119.98	-3.31	-4.42
5.69	8120.37	-4.06	-4.44
5.69	8120.76	-3.30	-4.71
5.69	8121.15	-2.71	-4.48
5.69	8121.54	-2.58	-4.00
5.69	8121.93	-3.67	-4.70
5.69	8122.31	-3.38	-4.65
5.69	8122.70	-2.57	-4.24
5.69	8123.09	-3.62	-3.96
5.69	8123.48	-2.56	-4.13
5.70	8123.87	-2.13	-4.27
5.70	8124.26	-3.13	-3.73
5.70	8124.64	-3.17	-3.82
5.70	8125.03	-3.90	-4.01
5.70	8125.42	-2.19	-4.09
5.70	8125.81	-2.86	-4.15
5.70	8126.20	-2.53	-3.83
5.70	8126.59	-3.25	-4.62
5.70	8126.98	-2.00	-3.45
5.71	8127.36	-2.46	-3.73

5.71	8127.75	-2.21	-3.71
5.71	8128.14	-4.04	-4.16
5.71	8128.53	-4.24	-4.81
5.71	8128.92	-4.20	-4.68
5.71	8129.31	-3.18	-4.33
5.71	8129.69	-3.52	-3.90
5.71	8130.08	-3.40	-4.07
5.71	8130.47	-3.21	-3.79
5.72	8130.86	-4.35	-4.33
5.72	8131.25	-3.54	-3.77
5.72	8131.64	-4.05	-4.62
5.72	8132.02	-3.55	-4.48
5.72	8132.41	-3.04	-3.89
5.72	8132.80	-3.14	-4.43
5.72	8133.19	-3.29	-3.71
5.72	8133.58	-4.14	-4.00
5.73	8133.97	-3.30	-3.91
5.73	8134.36	-4.24	-3.90
5.73	8134.74	-3.66	-4.22
5.73	8135.13	-4.23	-3.68
5.73	8135.52	-3.24	-3.71
5.73	8135.91	-3.11	-3.21
5.73	8136.30	-3.26	-3.42
5.73	8136.69	-2.64	-3.71
5.73	8137.07	-2.58	-3.95
5.74	8137.46	-3.30	-3.38
5.74	8137.85	-2.19	-3.78
5.74	8138.24	-3.36	-3.58
5.74	8138.63	-3.04	-3.61
5.74	8139.02	-3.07	-4.26
5.74	8139.41	-3.80	-4.41
5.74	8139.79	-3.60	-3.96
5.74	8140.18	-3.24	-4.35
5.74	8140.57	-3.36	-3.95
5.75	8140.96	-3.11	-4.33
5.75	8141.35	-4.14	-3.88
5.75	8141.74	-3.44	-3.77
5.75	8142.12	-3.59	-4.44
5.75	8142.51	-3.28	-4.25
5.75	8142.90	-3.61	-3.91
5.75	8143.29	-4.10	-3.88
5.75	8143.68	-4.17	-3.71
5.75	8144.07	-4.31	-4.45
5.76	8144.45	-3.31	-3.95
5.76	8144.84	-2.61	-4.02
5.76	8145.23	-3.79	-4.41
5.76	8145.62	-4.12	-3.86
5.76	8146.01	-4.44	-4.12
5.76	8146.40	-3.28	-4.31

5.76	8146.79	-2.97	-2.92
5.76	8147.17	-3.34	-3.29
5.77	8147.56	-4.76	-4.44
5.77	8147.95	-5.02	-4.42
5.77	8148.34	-3.81	-4.28
5.77	8148.73	-4.37	-4.40
5.77	8149.12	-2.97	-5.32
5.77	8149.50	-3.42	-4.49
5.77	8149.89	-4.33	-4.38
5.77	8150.28	-4.71	-4.63
5.77	8150.67	-4.92	-4.50
5.78	8151.06	-4.92	-4.83
5.78	8151.45	-4.75	-4.62
5.78	8151.83	-4.33	-4.66
5.78	8152.22	-3.98	-4.20
5.78	8152.61	-4.11	-4.51
5.78	8153.00	-4.01	-4.59
5.78	8153.39	-3.69	-4.04
5.78	8153.78	-4.88	-3.99
5.78	8154.17	-4.51	-4.38
5.79	8154.55	-4.31	-4.08
5.79	8154.94	-3.87	-4.16
5.79	8155.33	-2.70	-4.14
5.79	8155.72	-3.10	-4.48
5.79	8156.11	-3.80	-4.05
5.79	8156.50	-4.07	-4.06
5.79	8156.88	-5.22	-3.88
5.79	8157.27	-3.68	-4.23
5.79	8157.66	-3.55	-4.08
5.80	8158.05	-4.47	-3.87
5.80	8158.44	-4.34	-4.25
5.80	8158.83	-3.83	-3.99
5.80	8159.22	-3.81	-4.62
5.80	8159.60	-4.45	-4.14
5.80	8159.99	-3.97	-4.98
5.80	8160.38	-4.49	-4.55
5.80	8160.77	-4.98	-4.44
5.81	8161.16	-5.37	-4.96
5.81	8161.55	-5.61	-4.06
5.81	8161.93	-4.89	-3.95
5.81	8162.32	-4.38	-4.19
5.81	8162.71	-3.80	-4.39
5.81	8163.10	-4.28	-4.06
5.81	8163.49	-3.71	-3.59
5.81	8163.88	-4.38	-3.75
5.81	8164.26	-4.07	-3.86
5.82	8164.65	-4.15	-3.75
5.82	8165.04	-4.35	-3.29
5.82	8165.43	-3.42	-4.18

5.82	8165.82	-3.45	-4.30
5.82	8166.21	-3.65	-4.02
5.82	8166.60	-2.06	-4.16
5.82	8166.98	-1.64	-4.10
5.82	8167.37	-1.69	-4.23
5.82	8167.76	-1.95	-4.13
5.83	8168.15	-3.47	-3.93
5.83	8168.54	-2.98	-3.83
5.83	8168.93	-4.16	-5.13
5.83	8169.31	-3.87	-4.27
5.83	8169.70	-3.88	-4.18
5.83	8170.09	-3.22	-4.27
5.83	8170.48	-4.24	-4.27
5.83	8170.87	-2.57	-4.30
5.83	8171.26	-4.34	-4.36
5.84	8171.64	-3.75	-4.16
5.84	8172.03	-3.63	-4.13
5.84	8172.42	-3.72	-3.92
5.84	8172.81	-3.44	-4.28
5.84	8173.20	-4.09	-4.12
5.84	8173.59	-3.00	-4.14
5.84	8173.98	-2.34	-3.96
5.84	8174.36	-3.45	-4.18
5.84	8174.75	-3.41	-4.18
5.85	8175.14	-3.07	-4.11
5.85	8175.53	-2.43	-4.18
5.85	8175.92	-3.00	-3.91
5.85	8176.31	-3.99	-3.88
5.85	8176.69	-3.28	-3.75
5.85	8177.08	-3.54	-3.60
5.85	8177.47	-2.79	-3.50
5.85	8177.86	-3.40	-3.71
5.86	8178.25	-3.95	-4.11
5.86	8178.64	-4.34	-3.33
5.86	8179.03	-3.60	-3.96
5.86	8179.41	-3.66	-4.31
5.86	8179.80	-3.58	-4.41
5.86	8180.19	-2.93	-3.83
5.86	8180.58	-2.74	-3.58
5.86	8180.97	-3.23	-3.85
5.86	8181.36	-2.03	-3.79
5.87	8181.74	-2.20	-4.37
5.87	8182.13	-4.17	-4.44
5.87	8182.52	-3.76	-4.38
5.87	8182.91	-2.57	-2.52
5.87	8183.30	-2.54	-2.49
5.87	8183.69	-2.64	-2.59
5.87	8184.07	-2.96	-2.91
5.87	8184.46	-2.58	-2.53

5.87	8184.85	-3.16	-3.11
5.88	8185.24	-3.05	-3.00
5.88	8185.63	-3.63	-3.58
5.88	8186.02	-4.31	-4.26
5.88	8186.41	-3.77	-3.72
5.88	8186.79	-3.66	-3.55
5.88	8187.18	-4.23	-4.18
5.88	8187.57	-2.94	-2.89
5.88	8187.96	-3.01	-2.90
5.88	8188.35	-4.38	-4.07
5.89	8188.74	-3.78	-3.67
5.89	8189.12	-4.67	-3.97
5.89	8189.51	-2.42	-4.45
5.89	8189.90	-3.27	-3.22
5.89	8190.29	-3.16	-3.05
5.89	8190.68	-3.66	-3.61
5.89	8191.07	-5.28	-4.66
5.89	8191.45	-3.30	-3.25
5.90	8191.84	-3.32	-3.27
5.90	8192.23	-3.57	-3.52
5.90	8192.62	-3.06	-3.01
5.90	8193.01	-3.64	-4.37
5.90	8193.40	-3.70	-4.59
5.90	8193.79	-2.80	-4.09
5.90	8194.17	-2.31	-3.98
5.90	8194.56	-2.84	-4.25
5.90	8194.95	-3.59	-4.06
5.91	8195.34	-3.92	-4.08
5.91	8195.73	-4.17	-4.09
5.91	8196.12	-3.67	-4.24
5.91	8196.50	-4.16	-4.06
5.91	8196.89	-3.79	-3.74
5.91	8197.28	-3.72	-3.80
5.91	8197.67	-3.98	-4.12
5.91	8198.06	-3.78	-4.04
5.91	8198.45	-3.78	-3.93
5.92	8198.83	-3.85	-3.87
5.92	8199.22	-4.46	-4.47
5.92	8199.61	-3.89	-4.31
5.92	8200.00	-4.16	-4.39
5.92	8200.39	-3.00	-4.44
5.92	8200.78	-4.19	-4.03
5.92	8201.17	-3.40	-4.35
5.92	8201.55	-4.33	-4.14
5.92	8201.94	-4.45	-4.57
5.93	8202.33	-4.11	-4.22
5.93	8202.72	-4.14	-3.92
5.93	8203.11	-3.36	-4.21
5.93	8203.50	-4.21	-4.83

5.93	8203.88	-3.72	-4.24
5.93	8204.27	-3.84	-4.30
5.93	8204.66	-3.20	-4.11
5.93	8205.05	-2.98	-3.87
5.94	8205.44	-3.71	-4.07
5.94	8205.83	-4.76	-4.84
5.94	8206.22	-4.07	-4.41
5.94	8206.60	-4.42	-4.94
5.94	8206.99	-3.65	-4.03
5.94	8207.38	-3.43	-4.45
5.94	8207.77	-4.70	-4.15
5.94	8208.16	-4.41	-4.62
5.94	8208.55	-3.54	-4.64
5.95	8208.93	-3.04	-4.27
5.95	8209.32	-3.68	-4.63
5.95	8209.71	-3.44	-4.45
5.95	8210.10	-3.47	-4.61
5.95	8210.49	-3.15	-4.42
5.95	8210.88	-3.78	-4.51
5.95	8211.26	-3.34	-4.43
5.95	8211.65	-3.30	-4.53
5.95	8212.04	-3.70	-4.11
5.96	8212.43	-4.24	-3.97
5.96	8212.82	-5.13	-4.47
5.96	8213.21	-5.12	-4.37
5.96	8213.60	-5.00	-4.59
5.96	8213.98	-2.85	-4.65
5.96	8214.37	-2.52	-4.28
5.96	8214.76	-3.05	-4.27
5.96	8215.15	-1.91	-4.17
5.96	8215.54	-2.02	-4.28
5.97	8215.93	-2.49	-4.43
5.97	8216.31	-3.24	-4.13
5.97	8216.70	-3.24	-4.34
5.97	8217.09	-2.81	-4.32
5.97	8217.48	-3.77	-4.33
5.97	8217.87	-3.48	-4.62
5.97	8218.26	-3.96	-4.56
5.97	8218.64	-4.13	-4.57
5.97	8219.03	-3.78	-4.39
5.98	8219.42	-2.93	-4.40
5.98	8219.81	-3.74	-4.45
5.98	8220.20	-4.57	-4.73
5.98	8220.59	-2.37	-4.18
5.98	8220.98	-2.77	-4.29
5.98	8221.36	-2.22	-4.22
5.98	8221.75	-1.87	-4.34
5.98	8222.14	-2.70	-4.11
5.99	8222.53	-1.95	-4.36

5.99	8222.92	-2.94	-4.29
5.99	8223.31	-2.82	-4.02
5.99	8223.69	-2.57	-4.23
5.99	8224.08	-2.70	-4.12
5.99	8224.47	-2.43	-4.04
5.99	8224.86	-3.32	-4.08
5.99	8225.25	-2.92	-4.06
5.99	8225.64	-2.67	-4.05
6.00	8226.03	-2.96	-4.43
6.00	8226.41	-2.41	-4.10
6.00	8226.80	-3.03	-4.30
6.00	8227.19	-3.30	-4.28
6.00	8227.58	-3.05	-4.00
6.00	8227.97	-3.08	-3.98
6.00	8228.35	-3.06	-3.98
6.00	8228.74	-3.22	-4.22
6.00	8229.13	-4.16	-3.86
6.01	8229.51	-4.37	-4.68
6.01	8229.90	-3.33	-4.70
6.01	8230.29	-3.41	-4.52
6.01	8230.68	-3.41	-4.39
6.01	8231.06	-2.80	-4.46
6.01	8231.45	-3.27	-4.07
6.01	8231.84	-3.02	-3.88
6.01	8232.22	-2.35	-3.94
6.01	8232.61	-2.26	-4.15
6.02	8233.00	-2.48	-3.80
6.02	8233.39	-2.70	-3.83
6.02	8233.77	-2.51	-3.74
6.02	8234.16	-2.77	-3.79
6.02	8234.55	-2.38	-3.79
6.02	8234.93	-2.13	-4.24
6.02	8235.32	-2.79	-4.34
6.02	8235.71	-2.65	-4.38
6.03	8236.10	-2.92	-4.41
6.03	8236.48	-2.46	-4.16
6.03	8236.87	-2.62	-4.49
6.03	8237.26	-3.01	-4.44
6.03	8237.64	-2.64	-4.44
6.03	8238.03	-2.39	-4.13
6.03	8238.42	-2.71	-4.27
6.03	8238.80	-3.83	-4.30
6.03	8239.19	-2.89	-4.42
6.04	8239.58	-2.43	-4.14
6.04	8239.97	-2.39	-4.65
6.04	8240.35	-3.10	-4.44
6.04	8240.74	-2.67	-4.12
6.04	8241.13	-2.86	-4.09
6.04	8241.51	-1.88	-3.96

6.04	8241.90	-2.24	-3.57
6.04	8242.29	-2.93	-4.56
6.04	8242.68	-3.51	-4.52
6.05	8243.06	-1.72	-4.25
6.05	8243.45	-2.15	-4.31
6.05	8243.84	-2.11	-4.42
6.05	8244.22	-2.21	-4.37
6.05	8244.61	-3.90	-4.40
6.05	8245.00	-2.99	-4.25
6.05	8245.39	-2.43	-4.41
6.05	8245.77	-2.94	-4.49
6.05	8246.16	-3.00	-4.32
6.06	8246.55	-1.80	-4.33
6.06	8246.93	-3.17	-4.24
6.06	8247.32	-1.97	-3.91
6.06	8247.71	-1.97	-4.03
6.06	8248.10	-3.65	-3.77
6.06	8248.48	-2.56	-4.00
6.06	8248.87	-3.90	-4.31
6.06	8249.26	-2.06	-4.18
6.06	8249.64	-2.70	-3.91
6.07	8250.03	-3.45	-4.43
6.07	8250.42	-3.29	-3.98
6.07	8250.81	-3.90	-4.40
6.07	8251.19	-2.23	-4.64
6.07	8251.58	-2.29	-4.27
6.07	8251.97	-2.15	-4.63
6.07	8252.35	-3.01	-4.58
6.07	8252.74	-2.42	-4.21
6.08	8253.13	-2.07	-4.37
6.08	8253.51	-1.23	-4.56
6.08	8253.90	-1.72	-4.55
6.08	8254.29	-2.14	-4.82
6.08	8254.68	-2.01	-4.67
6.08	8255.06	-2.54	-4.29
6.08	8255.45	-1.22	-3.79
6.08	8255.84	-0.99	-4.01
6.08	8256.22	-0.27	-4.37
6.09	8256.61	-0.33	-4.50
6.09	8257.00	-1.97	-4.06
6.09	8257.39	-0.59	-3.82
6.09	8257.77	-2.33	-3.69
6.09	8258.16	-2.59	-3.79
6.09	8258.55	-3.47	-4.04
6.09	8258.93	-2.34	-3.94
6.09	8259.32	-2.44	-4.73
6.09	8259.71	-2.85	-4.69
6.10	8260.10	-2.78	-3.89
6.10	8260.48	-1.45	-4.16

6.10	8260.87	-2.61	-3.91
6.10	8261.26	-2.48	-3.95
6.10	8261.64	-2.99	-4.09
6.10	8262.03	-2.41	-3.75
6.10	8262.42	-2.84	-3.83
6.10	8262.81	-2.34	-4.44
6.10	8263.19	-2.55	-4.27
6.11	8263.58	-2.55	-4.00
6.11	8263.97	-1.78	-3.71
6.11	8264.35	-0.19	-3.67
6.11	8264.74	-0.74	-4.13
6.11	8265.13	-0.60	-3.91
6.11	8265.52	-1.84	-3.87
6.11	8265.90	-3.06	-4.37
6.11	8266.29	-2.51	-4.05
6.11	8266.68	-2.90	-3.99
6.12	8267.06	-2.81	-4.79
6.12	8267.45	-2.88	-4.27
6.12	8267.84	-3.17	-4.45
6.12	8268.22	-3.31	-4.19
6.12	8268.61	-3.76	-4.41
6.12	8269.00	-3.48	-4.14
6.12	8269.39	-3.77	-4.33
6.12	8269.77	-2.75	-3.90
6.13	8270.16	-2.14	-3.70
6.13	8270.55	-2.04	-3.53
6.13	8270.93	-1.73	-4.00
6.13	8271.32	-1.73	-3.65
6.13	8271.71	-2.84	-4.03
6.13	8272.10	-2.43	-4.00
6.13	8272.48	-2.36	-3.81
6.13	8272.87	-2.32	-4.09
6.13	8273.26	-2.03	-3.83
6.14	8273.64	-1.82	-4.02
6.14	8274.03	-2.75	-4.70
6.14	8274.42	-2.90	-4.37
6.14	8274.81	-2.65	-3.80
6.14	8275.19	-2.00	-3.61
6.14	8275.58	-2.62	-3.43
6.14	8275.97	-3.17	-3.72
6.14	8276.35	-3.06	-4.24
6.14	8276.74	-3.09	-4.16
6.15	8277.13	-3.19	-4.40
6.15	8277.52	-3.18	-4.06
6.15	8277.90	-3.34	-3.81
6.15	8278.29	-4.26	-4.18
6.15	8278.68	-3.11	-4.07
6.15	8279.06	-3.95	-4.29
6.15	8279.45	-3.52	-4.07

6.15	8279.84	-2.71	-4.71
6.15	8280.23	-2.73	-4.49
6.16	8280.61	-2.88	-4.31
6.16	8281.00	-2.69	-4.03
6.16	8281.39	-3.16	-4.32
6.16	8281.77	-3.44	-4.63
6.16	8282.16	-3.16	-4.83
6.16	8282.55	-3.58	-4.54
6.16	8282.93	-3.52	-4.29
6.16	8283.32	-1.92	-3.93
6.16	8283.71	-2.14	-3.96
6.17	8284.10	-2.53	-4.04
6.17	8284.48	-2.29	-4.03
6.17	8284.87	-2.19	-3.89
6.17	8285.26	-2.73	-4.23
6.17	8285.64	-3.58	-4.78
6.17	8286.03	-2.92	-4.39
6.17	8286.42	-3.51	-4.52
6.17	8286.81	-2.38	-4.20
6.17	8287.19	-2.25	-4.60
6.18	8287.58	-2.64	-4.43
6.18	8287.97	-2.42	-4.62
6.18	8288.35	-2.67	-4.46
6.18	8288.74	-2.33	-4.39
6.18	8289.13	-2.67	-4.47
6.18	8289.52	-2.47	-4.52
6.18	8289.90	-2.21	-4.41
6.18	8290.29	-1.70	-3.89
6.19	8290.68	-1.09	-4.22
6.19	8291.06	-1.97	-3.98
6.19	8291.45	-2.02	-3.74
6.19	8291.84	-2.10	-3.91
6.19	8292.23	-2.92	-4.35
6.19	8292.61	-3.48	-3.98
6.19	8293.00	-1.29	-4.39
6.19	8293.39	-2.19	-4.35
6.19	8293.77	-2.93	-4.69
6.20	8294.16	-1.48	-4.11
6.20	8294.55	-2.81	-4.14
6.20	8294.94	-2.84	-4.14
6.20	8295.32	-2.39	-4.63
6.20	8295.71	-2.29	-4.10
6.20	8296.10	-2.78	-4.35
6.20	8296.48	-2.94	-4.52
6.20	8296.87	-2.46	-4.16
6.20	8297.26	-2.54	-4.23
6.21	8297.64	-2.78	-4.59
6.21	8298.03	-2.25	-4.24
6.21	8298.42	-1.21	-4.24

6.21	8298.81	-1.53	-4.45
6.21	8299.19	-2.36	-4.22
6.21	8299.58	-2.56	-4.31
6.21	8299.97	-2.03	-4.05
6.21	8300.35	-1.47	-4.12
6.21	8300.74	-1.91	-4.33
6.22	8301.13	-1.86	-4.03
6.22	8301.52	-1.77	-4.19
6.22	8301.90	-1.17	-4.06
6.22	8302.29	-1.79	-4.01
6.22	8302.68	-2.98	-4.22
6.22	8303.06	-2.90	-4.41
6.22	8303.45	-3.49	-4.69
6.22	8303.84	-3.26	-4.86
6.22	8304.23	-2.11	-4.65
6.23	8304.61	-2.01	-4.51
6.23	8305.00	-2.55	-4.14
6.23	8307.51	-2.56	-4.33
6.23	8310.01	-3.64	-4.37
6.23	8312.52	-1.03	-3.48
6.23	8315.03	-1.61	-3.77
6.23	8317.54	-1.42	-3.78
6.23	8320.04	-2.81	-3.74
6.24	8322.55	-2.43	-3.98
6.24	8325.06	-2.39	-3.92
6.24	8327.56	-2.36	-3.46
6.24	8330.07	-1.58	-4.19
6.24	8332.58	-1.66	-3.88
6.24	8335.08	-1.96	-4.14
6.24	8337.59	-2.16	-4.11
6.24	8340.10	-2.95	-3.77
6.24	8342.61	-2.40	-3.93
6.25	8345.11	-3.06	-4.14
6.25	8347.62	-3.27	-4.22
6.25	8350.13	-2.09	-3.81
6.25	8352.63	-0.61	-3.90
6.25	8355.14	-0.47	-3.38
6.25	8357.65	-0.49	-3.13
6.25	8360.15	-0.03	-2.94
6.25	8362.66	-1.93	-3.74
6.25	8365.17	-2.81	-3.87
6.26	8367.68	-3.30	-4.63
6.26	8370.18	-3.11	-4.79
6.26	8372.69	-3.18	-4.56
6.26	8375.20	-1.75	-4.30
6.26	8377.70	-2.87	-4.54
6.26	8380.21	-3.07	-3.94
6.26	8382.72	-1.80	-3.58
6.26	8385.22	-1.24	-3.65

6.26	8387.73	-1.09	-3.44
6.27	8390.24	-1.38	-3.23
6.27	8392.75	-0.97	-3.59
6.27	8395.25	-1.49	-4.18
6.27	8397.76	-2.55	-4.16
6.27	8400.27	-2.50	-4.41
6.27	8402.77	-2.67	-4.27
6.27	8405.28	-2.98	-4.20
6.27	8407.79	-3.52	-4.10
6.28	8410.29	-2.14	-3.80
6.28	8412.80	-2.55	-3.98
6.28	8415.31	-3.25	-4.23
6.28	8417.82	-2.20	-4.14
6.28	8420.32	-2.16	-4.01
6.28	8422.83	-2.23	-3.93
6.28	8425.34	-3.06	-4.46
6.28	8427.84	-3.03	-4.30
6.28	8430.35	-2.63	-4.10
6.29	8432.86	-1.80	-3.52
6.29	8435.36	-1.55	-3.29
6.29	8437.87	-3.26	-4.26
6.29	8440.38	-2.50	-3.82
6.29	8442.89	-2.28	-4.07
6.29	8445.39	-3.28	-4.21
6.29	8447.90	-3.04	-4.08
6.29	8450.41	-2.14	-3.84
6.29	8452.91	-2.99	-4.13
6.30	8455.42	-2.41	-3.81
6.30	8457.93	-2.63	-3.91
6.30	8460.43	-2.02	-4.22
6.30	8462.94	-2.15	-4.20
6.30	8465.45	-1.91	-4.55
6.30	8467.96	-2.67	-4.31
6.30	8470.46	-2.12	-4.38
6.30	8475.48	-2.15	-4.54
6.31	8477.98	-2.51	-4.32
6.31	8480.49	-2.36	-4.47
6.31	8483.00	-2.37	-4.42
6.31	8490.52	-2.19	-4.02
6.31	8493.03	-2.12	-4.28
6.31	8495.53	-2.03	-4.37
6.31	8498.04	-2.79	-4.66
6.32	8500.55	-2.18	-4.35
6.32	8503.05	-2.20	-4.50
6.32	8505.56	-2.01	-4.71
6.32	8515.59	-2.01	-4.32
6.32	8518.10	-2.03	-4.10
6.33	8520.60	-1.61	-4.40
6.33	8523.11	-0.99	-4.20

6.33	8525.62	-2.14	-4.17
6.33	8528.12	-1.95	-4.17
6.33	8530.63	-2.20	-4.12
6.33	8535.64	-2.08	-4.45
6.33	8538.15	-1.56	-4.51
6.33	8540.66	-1.90	-4.49
6.34	8543.17	-2.00	-4.21
6.34	8545.67	-1.76	-4.10
6.34	8548.18	-1.53	-3.90
6.34	8550.69	-1.94	-4.23
6.34	8553.19	-1.70	-3.69
6.34	8555.70	-1.69	-4.08
6.34	8558.21	-2.19	-4.26
6.34	8560.71	-2.93	-4.08
6.34	8563.22	-2.66	-4.56
6.35	8565.73	-1.98	-4.25
6.35	8568.24	-2.61	-4.65
6.35	8570.74	-2.71	-4.34
6.35	8573.25	-3.21	-4.89
6.35	8575.76	-1.49	-4.41
6.35	8578.26	-2.67	-4.92
6.35	8580.77	-0.18	-4.68
6.35	8583.28	-0.05	-4.45
6.35	8585.78	0.62	-4.50
6.36	8588.29	-2.59	-4.10
6.36	8590.80	-2.24	-3.80
6.36	8593.31	-1.82	-4.57
6.36	8595.81	-1.27	-4.18
6.36	8598.32	-2.72	-4.02
6.36	8600.83	-1.86	-3.70
6.36	8603.33	-1.94	-4.39
6.36	8605.84	-2.74	-4.41
6.36	8608.35	-2.13	-4.13
6.37	8610.85	-2.11	-4.15
6.37	8613.36	-1.77	-4.16
6.37	8615.87	-1.64	-3.87
6.37	8618.38	-1.99	-4.61
6.37	8620.88	-1.39	-4.14
6.37	8623.39	-1.75	-4.15
6.37	8625.90	-1.71	-4.29
6.37	8628.40	-2.43	-4.38
6.38	8630.91	-2.05	-4.24
6.38	8633.42	-2.62	-4.46
6.38	8635.92	-1.82	-4.19
6.38	8638.43	-2.44	-4.48
6.38	8640.94	-2.77	-4.49
6.38	8643.45	-1.66	-4.36
6.38	8645.95	-1.57	-4.35
6.38	8648.46	-2.03	-4.63

6.38	8650.97	-2.25	-4.43
6.39	8653.47	-2.38	-4.19
6.39	8655.98	-1.63	-4.16
6.39	8658.49	-1.25	-4.03
6.39	8660.99	-1.87	-4.09
6.39	8663.50	-2.57	-4.09
6.39	8666.01	-3.24	-4.37
6.39	8668.52	-3.27	-4.29
6.39	8671.02	-1.98	-4.28
6.39	8673.53	-3.02	-4.03
6.40	8676.04	-3.01	-4.49
6.40	8678.54	-2.17	-3.92
6.40	8681.05	-2.21	-4.18
6.40	8683.56	-2.25	-4.29
6.40	8686.07	-2.22	-4.27
6.40	8688.57	-2.49	-4.09
6.40	8691.08	-2.86	-4.37
6.40	8693.59	-2.53	-4.19
6.40	8696.09	-3.44	-4.04
6.41	8698.60	-2.25	-4.15
6.41	8701.11	-1.04	-4.09
6.41	8703.61	-2.19	-4.11
6.41	8706.12	-0.79	-3.66
6.41	8708.63	-1.51	-3.70
6.41	8711.14	-1.87	-3.68
6.41	8713.64	-1.36	-4.02
6.41	8716.15	-1.59	-4.09
6.41	8718.66	-2.42	-4.08
6.42	8721.16	-2.30	-4.01
6.42	8723.67	-3.17	-4.30
6.42	8726.18	-3.66	-4.02
6.42	8728.68	-3.15	-3.97
6.42	8731.19	-3.07	-4.22
6.42	8733.70	-1.14	-3.90
6.42	8736.21	-2.76	-4.41
6.42	8738.71	-1.63	-3.90
6.43	8741.22	-1.63	-3.98
6.43	8743.73	-1.24	-3.76
6.43	8746.23	-0.70	-3.51
6.43	8748.74	-2.19	-4.08
6.43	8751.25	-1.07	-3.74
6.43	8753.75	-0.01	-3.37
6.43	8756.26	-0.82	-3.72
6.43	8758.77	-0.64	-3.77
6.43	8761.28	-1.39	-3.86
6.44	8763.78	-1.54	-3.95
6.44	8766.29	-1.33	-3.96
6.44	8768.80	-2.58	-4.29
6.44	8771.30	-1.90	-4.29

6.44	8773.81	-3.09	-4.92
6.44	8776.32	-2.81	-4.54
6.44	8778.82	-1.64	-3.67
6.44	8781.33	-1.04	-3.75
6.44	8783.84	-1.38	-3.54
6.45	8786.35	-1.00	-3.78
6.45	8788.85	-0.57	-3.71
6.45	8791.36	-1.40	-3.95
6.45	8793.87	-2.13	-4.09
6.45	8796.37	-1.79	-4.23
6.45	8798.88	-1.76	-4.05
6.45	8801.39	-1.92	-3.84
6.45	8803.89	-1.70	-3.87
6.45	8806.40	-2.52	-3.89
6.46	8808.91	-2.36	-4.00
6.46	8811.42	-2.29	-4.33
6.46	8813.92	-1.80	-4.45
6.46	8816.43	-1.20	-4.22
6.46	8818.94	-1.36	-4.16
6.46	8821.44	-1.98	-4.24
6.46	8823.95	-1.92	-4.23
6.46	8826.46	-1.86	-4.42
6.46	8828.96	-1.74	-4.20
6.47	8831.47	-2.41	-4.46
6.47	8833.98	-1.71	-3.69
6.47	8836.49	-1.26	-3.92
6.47	8838.99	-1.48	-3.89
6.47	8841.50	-1.84	-3.97
6.47	8844.01	-2.04	-4.32
6.47	8846.51	-1.37	-3.86
6.47	8849.02	-0.46	-3.93
6.48	8851.53	0.03	-3.41
6.48	8854.03	-0.91	-3.60
6.48	8855.39	-1.65	-4.74
6.48	8859.25	-1.82	-4.91
6.48	8863.11	-1.85	-4.50
6.48	8866.97	-1.82	-4.53
6.48	8870.83	-1.55	-4.50
6.49	8874.69	-1.51	-4.33
6.49	8878.55	-1.07	-4.27
6.49	8882.41	-1.88	-4.19
6.49	8886.27	-1.11	-4.08
6.49	8890.14	-2.37	-4.08
6.49	8894.00	-1.75	-4.39
6.50	8897.86	-1.77	-4.50
6.50	8901.72	-1.96	-4.67
6.50	8905.58	-1.78	-4.63
6.50	8909.44	-1.60	-4.59
6.50	8913.30	-1.57	-4.12

6.50	8917.16	-1.66	-4.43
6.51	8921.02	-2.11	-4.22
6.51	8924.88	-2.31	-4.32
6.51	8928.74	-2.17	-4.29
6.51	8932.60	-1.44	-4.08
6.51	8936.46	-1.69	-3.94
6.52	8940.33	-1.56	-3.78
6.52	8944.19	-1.46	-4.09
6.52	8948.05	-1.51	-4.02
6.52	8951.91	-1.47	-4.08
6.52	8955.77	-1.36	-4.08
6.52	8959.63	-1.60	-4.15
6.53	8963.49	-1.79	-3.95
6.53	8967.35	-1.96	-4.79
6.53	8971.21	-2.46	-4.46
6.53	8975.07	-1.40	-4.03
6.53	8978.93	-0.90	-4.35
6.53	8982.79	-0.78	-3.94
6.54	8986.66	-0.38	-3.57
6.54	8990.52	-1.75	-4.15
6.54	8994.38	-1.41	-4.29
6.54	8998.24	-1.05	-3.81
6.54	9002.10	-1.77	-4.04
6.55	9005.96	-2.09	-4.16
6.55	9009.82	-2.49	-4.21
6.55	9013.68	-1.68	-4.24
6.55	9017.54	-2.14	-4.45
6.55	9021.40	-2.04	-4.38
6.55	9025.26	-1.46	-4.72
6.56	9029.12	-0.90	-4.55
6.56	9032.98	-2.32	-4.76
6.56	9036.85	-2.50	-4.53
6.56	9040.71	-2.18	-4.73
6.56	9044.57	-1.32	-4.44
6.56	9048.43	-2.65	-4.74
6.57	9052.29	-1.34	-4.29
6.57	9056.15	-0.97	-4.03
6.57	9060.01	-1.62	-3.99
6.57	9063.87	-1.65	-4.56
6.57	9067.73	-2.45	-4.49
6.57	9071.59	-2.20	-4.33
6.58	9075.45	-0.27	-3.99
6.58	9079.31	0.36	-4.15
6.58	9083.17	-0.74	-4.21
6.58	9087.04	-0.11	-4.72
6.58	9090.90	-0.29	-4.84
6.59	9094.76	0.48	-4.29
6.59	9098.62	-1.23	-3.97
6.59	9102.48	-0.59	-4.49

6.59	9106.34	-1.19	-4.16
6.59	9110.20	-1.01	-4.19
6.59	9114.06	-1.22	-3.92
6.60	9117.92	-0.75	-4.14
6.60	9121.78	-0.65	-3.94
6.60	9125.64	-0.90	-3.77
6.60	9129.50	-2.27	-3.99
6.60	9133.37	-1.62	-4.11
6.60	9137.23	-1.47	-4.13
6.61	9141.09	-1.38	-3.65
6.61	9144.95	-1.87	-3.68
6.61	9148.81	-1.55	-3.70
6.61	9152.67	-1.41	-4.22
6.61	9156.53	-1.64	-4.17
6.62	9160.39	-1.52	-3.99
6.62	9164.25	-2.09	-3.93
6.62	9168.11	-0.78	-4.26
6.62	9171.97	-0.14	-3.95
6.62	9175.83	-0.43	-4.21
6.62	9179.69	-0.72	-4.18
6.63	9183.56	-1.23	-4.32
6.63	9187.42	-1.52	-4.12
6.63	9191.28	-0.83	-4.18
6.63	9195.14	-0.42	-4.25
6.63	9199.00	-1.25	-4.19
6.63	9202.86	-1.36	-4.43
6.64	9206.72	-1.17	-3.94
6.64	9210.58	-0.98	-3.78
6.64	9214.44	-0.81	-3.78
6.64	9218.30	-0.80	-3.71
6.64	9222.16	-1.35	-3.87
6.64	9226.02	-1.57	-3.80
6.65	9229.88	-1.49	-4.31
6.65	9233.75	-1.50	-4.31
6.65	9237.61	-1.04	-4.04
6.65	9241.47	-0.83	-3.62
6.65	9245.33	-0.86	-3.62
6.66	9249.19	-0.69	-3.60
6.66	9253.05	-0.77	-3.89
6.66	9256.91	-0.29	-3.85
6.66	9260.77	-1.53	-4.48
6.66	9264.63	-0.31	-4.11
6.66	9268.49	-1.69	-4.84
6.67	9272.35	-2.71	-4.72
6.67	9276.21	-1.93	-3.95
6.67	9280.08	-1.14	-4.00
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6.67	9287.80	-2.00	-4.16
6.67	9291.66	-1.85	-4.12

6.68	9295.52	-1.88	-4.19
6.68	9299.38	-0.57	-3.61
6.68	9303.24	0.06	-3.34
6.68	9307.10	-1.56	-4.29
6.68	9310.96	-1.37	-4.01
6.69	9314.82	-0.98	-3.77
6.69	9318.68	-0.36	-3.64
6.69	9322.54	0.14	-3.93
6.69	9326.40	-0.14	-3.83
6.69	9330.27	0.60	-3.71
6.69	9334.13	0.04	-3.88
6.70	9337.99	-2.14	-4.19
6.70	9341.85	-1.62	-4.06
6.70	9345.71	-2.09	-3.79
6.70	9349.57	-1.94	-4.39
6.70	9353.43	-2.14	-4.78
6.70	9357.29	-2.24	-4.33
6.71	9361.15	-2.31	-4.23
6.71	9365.01	-1.20	-3.72
6.71	9368.87	-1.95	-4.02
6.71	9372.73	-1.08	-4.14
6.71	9376.60	-0.28	-3.61
6.71	9380.46	-0.33	-3.54
6.72	9384.32	0.12	-3.66
6.72	9388.18	-0.74	-4.10
6.72	9392.04	-1.07	-4.18
6.72	9395.90	-0.59	-4.17
6.72	9399.76	-0.56	-4.33
6.73	9403.62	-0.58	-4.55
6.73	9407.48	-0.27	-4.42
6.73	9411.34	-0.06	-4.42
6.73	9415.20	-1.16	-4.09
6.73	9419.06	-0.85	-3.75
6.73	9422.92	-1.35	-3.91
6.74	9426.79	-0.77	-4.02
6.74	9430.65	-1.53	-4.21
6.74	9434.51	-1.22	-4.07
6.74	9438.37	-1.36	-3.92
6.74	9442.23	-1.13	-3.82
6.74	9446.09	-1.33	-3.96
6.75	9449.95	-1.57	-3.98
6.75	9453.81	-0.95	-4.30
6.75	9457.67	-0.42	-3.99
6.75	9461.53	-1.67	-3.83
6.75	9465.39	-1.13	-4.21
6.76	9469.25	-0.69	-3.96
6.76	9473.11	-0.66	-3.53
6.76	9476.98	-1.26	-3.73
6.76	9480.84	-1.70	-4.00

6.76	9484.70	-1.64	-4.21
6.76	9488.56	-1.18	-4.09
6.77	9492.42	-1.45	-4.01
6.77	9496.28	-1.35	-4.01
6.77	9500.14	-1.03	-3.87
6.77	9504.00	-1.49	-3.88
6.77	9507.86	-1.32	-3.64
6.77	9511.72	-0.96	-3.89
6.78	9515.58	-0.54	-3.71
6.78	9519.44	-1.43	-3.92
6.78	9523.31	-1.08	-3.81
6.78	9527.17	-0.75	-3.62
6.78	9531.03	-1.43	-4.14
6.78	9534.89	-0.24	-3.95
6.79	9538.75	-0.67	-3.82
6.79	9542.61	-1.14	-3.63
6.79	9546.47	-0.34	-3.77
6.79	9550.33	-1.59	-4.04
6.79	9554.19	-1.75	-4.05
6.80	9558.05	-2.09	-3.88
6.80	9561.91	-2.05	-3.88
6.80	9565.77	-1.33	-3.69
6.80	9569.63	-0.57	-3.53
6.80	9573.50	0.35	-3.45
6.80	9577.36	-0.02	-4.00
6.81	9581.22	-1.66	-4.17
6.81	9585.08	-2.21	-4.49
6.81	9588.94	-1.18	-3.96
6.81	9592.80	-0.36	-3.51
6.81	9596.66	-1.55	-4.00
6.81	9600.52	-1.60	-4.08
6.82	9604.38	-0.77	-3.83
6.82	9608.24	-1.70	-3.55
6.82	9612.10	-0.55	-2.93
6.82	9615.96	0.01	-2.88
6.82	9619.82	-0.86	-3.79
6.83	9623.69	-1.47	-3.72
6.83	9627.55	-1.58	-3.93
6.83	9631.41	-1.80	-3.98
6.83	9635.27	-1.61	-4.23
6.83	9639.13	-2.35	-4.30
6.83	9642.99	-0.64	-4.23
6.84	9646.85	-1.17	-4.19
6.84	9650.71	-1.73	-4.08
6.84	9654.57	-2.52	-3.86
6.84	9658.43	-2.00	-4.02
6.84	9662.29	-1.10	-3.79
6.84	9666.15	-1.51	-3.37
6.85	9670.02	-0.87	-3.68

6.85	9673.88	-0.52	-3.31
6.85	9677.74	-1.63	-3.43
6.85	9681.60	-1.74	-4.37
6.85	9685.46	-0.16	-3.84
6.85	9689.32	-0.91	-4.00
6.86	9693.18	-0.75	-3.85
6.86	9697.04	-0.50	-3.74
6.86	9700.90	-1.07	-3.79
6.86	9704.76	-0.99	-4.02
6.86	9708.62	-0.83	-3.52
6.87	9712.48	-1.38	-3.92
6.87	9716.34	-0.92	-4.30
6.87	9720.21	-0.33	-4.00
6.87	9724.07	-1.18	-3.86
6.87	9727.93	-1.57	-4.15
6.87	9731.79	-1.42	-4.24
6.88	9735.65	-1.62	-4.26
6.88	9739.51	-1.15	-4.06
6.88	9743.37	-1.29	-4.09
6.88	9747.23	-1.46	-4.12
6.88	9751.09	-1.79	-4.02
6.88	9754.95	-1.51	-4.12
6.89	9758.81	-1.42	-4.15
6.89	9762.67	-1.81	-4.08
6.89	9766.53	-1.41	-4.00
6.89	9770.40	-1.60	-4.10
6.89	9774.26	-1.86	-3.71
6.90	9778.12	-1.02	-3.47
6.90	9781.98	-2.03	-3.94
6.90	9785.84	-1.64	-3.92
6.90	9789.70	-1.67	-3.99
6.90	9793.56	-1.35	-3.92
6.90	9797.42	-0.95	-3.93
6.91	9801.28	-1.01	-3.77
6.91	9805.14	-1.13	-3.94
6.91	9809.00	-1.29	-4.28
6.91	9812.86	-0.62	-3.98
6.91	9816.73	-1.10	-4.45
6.91	9820.59	-2.05	-4.54
6.92	9824.45	-1.55	-4.33
6.92	9828.31	-1.13	-4.23
6.92	9832.17	-1.46	-4.56
6.92	9836.03	-2.19	-4.37
6.92	9839.89	-1.85	-4.40
6.92	9843.75	-1.47	-4.24
6.93	9847.61	-1.73	-4.46
6.93	9851.47	-1.77	-4.48
6.93	9855.33	-2.10	-4.15
6.93	9859.19	-1.69	-4.37

6.93	9863.05	-1.01	-4.28
6.94	9866.92	-0.64	-3.68
6.94	9870.78	-1.36	-3.99
6.94	9874.64	-1.03	-3.94
6.94	9878.50	-0.84	-3.59
6.94	9882.36	-0.32	-3.60
6.94	9886.22	-1.26	-3.58
6.95	9890.08	-0.89	-3.52
6.95	9893.94	-1.39	-4.12
6.95	9897.80	-1.37	-4.49
6.95	9901.66	-0.78	-3.51
6.95	9905.52	-1.29	-3.60
6.95	9909.38	-0.89	-3.14
6.96	9913.24	-0.45	-3.41
6.96	9917.11	-0.94	-3.81
6.96	9920.97	0.00	-3.72
6.96	9924.83	-0.20	-3.50
6.96	9928.69	-0.76	-4.05
6.97	9932.55	-0.33	-3.67
6.97	9936.41	-0.70	-3.45
6.97	9940.27	-1.24	-3.51
6.97	9944.13	-0.40	-3.59
6.97	9947.99	-0.61	-3.50
6.97	9951.85	-0.56	-3.59
6.98	9955.71	-0.76	-3.47
6.98	9959.57	-0.99	-3.87
6.98	9963.44	-1.33	-3.86
6.98	9967.30	-1.36	-3.94
6.98	9971.16	-0.69	-4.46
6.98	9975.02	-1.09	-4.59
6.99	9978.88	-0.89	-4.18
6.99	9982.74	-0.78	-3.63
6.99	9986.60	-0.43	-3.65
6.99	9990.46	-1.18	-3.60
6.99	9994.32	-0.72	-4.25
6.99	9998.18	-1.54	-4.29
7.00	10002.04	-1.96	-4.42
7.00	10005.90	-1.15	-4.08
7.00	10009.76	-1.57	-4.15
7.00	10012.30	0.60	-3.10
7.00	10014.98	0.51	-3.58
7.00	10017.66	-0.96	-3.87
7.00	10020.34	-0.74	-3.51
7.01	10023.02	-0.37	-3.05
7.01	10025.70	-0.41	-3.64
7.01	10028.38	0.00	-2.93
7.01	10031.06	-0.59	-3.74
7.01	10033.73	-0.87	-3.76
7.01	10036.41	-0.70	-3.85

7.01	10039.09	-0.95	-3.68
7.01	10041.77	-0.55	-3.90
7.02	10044.45	-0.38	-4.62
7.02	10047.13	-0.76	-4.65
7.02	10049.81	0.22	-4.38
7.02	10052.49	-0.36	-4.54
7.02	10055.17	0.25	-4.51
7.02	10057.85	0.94	-4.24
7.02	10060.53	0.91	-4.20
7.02	10063.21	0.32	-3.91
7.03	10065.89	-0.17	-4.34
7.03	10068.57	-0.44	-3.97
7.03	10071.24	-0.02	-3.89
7.03	10073.92	-0.31	-3.71
7.03	10076.60	-0.46	-4.32
7.03	10079.28	-0.27	-3.73
7.03	10081.96	-0.53	-4.27
7.03	10084.64	0.49	-3.90
7.04	10087.32	0.22	-4.78
7.04	10090.00	0.26	-5.05
7.04	10093.40	-0.07	-3.95
7.04	10096.80	0.60	-3.90
7.04	10100.20	0.75	-3.94
7.04	10103.60	0.23	-3.55
7.04	10107.00	-0.15	-3.99
7.04	10110.40	-0.54	-3.87
7.04	10113.80	-0.29	-4.03
7.05	10117.19	-0.18	-3.46
7.05	10120.59	0.42	-3.24
7.05	10123.99	1.12	-3.06
7.05	10127.39	0.17	-3.48
7.05	10130.79	0.63	-3.35
7.05	10134.19	-0.10	-3.65
7.05	10137.59	-0.08	-3.64
7.05	10140.99	0.09	-3.74
7.06	10144.39	0.64	-3.66
7.06	10147.79	0.57	-3.41
7.06	10151.19	0.06	-3.94
7.06	10154.59	-0.60	-3.87
7.06	10157.99	0.30	-3.73
7.06	10161.39	0.42	-3.64
7.06	10164.79	0.44	-3.87
7.06	10168.19	0.92	-3.61
7.07	10171.58	0.88	-3.36
7.07	10174.98	1.37	-3.20
7.07	10178.38	1.41	-3.59
7.07	10181.78	1.10	-3.56
7.07	10185.18	0.73	-3.49
7.07	10188.58	0.97	-3.23

7.07	10191.98	0.29	-3.44
7.07	10195.38	1.08	-3.47
7.08	10198.78	0.85	-3.53
7.08	10202.18	0.99	-3.25
7.08	10205.58	0.57	-3.18
7.08	10208.98	0.67	-3.50
7.08	10212.38	0.85	-3.48
7.08	10215.78	0.78	-3.72
7.08	10219.18	0.55	-3.49
7.08	10222.58	0.00	-3.62
7.08	10225.97	0.79	-3.62
7.09	10229.37	0.75	-3.80
7.09	10232.77	0.34	-3.54
7.09	10236.17	1.24	-3.18
7.09	10239.57	1.41	-3.39
7.09	10242.97	-0.07	-4.38
7.09	10246.37	0.64	-3.50
7.09	10249.77	1.44	-2.84
7.09	10253.17	1.48	-3.30
7.10	10256.57	0.51	-3.71
7.10	10259.97	0.36	-4.17
7.10	10263.37	0.81	-3.92
7.10	10266.77	1.14	-3.85
7.10	10270.17	1.33	-3.58
7.10	10273.57	1.03	-3.28
7.10	10276.96	0.49	-3.80
7.10	10280.36	0.53	-3.90
7.11	10283.76	0.08	-3.61
7.11	10287.16	0.51	-3.41
7.11	10290.56	0.83	-3.71
7.11	10293.96	1.56	-3.68
7.11	10297.36	0.74	-3.72
7.11	10300.76	0.45	-3.57
7.11	10304.16	0.37	-3.62
7.11	10307.56	0.91	-3.56
7.12	10310.96	0.95	-3.52
7.12	10314.36	1.27	-3.06
7.12	10317.76	1.29	-3.46
7.12	10321.16	1.82	-3.62
7.12	10324.56	1.58	-3.49
7.12	10327.96	1.74	-3.85
7.12	10331.35	1.44	-3.61
7.12	10334.75	1.90	-3.59
7.13	10338.15	1.81	-3.71
7.13	10341.55	2.37	-3.81
7.13	10344.95	1.76	-3.79
7.13	10348.35	2.40	-4.05
7.13	10351.75	2.01	-3.77
7.13	10355.15	2.35	-3.50

7.13	10358.55	1.69	-3.59
7.13	10361.95	2.20	-3.55
7.13	10365.35	2.05	-3.33
7.14	10368.75	2.96	-3.44
7.14	10372.15	3.04	-3.44
7.14	10375.55	2.30	-3.31
7.14	10378.95	1.69	-3.39
7.14	10382.34	1.74	-3.77
7.14	10385.74	1.75	-3.84
7.14	10389.14	2.52	-3.24
7.14	10392.54	1.90	-3.34
7.15	10395.94	2.09	-3.30
7.15	10399.34	2.19	-3.35
7.15	10402.74	2.30	-3.11
7.15	10406.14	2.18	-3.60
7.15	10409.54	2.00	-3.54
7.15	10412.94	2.31	-3.49
7.15	10416.34	2.67	-3.60
7.15	10419.74	2.49	-3.70
7.16	10423.14	2.48	-3.63
7.16	10426.54	2.05	-3.66
7.16	10429.94	2.27	-4.00
7.16	10433.34	2.15	-3.75
7.16	10436.73	2.45	-3.46
7.16	10440.13	3.04	-3.59
7.16	10443.53	2.50	-3.19
7.16	10446.93	2.24	-3.31
7.17	10450.33	3.00	-3.37
7.17	10453.73	3.02	-3.95
7.17	10457.13	2.33	-3.71
7.17	10460.53	2.27	-3.79
7.17	10463.93	2.09	-3.77
7.17	10467.33	2.07	-3.76
7.17	10470.73	3.55	-2.50
7.17	10474.13	3.27	-2.84
7.17	10477.53	2.50	-2.85
7.18	10480.93	2.08	-3.34
7.18	10484.33	2.35	-3.20
7.18	10487.73	2.74	-3.24
7.18	10491.12	2.69	-3.03
7.18	10494.52	2.09	-3.03
7.18	10497.92	2.40	-3.24
7.18	10501.32	2.75	-3.39
7.18	10504.72	3.42	-3.39
7.19	10508.12	2.62	-3.47
7.19	10511.52	2.53	-3.64
7.19	10514.92	2.85	-3.29
7.19	10518.32	3.57	-3.31
7.19	10521.72	2.57	-3.63

7.19	10525.12	2.93	-3.46
7.19	10528.52	2.73	-3.57
7.19	10531.92	2.54	-3.36
7.20	10535.32	3.43	-2.99
7.20	10538.72	3.81	-3.24
7.20	10542.11	3.82	-3.16
7.20	10545.51	3.11	-3.56
7.20	10548.91	2.79	-3.50
7.20	10552.31	3.01	-3.49
7.20	10555.71	2.26	-4.30
7.20	10559.11	3.05	-4.10
7.21	10562.51	3.41	-3.26
7.21	10565.91	3.32	-3.78
7.21	10569.31	3.10	-3.62
7.21	10572.71	3.14	-3.73
7.21	10576.11	2.60	-3.75
7.21	10579.51	3.60	-3.71
7.21	10582.91	3.21	-3.41
7.21	10586.31	3.95	-3.40
7.21	10589.71	3.68	-2.81
7.22	10593.11	4.41	-3.09
7.22	10596.50	3.41	-3.14
7.22	10599.90	3.26	-3.20
7.22	10603.30	3.35	-3.10
7.22	10606.70	4.01	-3.14
7.22	10610.10	4.21	-3.56
7.22	10613.50	3.01	-3.95
7.22	10616.90	3.89	-3.66
7.23	10620.30	3.50	-3.62
7.23	10623.70	4.41	-3.81
7.23	10627.10	4.43	-4.11
7.23	10630.50	3.72	-4.08
7.23	10633.90	3.20	-4.30
7.23	10637.30	2.86	-4.17
7.23	10640.70	4.08	-3.71
7.23	10644.10	4.45	-3.58
7.24	10647.50	4.72	-3.03
7.24	10650.89	4.77	-3.03
7.24	10654.29	4.22	-3.43
7.24	10657.69	4.43	-3.60
7.24	10661.09	3.96	-3.79
7.24	10664.49	3.95	-3.96
7.24	10667.89	3.83	-3.74
7.24	10671.29	3.96	-3.23
7.25	10674.69	3.89	-2.99
7.25	10678.09	3.31	-3.17
7.25	10681.49	3.74	-3.80
7.25	10684.89	3.81	-3.71
7.25	10688.29	4.76	-3.33

7.25	10691.69	4.50	-3.52
7.25	10695.09	3.83	-3.44
7.25	10698.49	4.40	-3.63
7.25	10701.88	4.41	-3.69
7.26	10705.28	4.72	-3.40
7.26	10708.68	3.75	-4.04
7.26	10712.08	4.43	-3.94
7.26	10715.48	5.28	-3.57
7.26	10718.88	5.12	-3.90
7.26	10722.28	5.17	-3.45
7.26	10725.68	5.14	-3.45
7.26	10729.08	4.92	-3.77
7.27	10732.48	5.03	-3.57
7.27	10735.88	4.58	-3.67
7.27	10739.28	4.48	-3.94
7.27	10742.68	4.03	-3.70
7.27	10746.08	4.75	-3.92
7.27	10749.48	4.10	-3.66
7.27	10752.88	4.14	-3.87
7.27	10756.27	4.92	-3.84
7.28	10759.67	4.30	-3.87
7.28	10763.07	4.37	-3.68
7.28	10766.47	5.31	-3.44
7.28	10769.87	5.34	-3.70
7.28	10773.27	4.86	-3.70
7.28	10776.67	4.66	-3.52
7.28	10780.07	4.96	-3.28
7.28	10783.47	4.55	-3.63
7.29	10786.87	4.67	-3.62
7.29	10790.27	5.28	-3.47
7.29	10793.67	5.15	-3.73
7.29	10797.07	4.95	-3.63
7.29	10800.47	4.75	-3.73
7.29	10803.87	4.98	-3.74
7.29	10807.26	4.81	-3.83
7.29	10810.66	5.01	-3.61
7.30	10814.06	5.04	-3.72
7.30	10817.46	5.19	-3.80
7.30	10820.86	5.22	-3.76
7.30	10824.26	4.93	-3.94
7.30	10827.66	5.28	-3.90
7.30	10831.06	4.97	-3.46
7.30	10834.46	5.20	-3.62
7.30	10837.86	4.76	-3.63
7.30	10841.26	4.85	-3.82
7.31	10844.66	4.75	-3.75
7.31	10848.06	4.67	-3.72
7.31	10851.46	4.66	-3.78
7.31	10854.86	4.70	-3.76

7.31	10858.26	4.76	-3.62
7.31	10861.65	4.81	-3.41
7.31	10865.05	4.47	-3.62
7.31	10868.45	4.52	-3.40
7.32	10871.85	4.69	-3.43
7.32	10875.25	4.88	-3.72
7.32	10878.65	4.92	-3.21
7.32	10882.05	4.78	-3.70
7.32	10885.45	4.87	-3.39
7.32	10888.85	4.72	-3.50
7.32	10892.25	4.69	-3.47
7.32	10895.65	4.62	-3.59
7.33	10899.05	4.58	-3.65
7.33	10902.45	4.65	-3.56
7.33	10905.85	4.25	-3.50
7.33	10909.25	4.18	-3.35
7.33	10912.65	4.47	-3.66
7.33	10916.04	3.88	-3.67
7.33	10922.24	4.37	-3.65
7.33	10925.64	4.57	-3.49
7.34	10929.04	4.88	-4.03
7.34	10932.44	3.90	-3.88
7.34	10935.84	4.56	-3.87
7.34	10939.24	4.13	-3.88
7.34	10942.64	4.40	-3.90
7.34	10946.04	4.37	-3.96
7.34	10949.44	4.24	-4.09
7.34	10952.84	4.49	-4.06
7.35	10956.24	4.45	-4.00
7.35	10959.64	4.30	-4.21
7.35	10963.04	4.80	-4.05
7.35	10966.43	4.74	-3.97
7.35	10969.83	4.62	-4.09
7.35	10973.23	4.11	-3.99
7.35	10976.63	4.03	-3.62
7.35	10980.03	4.17	-3.80
7.36	10983.43	4.21	-3.71
7.36	10986.83	4.09	-3.77
7.36	10990.23	4.25	-3.68
7.36	10993.63	4.10	-3.64
7.36	10997.03	4.11	-3.71
7.36	11000.43	4.25	-3.84
7.36	11003.83	4.27	-3.73
7.36	11007.23	4.25	-3.82
7.37	11010.63	4.23	-3.70
7.37	11014.03	4.28	-3.66
7.37	11017.42	4.14	-3.53
7.37	11020.82	4.12	-3.44
7.37	11024.22	4.13	-3.58

7.37	11027.62	4.10	-3.82
7.37	11031.02	3.90	-3.73
7.37	11034.42	4.14	-3.66
7.37	11037.82	4.12	-3.72
7.38	11041.22	3.91	-3.78
7.38	11044.62	3.64	-3.51
7.38	11048.02	3.96	-3.61
7.38	11051.42	3.99	-3.61
7.38	11054.82	4.17	-3.40
7.38	11058.22	4.30	-3.35
7.38	11061.62	4.16	-3.21
7.38	11065.02	4.20	-3.35
7.39	11068.42	4.11	-3.36
7.39	11071.81	4.15	-3.46
7.39	11075.21	4.16	-3.46
7.39	11078.61	4.20	-3.42
7.39	11082.01	4.33	-3.45
7.39	11085.41	4.13	-3.71
7.39	11088.81	4.13	-3.36
7.39	11092.21	4.26	-3.79
7.40	11095.61	4.03	-3.62
7.40	11099.01	3.89	-3.16
7.40	11102.41	4.07	-3.30
7.40	11105.81	4.09	-3.35
7.40	11109.21	4.41	-3.23
7.40	11112.61	4.56	-3.51
7.40	11116.01	4.41	-3.50
7.40	11119.41	4.48	-3.49
7.41	11122.81	4.58	-3.46
7.41	11126.20	4.62	-3.65
7.41	11129.60	4.57	-3.75
7.41	11133.00	4.58	-3.37
7.41	11136.40	4.52	-3.43
7.41	11139.80	4.65	-3.62
7.41	11143.20	4.32	-3.63
7.41	11146.60	4.53	-3.55
7.42	11150.00	4.80	-3.75
7.42	11156.25	4.85	-3.60
7.42	11162.50	4.74	-3.92
7.42	11168.75	4.72	-3.66
7.42	11175.00	4.59	-4.00
7.42	11181.25	4.67	-3.80
7.42	11187.50	4.60	-4.10
7.42	11193.75	4.70	-4.00
7.42	11200.00	4.62	-3.89
7.43	11206.25	4.87	-4.02
7.43	11212.50	4.40	-4.27
7.43	11218.75	4.48	-4.40
7.43	11225.00	4.66	-4.14

7.43	11231.25	4.65	-3.75
7.43	11237.50	4.67	-3.90
7.43	11243.75	4.54	-3.83
7.43	11250.00	4.50	-4.37
7.44	11256.25	4.42	-4.24
7.44	11262.50	4.19	-4.31
7.44	11268.75	4.36	-4.43
7.44	11275.00	4.25	-4.54
7.44	11281.25	4.41	-4.43
7.44	11287.50	4.51	-4.45
7.44	11293.75	4.57	-4.42
7.44	11300.00	4.46	-4.39
7.45	11306.25	4.52	-4.57
7.45	11312.50	4.46	-4.56
7.45	11318.75	4.51	-4.50
7.45	11325.00	4.38	-4.89
7.45	11331.25	4.43	-4.82
7.45	11337.50	4.33	-4.84
7.45	11343.75	4.37	-4.67
7.45	11350.00	4.40	-5.07
7.46	11356.25	4.42	-4.97
7.46	11362.50	4.40	-5.06
7.46	11368.75	4.56	-4.82
7.46	11375.00	4.51	-5.00
7.46	11381.25	4.42	-4.85
7.46	11387.50	4.48	-4.92
7.46	11393.75	4.30	-4.99
7.46	11400.00	4.12	-5.23
7.46	11430.02	4.34	-5.16
7.47	11460.03	3.73	-5.47
7.47	11490.05	3.90	-5.66
7.47	11520.06	4.15	-5.24
7.47	11550.08	4.03	-5.23
7.47	11580.09	4.09	-5.21
7.47	11610.11	3.65	-5.78
7.47	11640.12	3.53	-6.13
7.47	11670.14	3.62	-5.79
7.48	11700.15	3.23	-6.99
7.49	11952.60	3.67	-6.07
7.50	12205.05	3.02	-5.74
7.51	12457.50	3.26	-6.19
7.52	12709.95	3.08	-6.44
7.52	12739.97	2.66	-6.25
7.52	12769.98	3.49	-5.90
7.52	12800.00	3.55	-5.29
7.52	12802.73	4.07	-5.02
7.52	12805.47	4.02	-4.95
7.52	12808.20	4.11	-4.70
7.53	12810.93	3.90	-4.93

7.53	12813.66	4.22	-4.53
7.53	12816.40	4.27	-4.37
7.53	12819.13	4.47	-4.17
7.53	12821.86	5.03	-3.96
7.53	12824.60	5.00	-3.99
7.53	12827.33	4.74	-3.60
7.53	12830.06	5.62	-3.42
7.53	12832.79	5.50	-3.74
7.54	12835.53	4.77	-3.12
7.54	12838.26	5.69	-3.32
7.54	12840.99	4.87	-3.14
7.54	12843.72	4.41	-3.19
7.54	12846.46	4.49	-3.48
7.54	12849.19	4.24	-3.32
7.54	12851.92	3.98	-3.44
7.54	12854.66	4.22	-3.33
7.55	12857.39	4.22	-3.12
7.55	12860.12	4.33	-3.13
7.55	12862.85	4.37	-3.14
7.55	12865.59	4.37	-3.31
7.55	12868.32	4.28	-2.88
7.55	12871.05	4.02	-2.77
7.55	12873.79	4.32	-2.99
7.55	12876.52	4.36	-3.01
7.56	12879.25	4.04	-2.97
7.56	12881.98	4.13	-2.64
7.56	12884.72	4.39	-2.73
7.56	12887.45	3.74	-2.87
7.56	12890.18	4.90	-2.69
7.56	12892.91	4.70	-3.46
7.56	12895.65	4.36	-3.32
7.56	12898.38	5.14	-3.08
7.57	12901.11	4.98	-3.08
7.57	12903.85	4.76	-2.87
7.57	12906.58	4.89	-2.94
7.57	12909.31	4.75	-3.08
7.57	12912.04	4.86	-2.86
7.57	12914.78	4.39	-3.04
7.57	12917.51	4.88	-2.96
7.57	12920.24	4.80	-3.05
7.57	12922.98	4.12	-3.57
7.58	12925.71	3.70	-3.40
7.58	12928.44	4.10	-3.43
7.58	12931.17	4.92	-3.22
7.58	12933.91	4.23	-3.63
7.58	12936.64	4.04	-3.50
7.58	12939.37	4.03	-3.58
7.58	12942.10	4.30	-3.67
7.58	12944.84	4.27	-3.72

7.59	12947.57	4.89	-3.41
7.59	12950.30	5.83	-3.59
7.59	12953.04	4.97	-3.57
7.59	12955.77	5.48	-3.41
7.59	12958.50	4.44	-3.57
7.59	12961.23	4.93	-3.29
7.59	12963.97	4.61	-3.33
7.59	12966.70	4.54	-3.32
7.60	12969.43	4.48	-3.56
7.60	12972.17	4.37	-3.84
7.60	12974.90	4.37	-3.86
7.60	12977.63	4.80	-3.91
7.60	12980.36	4.42	-4.02
7.60	12983.10	4.37	-3.99
7.60	12985.83	4.34	-3.97
7.60	12988.56	4.87	-3.92
7.61	12991.29	4.92	-3.99
7.61	12994.03	4.64	-3.98
7.61	12996.76	4.91	-4.12
7.61	12999.49	4.66	-3.98
7.61	13002.23	4.39	-4.03
7.61	13004.96	4.44	-3.97
7.61	13007.69	4.43	-3.79
7.61	13010.42	4.05	-3.66
7.62	13013.16	4.18	-4.02
7.62	13015.89	4.65	-4.09
7.62	13018.62	4.19	-3.97
7.62	13021.36	4.15	-3.99
7.62	13024.09	4.03	-3.93
7.62	13026.82	4.21	-4.04
7.62	13029.55	4.08	-4.06
7.62	13032.29	5.12	-4.18
7.62	13035.02	4.88	-3.91
7.63	13037.75	4.17	-4.22
7.63	13040.48	4.32	-4.88
7.63	13043.22	4.43	-4.50
7.63	13045.95	3.88	-4.93
7.63	13048.68	3.77	-4.84
7.63	13051.42	3.92	-4.77
7.63	13054.15	4.18	-4.57
7.63	13056.88	3.56	-4.77
7.64	13059.61	3.97	-4.39
7.64	13062.35	3.75	-4.39
7.64	13065.08	3.59	-4.16
7.64	13067.81	4.04	-4.22
7.64	13070.55	3.96	-4.29
7.64	13073.28	3.98	-4.40
7.64	13076.01	3.85	-4.47
7.64	13078.74	4.13	-4.30

7.65	13081.48	3.67	-4.65
7.65	13084.21	3.84	-4.43
7.65	13086.94	3.95	-4.18
7.65	13089.67	3.68	-4.57
7.65	13092.41	3.31	-4.57
7.65	13095.14	3.85	-4.40
7.65	13097.87	3.51	-4.49
7.65	13100.61	3.66	-4.42
7.66	13103.34	3.86	-4.52
7.66	13106.07	3.95	-4.63
7.66	13108.80	3.79	-4.41
7.66	13111.54	3.44	-4.25
7.66	13114.27	3.84	-4.09
7.66	13117.00	4.14	-4.05
7.66	13119.74	4.18	-4.00
7.66	13122.47	3.99	-3.39
7.66	13125.20	3.68	-3.61
7.67	13127.93	3.85	-3.43
7.67	13130.67	3.77	-3.59
7.67	13133.40	3.60	-3.77
7.67	13136.13	3.58	-3.73
7.67	13138.86	3.49	-3.42
7.67	13141.60	3.64	-3.68
7.67	13144.33	3.94	-3.80
7.67	13147.06	3.99	-3.48
7.68	13149.80	3.92	-3.61
7.68	13152.53	3.82	-3.16
7.68	13155.26	3.99	-3.53
7.68	13157.99	4.24	-3.19
7.68	13160.73	4.19	-3.61
7.68	13163.46	4.14	-2.98
7.68	13166.19	3.74	-3.45
7.68	13168.93	4.11	-3.35
7.69	13171.66	3.64	-3.29
7.69	13174.39	3.88	-3.66
7.69	13177.12	4.08	-3.44
7.69	13179.86	3.63	-3.22
7.69	13182.59	3.73	-3.33
7.69	13185.32	3.60	-3.23
7.69	13188.05	3.77	-3.18
7.69	13190.79	4.10	-3.23
7.70	13193.52	4.28	-3.01
7.70	13196.25	4.03	-3.20
7.70	13198.99	3.78	-3.12
7.70	13201.72	4.16	-3.42
7.70	13204.45	4.09	-3.22
7.70	13207.18	3.96	-3.33
7.70	13209.92	4.67	-3.33
7.70	13212.65	4.22	-3.29

7.70	13215.38	4.69	-3.41
7.71	13218.12	4.41	-3.37
7.71	13220.85	3.62	-3.38
7.71	13223.58	3.96	-3.42
7.71	13226.31	3.74	-3.43
7.71	13229.05	3.86	-3.47
7.71	13231.78	3.73	-3.45
7.71	13234.51	3.54	-3.26
7.71	13237.24	3.76	-3.38
7.72	13239.98	3.58	-3.73
7.72	13242.71	3.95	-3.47
7.72	13245.44	3.87	-3.79
7.72	13248.18	4.18	-3.33
7.72	13250.91	3.81	-3.58
7.72	13253.64	3.70	-3.76
7.72	13256.37	4.37	-3.46
7.72	13259.11	3.56	-3.56
7.73	13261.84	3.76	-3.72
7.73	13264.57	3.52	-3.64
7.73	13267.31	3.85	-3.45
7.73	13270.04	3.61	-3.49
7.73	13272.77	3.51	-3.27
7.73	13275.50	3.78	-3.25
7.73	13278.24	3.79	-2.94
7.73	13280.97	3.64	-3.10
7.74	13283.70	3.77	-3.00
7.74	13286.43	3.93	-3.14
7.74	13289.17	4.37	-3.12
7.74	13291.90	3.46	-3.75
7.74	13294.63	3.58	-3.46
7.74	13297.37	4.36	-3.43
7.74	13300.10	4.50	-3.12
7.74	13302.83	4.58	-3.43
7.74	13305.56	4.51	-3.33
7.75	13308.30	4.31	-3.40
7.75	13311.03	4.07	-3.03
7.75	13313.76	4.41	-3.20
7.75	13316.50	4.50	-3.23
7.75	13319.23	4.70	-3.13
7.75	13321.96	4.66	-3.02
7.75	13324.69	4.35	-3.21
7.75	13327.43	4.44	-3.26
7.76	13330.16	4.53	-3.06
7.76	13332.89	4.36	-2.89
7.76	13335.63	4.08	-2.87
7.76	13338.36	4.43	-3.11
7.76	13341.09	3.92	-2.78
7.76	13343.82	4.67	-3.21
7.76	13346.56	4.29	-2.96

7.76	13349.29	3.60	-2.76
7.77	13352.02	4.78	-3.08
7.77	13354.75	5.11	-3.05
7.77	13357.49	4.91	-2.68
7.77	13360.22	5.56	-2.88
7.77	13362.95	4.38	-2.70
7.77	13365.69	4.36	-2.84
7.77	13368.42	4.07	-2.71
7.77	13371.15	3.88	-2.62
7.78	13373.88	4.02	-3.04
7.78	13376.62	3.79	-3.46
7.78	13379.35	3.86	-3.14
7.78	13382.08	3.97	-3.11
7.78	13384.82	3.93	-2.93
7.78	13387.55	4.19	-2.67
7.78	13390.28	4.04	-2.46
7.78	13393.01	3.49	-3.29
7.79	13395.75	3.12	-3.46
7.79	13398.48	4.13	-2.91
7.79	13401.21	3.96	-3.17
7.79	13403.94	4.00	-3.34
7.79	13406.68	4.62	-3.34
7.79	13409.41	4.57	-3.25
7.79	13412.14	4.07	-3.46
7.79	13414.88	4.26	-3.33
7.79	13417.61	3.90	-2.99
7.80	13420.34	4.17	-3.51
7.80	13423.07	4.32	-3.10
7.80	13425.81	4.36	-3.27
7.80	13428.54	4.64	-2.92
7.80	13431.27	4.19	-3.13
7.80	13434.01	4.90	-2.85
7.80	13436.74	5.41	-3.06
7.80	13439.47	4.04	-3.42
7.81	13442.20	4.57	-3.22
7.81	13444.94	4.72	-3.04
7.81	13447.67	4.02	-3.63
7.81	13450.40	4.12	-3.68
7.81	13453.13	4.32	-3.56
7.81	13455.87	4.56	-3.39
7.81	13458.60	4.16	-3.59
7.81	13461.33	4.67	-3.49
7.82	13464.07	5.48	-3.20
7.82	13466.80	4.95	-3.43
7.82	13469.53	5.72	-3.23
7.82	13472.26	4.93	-3.09
7.82	13475.00	4.79	-3.52
7.82	13477.73	4.92	-3.53
7.82	13480.46	5.18	-3.53

7.82	13483.20	5.02	-3.22
7.83	13485.93	4.78	-3.12
7.83	13488.66	5.19	-2.85
7.83	13491.39	4.89	-2.90
7.83	13494.13	4.99	-2.99
7.83	13496.86	4.82	-3.25
7.83	13499.59	4.84	-3.15
7.83	13502.32	5.07	-2.93
7.83	13505.06	4.15	-3.19
7.83	13507.79	3.79	-2.95
7.84	13510.52	4.58	-3.23
7.84	13513.26	5.00	-3.23
7.84	13515.99	4.73	-2.88
7.84	13518.72	5.33	-3.07
7.84	13521.45	4.74	-3.01
7.84	13524.19	4.70	-2.91
7.84	13526.92	4.89	-3.15
7.84	13529.65	5.00	-3.49
7.85	13532.39	4.67	-3.08
7.85	13535.12	4.66	-3.37
7.85	13537.85	4.77	-3.46
7.85	13540.58	5.17	-3.67
7.85	13543.32	5.17	-3.65
7.85	13546.05	5.09	-3.52
7.85	13548.78	5.59	-3.65
7.85	13551.51	5.26	-3.87
7.86	13554.25	4.73	-3.50
7.86	13556.98	4.44	-3.40
7.86	13559.71	3.94	-3.92
7.86	13562.45	4.13	-4.07
7.86	13565.18	4.38	-3.92
7.86	13567.91	4.51	-3.95
7.86	13570.64	4.86	-3.56
7.86	13573.38	4.97	-3.91
7.87	13576.11	4.50	-3.74
7.87	13578.84	4.24	-3.77
7.87	13581.58	4.51	-3.68
7.87	13584.31	4.48	-4.03
7.87	13587.04	4.78	-3.87
7.87	13589.77	4.82	-4.09
7.87	13592.51	4.57	-4.02
7.87	13595.24	4.55	-4.05
7.87	13597.97	5.32	-3.90
7.88	13600.70	5.18	-3.74
7.88	13603.44	4.95	-3.45
7.88	13606.17	5.00	-3.70
7.88	13608.90	5.16	-3.34
7.88	13611.64	4.94	-3.45
7.88	13614.37	4.90	-3.18

7.88	13617.10	4.79	-3.39
7.88	13619.83	5.06	-3.61
7.89	13622.57	4.95	-3.35
7.89	13625.30	4.55	-3.37
7.89	13628.03	4.86	-2.98
7.89	13630.77	4.54	-3.42
7.89	13633.50	5.12	-2.95
7.89	13636.23	4.66	-3.39
7.89	13638.96	4.70	-3.72
7.89	13641.70	4.49	-4.05
7.90	13644.43	4.10	-3.85
7.90	13647.16	5.25	-3.19
7.90	13649.89	5.61	-3.65
7.90	13652.63	4.72	-2.93
7.90	13655.36	5.18	-2.79
7.90	13658.09	5.25	-2.95
7.90	13660.83	5.09	-2.89
7.90	13663.56	4.87	-3.22
7.91	13666.29	5.80	-3.31
7.91	13669.02	5.58	-3.35
7.91	13671.76	4.34	-3.29
7.91	13674.49	4.61	-3.28
7.91	13677.22	4.85	-3.41
7.91	13679.96	4.52	-3.22
7.91	13682.69	5.12	-3.39
7.91	13685.42	5.13	-3.19
7.91	13688.15	5.61	-3.09
7.92	13690.89	5.19	-3.10
7.92	13693.62	5.39	-3.43
7.92	13696.35	5.44	-3.04
7.92	13699.08	5.10	-2.91
7.92	13701.82	4.62	-3.16
7.92	13704.55	4.96	-3.13
7.92	13707.28	4.87	-3.38
7.92	13710.02	4.85	-3.23
7.93	13712.75	5.14	-3.00
7.93	13715.48	5.41	-3.19
7.93	13718.21	5.37	-3.32
7.93	13720.95	5.07	-3.33
7.93	13723.68	5.44	-2.95
7.93	13726.41	4.68	-3.08
7.93	13729.15	4.68	-3.37
7.93	13731.88	4.68	-3.27
7.94	13734.61	4.83	-3.05
7.94	13737.34	4.87	-3.13
7.94	13740.08	5.17	-3.29
7.94	13742.81	5.34	-3.29
7.94	13745.54	5.72	-3.20
7.94	13748.27	4.98	-2.75

7.94	13751.01	5.00	-2.73
7.94	13753.74	4.97	-2.99
7.95	13756.47	5.16	-2.80
7.95	13759.21	5.74	-2.74
7.95	13761.94	6.03	-3.01
7.95	13764.67	5.20	-3.26
7.95	13767.40	6.08	-2.55
7.95	13770.14	6.18	-2.97
7.95	13772.87	5.62	-3.17
7.95	13775.60	5.81	-3.05
7.96	13778.34	5.73	-3.04
7.96	13781.07	5.68	-3.15
7.96	13783.80	5.44	-3.51
7.96	13786.53	5.46	-3.42
7.96	13789.27	6.02	-3.70
7.96	13792.00	6.01	-3.24
7.96	13794.73	5.65	-3.57
7.96	13797.46	5.53	-3.30
7.96	13800.20	5.56	-3.65
7.97	13802.93	5.20	-3.49
7.97	13805.66	5.13	-3.78
7.97	13808.40	5.30	-3.30
7.97	13811.13	5.57	-3.25
7.97	13813.86	6.05	-3.58
7.97	13816.59	4.90	-3.10
7.97	13819.33	5.14	-3.69
7.97	13822.06	5.17	-3.37
7.98	13824.79	4.94	-3.36
7.98	13827.53	5.09	-3.11
7.98	13830.26	5.62	-2.97
7.98	13832.99	4.94	-3.19
7.98	13835.72	4.73	-3.58
7.98	13838.46	5.19	-3.80
7.98	13841.19	5.00	-3.58
7.98	13843.92	4.97	-3.35
7.99	13846.66	5.19	-3.30
7.99	13849.39	5.54	-3.56
7.99	13852.12	4.87	-3.48
7.99	13854.85	5.71	-3.52
7.99	13857.59	5.57	-3.65
7.99	13860.32	5.87	-3.51
7.99	13863.05	5.70	-3.44
7.99	13865.78	5.61	-3.40
8.00	13868.52	5.44	-3.57
8.00	13871.25	5.04	-3.52
8.00	13873.98	4.86	-3.41
8.00	13876.72	5.07	-3.44
8.00	13879.45	5.68	-3.82
8.00	13881.70	5.73	-2.82

8.00	13883.95	5.38	-3.35
8.00	13886.20	5.18	-3.63
8.00	13888.45	4.92	-3.82
8.00	13890.70	5.34	-3.50
8.01	13892.95	5.22	-3.52
8.01	13895.20	5.54	-3.40
8.01	13897.45	5.35	-3.71
8.01	13899.70	5.19	-3.58
8.01	13901.95	5.02	-4.02
8.01	13904.20	5.71	-3.99
8.01	13906.45	5.69	-3.87
8.01	13908.70	4.96	-4.34
8.01	13910.95	4.68	-4.52
8.01	13913.20	4.33	-4.14
8.02	13915.45	4.49	-4.47
8.02	13917.70	4.11	-4.13
8.02	13919.95	4.65	-4.22
8.02	13922.20	4.83	-4.30
8.02	13924.45	4.89	-3.86
8.02	13926.70	4.92	-4.19
8.02	13928.95	4.80	-4.06
8.02	13931.20	4.74	-4.06
8.02	13933.45	4.88	-4.01
8.02	13935.70	4.67	-4.25
8.03	13937.95	4.29	-4.75
8.03	13940.20	4.25	-4.95
8.03	13942.45	4.29	-4.80
8.03	13944.70	4.33	-5.05
8.03	13946.95	4.20	-5.07
8.03	13949.20	4.39	-5.11
8.03	13951.46	4.76	-4.58
8.03	13953.71	4.72	-4.55
8.03	13955.96	4.79	-4.61
8.03	13958.21	4.79	-4.43
8.04	13960.46	4.87	-4.29
8.04	13962.71	4.86	-4.73
8.04	13964.96	5.04	-3.66
8.04	13967.21	4.83	-4.14
8.04	13969.46	4.93	-3.87
8.04	13971.71	4.94	-3.68
8.04	13973.96	5.08	-3.72
8.04	13976.21	4.74	-3.90
8.04	13978.46	4.84	-4.08
8.04	13980.71	4.91	-4.03
8.05	13982.96	4.78	-3.34
8.05	13985.21	4.88	-3.75
8.05	13987.46	4.71	-3.57
8.05	13989.71	5.12	-3.84
8.05	13991.96	4.99	-4.02

8.05	13994.21	5.19	-3.86
8.05	13996.46	4.39	-4.24
8.05	13998.71	5.02	-3.62
8.05	14000.96	5.17	-3.31
8.05	14003.21	4.91	-3.39
8.06	14005.46	4.93	-3.07
8.06	14007.71	4.61	-4.22
8.06	14009.96	4.58	-4.47
8.06	14012.21	4.82	-4.20
8.06	14014.46	4.43	-3.68
8.06	14016.71	4.81	-3.90
8.06	14018.96	4.77	-3.72
8.06	14021.21	5.21	-3.47
8.06	14023.46	5.68	-4.16
8.06	14025.71	5.60	-3.68
8.07	14027.96	5.55	-3.42
8.07	14030.21	5.53	-3.79
8.07	14032.46	5.81	-3.27
8.07	14034.71	5.09	-3.87
8.07	14036.96	4.84	-3.78
8.07	14039.21	4.70	-3.99
8.07	14041.46	5.30	-3.70
8.07	14043.71	5.37	-3.46
8.07	14045.96	5.70	-3.27
8.07	14048.21	5.11	-4.06
8.08	14050.46	5.43	-3.70
8.08	14052.71	4.82	-4.11
8.08	14054.96	4.66	-4.17
8.08	14057.21	5.13	-4.03
8.08	14059.46	5.53	-3.91
8.08	14061.72	5.22	-2.92
8.08	14063.97	5.24	-4.04
8.08	14066.22	5.23	-3.58
8.08	14068.47	5.00	-3.83
8.08	14070.72	4.91	-3.79
8.09	14072.97	4.60	-3.99
8.09	14075.22	4.56	-3.53
8.09	14077.47	4.74	-3.81
8.09	14079.72	4.69	-3.84
8.09	14081.97	4.09	-3.97
8.09	14084.22	4.92	-3.33
8.09	14086.47	4.59	-3.47
8.09	14088.72	4.69	-3.88
8.09	14090.97	5.40	-3.66
8.09	14093.22	4.51	-3.83
8.10	14095.47	4.45	-3.25
8.10	14097.72	4.42	-3.92
8.10	14099.97	5.53	-3.09
8.10	14102.22	4.97	-4.04

8.10	14104.47	4.89	-3.75
8.10	14106.72	5.21	-3.95
8.10	14108.97	5.17	-3.48
8.10	14111.22	5.41	-3.72
8.10	14113.47	4.73	-3.82
8.10	14115.72	4.75	-3.87
8.11	14117.97	4.82	-3.26
8.11	14120.22	4.30	-3.96
8.11	14122.47	4.26	-3.97
8.11	14124.72	4.26	-3.63
8.11	14126.97	5.67	-3.74
8.11	14129.22	4.64	-3.95
8.11	14131.47	4.87	-3.42
8.11	14133.72	4.09	-3.62
8.11	14135.97	4.95	-3.67
8.11	14138.22	4.73	-4.11
8.12	14140.47	4.85	-3.66
8.12	14142.72	4.80	-3.68
8.12	14144.97	4.30	-3.49
8.12	14147.22	4.84	-3.64
8.12	14149.47	4.64	-3.77
8.12	14151.72	5.01	-3.84
8.12	14153.97	5.03	-3.48
8.12	14156.22	4.75	-3.69
8.12	14158.47	4.34	-4.16
8.12	14160.72	4.22	-3.76
8.13	14162.97	4.77	-3.69
8.13	14165.22	4.50	-3.43
8.13	14167.47	4.75	-3.04
8.13	14169.73	4.39	-2.99
8.13	14171.98	4.50	-3.74
8.13	14174.23	4.07	-3.49
8.13	14176.48	4.46	-3.31
8.13	14178.73	4.82	-3.47
8.13	14180.98	4.51	-3.48
8.13	14183.23	4.60	-3.14
8.14	14185.48	4.46	-3.61
8.14	14187.73	4.66	-3.41
8.14	14189.98	4.83	-3.43
8.14	14192.23	4.71	-3.65
8.14	14194.48	4.88	-3.40
8.14	14196.73	4.59	-3.50
8.14	14198.98	4.46	-3.65
8.14	14201.23	4.76	-3.27
8.14	14203.48	4.67	-3.20
8.14	14205.73	4.74	-3.80
8.15	14207.98	3.93	-3.81
8.15	14210.23	4.47	-3.98
8.15	14212.48	4.47	-3.80

8.15	14214.73	4.43	-3.75
8.15	14216.98	4.84	-3.70
8.15	14219.23	4.58	-3.58
8.15	14221.48	4.06	-3.75
8.15	14223.73	4.51	-3.49
8.15	14225.98	5.11	-3.35
8.15	14228.23	4.98	-3.31
8.16	14230.48	5.21	-3.17
8.16	14232.73	4.51	-3.68
8.16	14234.98	4.88	-3.95
8.16	14237.23	4.69	-4.05
8.16	14239.48	4.60	-4.21
8.16	14241.73	4.51	-3.63
8.16	14243.98	4.76	-3.73
8.16	14246.23	4.61	-3.87
8.16	14248.48	4.71	-3.43
8.16	14250.73	4.64	-3.42
8.17	14252.98	4.56	-3.43
8.17	14255.23	4.31	-3.54
8.17	14257.48	4.53	-3.54
8.17	14259.73	5.09	-3.39
8.17	14261.98	4.92	-3.92
8.17	14264.23	4.84	-3.18
8.17	14266.48	4.81	-3.29
8.17	14268.73	4.55	-3.59
8.17	14270.98	4.68	-3.60
8.17	14273.23	4.54	-4.15
8.18	14275.48	4.12	-3.67
8.18	14277.73	4.77	-3.68
8.18	14279.99	4.28	-3.54
8.18	14282.24	4.09	-4.17
8.18	14284.49	3.86	-3.91
8.18	14286.74	4.08	-4.05
8.18	14288.99	4.31	-4.04
8.18	14291.24	4.58	-4.02
8.18	14293.49	4.83	-3.99
8.18	14295.74	4.52	-3.72
8.19	14297.99	4.77	-3.51
8.19	14300.24	4.61	-3.65
8.19	14302.49	4.42	-3.92
8.19	14304.74	4.35	-3.76
8.19	14306.99	4.34	-3.69
8.19	14309.24	4.40	-3.52
8.19	14311.49	4.29	-3.59
8.19	14313.74	4.35	-3.58
8.19	14315.99	4.38	-3.48
8.19	14318.24	4.48	-3.48
8.20	14320.49	4.50	-3.44
8.20	14322.74	3.95	-3.17

8.20	14324.99	4.47	-3.20
8.20	14327.24	4.37	-3.27
8.20	14329.49	4.83	-3.62
8.20	14331.74	4.79	-3.16
8.20	14333.99	4.47	-3.61
8.20	14336.24	4.68	-3.37
8.20	14338.49	4.54	-3.96
8.20	14340.74	4.66	-4.20
8.21	14342.99	4.46	-3.69
8.21	14345.24	4.91	-3.18
8.21	14347.49	4.68	-3.37
8.21	14349.74	4.74	-3.53
8.21	14351.99	4.75	-3.23
8.21	14354.24	4.75	-3.26
8.21	14356.49	4.68	-3.55
8.21	14358.74	4.82	-2.90
8.21	14360.99	4.68	-3.46
8.21	14363.24	5.01	-2.74
8.22	14365.49	5.19	-3.02
8.22	14367.74	4.85	-2.91
8.22	14369.99	4.98	-2.94
8.22	14372.24	4.92	-3.10
8.22	14374.49	4.53	-2.60
8.22	14376.74	4.44	-3.03
8.22	14378.99	4.35	-2.88
8.22	14381.24	4.37	-3.09
8.22	14383.49	4.49	-3.13
8.22	14385.74	4.54	-2.89
8.23	14388.00	4.72	-3.00
8.23	14390.25	4.57	-3.26
8.23	14392.50	4.72	-2.55
8.23	14394.75	4.75	-2.84
8.23	14397.00	4.45	-3.25
8.23	14399.25	3.89	-3.49
8.23	14401.50	4.40	-2.70
8.23	14403.75	4.46	-3.02
8.23	14406.00	4.60	-3.16
8.23	14408.25	4.22	-3.21
8.24	14410.50	4.40	-3.18
8.24	14412.75	3.94	-3.54
8.24	14415.00	3.79	-3.60
8.24	14417.25	3.68	-3.28
8.24	14419.50	3.47	-3.65
8.24	14421.75	3.16	-3.90
8.24	14424.00	3.36	-3.25
8.24	14426.25	3.93	-3.28
8.24	14428.50	3.60	-3.13
8.24	14430.75	3.64	-3.01
8.25	14433.00	3.98	-3.03

8.25	14435.25	3.70	-2.89
8.25	14437.50	3.49	-3.04
8.25	14439.75	3.99	-2.92
8.25	14442.00	4.01	-2.81
8.25	14444.25	3.71	-3.27
8.25	14446.50	4.31	-2.98
8.25	14448.75	3.31	-2.93
8.25	14451.00	3.97	-3.30
8.25	14453.25	4.44	-3.56
8.26	14455.50	4.44	-3.60
8.26	14457.75	3.70	-4.10
8.26	14460.00	3.30	-3.89
8.26	14462.25	3.92	-3.45
8.26	14464.50	2.88	-3.78
8.26	14466.75	3.47	-3.73
8.26	14469.00	3.71	-3.74
8.26	14471.25	3.96	-3.76
8.26	14473.50	4.11	-4.45
8.27	14489.25	4.95	-5.05
8.28	14511.76	4.95	-4.75
8.29	14534.26	3.13	-6.71
8.30	14556.76	3.17	-7.33
8.31	14579.26	3.01	-7.64
8.32	14601.76	3.22	-7.56
8.33	14624.27	3.14	-7.64
8.34	14646.77	3.10	-7.69
8.35	14669.27	3.15	-7.91
8.36	14691.77	2.95	-7.56
8.37	14714.27	2.92	-7.64
8.38	14736.78	2.97	-7.18
8.39	14759.28	3.48	-7.44
8.40	14781.78	2.92	-7.34
8.41	14804.28	3.41	-7.26
8.42	14826.79	3.03	-6.99
8.43	14849.29	3.27	-7.36
8.44	14871.79	3.08	-7.12
8.45	14894.29	3.02	-7.14
8.46	14916.79	3.12	-6.93
8.47	14939.30	3.22	-7.04
8.48	14961.80	3.01	-7.09
8.49	14984.30	3.04	-6.70
8.50	15006.80	2.98	-6.58
8.51	15029.30	3.14	-6.83
8.52	15051.81	2.98	-7.16
8.53	15074.31	3.16	-6.87
8.54	15096.81	3.05	-6.79
8.55	15119.31	2.86	-7.05
8.56	15141.81	3.05	-6.81
8.57	15164.32	2.96	-6.95

8.58	15186.82	2.91	-7.25
8.59	15209.32	2.89	-6.78
8.60	15231.82	2.88	-6.88
8.61	15254.32	2.92	-6.97
8.62	15276.83	2.88	-7.05
8.63	15299.33	2.89	-7.12