Report to
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Eutrophication in Farmington Bay, Great Salt Lake, Utah
2005 Annual Report

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Summary

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Phytoplankton, zooplankton, and other related limnological parameters were sampled at three or more sites in Farmington Bay and at three similarly shallow sites in Gilbert Bay from May through November 2005 to assess eutrophication and beneficial use attainment in Farmington Bay. Salinities in Farmington Bay ranged from 0.6% during spring runoff (May) to 5% in September 2005, whereas salinities in Gilbert Bay ranged from 13% to 16% over this period.

In Farmington Bay, densities of toxic cyanobacteria and chlorophyll levels greatly exceeded the World Health Organization's criteria for moderate to high probabilities of public health risk. A massive bloom of the cyanobacterium *Nodularia spumigena* was present for most of the study period, as well as relatively high densities of non-toxic diatoms, pyrrophytes and chlorophytes. Surface scums of *Nodularia* were sometimes present. Very high nitrogen fixation rates by *Nodularia* in Farmington Bay during 2005 likely helped sustain phytoplankton growth in the bay. Chlorophyll levels averaged 263 µg L^{-1} and reached over 400 µg L^{-1} on three occasions – nearly double that found in 2003 when salinities were usually above 5%. A laboratory experiment demonstrated that *Nodularia* survived poorly and stopped fixing nitrogen at salinities above 5%. Preliminary analyses of the toxin nodularin that is produced by *Nodularia* indicated that it was present at extremely high concentrations. In August, samples were collected from three stations for pathogens and analyzed using molecular techniques. The preliminary analyses indicate that amoeba and taxa belonging to the Legionella group were present in all samples, but additional analyses will be necessary to determine if they could be the pathogenic *Legionaris pneumophila*. These preliminary findings raise human and wildlife health issues that merit further investigation.

Secchi disk readings averaged only 0.3 m, and mean total phosphorus concentrations were 673 µg L^{-1}. A mean Trophic state index calculated from these values was 87, indicating that Farmington Bay is hypereutrophic, and has the highest TSI of any water body in the state of Utah.

The high algal production and a shallow water column led to anoxia in Farmington Bay. Nighttime anoxia was frequent, and several boughts of prolonged anoxia for more than one day occurred at both the north and south ends of the bay. After July, a salt wedge protruded into the north end of Farmington from Gilbert Bay, and this layer was always anoxic and had high concentrations of hydrogen sulfide, thus making it uninhabitable for aquatic organisms other than bacteria.

From July through October, ammonia concentrations in Farmington Bay were usually greater than 150 µg N L^{-1} and they reached 400 µg N L^{-1} in May. The pH in Farmington Bay was usually above 9 and went above 9.5 frequently, indicating that a significant proportion of the

ammonia would be in the unionized, toxic form. At these pH levels, total ammonia concentrations from July-November greatly exceeded the EPA's suggested concentration for this pollutant (95 µg L^{-1} freshwater; 90 µg L^{-1} marine).

Zooplankton densities in Farmington Bay fluctuated greatly. In early May and during June and July total cladoceran and copepod densities were extremely high (> 400 L^{-1}) indicating that the high production in the bay is passed up the food web at certain times. After late August, however, nearly all the crustaceans disappeared, and an air-breathing insect predator, *Trichocorixa verticalis* (corixid) dominated the community. Brine shrimp were not abundant in Farmington Bay. Zooplankton biomass was approximately three times higher in Farmington than in Gilbert Bay, where brine shrimp were the only abundant organism. Both field and laboratory bioassays indicated that *Artemia* survived poorly in the Farmington Bay water, but it was not clear if this was due to poor water quality (anoxia, algal toxins, ammonia, etc.), or to some other factor associated with the low salinities in the bay. In addition to the poor survival in Farmington Bay water, two field mesocosm experiments demonstrated that densities of the predatory corixid in Farmington Bay during 2005 were sufficient to greatly limit *Artemia* densities there.

Artificial substrates deployed in Gilbert and Farmington Bays showed there were large differences in the bottom-dwelling (benthic) organisms in the two systems. In Gilbert Bay densities of the brine fly (*Ephydra cinerea*) larvae and pupae were each nearly 4,000 and 6,000 m^{-2} and no other invertebrates were abundant. In contrast, densities of a similar species of brine fly (*Ephydra hians*) in Farmington Bay were only 60 m^{-2}. Corixids were, however, abundant on the Farmington Bay substrates.

A large synoptic analysis of the Great Salt Lake during June indicated that chlorophyll and cyanobacterial pigments are far higher in Farmington Bay than in Gilbert Bay or in Bear River Bay. The high concentration of algae in Farmington Bay was associated with low salinity and high nutrient levels. However, nutrient levels are also high in Gilbert and Bear River Bays, so it is likely the interaction of salinity and nutrients that allow the extremely high algal populations in Farmington Bay. Satellite imagery demonstrated that a plume of high chlorophyll water extends approximately 10 miles from Farmington Bay out into Gilbert Bay. The laboratory bioassay described above showed that when the organic-rich water from Farmington Bay is diluted into Gilbert Bay with high salinity, the organic matter promotes the growth and survival of *Artemia.*

In summary, our analyses of Farmington Bay indicate it is hypereutrophic with poor water quality. Low oxygen and apparently high unionized ammonia concentrations do not meet either marine or freshwater criteria. Cyanobacterial blooms in 2005 also greatly exceeded levels considered to pose moderate or high probabilities of public health risk. Because of the unusual characteristics of Farmington Bay and the rest of the Great Salt Lake, the Utah Division of Water Quality has not, however, applied criteria for the bay established for other waters in the United States. The data presented here suggest that the state needs to move towards developing site-specific water quality standards for Farmington Bay that will protect its designated uses for contact recreation and the protection of aquatic wildlife.

Introduction

Farmington Bay, located in the southeast corner of the Great Salt Lake (Utah), receives the majority of municipal and industrial wastewater from the Salt Lake City metropolitan area, as well as non-point source pollution from agriculture and urban runoff. Nutrients from seven wastewater plants flow into Farmington Bay, either directly or via wetland complexes, and the bay also receives industrial effluents. Farmington Bay covers 100 mi^2 (260 km^2) with a mean depth of near 1 m, depending on cyclic changes in the elevation of this terminal lake. Nutrient and other pollutant loads are concentrated in Farmington Bay due to a causeway to Antelope Island. Consequently, natural mixing of contaminants with the the central part of the lake, Gilbert Bay, is substantially reduced and allows salinities in the bay to fluctuate between 0.5% and 10%, depending on inter-annual differences in runoff and seasonal fluctuations.

Monitoring to date indicates that Farmington Bay is hypereutrophic, with chlorophyll *a* concentrations >100 µg L^{-1}, Secchi depths <0.3 m and blooms of cyanobacteria (Carter 1971; Wurtsbaugh & Marcarelli 2004a). The trophic state indices are the highest of any water body in Utah. The filamentous cyanophyte (blue-green alga), *Nodularia spumigena* is sometimes abundant in Farmington Bay but is rarely seen at the higher salinities of the main lake. *Nodularia* can fix atmospheric nitrogen, and may thus contribute to the overall nutrient loading in Farmington Bay when low salinities allow it to persist. *Nodularia* and other cyanobacteria produce toxins, and are thus thought to be unpalatable to most zooplankton. A routine bioassay for cyanobacterial toxins utilizes brine shrimp nauplii as the test organism (e.g. Lahti et al. 1995), thus suggesting that these toxins may impact natural brine shrimp populations in the Great Salt Lake.

The automobile causeway across Farmington Bay not only impedes circulation with the main lake, but induces density-stratification in the bay. A high-density salt wedge (16%) from Gilbert Bay often underflows the less dense water in the northern portion of Farmington Bay. The hypereutrophic conditions are accentuated because the salt wedge traps organic matter, thus forming anoxic, reducing conditions that produce H_2S. Preliminary results suggest that when wind storms mix the H_2S trapped in the salt wedge into the overlying water, the entire bay may go anoxic for up to two days (Wurtsbaugh & Marcarelli 2004b). Water column anoxia related to wind mixing and the entrainment of H_2S–rich bottom water occurs in the hypereutrophic Salton Sea, and there it has been documented to kill phytoplankton, zooplankton and fish (Watts et al. 2001).

Preliminary sampling indicates that the densities of brine shrimp and brine flies in Farmington Bay are usually far lower than those in the remainder of the lake, despite the high algal production in the bay (Marcarelli et al. 2003; Wurtsbaugh and Marcarelli 2004a). Brine shrimp and brine flies are very important to the ecosystem, both as a primary food resource for migratory birds and for the commercial value of brine shrimp cysts. The poor water quality conditions in Farmington Bay may cause invertebrate abundances to be low, but it is also possible that densities are lower than in Gilbert Bay because low salinities in the bay may physiologically exclude certain species. At times, the lower salinities in Farmington Bay also provide acceptable conditions for air-breathing predatory insects (corixids) and a harpacticoid copepod, both of which may prey on brine shrimp. Consequently, it is possible that low brine shrimp densities, and possibly brine fly densities are due to predation by these invertebrates and not to water quality conditions.

Because of the unusual characteristics of Farmington Bay, a beneficial use assessment is not as straightforward as in freshwaters. Consequently, there were two primary goals for our 2005 research. First, we monitored water quality and plankton in the bay for the duration of the growing period to gain a better understanding, along with data collected in 2003, of how climatic and salinity changes influence limnological characteristics. Secondly we conducted field experiments to understand factors controlling the abundance of brine shrimp in the bay using two limnocorral experiments. Our goal was to understand whether the differences in brine shrimp abundance were due to salinity differences, eutrophication, or predation.

Methods

Routine monitoring – Three stations in Farmington Bay were sampled between May and November 2005. The GPS locations of these are shown in Table 1. We initially sampled stations 1, 2, and 4. However, shallow water conditions prevented sampling of Station 4 after 16 Aug 2005, at which point Station 3 replaced it as a routine sampling station. On seven dates we also sampled three stations (14, 15, and 18) in Gilbert Bay along a N-S transect west of Antelope Island, at depths comparable to those sampled in Farmington Bay.

To obtain high resolution measurements on some chemical parameters three TROLL 9000 multiparameter sonde were deployed from 27 May through 12 Nov 2005 stations 1 and 3/4. At station 1, two sondes were deployed, one 0.2 m below the surface and one 0.25 m above the lake bottom. The third sonde was deployed 0.2 m below the surface at station 4 until 15 Aug 2005, when it was moved north to station 3 because of lake shallowing. Temperature, dissolved oxygen, pH, oxidation-reduction potential (ORP), and conductivity were measured at 15 minute intervals by each sonde. Sondes were downloaded every 3-6 weeks and were re-calibrated at the time of each download. Weather data for comparison with the sonde data was obtained from the National Climactic Data Center (http://www.ncdc.noaa.gov) for the weather station at the Salt Lake City Airport (station code 24127, USAF code 725720).

Additional parameters were collected at 2-3 week intervals in Farmington Bay and 4-6 week intervals in Gilbert Bay. On each sampling date, routine limnological characteristics were measured. Vertical profiles of temperature, dissolved oxygen, pH, oxidation-reduction potential (ORP), and conductivity were measured using a TROLL 9000 multiparameter sonde. Secchi disk transparency and light transmission with a LiCor spherical sensor were measured to assess the depth of the photic zone in the bay. Water depth was determined with a weighted line or meter stick.

Water was collected at 0.4 m depth in both bays using a peristaltic pump and analyzed for a variety of chemical characteristics. Salinity was measured using a hand-held refractometer. In the laboratory, water was filtered through 0.8 µm GF/F filters and frozen for analysis of ammonium-N, nitrate-N, and phosphate-P. Internal spikes of these nutrients were done on a subset of split samples. Additionally, unfiltered water samples were frozen for total nitrogen and total phosphorus (TN/TP) analysis. Ammonium-N (detection limit 0.05 mg L^{-1}) and nitrate-N (detection limit 0.005 mg L^{-1}) were analyzed by the Utah State University Analysis Lab on a Lachat QuikChem 8000 Flow Injection Analyzer utilizing the cadmium reduction method for nitrate and the phenolate method for ammonia. Due to some methodological failure, nitrate-N concentrations were undetectable using their analysis technique and are not reported here. TN/TP samples were analyzed using a persulfate digestion followed by a second derivative analysis of N (detection limit 0.04 mg L^{-1}) (Crumpton et al. 1992). TP (after digestion) and phosphate-P samples were both analyzed using the malachite green method of Linge and Oldham (2001, 2002), which corrects for interference from arsenate, which is high in the Great Salt Lake (detection limit 0.006 mg L^{-1}).

Hydrogen sulfide (H_2S) measurements were made in Farmington Bay on each sampling date. Duplicate samples were collected from 3-4 depths in the mixed layer and 1-2 depths in the deep brine layer with a peristaltic pump into 300-mL BOD bottles. Bottles were filled using the “overflowing bottle” technique that insures that oxygen does not enter the bottle and change redox conditions. Samples were preserved using zinc acetate and the amount of hydrogen sulfide present was determined with the iodometric method (APHA 2000) within 48 hours (detection limit 0.31 mg L^{-1}).

Nitrogen fixation potential (acetylene reduction) was measured only at Station 1 in Farmington Bay on each sampling date. Water samples were collected at 0.2-m intervals from the entire water column using a peristaltic pump. Two 50-mL aliquots of water from each depth were placed in 62-mL glass serum vials and sealed with airtight septa. Samples were injected with 4-mL of acetylene gas generated from calcium carbide to achieve a headspace of approximately 20% ethylene gas and shaken for 30 seconds to ensure equal partitioning of gas between the liquid and vapor phases (Flett et al. 1976). All samples were then incubated for 2-hours minimum, suspended on an incubation line at the approximate depth of collection. Standards containing known concentrations of ethylene were also incubated with the samples. After the incubation, vials were shaken again to repartition the gas and final gas samples were collected into cleaned, re-evacuated 3-mL Vacutainers and returned to the lab. Ethylene and acetylene in each sample and standard were measured using a SRI 8610C gas chromatograph equipped with a Poropak T column, He carrier gas, and a flame ionization detector (Capone 1993). Concentrations of ethylene in the samples were compared to the known concentrations in the standards and then converted to the amount of N_2 fixed using an assumed 3:1 ethylene:N_2 conversion ratio (Capone 1993).

Phytoplankton were analyzed using both taxonomic identifications and measurements of chlorophyll *a* as a surrogate for overall algal biomass. Community samples were collected with an integrated tube sampler lowered to 10-cm above the bottom of the bay and preserved with 3% formalin. Phytoplankton cell density was determined by settling and counting samples in Utermohl chambers on an inverted microscope at 1000X (Wetzel and Likens 2000). Phytoplankton were identified to the lowest taxonomic group possible using Felix and Rushforth (1979)—usually genus or species. Because algal volumes can vary immensely between species, and because many ecological processes are more dependent on biovolumes than on densities, we also estimated the volume of each taxon. Length and width measurements were made on 10 individuals of each taxon and biovolumes were calculated using equations in Hillebrand et al. (1999). Two chlorophyll *a* samples were collected from 0.4 m for each station on each date—one with a peristaltic pump and one with an integrated tube sampler. In the laboratory, an aliquot (either 10 or 20-mL) of water was filtered through a 1.0-μm GF/F filter. The filter was wrapped in tin foil and immediately frozen until analysis within 1 month. The filters were extracted in 95% ethanol overnight and the chlorophyll *a* concentrations were measured with a Turner 10AU fluorometer using a non-acidification technique (Welschmeyer 1994).

Zooplankton were collected using vertical hauls with a 50-cm diameter net with 250-µm mesh from 10-cm above the bottom to the surface at each station. Zooplankton were preserved with 3% formalin and counted using a dissecting microscope at 10-30X. Entire samples were counted unless zooplankton were extremely abundant, in which case 5-50% of the sample was analyzed to give counts of 100-200 organisms. Zooplankton were identified to species and divided by sex and life stage (e.g. *Artemia* nauplii, juveniles, and adults).

Cement blocks covered with window mesh screening were deployed in May in both Farmington and Gilbert Bays to serve as artificial sampling substrates for brine fly larvae and pupae. Groups of these were retrieved at monthly intervals for analysis of chlorophyll levels and brine fly densities. Organisms on the substrates were preserved with 95% ethanol at the time of collection. Organisms were sorted and identified to species and divided by life stage. Identifications were made using a dissecting microscope at 10-30X when necessary. *E. cinerea* is distinctive with caudal tubules and *E. hians* has distinctive chevron-like dorsal pigment patches (D. Herbst, personal communication, Sierra Nevada Aquatic Research Laboratory, Univ. Calif.).

Synoptic sampling – Three large-scale synoptic samplings were undertaken to examine the horizontal variation in environmental factors in Farmington and Gilbert Bays. The first of these focused on both bays and was done in conjunction with Dr. David Naftz of the USGS, Salt Lake City, and Mr. Shane Bradt, a remote sensing specialist from the University of New Hampshire. The second two synoptics focused on Farmington Bay with limited sampling in Gilbert Bay and Ogden Bay. The dates and stations sampled were:

Date	Bay	Stations
31 May to 3 June	Farmington	11
(referred to as June)	Gilbert	30
	Bear River	1
8-9 August	Farmington	11
	Gilbert	3
	Bear River	0
21-22 October	Farmington	12
	Gilbert	3
	Bear River	0

Station locations are shown in Figure 1. At some stations a full set of parameters were measured, whereas at others a partial subset were measured. The parameters measured and methods used are given in Table 2. Not all of the results from the synoptic analyses are reported here.

To support the June synoptic we used satellite imagery to assess chlorophyll levels in order to give a better spatial coverage of the lake. We used the MODIS Aqua sensor which provided an image on June 2 at 13:05 local time (20:05 UTC). The imagery was analyzed by Mr. Shane Bradt using SeaDAS 4.8.3 (http://oceancolor.gsfc.nasa.gov/seadas/). The MODIS bands used were a subset of the 1 km bands, which were reprojected to 1.1 km pixels. To process the imagery, he used SeaDAS to apply the standard atmospheric algorithm and the most commonly used chlorophyll a algorithm (called OC4). A color gradient was added to the resultant chlorophyll data to produce a map. Chlorophyll concentrations in Farmington Bay could not be processed with this algorithm, as the process identified the high pigment levels there as “land”. Additionally, a small cloud band obscured a portion of the lower part of Gilbert Bay precluding chlorophyll estimates there.

Pathogen and Toxin Analyses - On two dates, phytoplankton from Farmington Bay were collected for analysis of nodularin, a hepatotoxin produced by Nodularia. Integrated water column samples from Station 1 or 4 were filtered on GF/F filters, frozen at -20° C, freeze-dried and sent to the laboratory of Prof. Antonio Quesada, Biology Department, Universidad Autonoma de Madrid. The nodularin concentrations were analyzed there by high pressure liquid chromatography.

On August 8, 2005 samples were taken in Farmington Bay for analysis of pathogens at three sites: (1) slightly north of Farmington Bay Refuge were water was ca. 40-cm deep; (2) In front of Sewage Canal were water was 40-cm deep; (3) SW of Antelope Island Causeway breach where water was 35-40 cm deep. At each site three core samples were taken by inverting a 60-ml centrifuge tube and forcing it into the sediments. Each set of three was pooled for subsequent analyses. Three water surface water samples were collected at each site and pooled to yield approximately 500 mL. The water samples were transported to the lab and filtered through 90-mm GF/F filters until they clogged. The moist filters were frozen at -90° C and sent via overnight courier service packed between a layer of -90° C plastic ice to Dr. Rebecca Gast, Biology Department, Woods Hole Oceanographic Institution, MA. Sediments were analyzed for the presence of amoebas by culturing in five different media types that varied in salinity from full strength seawater to fresh water, and with a small amount of nutrient addition. *Legionella* bacteria were detected and identified using genus-specific amplification primers followed by DNA sequencing of the fragments.

Salinity controls of nitrogen fixation – To test the effect of phosphorus supply and salinity on phytoplankton populations and nitrogen fixation rates of the algal community in Farmington Bay, a bioassay experiment was conducted in May 2005. The Bay's salinity at this time was 1.5%, and the algal community was comprised of 85% *Nodularia spumegina*, a nitrogen-fixing cyanobacterium. Water was collected from Station 1 and transported back to the laboratory. Water was filtered through 153 µm Nitex netting to remove macrozooplankton and 500-mL aliquots were placed into 28, 900-mL glass jars. Jars were then randomly assigned to seven salinities: 2, 4, 5, 6, 7, 8, and 9%, for a final count of four jars of each salinity. The aliquots in the jars were then diluted to 800-mL using saline water (made with NaCl and $MgSO_4$ in a 7.8:1 ratio in deionized water) to reach the desired end salinity. Two jars within each salinity were then randomly assigned to either control or phosphorus-enriched treatments. Phosphorus was added to the jars as Na_2PO_4 at a final concentration of 200 µg P L^{-1}. After nutrient enrichments, jars were agitated and placed randomly in a temperature controlled incubation room at 20º C, with light intensities of approximately 150 µE m^{-2} sec^{-1} and an 18:6 light dark photoperiod for 6 days.

On days 1, 3, and 6, each jar was sampled to determine chlorophyll *a* concentrations and nitrogen fixation rates. Aliquots of 50-mL were collected from each sample jar, placed in a 62-mL glass serum vial, and sealed with a septum for N_2 fixation analysis as described above. After injection with acetylene, vials were incubated for 2 hours in the incubation chamber where the bioassay was conducted. Samples were collected and analyzed as described above. After termination of the acetylene reduction assay, a 10-mL aliquot was removed form the serum vial and filtered through a 25-mm Millipore AP 40 glass fiber filter with a nominal pore size of 0.7 µm. The filter was then stored and analyzed as described above for chlorophyll *a* analysis.

Mesocosm experiments – Three mesocosm experiments were run to assess the impact of corixid predation and salinity on brine shrimp survival. These experiments were conducted in 12 translucent fiberglass tubes that were 1.5-m long and 0.16 m in diameter and filled with 60 L each. Water depth in the tubes was 0.8 m, slightly higher than the mean depth of Farmington Bay. The tubes were suspended within wooden frames. The first experiment was deployed in the open water of Farmington Bay, but a wind storm destroyed the experiment and five tubes were lost. The two subsequent experiments were deployed in a boat birth in the Antelope Island Marina (Fig. 2).

The August experiment was conducted 7 – 23 August, to assess the impact of predacious corixids on *Artemia*. Surface water was collected in Farmington Bay 2 km south of the causeway on 7 August using large buckets. Salinity on this date was 3.6%. The water was filtered through 1-mm mesh to remove large *Artemia* and adult corixids, but most alternative zooplankton prey (cladoceran, copepods) passed through this mesh. Two days before the experiment adult and juvenile *Artemia* were collected from Gilbert Bay and juvenile *Artemia* nauplii were hatched from cysts in the laboratory. These were counted into plastic containers and added to the tubes at the start of the experiment. Corixids (3.5 - 5 mm) for the experiment were collected in the open water of Farmington Bay on 7 August and added with the prey. *Artemia* densities in the experiment were: Adults – 2 L^{-1}; juveniles – 2 L^{-1}; nauplii – 10 L^{-1}. These densities are common in Gilbert Bay (Wurtsbaugh and Gliwicz 2001). Densities of added corixids ranged from 0 to 1.2 L^{-1}, within the range observed in Farmington Bay (Fig. 20). Initial and final chlorophyll concentrations were measured as described above. After 16 days, the entire volume of the tube was filtered through 305-µm mesh and organisms were preserved using 3% formalin. Organisms were then identified and enumerated as described above.

The second experiment was conducted 10 – 26 September when temperatures were near 18° C. In this experiment, we tested both the effects of corixids and salinity on *Artemia* survival using a two-way factorial design (Table 3). Water was again collected from Farmington Bay on 10 September (ambient salinity 4%), filtered through 305-µm mesh to remove both small and large zooplankton, as well as some of the filamentous *Nodularia spumegina* that dominated the phytoplankton at this time. A 1:1 mixture of NaCl and Instant Oceans® was then added to half of the tubes to increase the salinity in those tubes to 8%, and the water was mixed until the salts were dissolved. This resulted in six high salinity tubes and six low salinity tubes. All of the tubes were then stocked with *Artemia* adults, juveniles, and nauplii at the same densities as described above. Approximately 30 adult brine flies were allowed to enter each tube before they were closed with the 1-mm mesh top. We anticipated that this would allow the brine flies to lay eggs and thus allow a measure of corixid predation in the different treatments. Corixids densities of 0, 0.6, and 1.2 L^{-1} were then randomly applied to two tubes of each salinity. After 16 days, the entire volume of the tube was filtered through 305-µm mesh and organisms were preserved using 3% formalin. Zooplankton and chlorophyll concentrations were estimated as described above.

Algal Suitability Bioassay Experiment – A single laboratory experiment was conducted to test the suitability of Farmington Bay water and Gilbert Bay water for the survival of *Artemia*. Water was collected from the two bays on August 8. *Nodularia* were at near peak densities in Farmington Bay at this time. Four water treatments were tested: (1) undiluted Farmington Bay (3% salinity); (2) undiluted Gilbert Bay water (15% salinity); (3) a mixture of 10% Farmington Bay and 90% Gilbert Bay water (13.8% salinity), and; (4) Gilbert Bay water diluted with deionized water (3% salinity). Water from Gilbert Bay was filtered through 150-μm mesh and water from Farmington Bay was filtered through 250-μm mesh to remove organisms but allow *Nodularia* to pass. Ten adult brine shrimp (5 mating pairs) were placed in 2-L buckets. Ten two-day old *Artemia* nauplii were placed in 900-ml jars of treatment water. Each treatment was duplicated. Survival of adult *Artemia* was assessed visually during the course of the 15-day experiment, but the initially small nauplii could not be seen by this method, and were preserved at the end of the experiment with 3% formalin for subsequent counting.

Results

Physical-chemical conditions – Water clarity in Farmington Bay was always lower than in Gilbert Bay in 2005, in contrast to 2003, when a water clearing event in May led to very deep Secchi depths in Farmington Bay (Fig. 3a). In Farmington, Secchi depths during 2005 were 0.14 - 0.75 m, compared to 0.60 – 2.90 m in Gilbert Bay. Not only were Secchi depths more variable through the entire sampling season in Gilbert Bay, but they were also more variable between sampling dates than in Farmington Bay (Fig. 3a). As observed in 2003, salinity was consistently higher in Gilbert Bay than in Farmington Bay for the duration of the 2005 monitoring, and ranged from 13.2% in June to 15.2% in November (Fig. 3b). In Farmington Bay, salinity ranged much more widely, from a low of 1.1% in early May to a peak of 5.1% in early October 2005. After this peak, salinity began to drop again, to a low of 2.8% in November (Fig. 3b). Water temperature was very similar between the two bays and strongly seasonally variable, ranging from a low of 7.5º C in November to 28.6º C in mid-July (Fig. 3c; Appendix 1).

Monitoring of water chemistry during 2005 showed that dissolved nutrient concentrations were very high in both bays, and total nutrient concentrations were more variable in Farmington Bay than in Gilbert Bay. In Gilbert Bay, ammonium-N concentrations were lowest in May, and increased to a steady concentration of around 400 µg N L^{-1} for the duration of the summer, then increasing again to 700 µg N L^{-1} in mid-November (Fig. 4a). Ammonium-N showed an opposite trend in Farmington Bay, where concentrations were greatest in early May at 400 µg N L^{-1}, and decreased by June to a stable level between 150 and 200 µg N L^{-1} (Fig. 4a; Appendix 2). Our ammonia results are consistent with those measured in Farmington Bay by the State DWQ, who found mean levels of 0.33 µg N L^{-1} (range 0.21-0.43) on five dates in 2004-2005. The pH in Farmington Bay was usually above 9 and went above 9.5 frequently (see below), indicating that >30% of the ammonia would be in the unionized, toxic form. At these pH levels, total ammonia concentrations from May-November exceeded the EPA's suggested chronic concentration for this pollutant (95 µg L^{-1} freshwater; 90 µg L^{-1} marine; EPA 1986, 1988).

Phosphate-P concentrations were stable between 26-78 µg P L^{-1} in Gilbert Bay during summer 2005. In Farmington Bay, phosphate concentrations were greatest in early May and late October at 119 and 105 µg P L^{-1}, respectively, while concentrations were <6 – 20 µg P L^{-1} on all other sampling dates (Fig. 4b). TN in Gilbert Bay was stable around 6000 µg N L^{-1}, and TP was stable around 350 µg P L^{-1} (Fig. 4c, d). In Farmington Bay, TN was around 6000 µg N L^{-1} in mid- May, then dipped to 2000 µg N L^{-1} in June, only to rise again by early July and range 5390 – 7440 µg N L^{-1} from July – Nov (Fig. 4c). TP in Farmington showed a very high peak of 2000 µg P L^{-1} in mid-May 2005, followed by a steep decline. TP ranged from 376 µg P L^{-1} on 29

July up to 818 µg P L^{-1} on 8 October (Fig. 4d). Mean TP concentrations in Farmington Bay were 673 µg P L^{-1} (with 1 outlier removed; Appendix 2).

The sondes deployed at Station 1 provide insight into the formation of the deep brine layer and mixing patterns of the surface and deep waters. The surface sonde shows very strong diel variations in dissolved oxygen (Fig. 5 middle). Conductivity rose through early October from approximately 18 mS cm^{-1} in late May to a high of 80 mS cm^{-1}in early October, followed by a decline to approximately 48 mS cm^{-1} in mid November (Fig. 5 middle), which matches the salinity pattern observed in the bay (Fig. 3b). The deep sonde at Station 1 showed highly variable conductivity measurements, likely due to two different phenomena. In the early part of the record (Late May and June), there was not a distinct deep brine layer at Station 1, so the bay frequently mixed to the bottom, resulting in alternating periods of anoxic and oxic conditions and large fluctuations in conductivity (Fig. 5 bottom). In August, prolonged periods of anoxia recorded by the deep sonde demonstrate the existence of a deep brine layer, and show that the bay mixed infrequently to the bottom during this period. However, in September, frequent deep mixing is again shown by the conductivity and oxygen record (Fig. 5 bottom). By this point, the water depth had decreased considerably, from 1.5 m in May to 0.9 m in September. Because our sonde was deployed on top of a 20-cm tall block, it's likely that the sonde here was moving into and out of the deep brine layer as wind mixing and seiche action resulted in vertical movement of the oxic-anoxic interface.

There was extreme diel variation in oxygen concentration in the overlying water layer, with frequent anoxia at night and supersaturation during the day. From August to November when the sondes were deployed, the Station 1 sonde at a depth of 0.2 m recorded anoxia (<0.5 mg/L) on 62% of the nights for which we have records. In addition to the frequent nighttime anoxia, there were also periods of sustained anoxia at Station 1. These occurred in late August, mid-September, and particularly from 27 – 31 October. On this latter date a peak in salinity was observed, indicating either: (1) mixing of surface water with the deep brine layer, or (2) high salinity water was pushed into Farmington Bay from Gilbert Bay. With this peak in conductivity, dissolved oxygen dropped to zero, and ORP remained negative until oxygen concentrations rose again on 31 October (Fig. 6 bottom). These near-anoxic or anoxic events usually occurred when wind velocities were high, but this correspondence was not as clear as we observed in 2003. In 2005 high wind velocities sometimes did not cause anoxia (Fig. 5 top; note early November). However, the wind gusts recorded on 27 October, immediately prior to the anoxic event, were the greatest winds in 2-3 weeks, and the water column was very shallow at this point, perhaps allowing the 30 mph winds (Fig. 6 top) to provide adequate mixing strength.

At Station 3/4 where water depth ranged from 0.7 to 1 m, conductivity and dissolved oxygen concentrations were much more variable than at Station 1. Conductivity rose from a low of 5 mS cm^{-1} (ca. 0.35% salinity) in May to a high of 80 mS cm^{-1} in October (Fig. 7 middle), but was highly variable on a daily-weekly scale. Station 3/4 was located in the south-central or central point (after 16 Aug) in the bay, and depending on the prevailing winds, may receive water from either the hypersaline north part of the bay, or the fresher south part of the bay. Frequent, prolonged periods of anoxia were also observed at this station, with 1-2 day events occurring throughout September and October (Fig. 7 middle). As this station lacked a deep brine layer, the anoxia at this station could be caused by wind suspension of the sediments and/or the associated hydrogen sulfide produced there.

The pH in Farmington Bay was very high, with values generally between 9.0 and 9.5 (Fig. 7 bottom). However, the plot of the data shows some marked changes in pH at the time the sondes were serviced, suggesting that the calibration was not held for the length of each deployment. When the sondes were redeployed pH was usually around 9.5. During the biweekly profiling with a fresh sonde, the average pH in the surface water (0–0.5 m) in Farmington Bay was 9.37, with a range 8.7–9.7. In Gilbert Bay profiles taken approximately monthly demonstrated a lower mean pH of 8.12, with a range of 7.8–8.5. The differences in pH are likely driven by the much higher rates of photosynthesis in Farmington Bay than in Gilbert Bay. Photosynthesis removes CO_2, an acid, thus allowing the pH to rise.

Hydrogen sulfide concentrations at Station 1 were very different between the mixed layer and the deep brine layer, and also showed seasonal variations. A sample vertical profile of sulfide, measured on 9 Aug, is shown in Fig. 8 (all profiles in Appendix 3). The mixed layer, above 1.0 m on this date as indicated by specific conductivity, was characterized by high concentrations of dissolved oxygen, likely due to active photosynthesis by phytoplankton, and very low concentrations of sulfide. In contrast, in the deep brine layer the oxygen concentration was zero by 1.2 m, and the sulfide concentration was 7.8 mg L^{-1} (Fig. 8). A seasonal examination of the deep brine layer and the mixed layer show that no hydrogen sulfide was stored in the bottom of Farmington Bay prior to June 1 in 2005, due to the lack of a deep brine layer (Fig. 9). Later in the season, concentrations peaked at 7.8 mg L^{-1}, but several decreases in sulfide to zero in early September and November suggest that mixing may have removed the sulfide from this layer. One such event was certainly the 4-day anoxic event observed beginning Oct 27 (Fig. 8). However, no such mixing event was recorded by the sondes at Station 1 in early September, suggesting some other mechanism resulted in the release of hydrogen sulfide from the deep brine layer on this date.

Phytoplankton and nitrogen fixation - Twenty-four different species or genera of algae were identified in Farmington Bay and Gilbert Bay, 23 of which occurred in Farmington Bay (Table 4). Only 14 of these taxa occurred in Gilbert Bay, and several, such as the cyanobacteria *Nodularia spumegina* and *Microcoleus* sp., were observed in only 1 or 2 samples from Gilbert (Table 4, Appendices 4 and 5). Although many of these species had been previously observed in the Great Salt Lake, several, such as *Scenedesmus* sp. and *Pediastrum* sp., had not been. These taxa were common in Farmington Bay when the salinity was less than 2%, and are very common freshwater genera. For convenience and clarity in these analyses, these species were grouped by division into four groups: green algae (division Chlorophyta), chrysophytes (division Pyrrophyta or Dinopyta), diatoms (division Bacillariophyta), and cyanobacteria (division Cyanophyta; Sze 1998).

Cell densities and biovolumes were all much greater in Farmington Bay than in Gilbert Bay for the duration of the 2005 sampling period and were comparable to the differences observed in 2003 (Fig. 10; Appendices 4 and 5). Densities in Farmington Bay ranged from 263,000 – 898,000 cells / mL, while they ranged from 14,000 – 74,000 in Gilbert Bay (Fig. 10a). The peak cell density in Farmington Bay was lower than the maximum of 1,900,000 cells / mL observed in 2003, but the means between the two years were similar (70,000 in 2003 vs. 60,000 in 2005). On all sampling dates in Farmington Bay, the phytoplankton biovolume was dominated by cyanobacteria, which averaged 61% and ranged from 19% – 92% of the total cell density (Fig. 11a). The dominant cyanobacterium in Farmington Bay was the nitrogen-fixing *Nodularia spumegina,* although *Microcoleus* sp. was also abundant on the 25 Aug and 13 Sep sampling dates. In Gilbert Bay in 2005, the algal community was routinely dominated by chlorophytes, particularly the green algae *Dunaliella viridis* and *Oocystus* sp. (Fig. 11b). In both bays an unidentified chrysophyte was observed on every sampling date, but in Farmington Bay the pyrrophytes *Glenodinium* sp. and *Chrysophyte* sp were also abundant on at least one sampling date, while they were never abundant in Gilbert Bay. Other moderately abundant taxa found only in Farmington Bay include the chlorophytes *Carteria* sp., *Scenedesmus* sp., *Pediastrum* sp., and the diatoms *Chaetocerous* sp, and *Synedra* sp. (Table 4). Biovolume showed very similar trends to density in both bays (Fig. 10b) and similar dominance by the different groups in each bay (Fig. 12).

Chlorophyll *a* concentrations, used as an indicator of algal biomass, were also much greater in Farmington Bay in 2005 than in Gilbert Bay, but were also greater than the concentrations observed in 2003. In both years there was an order of magnitude variation between the high and low observations, but in 2003, the mean chlorophyll concentration was 110 µg L^{-1}, compared to 262 µg L^{-1} in 2005 (Fig. 10c; Appendix 1). In contrast, 2005 Gilbert Bay concentrations ranged from 5.6 µg L^{-1} in early August to 27 µg L^{-1} on 15 May (Fig 10c). This increase in Farmington Bay from 2003 to 2005 is notable because a similar increase in cell density or biovolume (Fig. 10a, b) was not observed.

The high abundance and biovolume of nitrogen-fixing *Nodularia spumegina* in 2005 lead to very high rates of nitrogen fixation in the bay. A typical vertical profile for fixation is shown in Fig. 13 (all profiles are shown in Appendix 6). Note that fixation rates decline at a constant rate in the mixed layer of the hypolimnion, and drop to zero below the chemocline (Fig. 13). Temperature changes very little from the top to bottom of the water column on this sampling date, but light decreases dramatically in the short water column. A seasonal examination of nitrogen fixation within the entire mixed layer of Farmington Bay revealed that fixation rates were very closely related to abundance of *Nodularia* in the bay (Fig. 14). The one date where low fixation rates were observed despite high concentrations of *Nodularia* was May 17, when the weather was stormy, turbulent and cold, which may have depressed rates of nitrogen fixation. Interestingly, the decrease in nitrogen fixation and *Nodularia* biomass in late June was also correlated with a drop in total N concentrations, suggesting that nitrogen fixation was an important source of N to the bay (Fig. 14). A regression analysis comparing nitrogen fixation rates on the study dates to various environmental parameters showed that nitrogen fixation was negatively correlated with salinity and positively correlated with temperature, but these relationships were both weak and non-significant (r^2 approx. 0.10, $p > 0.25$; Fig. 15a, b). A positive, significant correlation was observed between nitrogen fixation rates and *Nodularia spumegina* biovolume ($r^2 = 0.41$, $p = 0.03$), but the scatter was high and the significant relationship was dependent on a single high value.

Pathogen and toxin analyses – Analysis of nodularin concentrations in Farmington Bay are incomplete. Initial analyses were difficult because the concentrations were higher than had ever been found by the analytical lab. The director of the lab reported: “I cannot estimate the concentration [of nodularin] because it is so high....but I have to tell you that it is terribly high.”

All of the samples analyzed for pathogens were positive for the presence of species of the *Legionella* genus. Amoeba cultures were recovered from all three sediments types. The Causeway Breach site yielded 11 amoeba cultures, primarily on the full strength seawater media. Four of those amoeba cultures were also positive by amplification for *Legionella*. The

Sewage Canal site yielded 13 cultures, on all types of media. Only one of those cultures was positive for *Legionella*, and it was from a seawater medium isolate. The site near Farmington Bay refuge yielded 20 cultures, again on all types of media. Ten of these were positive for *Legionella* by amplification, and all of these were from amoebas isolated on either seawater medium or brackish water medium. None of the PCR fragments yielded sequences that were identical to *L. pneumophila*, the human pathogen. The *Legionella* sequences from the Great Salt Lake were distinct from ones Dr. Gast has recovered from Mt. Hope Bay, Massachusetts, and overall tended to cluster together in similarity analyses. This work confirms the unexpected diversity and distribution of *Legionella* species in saline environments that Dr. Gast's research group has recently discovered. The lack of *L. pneumophila* sequences does not mean that these organisms are not present, but rather that tests with pneumophila-specific primer sets still need to be accomplished.

Salinity controls of nitrogen fixation – The bioassay experiment conducted to examine the effects of phosphorus supply and salinity on nitrogen fixation rates showed that nitrogen fixation by *Nodularia spumegina* ceases at salinities greater than 5% (Fig. 16). In this experiment, there was no difference in chlorophyll *a* and nitrogen fixation rates between the control and phosphorus treatments. In contrast, salinity exerted a very clear effect on both chlorophyll *a* and nitrogen fixation (Fig. 16). Chlorophyll *a* concentrations decreased in the salinity treatments greater than 5% through the duration of the experiment, while increasing in salinity treatments less than 5% (Fig. 16a). Nitrogen fixation ceased at salinities greater than 6% on all days of the study, but continued at high rates at the 2 and 4% salinities for the entire experiment (Fig. 16b).

Zooplankton – Seven zooplankton taxa were identified in Farmington and Gilbert Bays (Table 5). Of these taxa, they dominant taxa in each bay varied. Farmington Bay was dominated by the calanoid copepod, *Diaptomus conexus*, and the cladoceran *Moina* sp., whereas Gilbert Bay was most always dominated by *Artemia franciscana.*

Zooplankton densities were extremely variable in Farmington Bay, reaching peaks of 200-600 crustaceans per liter in May and July, but declining to only less than 4% of these highs in late May and October. Zooplankton density was much greater in Farmington Bay than in Gilbert Bay on most sampling dates, but biomass differed little between the two bays (Fig. 17a, b; Appendices 7 and 8). This is because the dominant *Diaptomus* and *Moina* sp. were much smaller than *Artemia*, which were the dominant taxa in Gilbert Bay (Fig. 18). Although *Artemia* were rare in Farmington Bay, when they were present they made up a large part of the zooplankton biomass because of their large size (Fig. 19a). Only a small portion of the biomass in Gilbert Bay was made of up *Ephydra* sp. (brine fly larvae), which is to be expected given that they are a benthic species that only infrequently moves into the water column. Nevertheless, *Ephydra* were the next most abundant taxa after *Artemia*, although they were very rare.

Studies in 2003 showed that *Artemia* biomass was strongly negatively correlated in Farmington Bay with the abundance of two predacious zooplanktors, *Cletocampus albequrquensis* and *Trichocorixa verticalis* (Fig. 20). In 2005, high concentrations of *Cletocampus* were observed only on 3 May, but *Trichocorixa* was abundant from July – Oct, and reached peak densities of 1.3 L^{-1} in late September. Additionally, for much of the summer we found that any solid substrate (ropes, cement blocks) became covered with a 5-10 mm thick layer of corixid eggs, and corixids were abundant on benthic substrates, suggesting that our vertical zooplankton tows may underestimate the true population size of corixids in Farmington Bay.

A regression examination of how salinity may control phytoplankton and zooplankton biomass in Farmington Bay was conducted using seasonal data from 2003 and 2005 at the northernmost sampling station (Station 1; Fig. 21). Both *Nodularia* and cyanophyte biovolume was significantly related to salinity, but *Nodularia* was negatively related ($r^2 = 0.26$, $p = 0.01$; Fig. 21a), while chlorophytes were positively related ($r^2 = 0.40$, $p < 0.01$; Fig. 21b). Of the four zooplankton taxa observed (*Artemia, Moina, Trichocorixa* and *Diaptomus*), none showed a statistically significant relationship with salinity. *Artemia* were the only zooplankton taxa to show a positive relationship with increasing salinity, but this relationship was non-significant and explained almost none of the observed variation, because of the influence of three very large biomass values measured during a population explosion in May 2003 when salinity was near 4% (Fig. 21c).

Benthic substrates—Analysis of the invertebrate taxa on the benthic substrates on a single date in September showed that the overall invertebrate density per m^2 was ca. 3 times lower in Farmington Bay than in Gilbert Bay (Fig. 22). In Farmington Bay, the benthic community was dominated by adult corixids, and the invertebrate screens in the location were covered by a 0.5 – 1.5 cm thick layer of corixid eggs that were much too numerous to quantify. In Gilbert Bay, the main taxa found on the benthic substrates were *Ephydra* sp. (Fig. 22). *Ephydra* sp. were also observed in Farmington Bay, but in much lower densities than in Gilbert Bay, and the species found in each bay were different (*E. hians* in Farmington Bay, *E. cinerea* in Gilbert Bay, Appendix 9).

Synoptic Analyses of Spatial Variations–At the time of the June synoptic, the Bear River was discharging 4,000-5,000 cfs, thus contributing substantially to both water and nutrient loading to the northeast corner of the lake. The Surplus Canal was discharging over 1,000 cfs into the southeast corner of Gilbert Bay. The Jordan River was discharging less that 60 cfs during the study.

The June synoptic demonstrated that salinity (and ΔO^{18}–data not shown) varied significantly in the different bays. In Farmington Bay salinities ranged from 0.4 to 1.6% (Fig. 23a) with the lowest values in the southern end of the bay near inflows. In Gilbert Bay salinities were >13% in the south and in most of the north end except where influenced by flows from the Bear River, Farmington Bay, and perhaps the Weber and Ogden Rivers. Salinities in those areas ranged from 7-12% (Appendix 10).

There was a great deal of spatial variability in the plankton populations in the Great Salt Lake, with distinctive differences between Farmington Bay, Bear River Bay, and both the north and south parts of Gilbert Bay (Fig. 23, 24). Chlorophyll levels in Farmington Bay were greater than 150 µg L^{-1} at all stations, with extracted concentrations averaging 262 µg L^{-1}. At the single station sampled in the southern part of Bear River Bay the chlorophyll level was only 17 µg L^{-1}. Chlorophyll levels in Gilbert Bay differed from south to north. In the south where brine shrimp populations were high and nutrient loading presumably low, most chlorophyll measurements were low with mean levels of 1.1 µg L^{-1} (Fig. 23b; Appendix 10). In the north-east end of Gilbert and Ogden Bays, chlorophyll concentrations were 40-80 µg L^{-1} in areas influenced by Farmington Bay and Bear River outflows. Elsewhere chlorophyll concentrations ranged from 0.5-5 µg L^{-1} and averaged 2.7 µg L^{-1}. The MODIS satellite imagery (Fig. 24 B) showed a distinct chlorophyll plume of 10 to > 60 µg L^{-1} extending out of Farmington Bay and flowing WSW approximately 10 miles (16 km). The imagery also showed that the area west of Freemont Island had elevated chlorophyll levels, presumably under the influence of nutrients from the Bear River. Relative concentrations of phycocyanin, a pigment specific to cyanobacteria, were about 100 times higher in Farmington Bay than in the southern and northwestern parts of Gilbert Bay, and about 10 times higher than in the areas influenced by Farmington Bay and Bear River inflows (Fig. 23c; Appendix 10).

Nitrogen fixation also showed a north-south trend during the synoptic sampling. Nitrogen fixation rates on all three sampling dates were generally lowest at the south part of Farmington Bay, close to the Farmington Bay Refuge and the sewage canal inflow, and then increased to a peak in the middle section of the bay (Fig. 23d). This peak was greatest (21 µg N L^{-1} h^{-1}) in the early August sampling, but still peaked at ca. 10 µg L^{-1} h^{-1} in both June and October. Fixation then steadily decreased with increasing proximity to the causeway. Fixation rates were negligible north of the causeway in Gilbert and Ogden Bays where salinity was high (Fig. 23d).

Mesocosm experiments -

August – Initial temperatures in the August mesocosms were high (31° C) and remained high throughout the experiment. Initial chlorophyll levels were also high, averaging 212 ± 4 µg L^{-1} and they did not change significantly in any of the treatments during the experiment. In this experiment the corixids added to the mesocosms apparently reproduced, as there were large numbers of small (ca. 1 mm) corixids in the mesocosms at the end of the experiment, and their numbers were highly correlated with the numbers of adults added (Juveniles = 11.8 * Adults; $r^2 = 0.96$). We expect that the young juveniles may not have had a large impact on other zooplankton, as they likely hatched late in the experiment. Alternative prey other than *Artemia* were abundant in the experiment. Final mean densities of calanoid copepods and *Moina* in the tubes were 20 and 21 L^{-1}. Neither copepod nor cladoceran densities were significantly related to corixid abundances ($p > 0.11$, $p > 0.17$, respectively), although there was a tendency for *Moina* to be lower at the higher densities of corixids.

Despite the presence of high densities of alternative prey, corixid predation decreased juvenile *Artemia* densities significantly ($p = 0.003$) by the end of the 15 day experiment. (Fig. 25). Initial densities of nauplii in the experiment were 10 L^{-1}, and these would have grown into juveniles during the trial. Control treatments at the end of the experiment averaged 5 juveniles L^{-1}, suggesting a 50% survival of added nauplii. This estimate, however, is approximate, because there may have been some nauplii produced by the adult *Artemia* early in the experiment and these could have also grown to juvenile size. At corixid densities of 0.7 L^{-1} juvenile *Artemia* densities were only 0.6 L^{-1}, and with 1.2 corixids L^{-1} juvenile *Artemia* densities averaged 0.05 L^{-1} at the end of the experiment. Adult *Artemia* survival in the experiment was low (3%), but was not significantly influenced by corixid densities (Fig. 25).

September – In the September mesocosm experiment temperatures were near 18° C and initial chlorophyll levels in the tubes were 231 µg L^{-1}, despite considerable amounts of *Nodularia* being filtered out at the start of the experiment. Visual inspection indicated that Nodularia was far less abundant in the 8% salinity by the end of the experiment, a result consistent with the salinity – nitrogen fixation experiment described earlier.

Both salinity and corixid predation had a large impact on *Artemia* abundances (Fig. 26). In the 4% salinity treatment, juvenile survival was negligible, final densities were only 0.04 L^{-1}, and corixids did not significantly influence their densities. In contrast, at 8% salinity with corixids absent, densities of *Artemia* juveniles were 12.4 L^{-1}. In this salinity treatment corixids had a significant impact on juvenile survival. As corixid densities increased to 0.6 and 1.2 L^{-1}, juvenile *Artemia* densities decreased to 0.4 and 0.05 L^{-1}, respectively. Adult *Artemia* were not affected by salinity and corixids had a marginal impact on adult survival at the 8% salinity.

Algal Suitability Bioassay Experiment – The laboratory bioassay experiment showed that survival of adult *Artemia* in Farmington Bay water was poor, with less than 20% survival after 15 days (Fig. 27). Survival in 100% Gilbert Bay water was relatively high (66%), but it was even higher when 10% Farmington Bay water was mixed with 90% Gilbert Bay water. The lowest survival (8%) was in the Gilbert Bay water that had its salinity decreased from 15% to 3%. Results for the nauplii in the different waters were relatively similar. Survival and development to the adult stage was reduced 50% in the Farmington Bay water in relation to *Artemia* in Gilbert Bay water (Fig. 28). Survival and development was, however, highest in the treatment with a mix of 10% Farmington Bay water and 90% Gilbert Bay water with a salinity of 13.8%. Survival and development was lowest in the Gilbert Bay water with its salinity reduced to 3%.

Discussion

Plankton sampling in 2005 confirmed earlier reports that Farmington Bay is hypereutrophic (Carter 1971, Sorensen et al. 1988, Wurtsbaugh 1995, Wurtsbaugh et al. 2002, Wurtsbaugh and Marcarelli 2004a). Trophic state indices (TSI; Carlson 1977) provide a way of summarizing trophic data and comparing them with other lakes. The 2005 trophic data and TSI indices for Farmington Bay were:

Trophic State Indices

Parameter	Level	TSI
Total Phosphorus (µg/L)	673	98
Chlorophyll a (µg/L)	262	85
Secchi (m)	0.32	76
Average		87

The mean TSI is similar to that from 2001 (TSI = 91) that was reported from a preliminary analysis of Farmington Bay (Wurtsbaugh et al. 2002). The trophic state can be compared with other lakes that are considered threatened or impaired, and thus are on the state of Utah's 303d list (Fig. 29). Although Farmington Bay is not on this list, its mean TSI of 87 clearly indicates that it is the most eutrophic system in the state. Although this index is useful for comparing the trophic state in different water bodies, care is necessary when utilizing it to identify impairment, because not all waters have the same beneficial uses.

The plankton community in 2005 was dominated by a large bloom of *Nodularia spumegina* that lasted from May through November. This cyanobacteria has been observed previously in Farmington Bay (Carter 1971), but was not noted in our 2002-2003 survey. This bloom has the potential to profoundly change the biological community in Farmington Bay and influence beneficial uses. It is also quite likely that in high runoff years when salinities drop further in the Bay, that we will encounter blooms of other toxic cyanobacteria, as they are common in eutrophic brackish water (Gasiunaite et al. 2005).

The finding of *Legionaris* bacteria and amoebas in Farmington Bay and the presence of high densities of cyanobacteria raises concerns for the health of human and wildlife populations. Much more work will need to be done on the *Legionaris* and amoeba populations to determine if these are human pathogens or not, as non-pathogenic strains of these are common in natural waters. Likewise, additional work is needed on the toxins produced by *Nodularia* in Farmington Bay. Different species of cyanobacteria can produce both hepato- and neurotoxins that are lethal to mammals (including humans) and aquatic organisms such as brine shrimp (World Health Organization 2003; Beattie et al. 2003; Ibelings 2005; Ibelings and Havens, 2005). The hepatotoxin produced by *Nodularia* (nodularin) has not been studied as extensively as other cyanobacterial toxins, but its chemical structure is similar to that of the well-studied toxin microcystin. Nevertheless, the US Center for Disease Control (CDC) and Prevention indicates that nodularins can cause skin and eye irritation (http://www.cdc.gov/hab/cyanobacteria/facts.htm). A severe skin rash was was observed by one of us (WW) on a child catching brine shrimp in an area where Farmington Bay water overflowed along the north peninsula of Antelope Island (May 13, 2005). The CDC also notes that nodularins are tumor-promoters in mammals. Dried cyanobacteria (*Lyngbya* sp.) can also cause respiratory irritation (Abal et al. 2003; Queensland EPA 2005), but this effect has not been noted from *Nodularia*.

The World Health Organization (WHO 2003) indicates that there is a moderate probability of adverse health effects in recreational waters when cyanobacterial densities exceed 100,000 cells / mL or when chlorophyll levels dominated by cyanobacteria exceed 50 µg

L^{-1}. In Farmington Bay these levels were frequently exceeded by a factor of 10. When a moderate probability of health effects is suspected the WHO suggests that on-site risk advisory signs should be posted. When dense surface scums of cyanobacteria are present (see cover) there is the potential for acute poisoning, potential long-term illness and short-term adverse health outcomes. Under these conditions the WHO recommends prohibition of water contact activities and public health follow-up investigation. Since Farmington Bay and the outflow waters near Bridger Bay have designated uses for primary and secondary contact recreation, state and county agencies need to move towards addressing the public health concerns.

Cyanobacterial toxins have also been shown to cause flamingo and bald eagle mortalities (Alonso-Andicoberry et al. 2002; Wilde et al. 2005), and they have been associated with and suspected of causing mortalities and initiating botulism in other aquatic bird populations (Henrikson et al. 1997; Murphy et al. 2003). However, direct cause and effect has yet to be established. The predominant *Nodularia* in Farmington Bay produces only hepatoxins, but apparently in very high concentrations. Toxin production by cyanobacteria in Farmington Bay is an important water quality concern that could be affecting the survival and health of zooplankton and birds, and must be more closely examined to determine if Farmington Bay is meeting its beneficial uses for these species.

One important species of concern in relation to beneficial use is *Artemia franciscana.* Populations of *Artemia* were even lower in Farmington Bay in 2005 than 2003, but it is not clear what factors kept their populations low. The results of our algal suitability bioassay and the second mesocosm experiment indicated that Farmington Bay water was not suitable for *Artemia* survival, but it is not clear whether this is due to toxicity or to salinity. In the algal suitability assay low survival also occurred in 3% salinity water when Gilbert Bay water was diluted to this salinity. We do not think that salinity alone was responsible for the low survival, as several researchers have reported good survival of *Artemia* in 3.5% salinity (Vanhaecke et al. 1984; Triantaphyllidis et al. 1995; B. Marden, personal communication), and the highest *Artemia* densities we've observed in the bay were at the same low salinity used in the bioassay (4%).

Artemia survival was also very low in the September mesocosm experiment when Farmington Bay was at a salinity of 4%, but not when the salinity of this water was raised to 8%. It is possible that the low salinity, alone, was responsible for the mortalities, but as mentioned above, this does not seem likely. It is more likely that raising the salinity to 8% killed some other organism(s) that harm *Artemia*. Nodularia will not survive at 8% salinity, so their demise is one possibility for the increased *Artemia* survival. However, other parasites or microbes that were not monitored could have also been killed by the 8% salinity, so it is not clear exactly what the mechanism was that lead to increased *Artemia* survival.

The low survival in the diluted Gilbert Bay water may have been due to low food availability, as phytoplankton biomass was low in the diluted Gilbert Bay water lake water (initial chlorophyll near 3 µg L^{-1}), and it is likely that the phytoplankton adapted to the 15% salinity of that bay may not have survived when the salinity was reduced to 3%. In future experiments control treatments should utilize artificial brine shrimp food that is not affected by salinity in order to avoid this possible confounding factor. The addition of 10% Farmington Bay water to Gilbert Bay water did not cause mortalities, but in fact, increased survival of *Artemia*. It is likely that: (1) the *Nodularia* from the Farmington Bay water would have died immediately in the high salinity water (Fig. 16), and (2) the nutrients and/or organic matter from the Farmington Bay water promoted *Artemia* growth in the mixed water. This suggests that any released toxins from the *Nodularia* flowing into Gilbert Bay may not be toxic to *Artemia* there, and that the high production in Farmington Bay may contribute to *Artemia* production in Gilbert. More experiments will be necessary to test these hypotheses.

Another factor that may reduce *Artemia* and other zooplankton in Farmington Bay is anoxia. When the deep brine layer was present, there was complete anoxia and toxic levels of hydrogen sulfide, thus making this zone unsuitable for organisms dependent on dissolved oxygen. Furthermore, nighttime anoxia was very common, and this may have stressed the zooplankton. Finally, longer-term anoxic events were common in the south-central part of the bay and they also occurred in the north end of the bay. The more common nighttime and prolonged anoxia in the south end of the bay than in the north was unexpected because a shallow water column should be able to be reairated more easily than a deeper layer (north). Nutrient loading is, however, likely higher at the south end of the lake where the Sewage Canal enters, and a shallow water column contains less oxygen to meet the demands of respiration in the sediments. Whatever the reasons, the frequent anoxia through much of the bay indicates that it is a stressful environment for most organisms.

The prolonged anoxic events of several-day duration that were linked to wind events were less frequent in 2005 than in 2003 (Wurtsbaugh and Marcarelli 2004c), and consequently we were unable to sample immediately after storms. Analysis of plankton samples collected automatically at the causeway breach suggests that there were no marked mortalities associated with the one anoxic event at Station 1 in October. The lack of prolonged anoxic events in June-July 2005 was likely because a deep brine layer did not form at Station 1 until mid-July. We have argued previously that the deep brine layer is instrumental to causing anoxic events, because the anoxic deep brine layer acts as a storage zone for hydrogen sulfide produced in the water column (e.g. Watts et al. 2001) and for sulfide that is produced in the sediments and diffused into the overlying anoxic water (Ingvorsen et al. 1981). Releases of hydrogen sulfide from anoxic hypolimnia have been linked to multiple day anoxic events in the Salton Sea and to mass die-offs of phytoplankton, zooplankton, and fish (Watts et al. 2001). Interestingly, in 2003 all anoxic events were correlated with high wind events measured at the Salt Lake City airport, while the 2005 mixing event was not correlated with a similar event, indicating that either (1) mixing was caused by a localized wind event such as a microburst, or (2) some other factor cause water column destabilization and mixing in 2005. The high variability of total zooplankton densities in Farmington Bay suggests that there may be massive die-offs of organisms there, but if this is the case, the cause of these is not clear, as the rapid declines were not clearly linked with anoxic events or the wax and wane of *Nodularia* populations. Continued monitoring is necessary to determine the potential effects of multiple-day anoxic events in Farmington Bay.

The final reason that *Artemia* were likely low in Farmington Bay in 2005 was the high density of corixids. Our mesocosm experiments demonstrated that at corixid densities equal to, or above, 0.6 L^{-1} *Artemia* populations could not survive, and these predator densities were exceeded for a considerable portion of the summer. Corixid predation decreased *Artemia* abundance even when high densities of potential alternative prey are available. This may be due to the high escape capabilities of the calanoid copepod, and to the tough carapace of *Moina. Artemia*, although resistant to harsh conditions and capable of extraordinary feeding and population growth, is known to be highly vulnerable to predators (Williams 1998). Mellison (2000) and Belovsky (2005) have also suggested that corixids could control *Artemia* in Farmington Bay if densities of the predators were to reach high levels.

Although Moina and copepods were extremely abundant in Farmington Bay through mid-summer, they were nearly absent after August. The high densities in the spring and early summer suggest that the high productivity of the phytoplankton can be transferred up the food web. The near absence of macrozooplankton latter in the summer suggests either that the harsh water quality conditions (anoxia, ammonia, cyanobacteria and toxins) limit their abundance then, and/or that predation by corixids keeps them at very low levels.

The high densities of *Nodularia* in Farmington Bay were a major change from our earlier sampling. Previous work has suggested that *Nodularia spumegina* are intolerant of high salinities. Previous surveys have shown that *Nodularia* sp. abundance declines dramatically in Farmington Bay at salinities greater than 6% (data of Carter 1971, plotted in Wurtsbaugh and

Marcarelli 2004b). Stephens (1990) noted that *N. spumegina* appeared in Gilbert Bay when salinities decreased to 6% in the mid-1980's. This intolerance likely explains why *Nodularia* were absent from Farmington Bay in 2002-2003, when salinities were consistently greater than 5%, but very abundant in 2005 when salinities ranged from 0.5 – 5%. A mesocosm study in Mono Lake examined the community composition of benthic algal mats at five salinities between 5 and 15%. The filamentous cyanobacteria *Oscillatoria* sp. only occurred in salinity treatments between 5% and 10% and no other cyanobacteria was present at any salinity (Herbst and Blinn 1998). Other studies have shown that high salinities may cause stress on cyanobacteria species (Pickney et al. 1995) or affect their ability to osmoregulate (Bebout et al. 1993), thus affecting their survival at increased salinity. More work is needed to determine the specific mechanism affecting survival of *Nodularia spumegina* in the Great Salt Lake at high salinities.

The high *Nodularia* densities in Farmington Bay in 2005 allowed nitrogen fixation rates that are among the highest reported in any lake. A conservative seasonal estimate can be calculated by taking the mean hourly fixation rate observed in this study, assuming 10 h / day of fixation, and then multiplying by the number of days in this study and the mean depth of Farmington Bay (0.5 m), resulting in a fixation rate in g N / m^2 / season. The 10 h / day of fixation is certainly conservative, but is comparable to assumed duration of fixation in a review of fixation rates in oceans, estuaries, and lakes by Howarth et al. (1988). Using these assumptions, we estimate a *seasonal* fixation rate of 5.0 g N / m^2 / season, which is lower than only one *annual* estimate in Howarth et al. (1988), and the only higher value was 9.2 g N m^{-2} yr^{-1} in a hypereutrophic reservoir in South Africa. This source of nitrogen is likely to be an important part of the nitrogen cycle in Farmington Bay. Horne and Galat (1985) found that nitrogen fixation by *Nodularia spumegina* provided 99.5% of the alga's needs and 81% of the total annual N input to Pyramid Lake in Nevada. However, this lake had very low hydrologic input of N, in contrast to Farmington Bay, which has excessively high dissolved nutrient loading from the sewage canal and sewage treatment plants along its shoreline (Wurtsbaugh et al. 2002).

Considerable amounts of nutrients from hydrologic sources in Farmington Bay are likely removed if the discharges flow through wetlands (Theron Miller, Utah Div. Water Quality; personal communication). The discharges into the Jordan River always pass through wetlands before entering the lake. During low water years that expose extensive mud flats, wetlands also develop along the wastewater outfalls of the Davis County sewage treatment plants, and these also remove nutrients. However, the loading from the Salt Lake Sewage Canal alone is adequate to cause hypereutrophic conditions in Farmington Bay, and this canal does not pass through a wetland. The estimates of loading from all of the domestic and industrial sources need to be analyzed and combined with estimates of nitrogen fixation to help understand eutrophication processes in Farmington Bay.

The high fixation rates may also explain why the usually nitrogen-limited waters were able to support far higher algal populations (as indicated by chlorophyll *a*) in 2005 than in 2003 when higher salinities precluded *Nodularia* from growing. When cyanobacteria die, a large portion of the nitrogen they fixed is released to the rest of the ecosystem via decomposition and mineralization, and recent research indicates that as much as 25% of the nitrogen fixed by pelagic cyanobacteria is released as dissolved organic nitrogen (Mulholland et al. 2004). Nitrogen fixation thus could potentially make Farmington Bay a net source of fixed nitrogen for the lake. However, it is unclear how much nitrogen is consumed by microbial reactions in Farmington Bay. The major counterbalancing forces to nitrogen fixation in the nitrogen budget are denitrification ($2NO_3 \rightarrow \rightarrow N_2$) and the recently discovered anammox reaction ($NO_2 + NH_3 \rightarrow N_2$; Dalsgaard et al. 2005). Both bacterially-driven reactions occur in anoxic or hypoxic environments when nitrate and nitrite are present. Farmington Bay is an ideal site for these reactions as there is an abundance of biological activity to generate ammonium, considerable oxygen during the daytime so that the ammonia can be oxidized to nitrite and nitrate via nitrification, and nighttime anoxia when bacteria can utilize the nitrate produced during the day and produce N_2. Additionally, these processes can occur at the sediment-water interface where anoxic and oxic conditions occur within millimeters of each other in the presence of high concentrations of nitrogen reactants. It is possible that denitrification and anammox more than counterbalance nitrogen fixation in the bay, with the system thus acting as a treatment pond to remove nitrogen before it can reach Gilbert Bay. Detailed studies on nitrogen fixation and nitrogen loss mechanisms are needed to test this hypothesis.

Our analyses of Farmington Bay indicate that water quality there is poor. Low oxygen and high unionized ammonia concentrations do not meet either marine or freshwater criteria. Cyanobacterial blooms in 2005 also greatly exceeded levels considered to pose moderate or high probabilities of public health risk. Because of the unusual characteristics of Farmington Bay and the rest of the Great Salt Lake, the Utah Division of Water Quality has not, however, applied criteria established for other waters in the United States. The data presented here suggest that the state needs to move towards either adopting the existing standards or to develop site-specific water quality standards for Farmington Bay.

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Table 1: Station numbers and GPS coordinates of sampling stations in Farmington and Gilbert Bays used in this study.

Station Name	**GPS Coordinates (lat long)**	**Location and notes**
1	N 41 02.985 W 112 11.321	N end of Farmington Bay, 3 km from causeway
2	N 41 01.823 W 112 09.547	SSE of Station 1
3	N 40 59.803 W 112 08.442	SSE of Station 2
4	N 40 57.849 W 112 06.548	SSE of Station 3; too shallow to sample after Aug 2005
14	N 41 00.829 W 112 15.397	West side of Antelope Island, North Site
15	N 40 55.518 W 112 15.387	West side of Antelope Island, South Site
18	N 40 57.572 W 112 15.832	West side of Antelope Island, between Stations 14 and 15

Table 2: Parameters and methods used in the synoptic surveys of Farmington, Bear River & Gilbert Bays.

Parameters	Method	Dates	All Sta.	Subset
Physical				
Temperature/conductivity profile	InSitu sonde	All		x
Light penetration	LiCor Radiometer	All		x
Current Profile	Acoustic doppler profiler (USGS)	June		x
Satellite imagery	MODIS satellite, NASA	June	lake	
Spectral reflectance signature		June		x
Surface skin temperature	Infarred gun	June	x	
Secchi depth	25-cm disk	All	x	
Biological				
Chlorophyll *a*(extracted)	Turner 10AU fluorometer (Welschmeyer method)	All	x	
Chlorophyll: in vivo fluorescence	Turner Aqua flour field fluorometer	June	x	
Phycocyanin (Lab fluorometer)*	Turner Trilogy fluorometer; Ex 600 nm; Em 640 nm	June	x	
Phycocyanin (Field Fluorometer*	Turner Aquaflour fluorometer Ex: 595 nm; Em 670 nm	June	x	
Phycoerythrin (Lab fluorometer)*	Turner Trilogy fluorometer. Ex 550 nm; Em 610 nm			x
Nitrogen Fixation	Acetylene reduction, laboratory incubation	All		x
Phytoplankton taxonomic sample	3% formalin preservation, inverted microscope	All		x
Zooplankton taxonomic sample	3% formalin preservation, dissecting scope	All		x
Zooplankton isotopic content 15N	Mass spectrometer (Ehlringer Laboratory, U of U)	June		x
Seston isotopic composition 15N, 13C	Mass spectrometer (Ehlringer Laboratory, U of U)	June		x
Chemical				
Salinity	Field refractometer	All	x	
Total N, Total P, Ammonium	Colorimetric analyses	All		x
H2O isotopic analysis ; ^{18}O, D	Mass spectrometer (Ehlringer Laboratory, U of U)	All	x	
Colored Dissolved Organic Matter	Absorbance at 440 nm	All		x

* cyanobacterial pigment

Table 3: Outline of predator and salinity treatments used in the Mesocosm experiment #2.

	PREDATOR DENSITY		
SALINITY	4%, 0 corixids L^{-1}	4%, 0.6 corixids L^{-1}	4%, 0.8 corixids L^{-1}
	8%, 0 corixids L^{-1}	8%, 0.6 corixids L^{-1}	8%, 0.8 corixids L^{-1}

Table 4. Phytoplankton observed in Farmington and Gilbert Bays during the 2005 sampling period. Divisions are shown in bold.

Name	**Farmington Bay**	**Gilbert Bay**
CHLOROPHYTA		
Carteria sp.	X	
Dunaliella viridis	X	X
Dunaliella salina	X	X
Oocystis sp.	X	X
Pediastrum sp.	X	
Spermatozopsis sp.	X	X
Scenedesmus sp.	X	
PYRROPHYTA		
Cryptomonas sp.	X	X
Glenodinium sp.	X	
Unidentified chrysophyte	X	X
BACILLARIOPHYTA		
Amphora sp.*	X	X
Amphora coffeaeformis	X	X
Chaetocerous sp.	X	
Cyclotella sp.	X	X
Nitzschia palea	X	
Navicula graciloides	X	X
Navicula lanceolata		X
Navicula tripuctata	X	
Navicula sp. (45 – 100 µm)	X	X
Synedra sp.	X	
CYANOPHYTA		
Microcoleus sp.	X	X
Nodularia spumegina.	X	X
Pseudanabaena sp.	X	
Spirulina sp.	X	

Table 5. Names and occurrence of zooplankton taxa observed in Farmington and Gilbert Bays during the 2002-2003 sampling period. X indicates that a taxa was found in that bay during the study period.

Name	Stage	Farmington Bay	Gilbert Bay
Artemia franciscana	Adult	X	X
	Juvenile	X	X
	Nauplii	X	X
Trichocorixa verticalis		X	X
Ephydra sp.	Adult	X	X
	Pupae	X	X
	Larvae	X	X
Cletocampus albuquerquensis		X	
Diaptomus conexus		X	X
Moina sp.		X	X
Cyclopoid copepod (very rare)		X	X

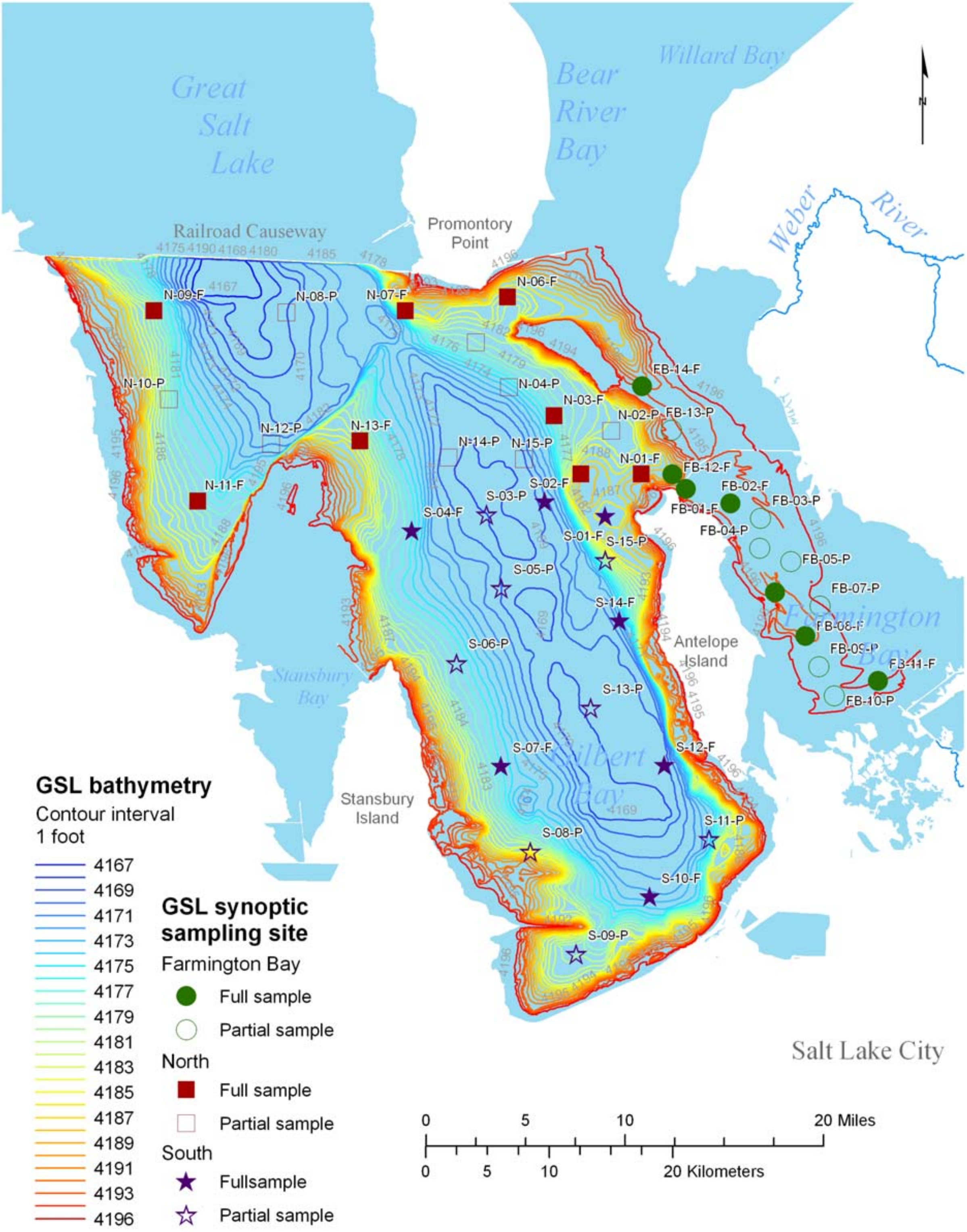


Figure 1. Location of the synoptic sampling sites used in this study. Note that Stations FB 12, 13 and 14 were collected north of the automobile causeway in Ogden Bay.

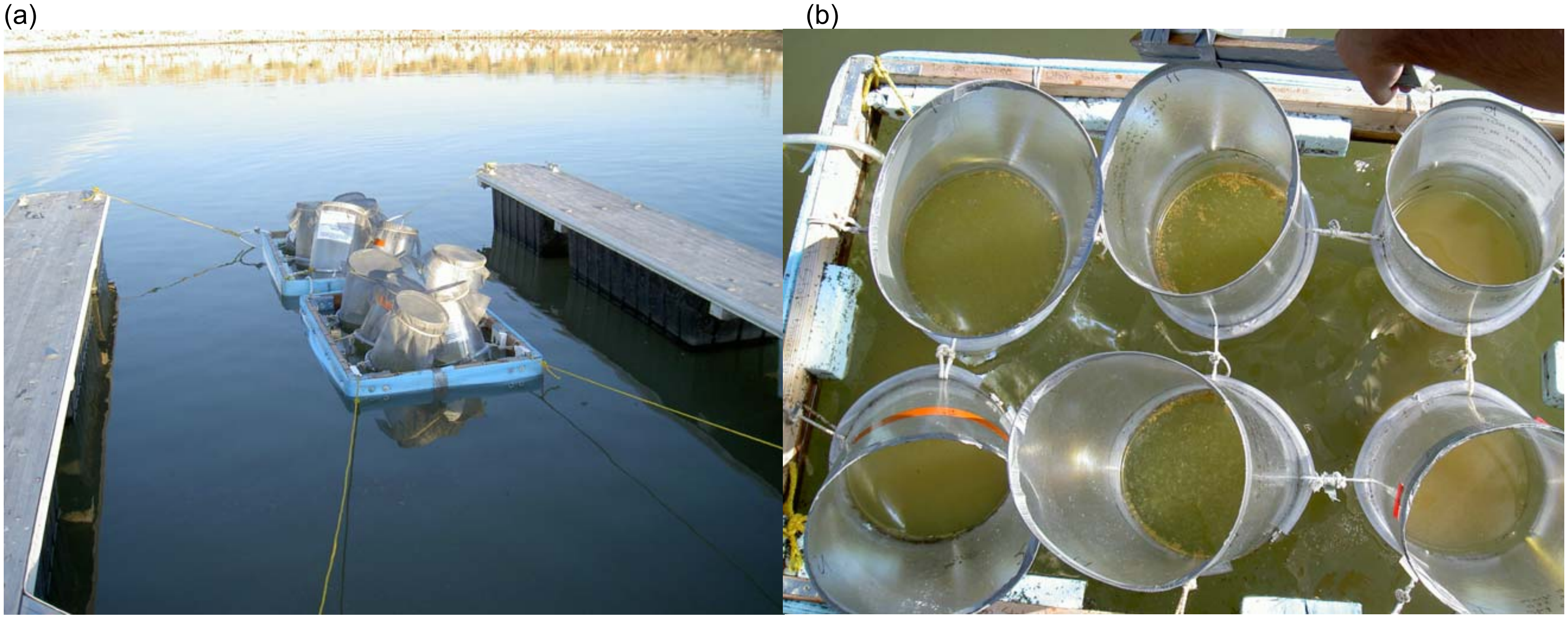


Figure 2. Fiberglass cylinders used in the mesocosm experiments (a) located in Antelope Island Marina, and (b) close up of one set. Photos by J. Armegol Diaz.

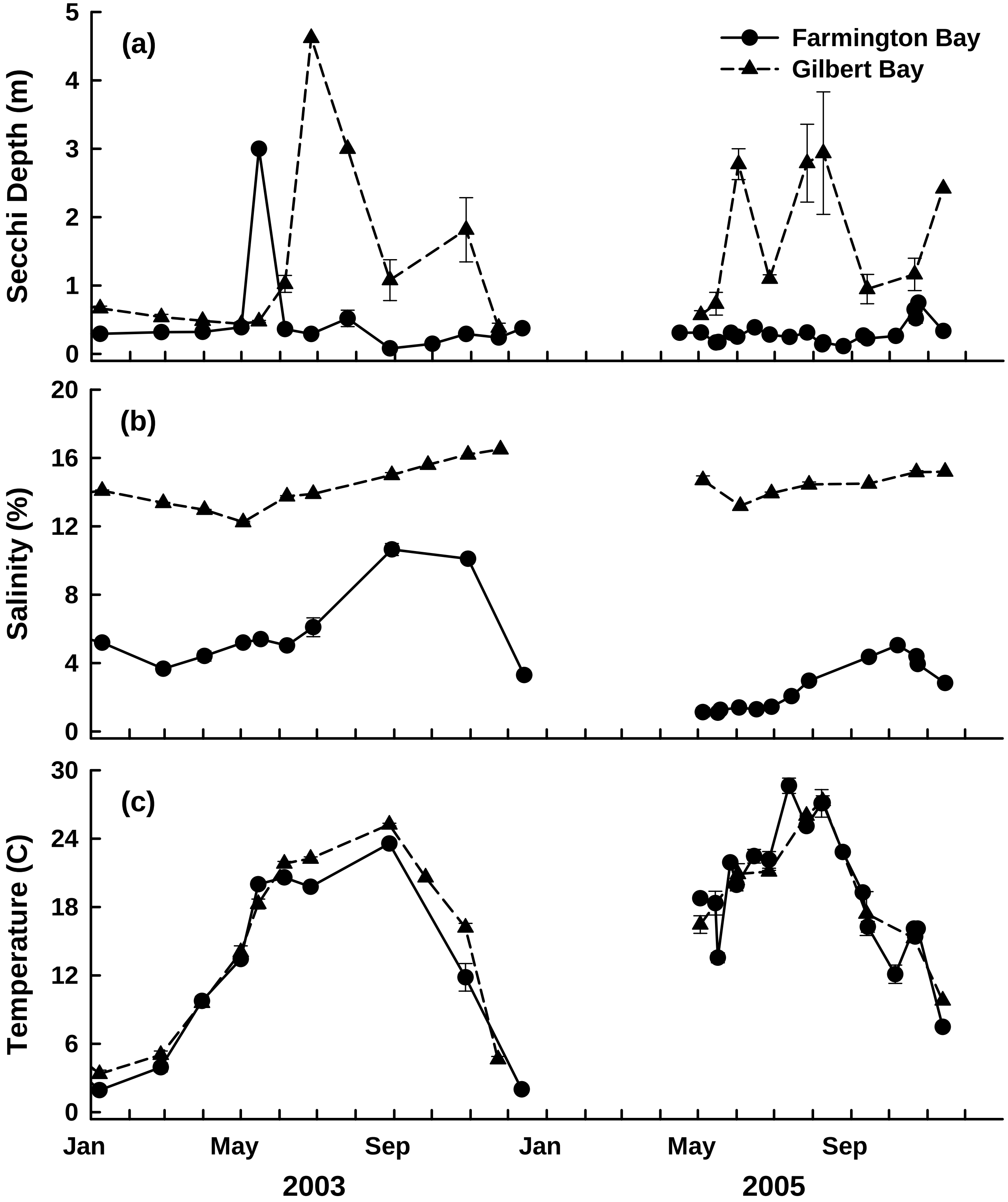


Figure 3. Trend in (a) Secchi depth (index of water clarity), (b) salinity, and (c) temperature in the mixed layer in Farmington and Gilbert bays during 2003 and 2005. Error bars are ± 1 S. E.

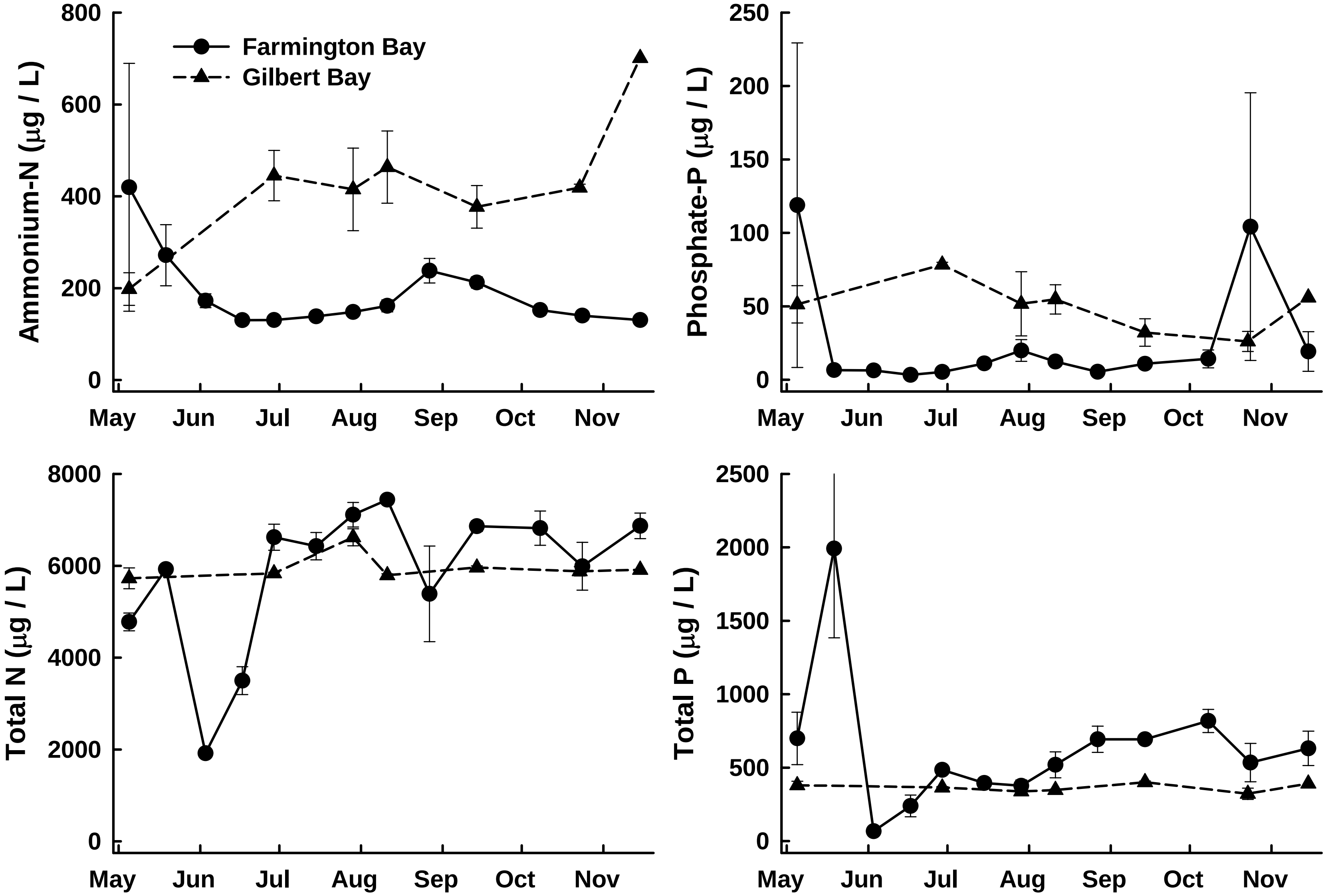


Figure 4. Trends in chemical species measured in Farmington and Gilbert Bays during the 2005 study. Error bars are ± 1 S. E.

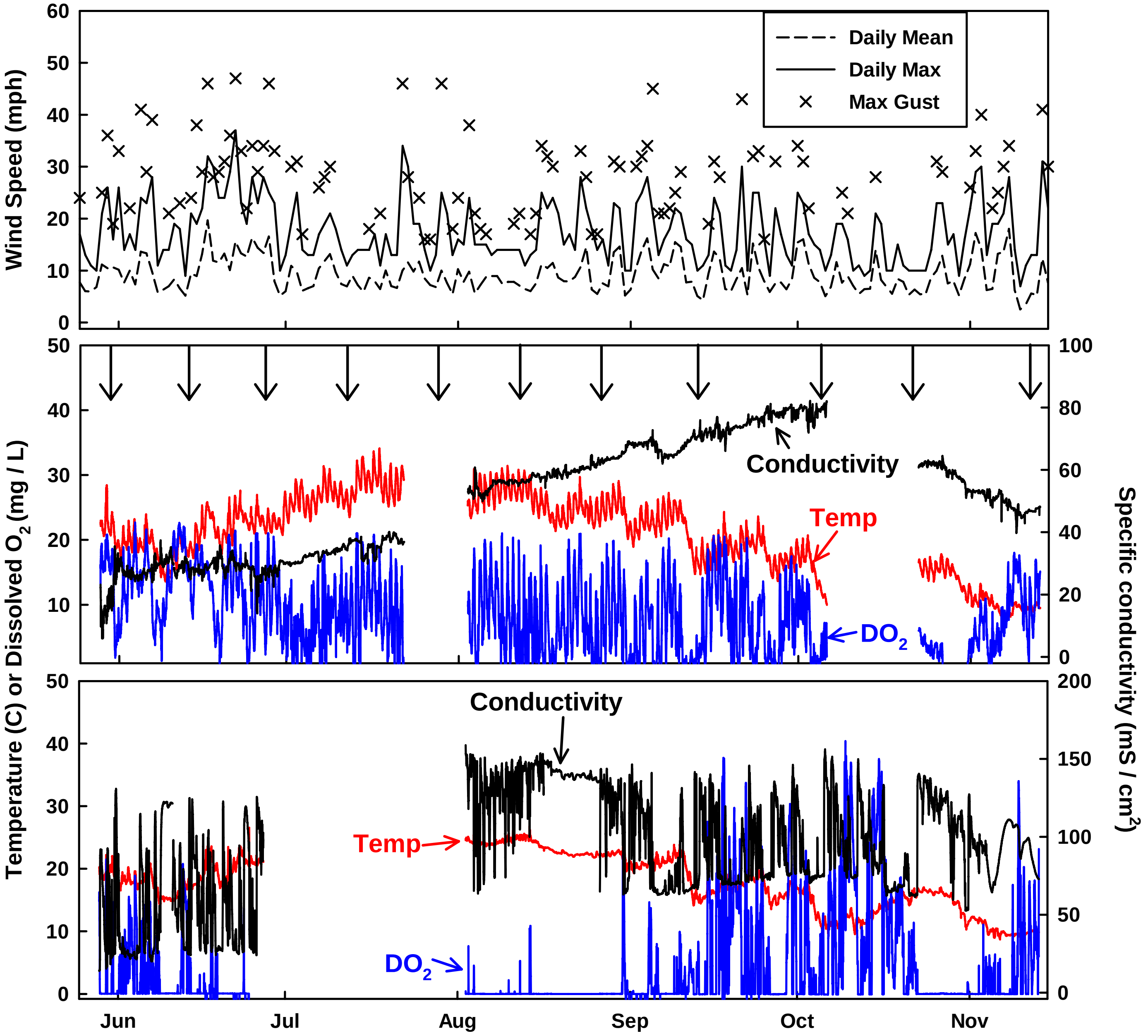


Figure 5. Weather data (top pane) collected at SLC international airport, compared to water quality data measured *in situ* at 0.2m (middle pane) and the bottom of the water column (bottom pane) at Station 1 in Farmington Bay in 2005. Arrows represent 2005 project sampling dates on Farmington Bay. Daily weather means and maximums determined from hourly observations from the National Climate Data Center (http://www.ncdc.noaa.gov). "Speed" indicates that the observation is 2-minute average of the conditions just prior to the observation; "gust" is the maximum 5 second wind speed measured in the 5 minutes prior to the observation.

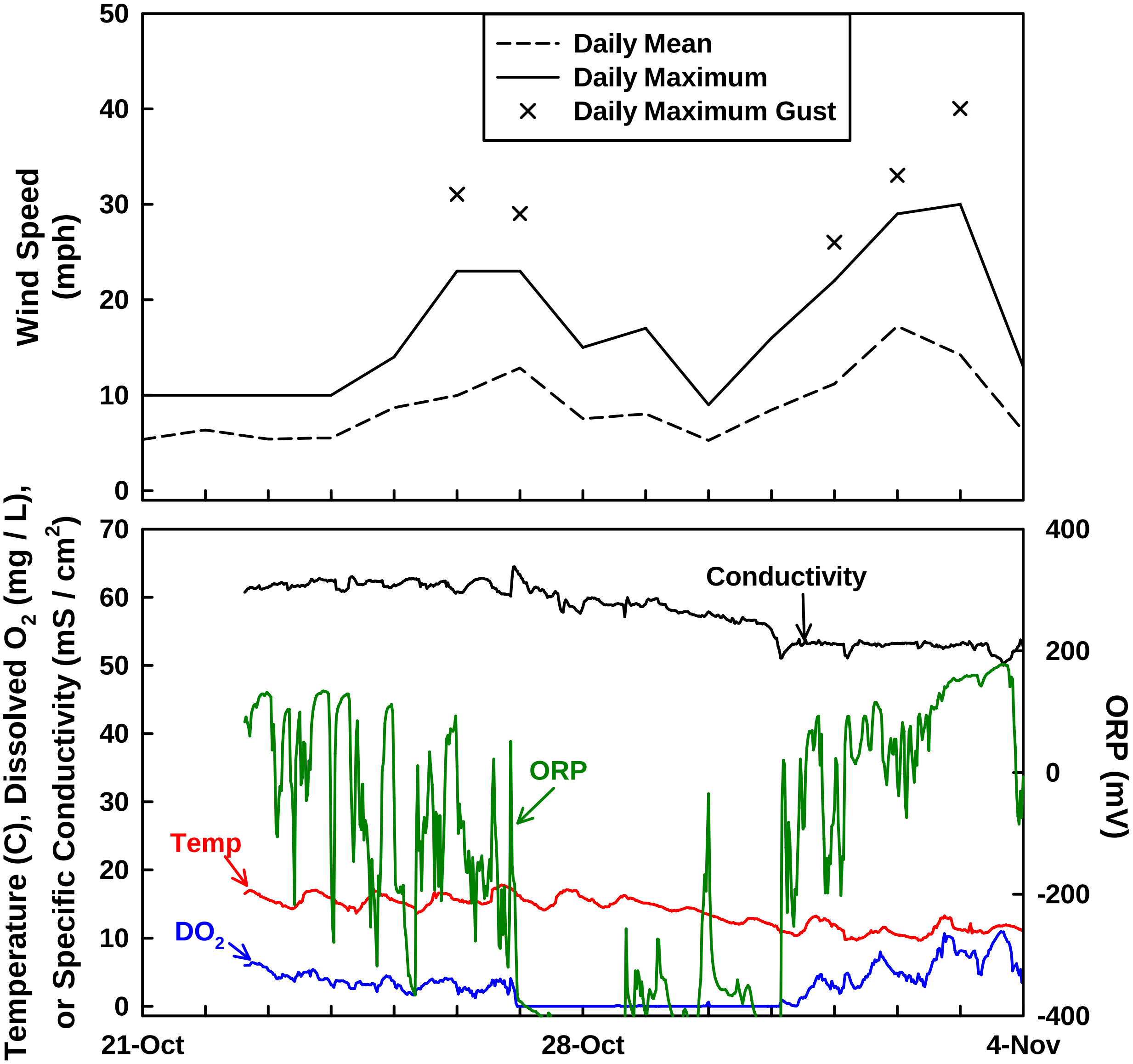


Figure 6. An expanded view of (a) wind data, collected at the Salt Lake airport, and (b) water quality record at Station P1, showing in detail the single period of anoxia documented in 2005, from 27-Oct to 31-Oct. Note that when oxygen concentrations drop to zero, ORP is negative. This event was not correlated with a large wind event at the salt lake airport, but there was a peak in salinity indicating mixing with the deep brine layer or that high-salinity water was pushed into Farmington Bay from Gilbert Bay.

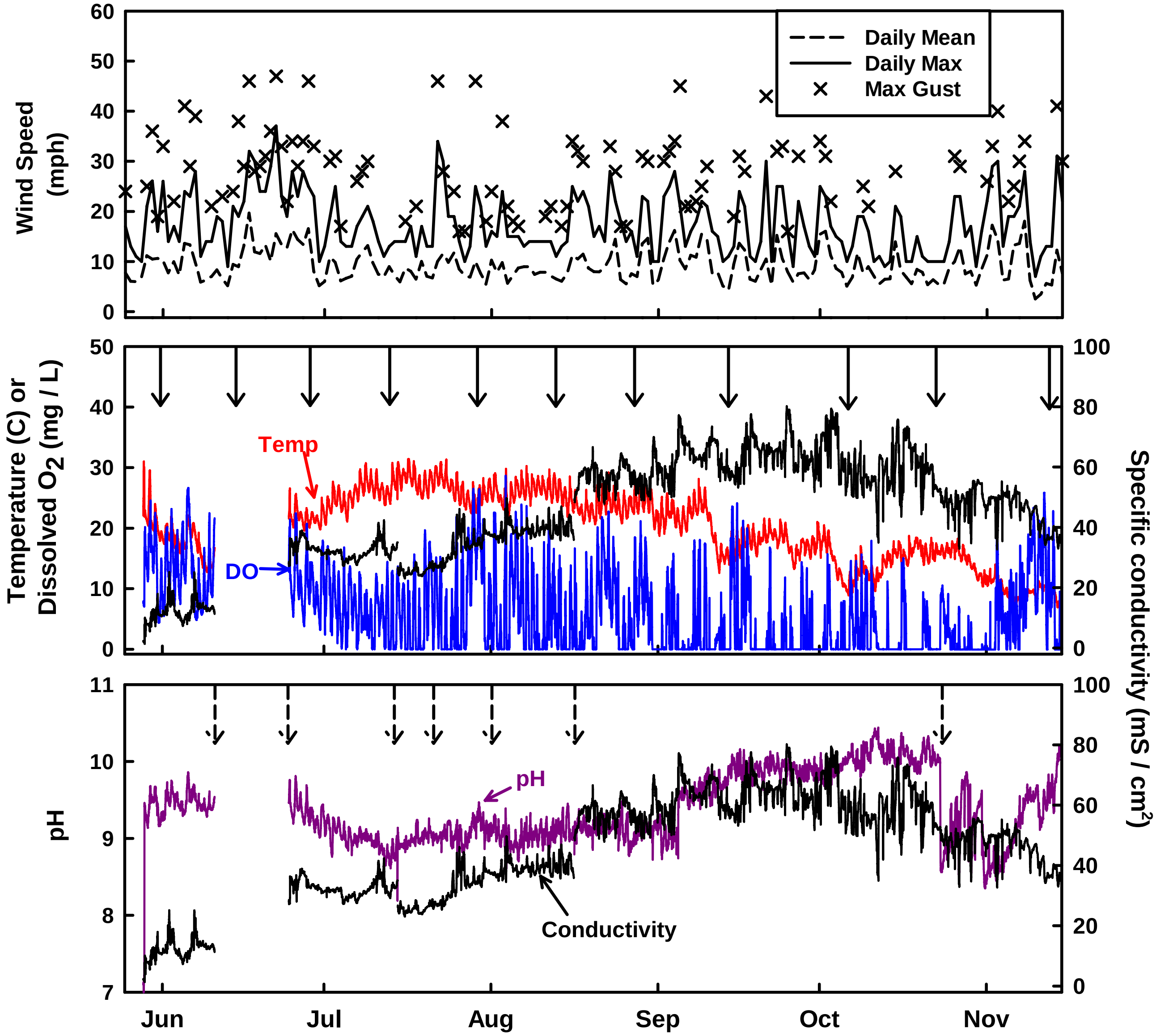


Figure 7. Weather data (top pane) collected at SLC international airport, compared to water quality data (bottom and middle panes) measured *in situ* at Station 3 in 2005. Solid arrows on the middle pane represent 2005 project sampling dates on Farmington Bay. Dashed arrows on the bottom pane represent days that the sondes were downloaded and calibrated. Daily weather means and maximums determined from hourly observations from the National Climate Data Center (http://www.ncdc.noaa.gov). “Speed” indicates that the observation is 2-minute average of the conditions just prior to the observation; “gust” is the maximum 5 second wind speed measured in the 5 minutes prior to the observation.

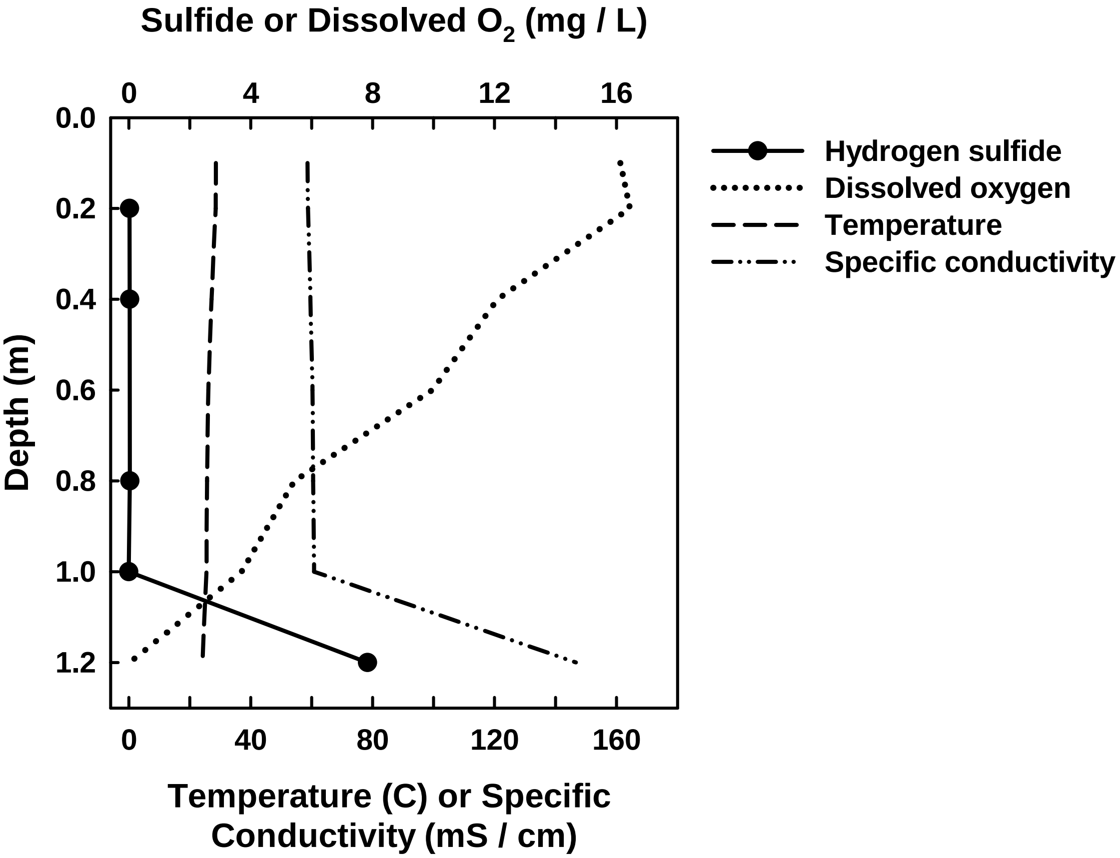


Figure 8. Typical vertical profile for hydrogen sulfide concentrations observed in Farmington Bay in the 2005 study. This profile was measured at 15:00, 9 Aug 2005. n=1 for each measurement.

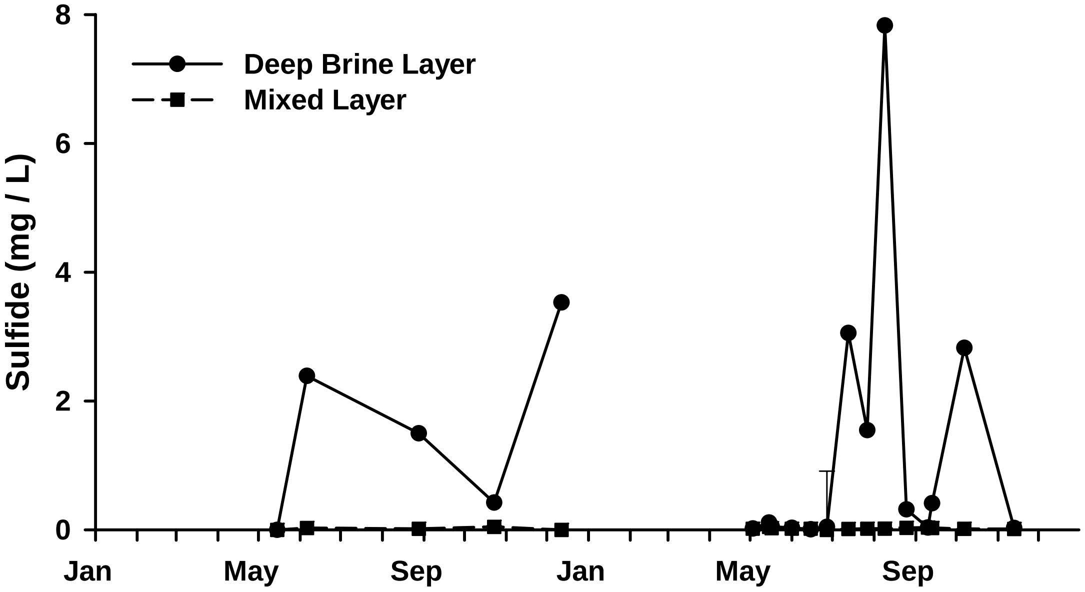


Figure 9. Seasonal pattern of hydrogen sulfide concentrations in the mixed and deep brine layers at Station P1 in Farmington Bay. Error bars are ± 1 S. E, n varies between sampling dates. In 2005, a deep brine layer did not form until early July, while it was present for the entire sampling period in 2003.

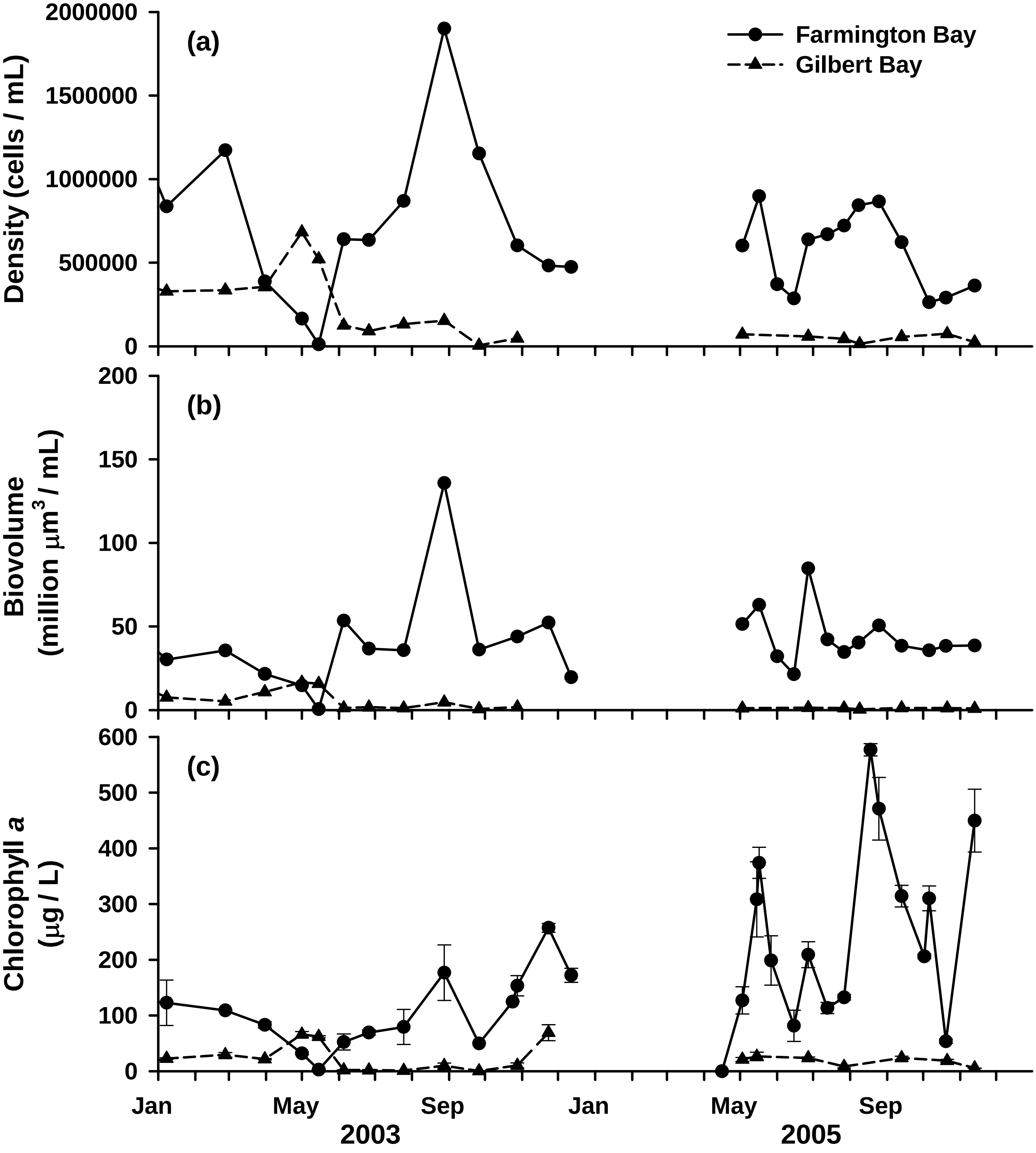


Figure 10. (a) Total phytoplankton density, (b) biomass, and (c) chlorophyll *a* in Farmington and Gilbert Bays during 2003 and 2005. Error bars are ± 1 S. E.

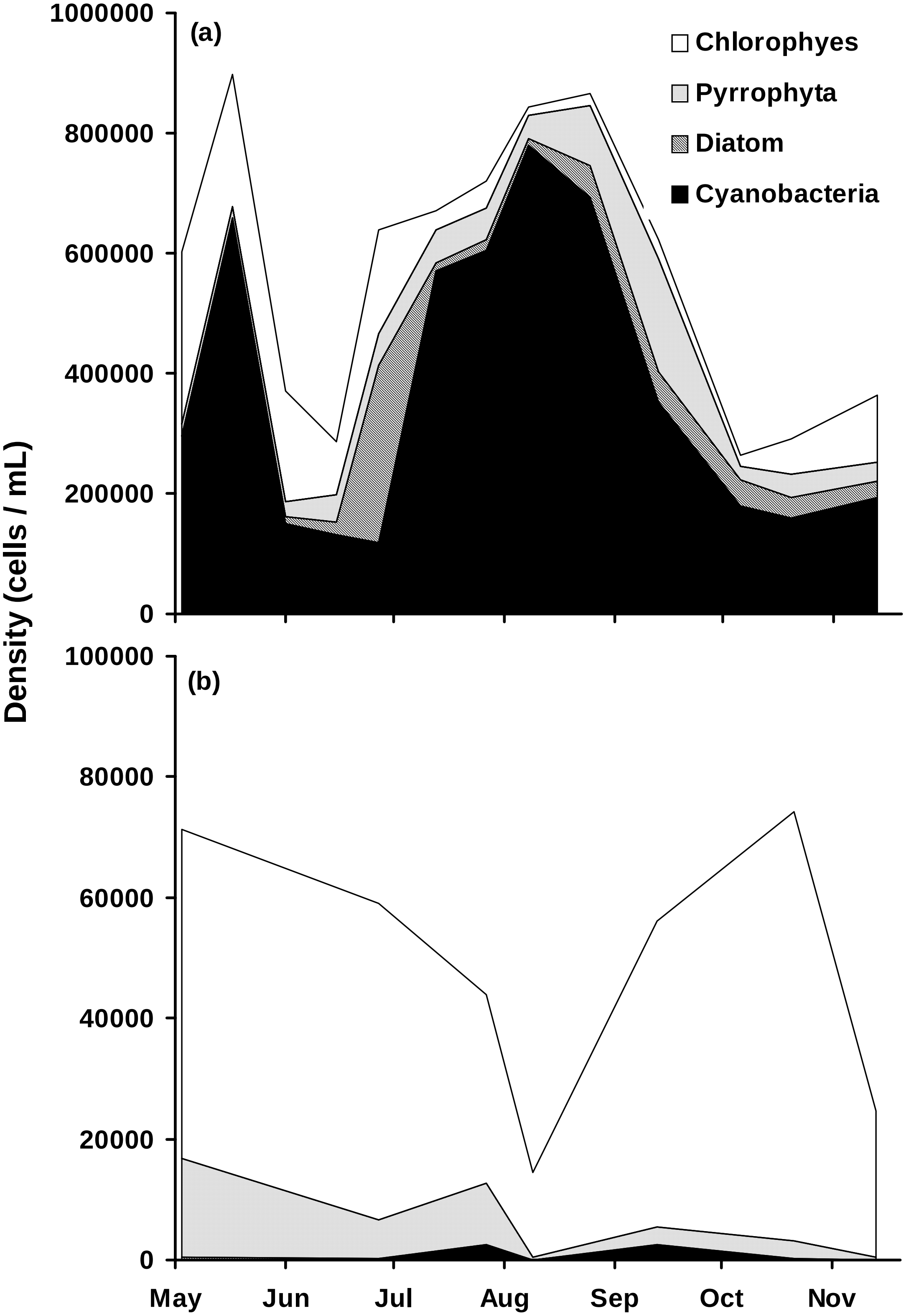


Figure 11. Phytoplankton densities in (a) Farmington and (b) Gilbert Bays during the 2005 study. Note x-axis on (a) is 10X greater than on (b).

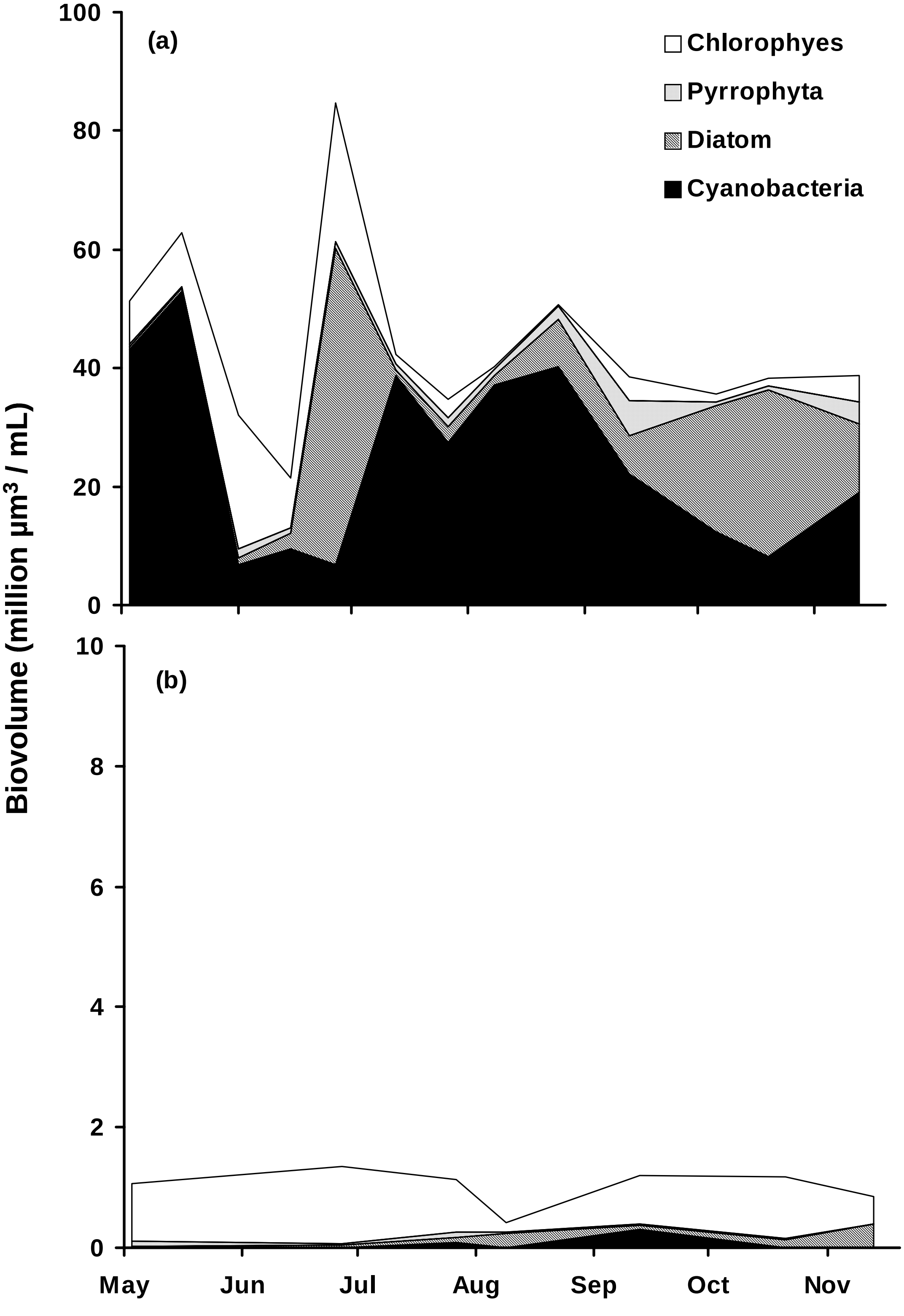


Figure 12. Phytoplankton biovolumes in (a) Farmington and (b) Gilbert Bays during 2005. Note x-axis on (a) is 10X greater than on (b). Biovolume is expressed at 1 million µm^3 / mL of ease of presentation; 1 million µm^3 / mL = 10^{-6} µm^3 / mL.

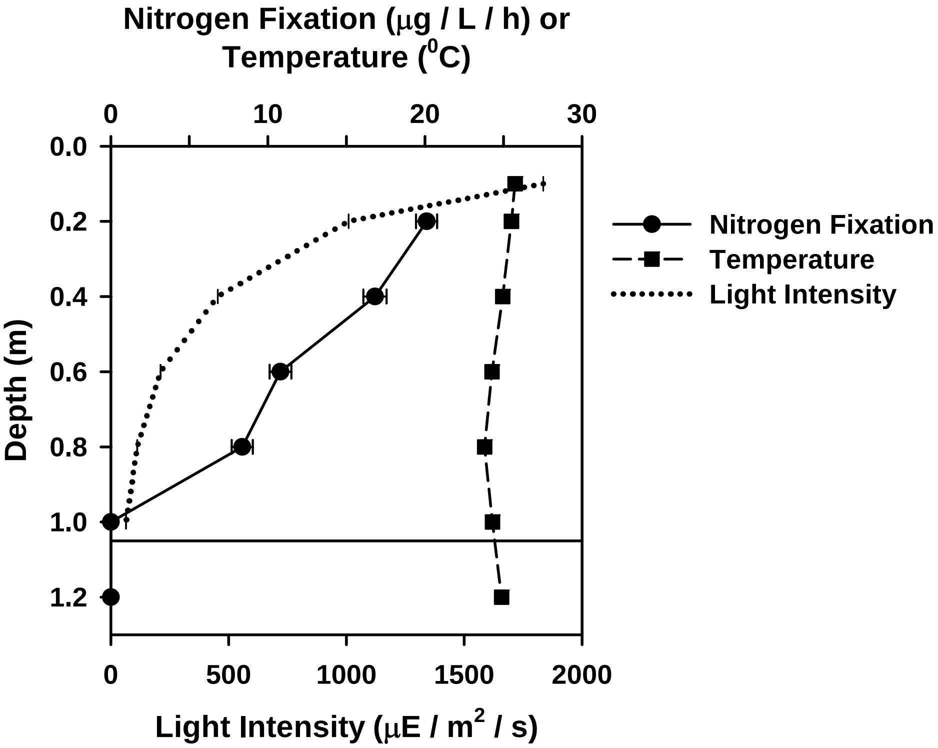


Figure 13. Typical vertical profile for nitrogen fixation observed in Farmington Bay in the 2005 study. This profile was measured on 25 Jul 2005. The horizontal line indicates the approximate depth of the deep brine layer on the study date. Error bars are ± 1 S. E, n=2.

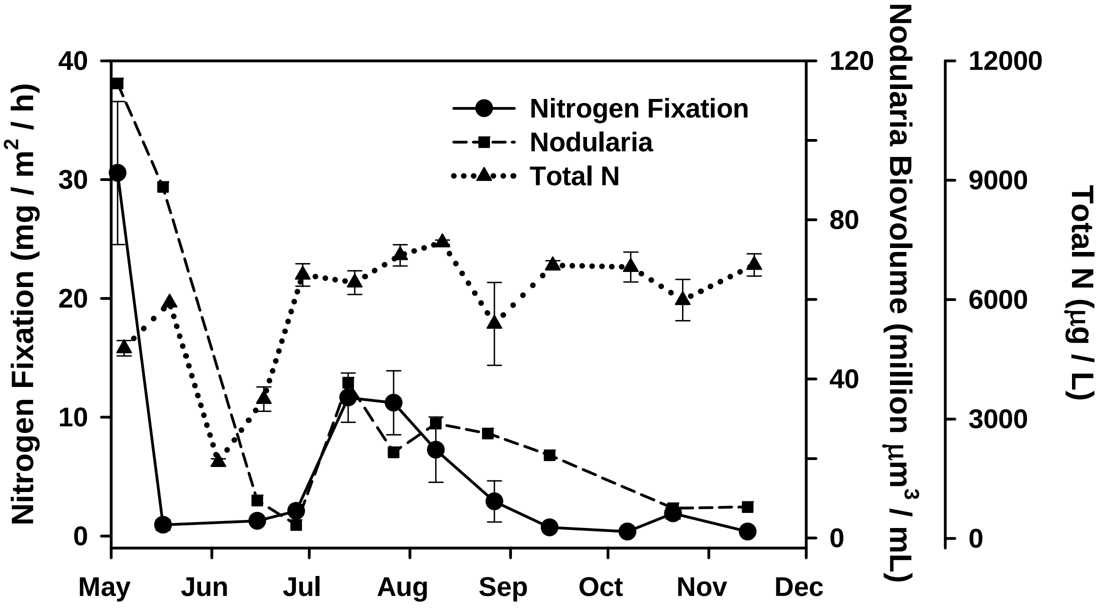


Figure 14. Seasonal pattern of nitrogen fixation in the middle of the water column (0.4-0.6m) in Farmington Bay at the northernmost sampling station in 2005. For comparison, Nodularia biovolume is also plotted. For nitrogen fixation, error bars are ± 1 S. E, n=2.

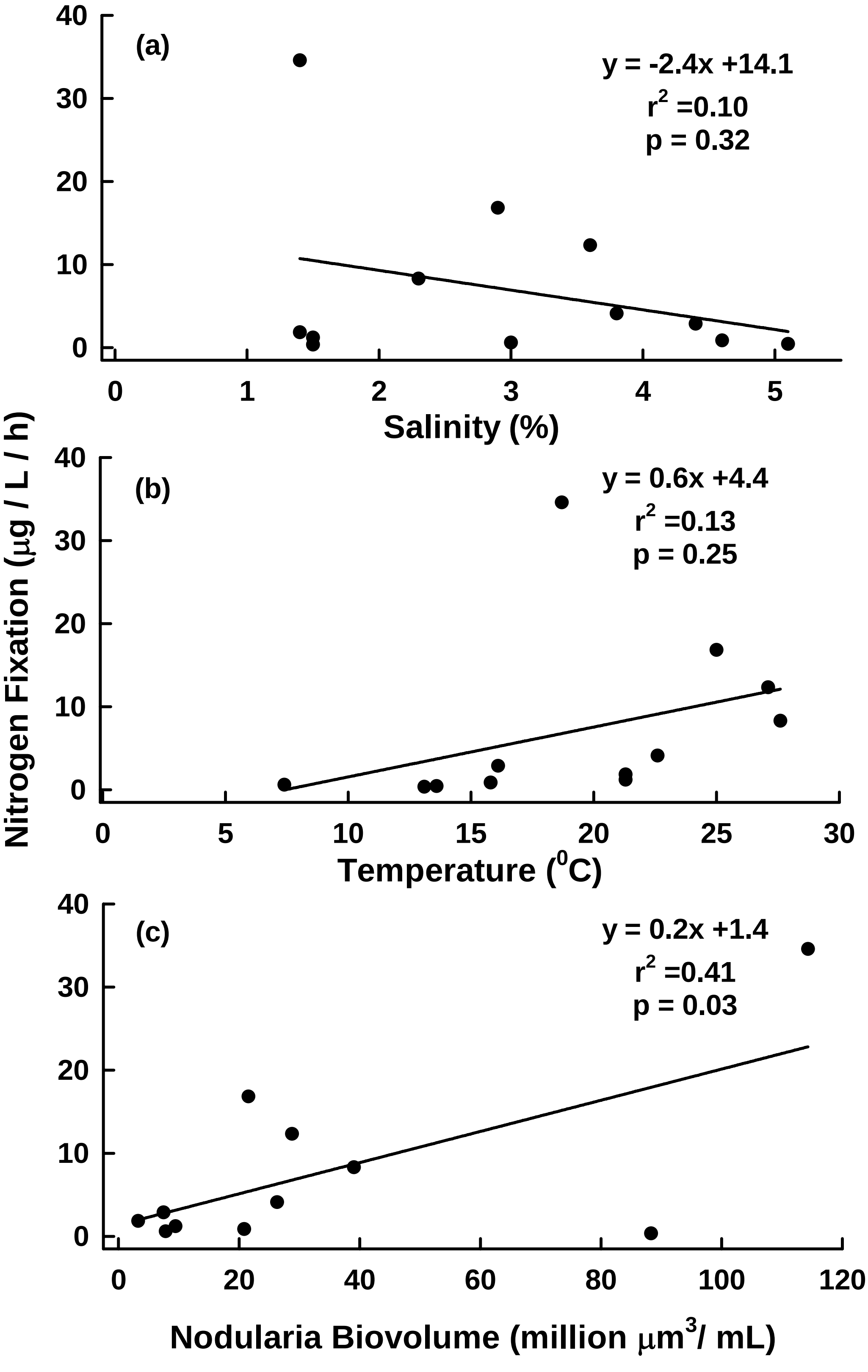


Figure 15. Nitrogen fixation rates, measured in the middle of the water column at Station 1, vs. (a) salinity, (b), temperature, and (c) Nodularia biovolume.

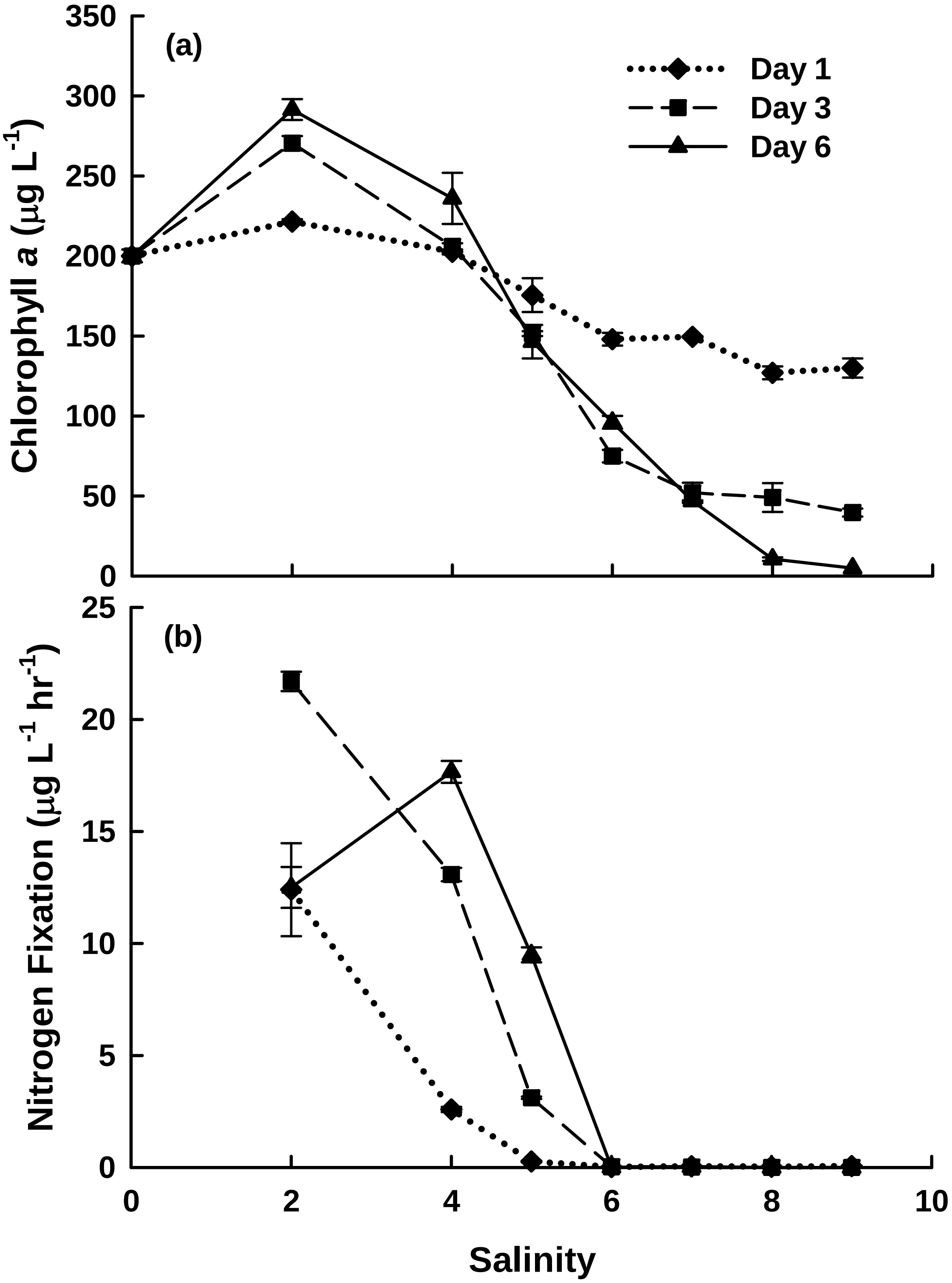


Figure 16. (A) Chlorophyll *a* and (b) nitrogen fixation results from the salinity-bioassay on the three days of the experiment. Note (1) how nitrogen fixation peaks later at higher salinities and (2) how nitrogen fixation ceases on all days at greater than 6% salinity. Error bars are ± 1 S.E. Results from the control and phosphorus treatments were not significantly different (Two—way ANOVA on each sample day, $p > 0.40$) and are combined for this figure.

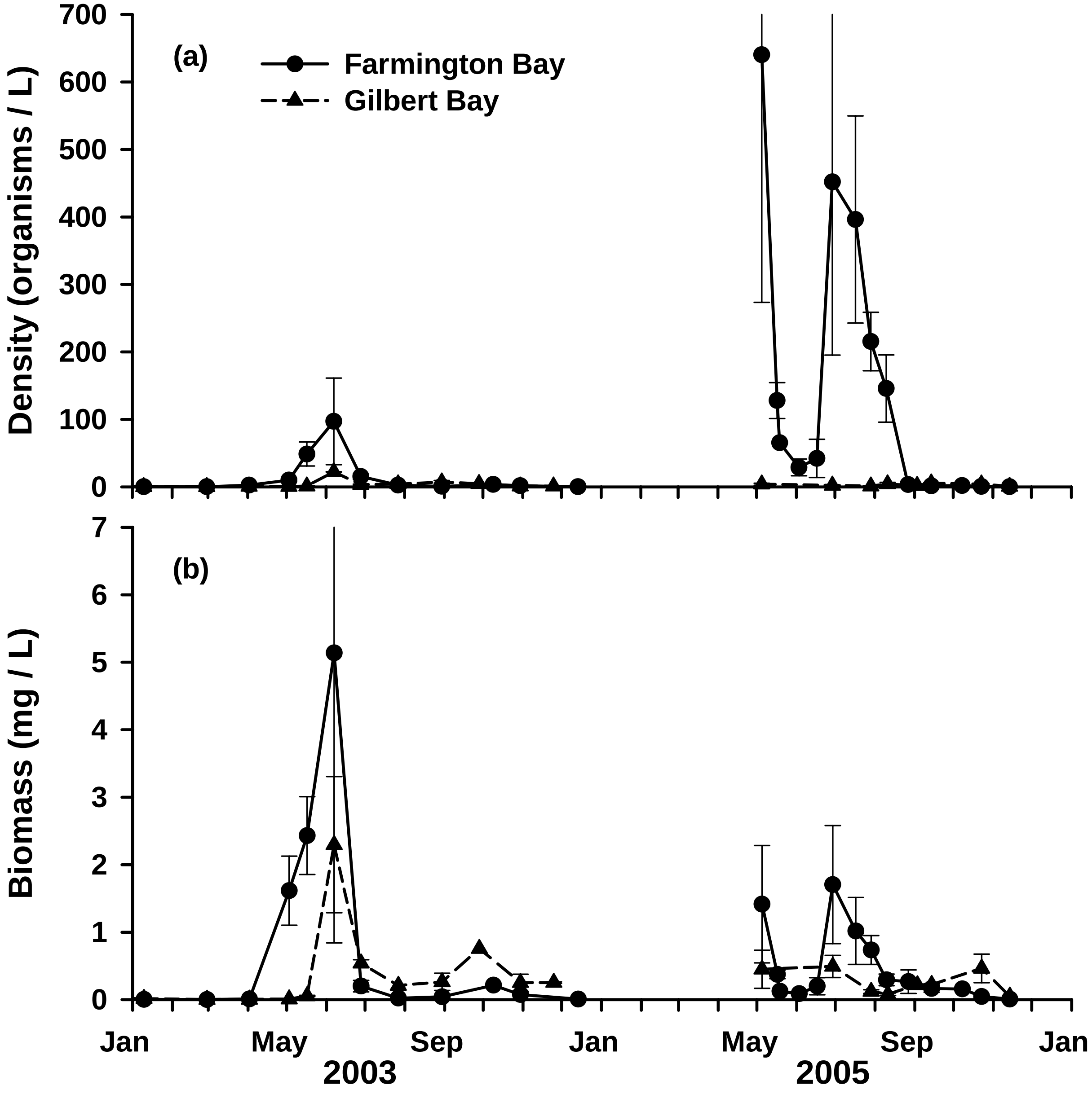


Figure 17. (a) Total zooplankton density and (b) biomass in Farmington and Gilbert Bays during 2003 and 2005. Error bars are ± 1 S. E.

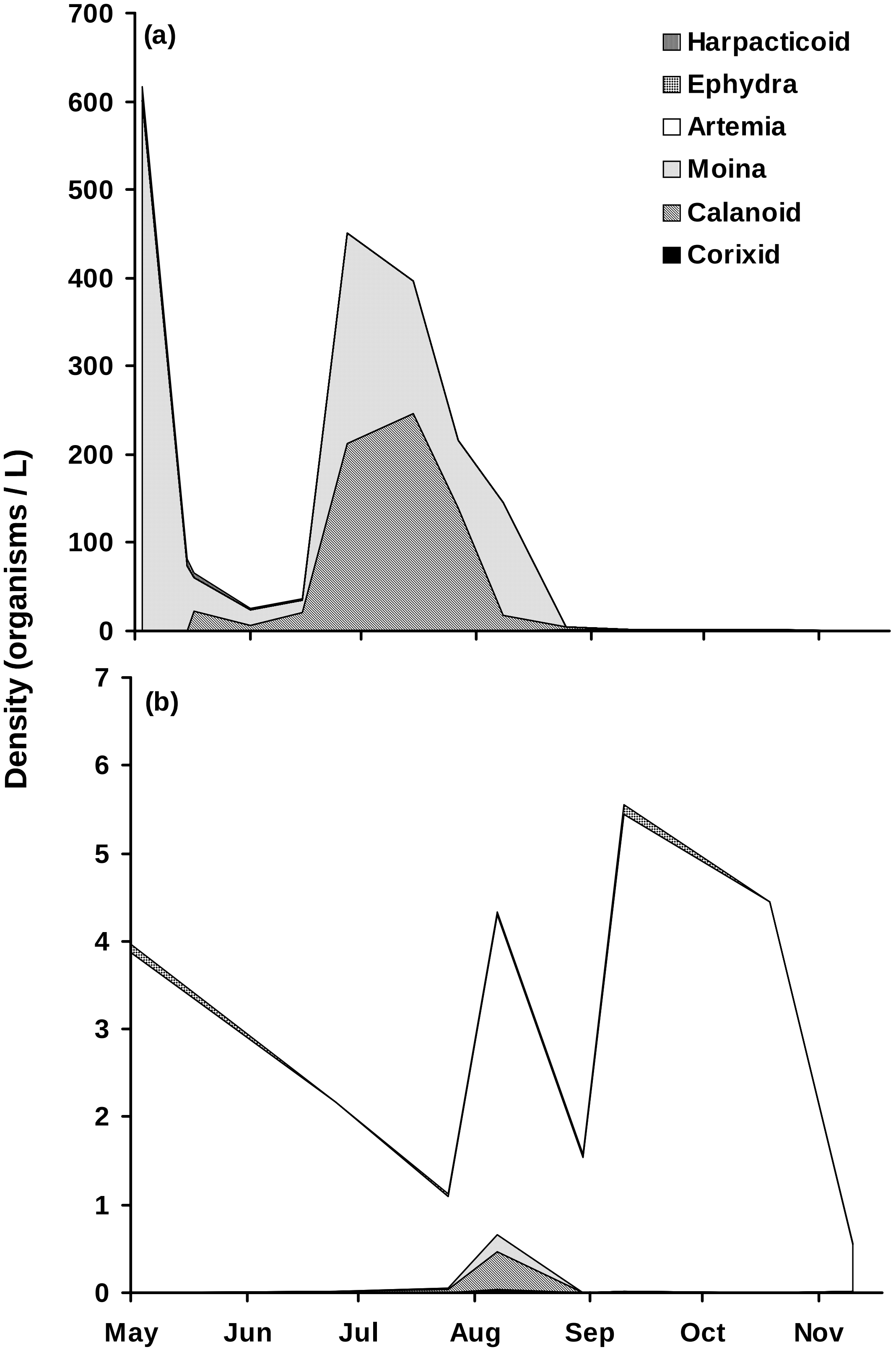


Figure 18. Zooplankton densities in (a) Farmington and (b) Gilbert Bays during the 2005 study. Note x-axis on (a) is 40X greater than on (b).

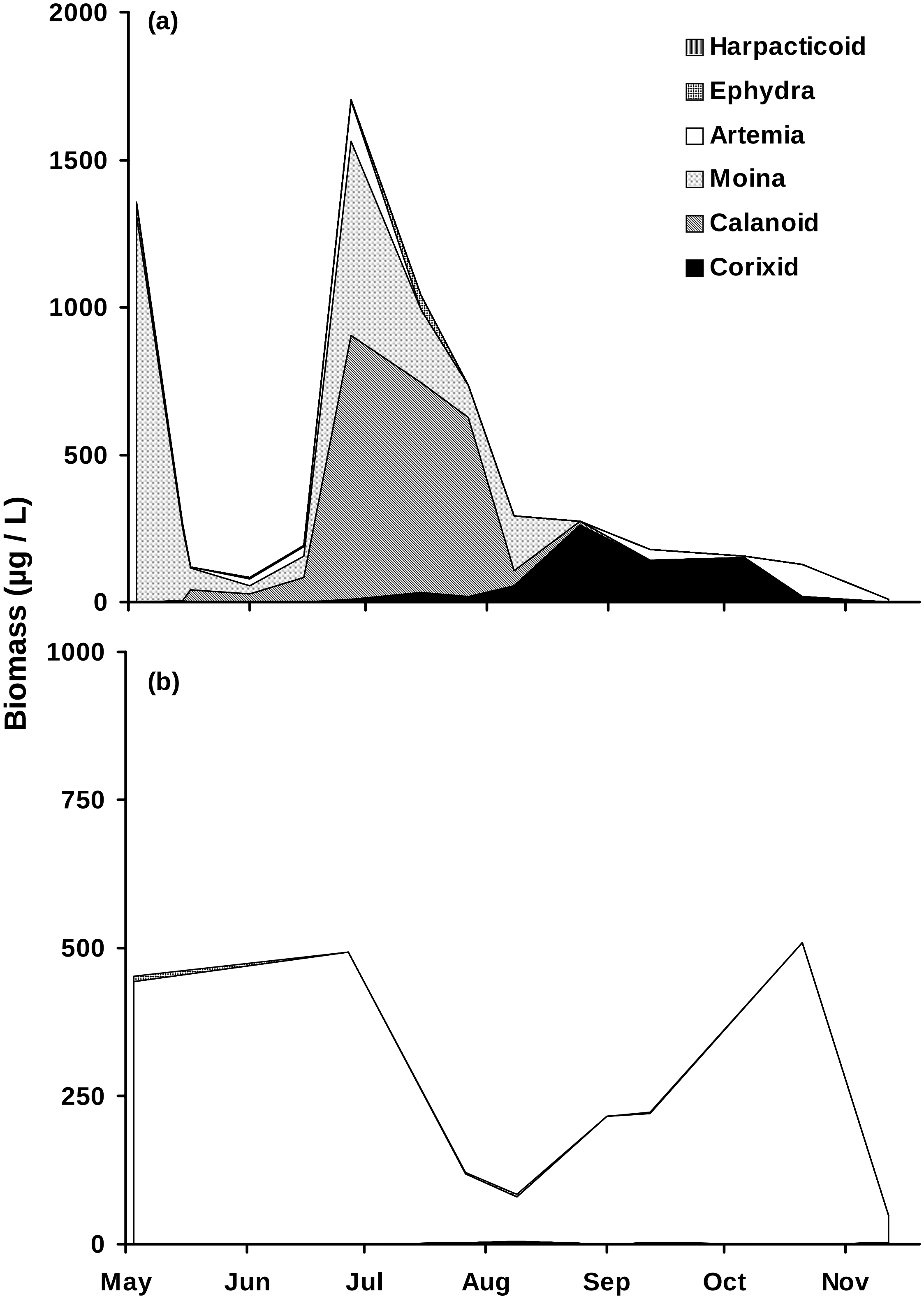


Figure 19. Zooplankton biomass in (a) Farmington and (b) Gilbert Bays during 2005.

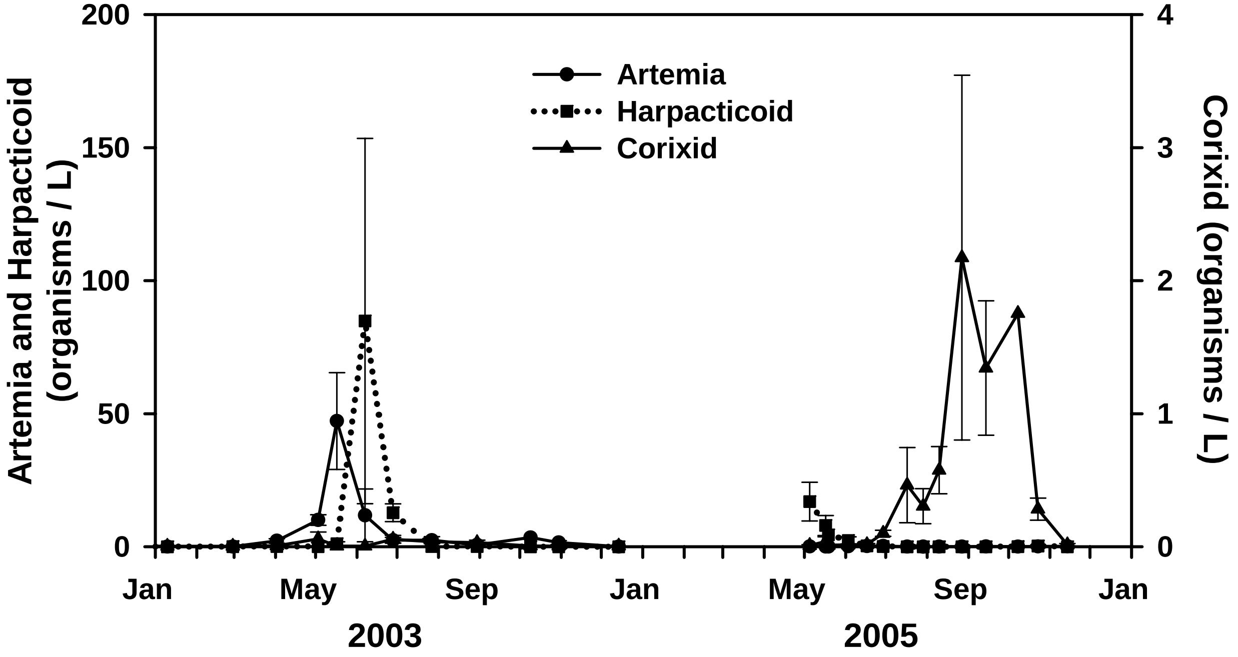


Figure 20. Relationship between brine shrimp and the predacious corixids and harpacticoids in Farmington Bay during 2003 and 2005. Note that densities of corixids are much lower than the other species (right scale). Error bars are ± 1 S. E.

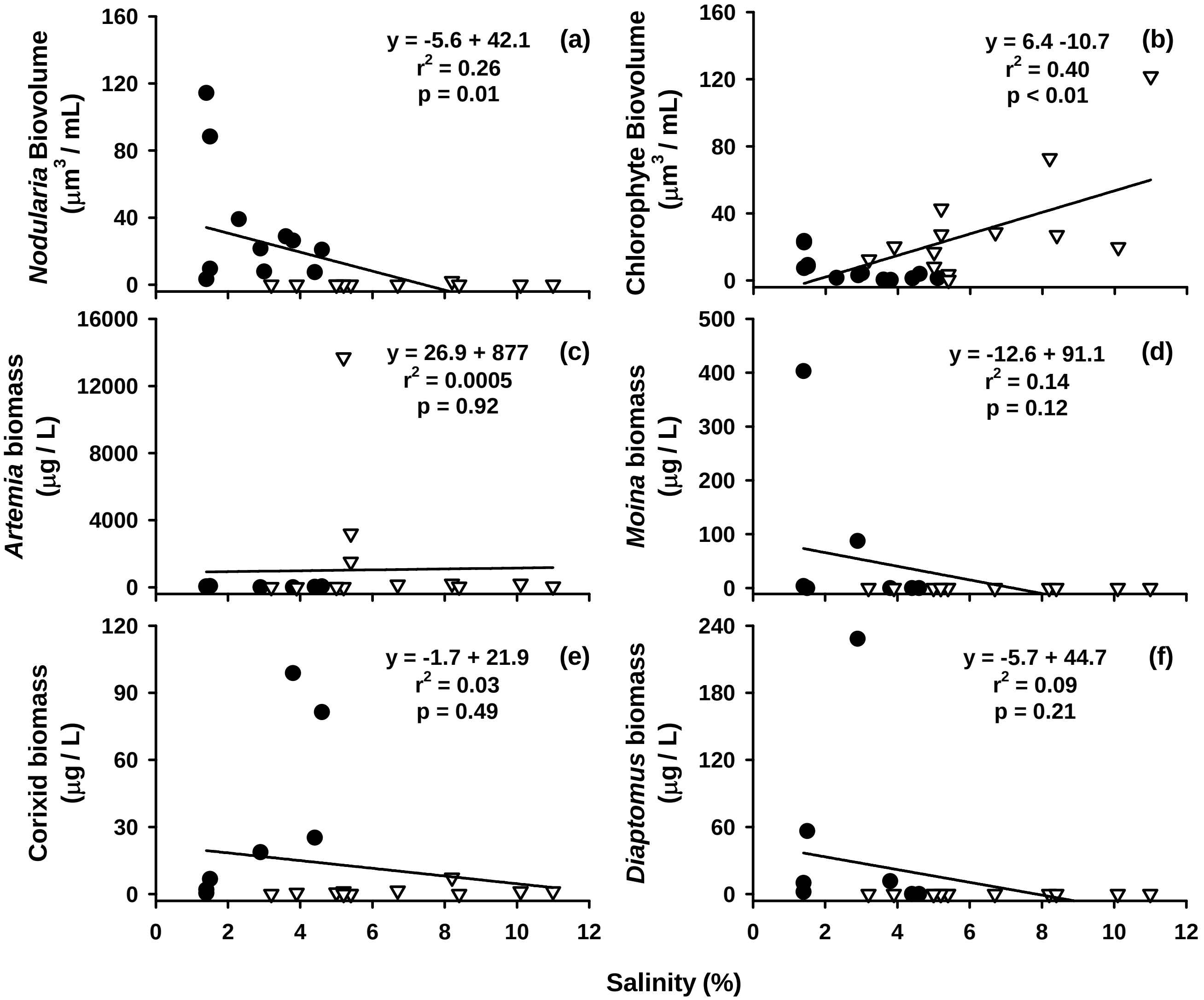


Figure 21. Salinity vs. the abundance of important phytoplankton and zooplankton taxa in 2003 (open triangles) and 2005 (closed circles), including (a) *Nodularia spumegina,* (b) green algae, (c) *Artemia franciscana*, (d) *Moina* sp., (e) *Trichocorixa verticalis*, and (f) *Diaptomus conexus*.

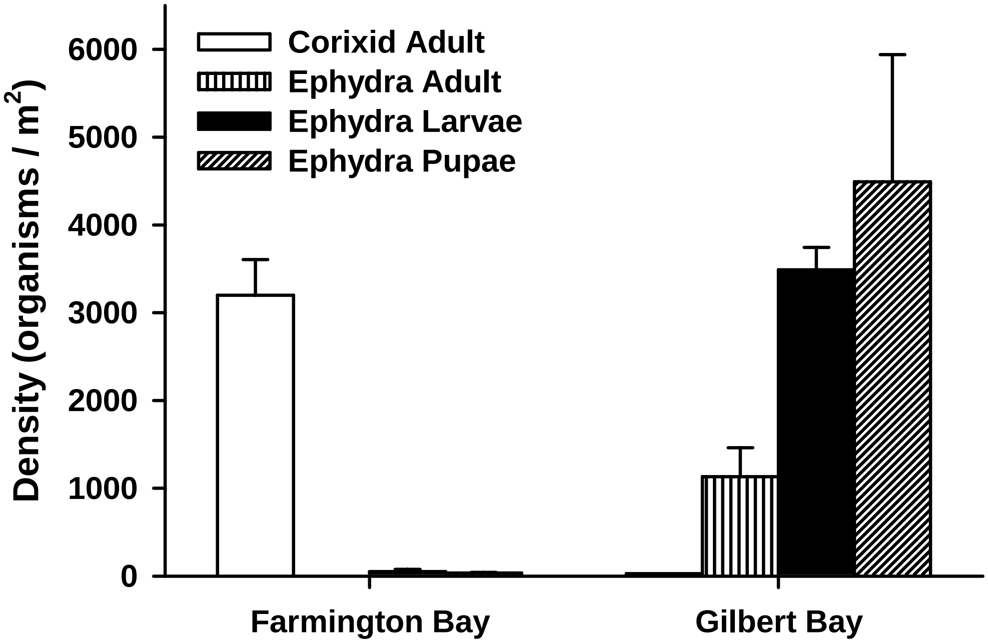


Figure 22. Density of organisms on benthic substrates on September 7, 2006 in Farmington and Gilbert bays. Ephydra species were different between the two bays, but are grouped here for ease of presentation. Error bars are ± 1 S. E.

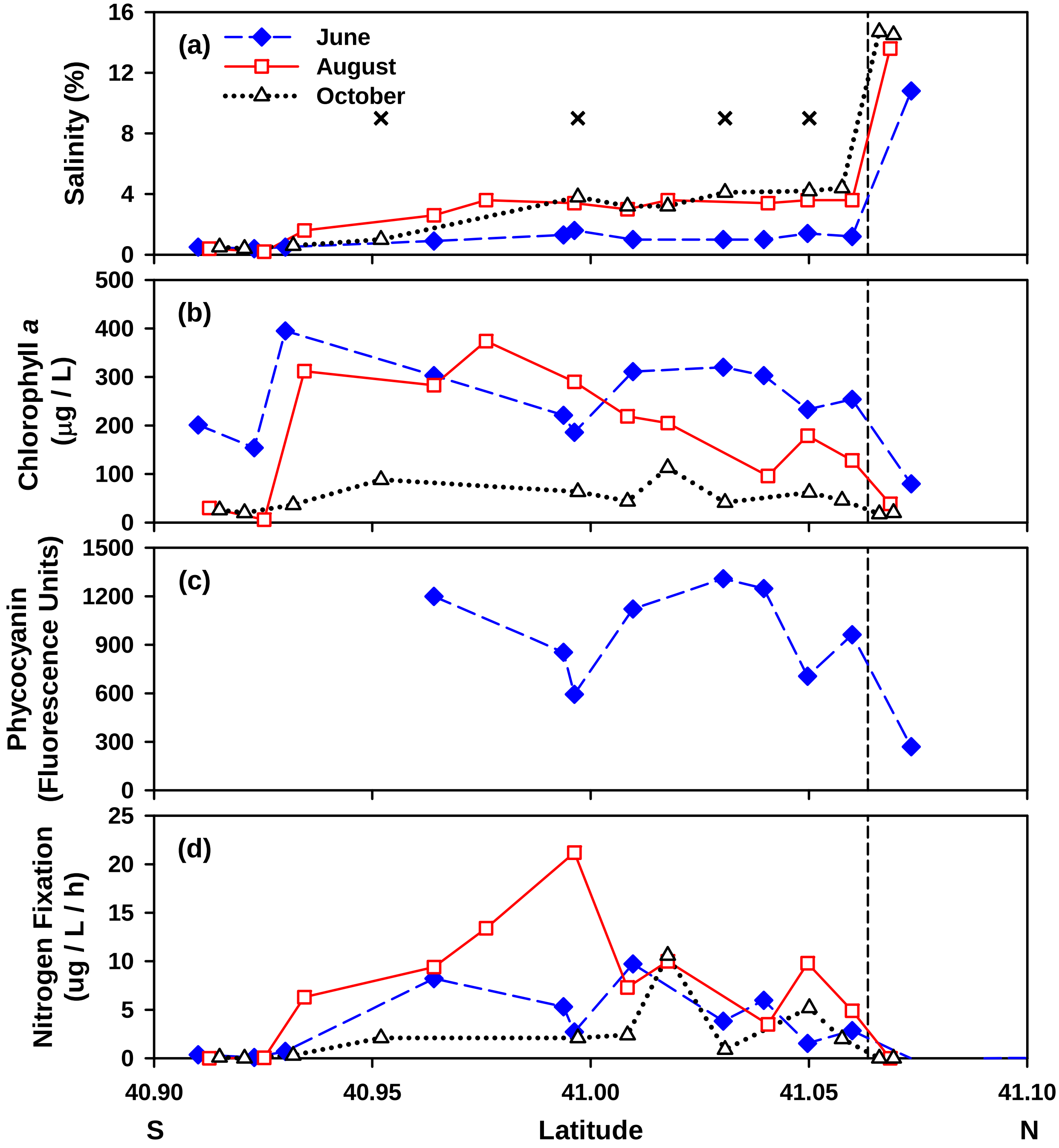


Figure 23. South to North variation in plankton in Farmington Bay and north of the Antelope Island Causeway during the June, August and October synoptic analyses. The southernmost stations were near the Farmington Bay Migratory Bird Refuge and the discharge point of the Sewage Canal. The position of the 4 routine sampling stations (Table 1) are shown as X's in the top frame. The dotted line shows the position of the Antelope Island causeway. (a) Salinity. (b) Chlorophyll *a*. (c) Concentrations of the cyanobacterial pigment phycocyanin during the June synoptic . This pigment was not measured at the three southernmost stations. (d) Nitrogen fixation rates.

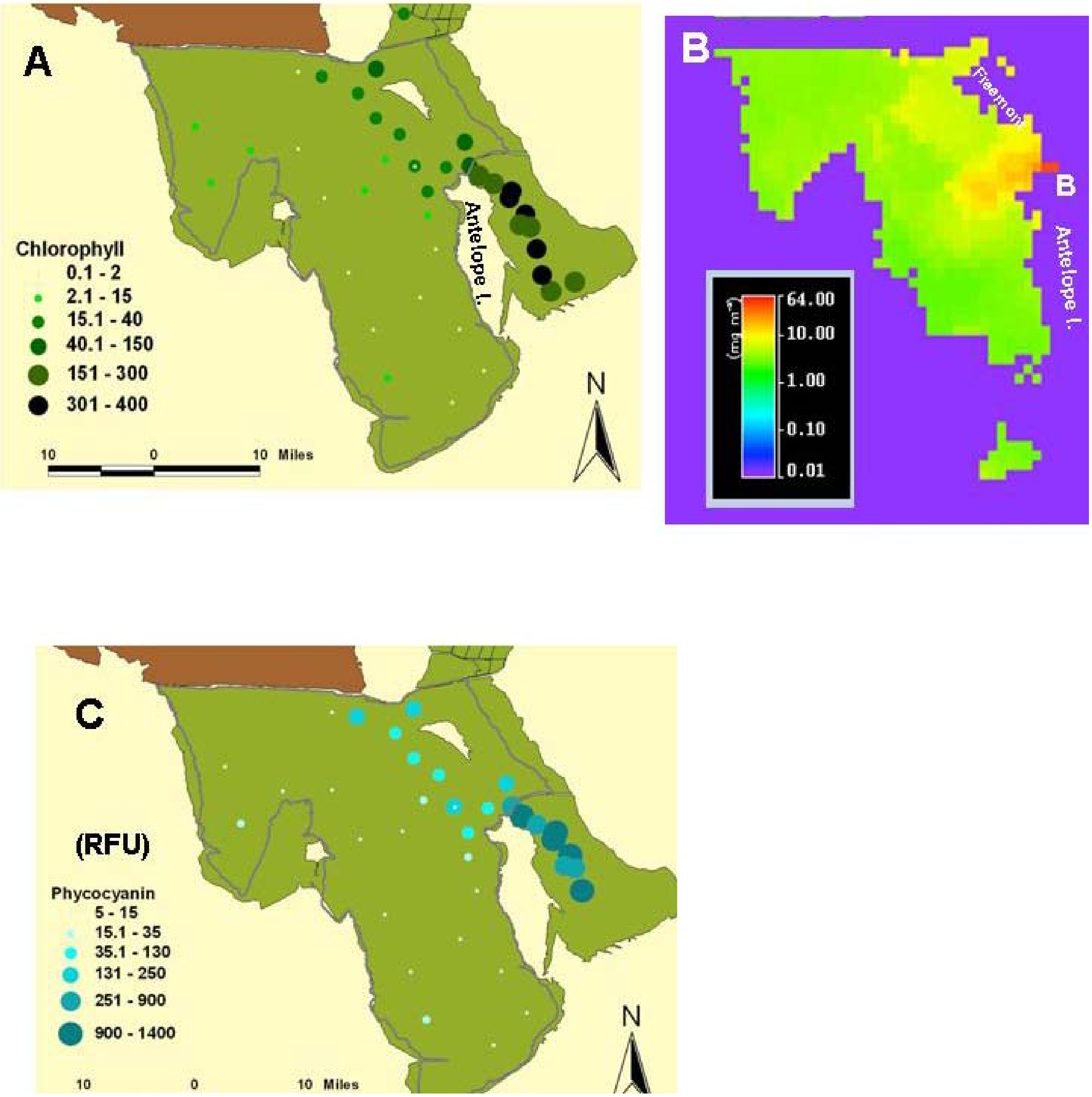


Figure 24. Spatial variation on plankton pigments during the June, 2005 synoptic of Farmington Bay, Bear River Bay (1 sta.), and Gilbert Bay. A. Chlorophyll *a* (extracted concentrations). B. Chlorophyll estimates in Gilbert Bay derived from MODIS satellite imagery (Terra) on June 2, 2005. A cloud covered parts of the southern part of Gilbert Bay, precluding measurements there. Spectra in Farmington and Ogden Bays could not be analyzed with the software C. Relative fluorescence units (RFU) of the cyanobacterial pigment, phycocyanin, at the synoptic stations.

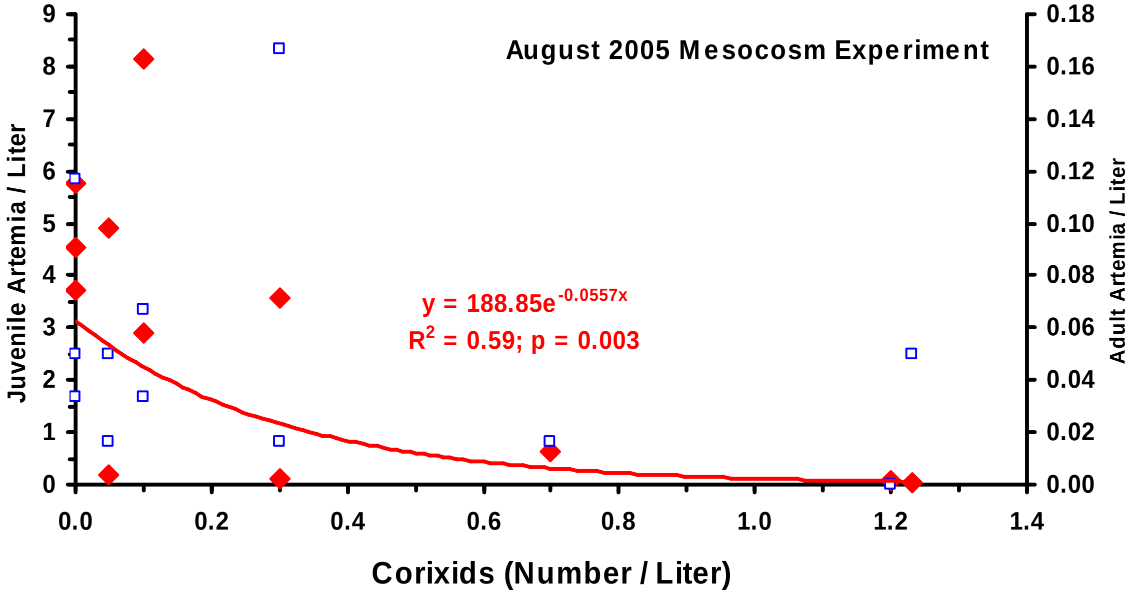
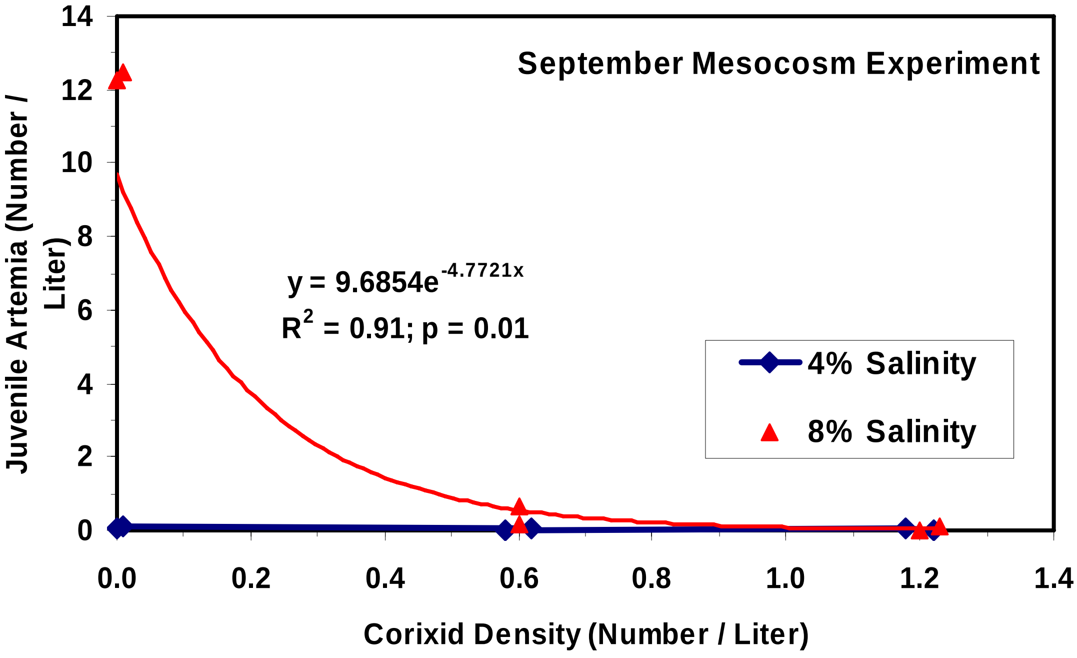


Figure 25. Densities of juvenile (solid dimonds) and adult *Artemia* at the end of a 15-day mesocosm experiment in August with different densities of corixid predators. Final adult densities were not significantly affected by corixids. Initial densities of *Artemia* nauplii in the experiment were 10/L, and these would have grown into the juvenile size class by the end of the experiment.



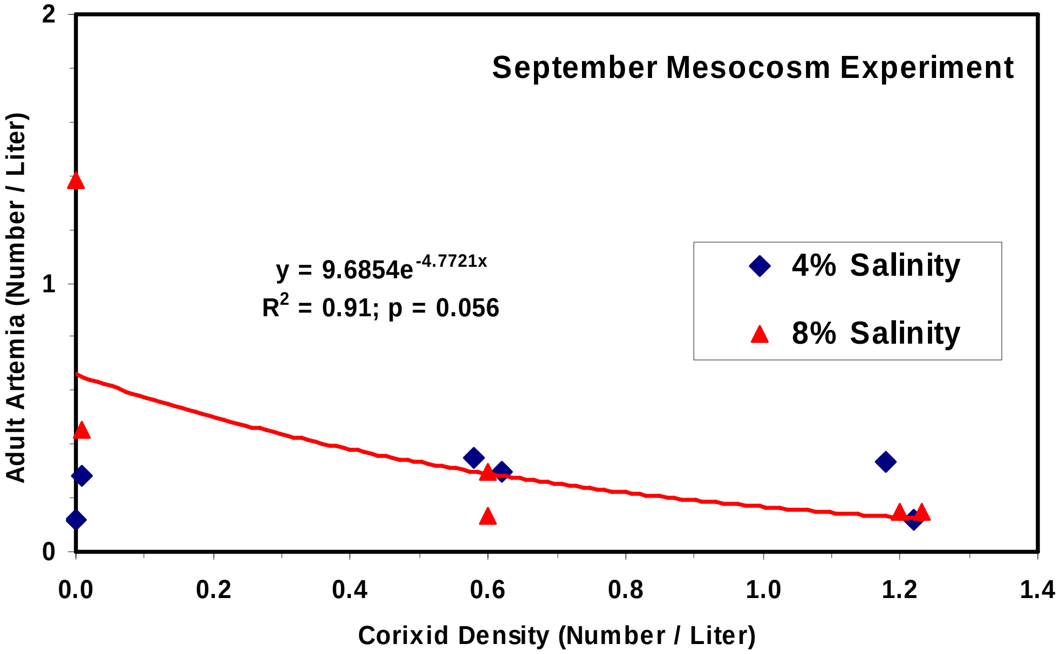


Figure 26. Final densities of juvenile (above) and adult (below) *Artemia* at three densities of corixid predators and two salinities (4%, 8"%) in the 16 day-long September mesocosm experiment. Initial nauplii densities were 10/L, and these would have grown to juvenile size during the experiment. Initial adult densities were 10/L.

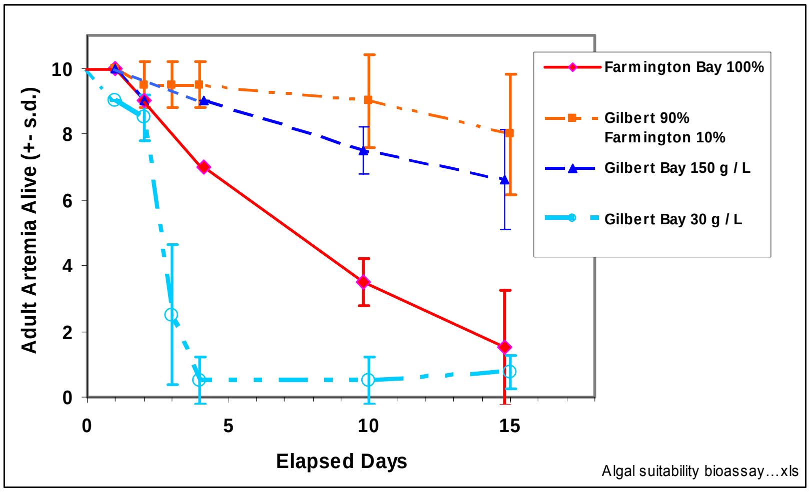


Figure 27. Influence of Farmington Bay and Gilbert Bay on adult *Artemia* survival in the Algal Suitability Bioassay Experiment. Treatments consisted of pure Farmington Bay water (Farmington 100%), 90% Gilbert Bay water mixed with 10% Farmington Bay water; 100% Gilbert Bay water, and Gilbert Bay water with its salinity reduced to 3% with deionized water.

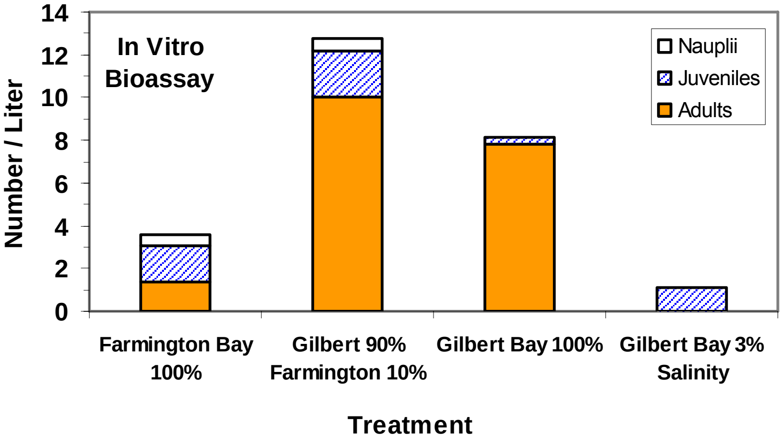


Figure 28. Influence of Farmington Bay and Gilbert Bay water on the survival and development of *Artemia* nauplii after a 15-day exposure. Treatments are as in Figure 27. Ten nauplii per liter were placed in the containers at the start of the experiment.

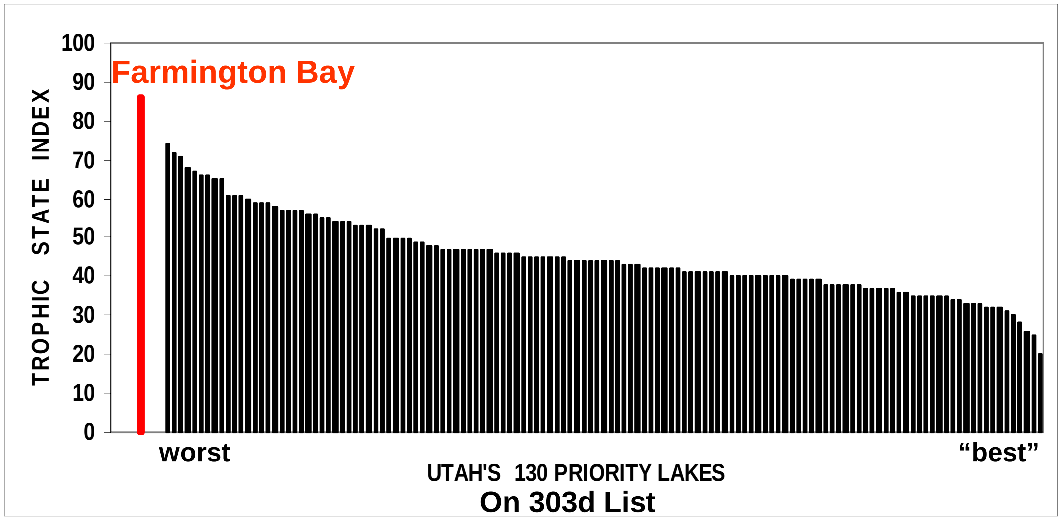


Figure 29. Trophic State Indices (Carlson 1977) from 130 lakes on the state of Utah's list of threatened or impaired waters (303d List). The higher the TSI, the more eutrophic the system. Although Farmington Bay is not on the list, it is clearly the most eutrophic water body in Utah with a TSI of 87 in 2005.

Appendix 1: Environmental characteristics collected during routine sampling. Measurements of temp, salinity, and chlorophyll *a* were made at 0.4m deep on all dates. Dashes indicate missing data.

Region	Date Sampled	Station	Temperature ºC	Salinity (%)	Secchi Depth (m)	Chlorophyll *a* (µg L^{-1})
Farmington	3-May-05	P1	18.7	1.4	0.33	178.75
Farmington	3-May-05	P2	18.9	1.4	0.33	150
Farmington	3-May-05	P4	18.7	0.6	0.28	52.5
Farmington	15-May-05	P1	15.2	1.1	0.23	263
Farmington	15-May-05	P2	19.7	–	0.09	511.5
Farmington	15-May-05	P4	19.4	–	0.25	151
Farmington	17-May-05	P1	13.1	1.5	0.15	433.5
Farmington	17-May-05	P2	13.1	1.0	0.19	288.5
Farmington	17-May-05	P3	14.4	1.3	0.18	400
Farmington	27-May-05	P1	21.8	–	0.35	122
Farmington	27-May-05	P4	22.0	–	0.27	275.5
Farmington	1-Jun-05	P1	18.9	1.4	0.25	233.0
Farmington	1-Jun-05	P3	20.7	–	0.27	186.0
Farmington	1-Jun-05	P4	20.2	–	0.24	303.0
Farmington	15-Jun-05	P1	21.3	1.5	0.39	37.3
Farmington	15-Jun-05	P2	23.4	1.5	0.475	37.75
Farmington	15-Jun-05	P4	22.7	0.9	0.3	169.5
Farmington	27-Jun-05	P1	21.3	1.4	0.25	176
Farmington	27-Jun-05	P2	23.6	–	0.29	169.5
Farmington	27-Jun-05	P4	21.5	1.5	0.31	282
Farmington	13-Jul-05	P1	27.6	2.3	0.195	132.5
Farmington	13-Jul-05	P2	28.4	2.1	0.33	82.8
Farmington	13-Jul-05	P4	29.9	1.8	0.22	125
Farmington	27-Jul-05	P1	25.0	2.9	0.31	119
Farmington	27-Jul-05	P2	25.3	3.4	0.24	135.5
Farmington	27-Jul-05	P4	25.0	2.6	0.39	143.5
Farmington	8-Aug-05	P3	28.3	–	0.12	290.0
Farmington	8-Aug-05	P4	25.9	–	0.16	283.0
Farmington	9-Aug-05	P1	27.1	–	0.17	179.0
Farmington	25-Aug-05	P1	22.6	–	0.16	327
Farmington	25-Aug-05	P2	23.1	–	0.08	600
Farmington	25-Aug-05	P3	22.8	–	0.1	486.5
Farmington	13-Sep-05	P1	15.8	4.6	0.22	274
Farmington	13-Sep-05	P2	15.8	4.5	0.23	295.5
Farmington	13-Sep-05	P3	17.2	4.0	0.23	373.5
Farmington	6-Oct-05	P1	12.9	5.1	0.27	283
Farmington	6-Oct-05	P2	11.3	5.0	0.26	337.5
Farmington	21-Oct-05	P1	16.1	4.4	0.65	54.05
Farmington	22-Oct-05	P2	15.1	4.1	0.59	41.2
Farmington	22-Oct-05	P3	15.7	3.8	0.45	59.8
Farmington	24-Oct-05	P4	16.1	1.0	0.75	88.1
Farmington	13-Nov-05	P1	7.4	3.0	0.34	356.5
Farmington	13-Nov-05	P2	7.2	2.7	0.33	379.5
Farmington	13-Nov-05	P3	7.8	2.8	–	613.5

Appendix 1 (con't)

Region	Date Sampled	Station	Temperature ºC	Salinity (%)	Secchi Depth (m)	Chlorophyll *a* (µg L^{-1})
Gilbert	3-May-05	P14	15.6	14.4	0.6	16.4
Gilbert	3-May-05	P15	18.0	15.2	0.45	32.175
Gilbert	3-May-05	P18	15.8	14.5	0.66	15.075
Gilbert	2-Jun-05	SW of P15	20.0	13.2	3	5.4
Gilbert	2-Jun-05	W of P18	21.8	–	2.55	3.3
Gilbert	27-Jun-05	P14	21.3	14.0	1	29.475
Gilbert	27-Jun-05	P15	20.9	13.8	1.2	19.825
Gilbert	27-Jun-05	P18	21.1	14.0	1.1	22.075
Gilbert	27-Jul-05	P14	26.0	14.6	1.66	15.9
Gilbert	27-Jul-05	P15	26.1	14.3	3.48	3.69
Gilbert	27-Jul-05	P18	25.9	–	3.23	5.38
Gilbert	8-Aug-05	P14	28.0	–	1.63	5.6
Gilbert	8-Aug-05	P15	26.4	–	4.65	1.5
Gilbert	8-Aug-05	P18	27.4	–	2.53	2.5
Gilbert	13-Sep-05	P14	15.5	14.5	0.66	26.6
Gilbert	13-Sep-05	P15	–	–	1.37	30.25
Gilbert	13-Sep-05	P18	19.4	–	0.82	14.6
Gilbert	21-Oct-05	P14	15.7	15.3	0.69	27.075
Gilbert	21-Oct-05	P15	14.9	15.0	1.4	12.35
Gilbert	21-Oct-05	P18	15.2	15.2	1.4	16.55
Gilbert	13-Nov-05	P18	9.8	15.2	2.42	5.6

Appendix 2: Water chemistry samples collected during the routine sampling. Dashes indicate missing data. Detection limit for nitrate-N was 0.005 mg L^{-1}.

Region	Date	Station	Ammonium-N (mg/L)	Nitrate-N (mg/L)	Phosphate-P (mg/L)	TN (mg/L)	TP (mg/L)
Farmington	3-May-05	P2	0.150	–	0.009	4.422	0.487
Farmington	3-May-05	P3	0.959	–	–	–	–
Farmington	3-May-05	P4	–	–	0.340	5.09	1.053
Farmington	17-May-05	P2	0.186	–	0.006	–	2.587
Farmington	17-May-05	P3	0.227	–	0.006	–	2.612
Farmington	1-Jun-05	P1	0.172	–	0.007	2.024	0.074
Farmington	1-Jun-05	P3	0.147	–	0.006	1.977	0.071
Farmington	1-Jun-05	P4	0.199	–	0.006	1.752	0.056
Farmington	15-Jun-05	P1	0.132	–	<0.006	3.295	0.151
Farmington	15-Jun-05	P2	0.137	–	<0.006	3.107	0.181
Farmington	15-Jun-05	P4	0.122	–	<0.006	4.097	0.386
Farmington	27-Jun-05	P1	0.135	<0.005	0.007	6.978	0.436
Farmington	27-Jun-05	P2	0.130	<0.005	–	6.063	0.484
Farmington	27-Jun-05	P4	0.127	<0.005	0.009	6.824	0.535
Farmington	13-Jul-05	P1	0.141	<0.005	0.013	6.525	0.385
Farmington	13-Jul-05	P2	0.140	<0.005	0.009	5.870	0.343
Farmington	13-Jul-05	P4	0.135	<0.005	0.011	6.886	0.460
Farmington	27-Jul-05	P1	0.153	<0.005	0.014	6.576	0.334
Farmington	27-Jul-05	P2	0.136	<0.005	0.011	7.395	0.341
Farmington	27-Jul-05	P4	0.154	<0.005	0.035	7.364	0.455
Farmington	8-Aug-05	P3	0.163	<0.005	0.012	7.454	0.473
Farmington	8-Aug-05	P4	0.184	<0.005	0.016	7.331	0.690
Farmington	9-Aug-05	P1	0.138	<0.005	0.009	7.529	0.395
Farmington	25-Aug-05	P1	0.193	<0.005	<0.006	7.385	0.518
Farmington	25-Aug-05	P2	0.235	<0.005	0.007	3.874	0.812
Farmington	25-Aug-05	P3	0.286	<0.005	0.006	4.913	0.750
Farmington	25-Aug-05	P4	–	–	<0.006	–	–
Farmington	12-Sep-05	P1	0.237	<0.005	0.009	6.634	0.674
Farmington	12-Sep-05	P2	0.198	<0.005	0.011	6.967	0.663
Farmington	12-Sep-05	P3	0.203	<0.005	0.013	6.987	0.742
Farmington	6-Oct-05	P1	0.141	<0.005	0.020	7.192	0.739
Farmington	6-Oct-05	P2	0.163	<0.005	0.008	6.446	0.897
Farmington	21-Oct-05	P1	0.130	–	0.012	6.602	0.368
Farmington	22-Oct-05	P2	0.129	<0.005	0.012	6.402	0.438
Farmington	22-Oct-05	P3	0.128	<0.005	0.016	6.517	0.409
Farmington	24-Oct-05	P4	0.173	<0.005	0.378	4.431	0.925
Farmington	13-Nov-05	P1	0.126	<0.005	0.006	6.780	0.525
Farmington	13-Nov-05	P2	0.135	<0.005	<0.006	6.438	0.504
Farmington	13-Nov-05	P3	0.130	<0.005	0.046	7.394	0.866

Appendix 2 (con't)

Region	Date	Station	Ammonium-N (mg/L)	Nitrate-N (mg/L)	Phosphate-P (mg/L)	TN (mg/L)	TP (mg/L)
Gilbert	3-May-05	P14	0.164	–	0.045	5.829	0.368
Gilbert	3-May-05	P15	0.269	–	0.076	6.057	0.432
Gilbert	3-May-05	P18	0.161	–	0.033	5.292	0.340
Gilbert	27-Jun-05	P14	0.336	<0.005	0.075	5.787	0.353
Gilbert	27-Jun-05	P15	0.513	<0.005	0.079	5.845	0.368
Gilbert	27-Jun-05	P18	0.486	<0.005	0.081	5.873	0.373
Gilbert	27-Jul-05	P14	0.242	<0.005	0.008	6.85	0.329
Gilbert	27-Jul-05	P15	0.545	<0.005	0.078	6.255	0.341
Gilbert	27-Jul-05	P18	0.458	<0.005	0.068	6.754	0.346
Gilbert	9-Aug-05	P14	0.320	<0.005	0.037	5.750	0.335
Gilbert	9-Aug-05	P15	0.591	<0.005	0.071	5.855	0.358
Gilbert	9-Aug-05	P18	0.480	<0.005	0.056	5.777	0.348
Gilbert	12-Sep-05	P14	0.318	<0.005	0.023	6.034	0.413
Gilbert	12-Sep-05	P15	0.469	<0.005	0.051	5.904	0.385
Gilbert	12-Sep-05	P18	0.344	<0.005	0.023	5.946	0.404
Gilbert	21-Oct-05	P14	0.427	–	0.019	6.044	0.247
Gilbert	21-Oct-05	P15	0.403	–	0.040	5.696	0.375
Gilbert	21-Oct-05	P18	0.426	–	0.019	5.896	0.343
Gilbert	13-Nov-05	P18	0.701	<0.005	0.056	5.913	0.391

Appendix 3: Hydrogen sulfide, oxygen, and salinity vertical profiles collected during routine sampling. Dashes indicate missing data

Bay	Date	Station	Depth (m)	Sulfide (mg L^{-1})	Temperature (C)	DO (mg L^{-1})	Salinity (%)
Farmington	3-May-05	P1	0.25	0.01	18.8	16	–
Farmington	3-May-05	P1	0.5	0.02	18.6	16	1.4
Farmington	3-May-05	P1	1	0.02	18.1	15.8	1.5
Farmington	3-May-05	P2	0.5	0.02	18.9	13.6	1.4
Farmington	3-May-05	P4	0.5	0.03	18.7	2.3	0.6
Farmington	15-May-05	P1	0.2	0.08	15.3	17.0	1.1
Farmington	15-May-05	P1	1.2	0.01	14.9	16.2	1.4
Farmington	15-May-05	P1	1.4	0.11	12.3	3.2	5.6
Farmington	15-May-05	P4	0.2	0.02	20.4	17.3	0.4
Farmington	15-May-05	P4	1.2	0.00	14.4	13.8	0.9
Farmington	17-May-05	P1	0.2	0.02	13.1	6.3	1.5
Farmington	17-May-05	P1	1.2	0.03	13.1	6.4	1.5
Farmington	17-May-05	P1	1.4	0.05	–	–	–
Farmington	17-May-05	P2	0.2	0.03	8.6	8.6	1
Farmington	17-May-05	P2	1.2	0.01	8.0	8.0	1.1
Farmington	17-May-05	P3	0.4	0.02	14.4	9.3	1.3
Farmington	1-Jun-05	P1	0.2	0.01	19.0	12.4	1.4
Farmington	1-Jun-05	P1	1.2	0.02	18.0	9.9	1.6
Farmington	1-Jun-05	P1	1.4	0.03	17.9	9.3	–
Farmington	1-Jun-05	P3	0.4	0.03	20.7	12.8	1.6
Farmington	1-Jun-05	P4	0.4	0.02	20.2	17.7	0.9
Farmington	15-Jun-05	P1	0.2	0.02	21.5	16.1	1.5
Farmington	15-Jun-05	P1	0.8	0.02	21.3	16.7	1.5
Farmington	15-Jun-05	P1	1.4	0.01	20.3	16.0	1.5
Farmington	15-Jun-05	P2	0.4	-0.08	23.4	17.7	1.5
Farmington	15-Jun-05	P4	0.4	0.01	22.7	22.2	0.9
Farmington	27-Jun-05	P1	0.2	0.01	22.5	12.7	1.4
Farmington	27-Jun-05	P1	0.8	0.01	20.6	9.5	1.4
Farmington	27-Jun-05	P1	1.2	-0.06	20.5	8.5	1.4
Farmington	27-Jun-05	P1	1.4	0.04	20.4	7.2	1.7
Farmington	27-Jun-05	P2	0.4	0.01	23.6	13.5	2
Farmington	27-Jun-05	P4	0.4	0.01	21.5	12.0	1.5
Farmington	13-Jul-05	P1	0.2	0.01	27.8	13.7	2.3
Farmington	13-Jul-05	P1	0.6	0.01	27.5	13.7	2.3
Farmington	13-Jul-05	P1	1	0.02	26.8	10.5	2.4
Farmington	13-Jul-05	P1	1.2	3.92	25.0	0.7	7.1
Farmington	13-Jul-05	P1	1.4	2.19	23.5	0.3	12
Farmington	13-Jul-05	P2	0.2	0.02	29.1	15.2	–
Farmington	13-Jul-05	P2	0.6	0.02	28.0	14.4	2.1
Farmington	13-Jul-05	P2	1	0.36	25.3	1.5	–
Farmington	13-Jul-05	P4	0.2	0.02	29.9	18.0	–
Farmington	13-Jul-05	P4	0.4	0.14	29.9	18.1	1.8
Farmington	13-Jul-05	P4	1	0.04	29.2	14.6	–

Appendix 3 (con't)

Bay	Date	Station	Depth (m)	Sulfide (mg L^{-1})	Temperature (C)	DO (mg L^{-1})	Salinity (%)
Farmington	27-Jul-05	P1	0.2	0.02	25.5	17.6	–
Farmington	27-Jul-05	P1	0.4	0.01	25.0	17.6	2.9
Farmington	27-Jul-05	P1	0.6	0.01	24.3	17.3	–
Farmington	27-Jul-05	P1	0.8	0.01	23.8	16.1	–
Farmington	27-Jul-05	P1	1	0.02	24.3	0.8	–
Farmington	27-Jul-05	P1	1.2	1.55	24.9	0.3	–
Farmington	27-Jul-05	P2	0.4	0.01	25.3	22.4	3.4
Farmington	27-Jul-05	P4	0.4	0.01	25.0	22.8	2.6
Farmington	8-Aug-05	P3	0.4	0.02	28.3	28.3	3.4
Farmington	8-Aug-05	P4	0.4	0.02	25.9	20.3	2.6
Farmington	9-Aug-05	P1	0.2	0.02	28.5	16.4	3.6
Farmington	9-Aug-05	P1	0.4	0.03	27.1	12.1	–
Farmington	9-Aug-05	P1	0.8	0.03	25.7	5.4	–
Farmington	9-Aug-05	P1	1	0.00	25.5	3.7	–
Farmington	9-Aug-05	P1	1.2	7.83	24.2	0.0	11.7
Farmington	25-Aug-05	P1	0.2	0.02	22.6	8.3	–
Farmington	25-Aug-05	P1	0.6	0.03	22.1	4.5	–
Farmington	25-Aug-05	P1	0.8	0.04	21.1	0.6	–
Farmington	25-Aug-05	P1	1	0.32	21.8	0.0	–
Farmington	25-Aug-05	P2	0.2	0.05	23.1	4.9	–
Farmington	25-Aug-05	P2	0.4	0.13	23.1	4.4	–
Farmington	25-Aug-05	P2	0.8	0.05	22.3	1.1	–
Farmington	25-Aug-05	P3	0.4	0.03	22.8	5.3	–
Farmington	10-Sep-05	P1	0.2	0.05	19.2	4.6	–
Farmington	10-Sep-05	P1	0.4	0.02	19.3	4.5	–
Farmington	10-Sep-05	P1	0.6	0.03	19.3	4.5	–
Farmington	10-Sep-05	P1	0.9	0.03	19.2	4.1	–
Farmington	13-Sep-05	P1	0.2	0.04	16.0	13.0	4.6
Farmington	13-Sep-05	P1	0.6	0.03	15.3	12.8	4.8
Farmington	13-Sep-05	P1	0.8	0.02	14.9	12.1	4.9
Farmington	13-Sep-05	P1	1	0.41	16.4	0.4	11.4
Farmington	13-Sep-05	P2	0.4	0.00	15.8	17.9	4.5
Farmington	13-Sep-05	P2	0.8	-0.02	15.2	0.7	–
Farmington	13-Sep-05	P3	0.4	0.07	17.2	20.0	4.0
Farmington	6-Oct-05	P1	0.2	0.01	13.6	18.7	–
Farmington	6-Oct-05	P1	0.6	0.02	9.9	17.6	5.1
Farmington	6-Oct-05	P1	1	2.82	11.3	0.2	11.5
Farmington	21-Oct-05	P1	0.2	0.00	16.1	9.7	–
Farmington	21-Oct-05	P1	0.6	0.00	16.1	9.7	4.4
Farmington	21-Oct-05	P1	1	7.66	17.0	3.7	–
Farmington	13-Nov-05	P1	0.2	0.01	7.4	19.4	–
Farmington	13-Nov-05	P1	0.6	0.01	7.4	21.6	3.0
Farmington	13-Nov-05	P1	1	0.03	7.4	22.0	–

Appendix 3 (con't)

Bay	Date	Station	Depth (m)	Sulfide (mg L^{-1})	Temperature (C)	DO (mg L^{-1})	Salinity (%)
Gilbert	3-May-05	P14A	0.5	-0.01	15.6	8.9	14.4
Gilbert	3-May-05	P15A	0.5	0.00	18.0	11.6	15.2
Gilbert	3-May-05	P18A	0.5	0.01	15.8	10.1	14.5
Gilbert	27-Jun-05	P14A	0.4	-0.01	21.3	11.2	14.0
Gilbert	27-Jun-05	P15A	0.4	0.00	20.9	8.8	13.8
Gilbert	27-Jun-05	P18A	0.4	0.00	21.1	8.9	14.0
Gilbert	27-Jul-05	P14A	0.4	0.02	26.0	13.3	14.6
Gilbert	27-Jul-05	P15A	0.4	0.01	26.1	3.4	14.3
Gilbert	27-Jul-05	P18A	0.4	0.00	25.9	5.3	–
Gilbert	9-Aug-05	P14A	0.4	0.01	28.0	10.7	14.2
Gilbert	9-Aug-05	P15A	0.4	0.00	26.4	3.7	14.2
Gilbert	9-Aug-05	P18A	0.4	0.00	27.5	5.5	14.1
Gilbert	13-Sep-05	P14A	0.4	-0.01	15.5	7.0	14.5
Gilbert	13-Sep-05	P15A	0.4	-0.01	19.9	4.1	14.8
Gilbert	13-Sep-05	P18A	0.4	0.00	18.8	7.5	14.8
Gilbert	21-Oct-05	P14A	0.4	-0.01	15.7	11.3	15.3
Gilbert	21-Oct-05	P15A	0.4	0.00	14.9	8.2	15.0
Gilbert	21-Oct-05	P18A	0.4	-0.01	15.2	9.8	15.2

Appendix 4: Algal Densities (cells/ml) collected during routine sampling. All data are results of single samples so variance estimates were not possible.

Date Sampled	**Region**	**Station**	***Carteria* sp.**	***Dunaliella salina***	***Dunaliella viridis***	***Oocystis* sp.**	***Pediastrum* sp.**	***Scenedesmus* sp.**	***Spermatozopsis* sp.**	**Chlorophyta Totals**
3-May-05	Farmington	1	4682	0	0	7491	0	22472	191945	226589
3-May-05	Farmington	2	0	0	0	7210	0	73407	392598	473214
3-May-05	Farmington	4	0	0	5012	1928	11759	109687	27759	156145
17-May-05	Farmington	1	6554	0	3745	16854	28090	58052	60861	174155
17-May-05	Farmington	2	0	0	0	4369	7282	83020	198083	292755
17-May-05	Farmington	3	4682	0	0	31835	0	159174	0	195690
1-Jun-05	Farmington	1	0	0	2979	103080	0	33069	28004	167133
1-Jun-05	Farmington	3	0	728	3277	97585	0	21847	37869	161307
1-Jun-05	Farmington	4	0	0	5098	167861	10924	11652	29494	225028
15-Jun-05	Farmington	1	0	205	1843	28265	0	1639	7783	39735
15-Jun-05	Farmington	2	0	0	0	76466	0	1456	0	77922
15-Jun-05	Farmington	4	0	0	4096	117976	0	2048	27036	151157
27-Jun-05	Farmington	1	0	0	2185	111422	0	4369	1639	119614
27-Jun-05	Farmington	2	0	0	1639	113606	0	6008	8739	129992
27-Jun-05	Farmington	4	0	0	0	208278	21119	26945	10924	267266
13-Jul-05	Farmington	1	0	0	4588	2622	0	0	0	7210
13-Jul-05	Farmington	2	0	0	4369	3641	0	1456	8011	17478
13-Jul-05	Farmington	4	0	0	21301	39325	0	3277	8193	72096
27-Jul-05	Farmington	1	0	0	3025	14117	0	0	0	17142
27-Jul-05	Farmington	2	0	0	0	40145	0	0	0	40145
27-Jul-05	Farmington	4	0	0	0	59807	0	19663	3277	82747
8-Aug-05	Farmington	3	0	0	6554	7491	0	0	1873	15917
8-Aug-05	Farmington	4	0	0	11470	7373	0	0	1639	20482
9-Aug-05	Farmington	1	0	0	1788	596	0	0	0	2383
25-Aug-05	Farmington	1	0	596	5958	1192	0	0	0	7746
25-Aug-05	Farmington	2	0	0	20482	3277	0	0	0	23759
25-Aug-05	Farmington	3	0	936	27153	0	0	0	0	28090
10-Sep-05	Farmington	1	0	1192	5958	7150	0	0	3575	17875
12-Sep-05	Farmington	2	0	3745	3745	6554	0	0	936	14981
13-Sep-05	Farmington	1	0	1788	0	14300	0	0	596	16683
13-Sep-05	Farmington	3	0	0	0	68000	0	7373	2458	77831
6-Oct-05	Farmington	2	0	6554	15293	3277	0	0	0	25124
20-Oct-05	Farmington	1	0	728	16750	8011	0	0	3641	29130
21-Oct-05	Farmington	1	0	0	1542	0	0	0	0	1542
22-Oct-05	Farmington	2	0	0	150419	2949	0	0	26545	179913
22-Oct-05	Farmington	3	0	262	2884	5506	0	0	11011	19663
13-Nov-05	Farmington	1	0	0	10768	3745	0	0	0	14513
13-Nov-05	Farmington	2	0	596	13704	5363	0	0	0	19663
13-Nov-05	Farmington	3	0	0	15293	224482	0	10924	43695	294394

Appendix 4 (con't)

Date Sampled	Region	Station	*Microcoleus* sp.	*Nodularia heterocyst*	*Nodularia* veg	*Pseudoanabaena* sp.	*Spirulina* sp.	Cyanophyta Totals	*Amphora coffeaeformis*	*Chaetocerous* sp.
3-May-05	Farmington	1	0	57115	651676	0	0	708792	0	0
3-May-05	Farmington	2	0	13108	161889	0	0	174998	0	0
3-May-05	Farmington	4	0	0	0	193	0	193	0	2120
17-May-05	Farmington	1	0	51497	831449	0	0	882947	0	0
17-May-05	Farmington	2	0	34956	433307	0	0	468262	0	0
17-May-05	Farmington	3	0	37453	585198	0	0	622651	0	0
1-Jun-05	Farmington	1	0	5958	109634	0	0	115593	0	16088
1-Jun-05	Farmington	3	0	10195	165676	0	0	175871	0	3277
1-Jun-05	Farmington	4	0	12380	144193	0	0	156573	0	4369
15-Jun-05	Farmington	1	0	10651	129036	0	0	139687	0	4711
15-Jun-05	Farmington	2	0	7100	78286	0	0	85387	0	0
15-Jun-05	Farmington	4	0	13108	155663	0	0	168771	0	9422
27-Jun-05	Farmington	1	0	4916	72096	0	0	77012	0	2731
27-Jun-05	Farmington	2	819	16386	238137	0	0	255341	0	1092
27-Jun-05	Farmington	4	1639	1456	21847	0	728	25671	0	0
13-Jul-05	Farmington	1	0	40636	559730	0	0	600366	0	7210
13-Jul-05	Farmington	2	0	47336	619009	0	0	666345	0	7282
13-Jul-05	Farmington	4	0	36048	406908	0	0	442956	0	5462
27-Jul-05	Farmington	1	0	34788	357457	0	504	392749	0	10083
27-Jul-05	Farmington	2	0	64723	728337	0	0	793060	0	6554
27-Jul-05	Farmington	4	0	44241	575952	1639	819	622651	0	0
8-Aug-05	Farmington	3	0	70224	896991	0	0	967215	0	10299
8-Aug-05	Farmington	4	0	54892	688193	0	0	743084	0	11470
9-Aug-05	Farmington	1	0	43496	582134	0	0	625630	0	2383
25-Aug-05	Farmington	1	32771	35154	409341	0	0	477266	596	17875
25-Aug-05	Farmington	2	9831	56530	734072	0	0	800434	0	18024
25-Aug-05	Farmington	3	8427	63670	730327	0	0	802423	936	29962
10-Sep-05	Farmington	1	2979	14896	246081	0	596	264552	0	59584
12-Sep-05	Farmington	2	11236	6086	154492	936	0	172750	468	48688
13-Sep-05	Farmington	1	11917	5958	359290	0	0	377165	0	10725
13-Sep-05	Farmington	3	7373	24578	559566	0	0	591518	0	1639
6-Oct-05	Farmington	2	0	13108	177510	0	273	190892	0	4369
20-Oct-05	Farmington	1	0	15293	184246	364	364	200268	0	9467
21-Oct-05	Farmington	1	0	10795	146506	0	0	157301	0	3470
22-Oct-05	Farmington	2	0	6554	91104	0	655	98313	0	655
22-Oct-05	Farmington	3	0	11535	170934	0	1049	183518	0	12846
13-Nov-05	Farmington	1	0	11236	146534	0	0	157769	0	31835
13-Nov-05	Farmington	2	0	11321	171005	0	0	182326	0	34559
13-Nov-05	Farmington	3	0	15293	224482	0	1639	241414	0	0

Appendix 4 (con’t)

Date Sampled	**Region**	**Station**	**"Clear oval diatom"**	***Cyclotella* sp.**	***Nitzschia palea***	***Navicula graciloides***	***Navicula tripuctata***	**Large *Navicula***	***Synedra* sp.**	**Diatom Totals**
3-May-05	Farmington	1	0	936	0	0	0	0	0	936
3-May-05	Farmington	2	0	655	0	655	0	0	0	1311
3-May-05	Farmington	4	193	0	0	0	0	0	0	2313
17-May-05	Farmington	1	0	936	0	0	0	0	0	936
17-May-05	Farmington	2	0	0	0	728	0	0	0	728
17-May-05	Farmington	3	0	0	0	0	0	0	0	0
1-Jun-05	Farmington	1	298	298	0	2681	0	0	596	19961
1-Jun-05	Farmington	3	728	364	0	2913	0	0	364	7647
1-Jun-05	Farmington	4	0	1092	0	1821	0	0	1456	8739
15-Jun-05	Farmington	1	0	0	0	0	0	0	5735	10446
15-Jun-05	Farmington	2	0	0	0	182	0	0	22029	22212
15-Jun-05	Farmington	4	0	819	0	5735	0	0	11470	27446
27-Jun-05	Farmington	1	0	2185	0	546	0	0	353382	358843
27-Jun-05	Farmington	2	2185	0	0	546	0	0	128900	132723
27-Jun-05	Farmington	4	728	2185	0	2185	0	0	388884	393981
13-Jul-05	Farmington	1	0	0	0	655	0	0	655	8520
13-Jul-05	Farmington	2	728	0	0	0	0	0	728	8739
13-Jul-05	Farmington	4	1639	1639	0	13655	0	546	0	22940
27-Jul-05	Farmington	1	0	1008	0	2521	0	1513	19663	34788
27-Jul-05	Farmington	2	0	819	0	819	0	0	2458	10651
27-Jul-05	Farmington	4	0	0	0	819	0	0	10651	11470
8-Aug-05	Farmington	3	936	0	0	1873	0	0	2809	15917
8-Aug-05	Farmington	4	1639	0	0	2458	0	0	819	16386
9-Aug-05	Farmington	1	1192	0	0	1192	0	0	1788	6554
25-Aug-05	Farmington	1	1788	596	0	10129	0	0	41709	72692
25-Aug-05	Farmington	2	0	0	0	1639	0	0	20482	40145
25-Aug-05	Farmington	3	0	936	0	2809	0	0	10299	44943
10-Sep-05	Farmington	1	1192	596	0	2383	0	0	9533	73288
12-Sep-05	Farmington	2	0	2341	468	2809	0	0	26217	80991
13-Sep-05	Farmington	1	596	0	0	1788	0	0	0	13108
13-Sep-05	Farmington	3	0	0	0	3277	0	0	33590	38506
2-Oct-05	Farmington	Causeway	0	252	0	1513	0	252	31259	39829
6-Oct-05	Farmington	2	0	15839	0	0	0	0	24032	44241
20-Oct-05	Farmington	1	0	21483	0	0	0	0	44059	75009
21-Oct-05	Farmington	1	0	1542	0	0	0	0	12337	17349
22-Oct-05	Farmington	2	0	1639	0	0	328	1311	17041	20973
22-Oct-05	Farmington	3	0	1311	0	524	262	0	9438	24382
13-Nov-05	Farmington	1	0	468	0	0	0	0	468	32771
13-Nov-05	Farmington	2	0	9235	0	0	0	0	298	44092
13-Nov-05	Farmington	3	0	0	0	546	0	0	0	546

Appendix 4 (con't)

Date Sampled	Region	Station	*Euplotes* sp.	Unknown ciliates	Protozoa Totals	"Chrysophytes"	*Cryptomonas* sp.	*Glenodinium* sp.	Pyrrophyta Totals	ALL TAXA
3-May-05	Farmington	1	0	0	0	0	0	0	0	936317
3-May-05	Farmington	2	0	0	0	3933	0	0	3933	653456
3-May-05	Farmington	4	193	0	193	27373	8482	1542	37398	196242
17-May-05	Farmington	1	936	0	936	11236	0	0	11236	1070210
17-May-05	Farmington	2	728	0	728	30586	0	728	31315	793788
17-May-05	Farmington	3	2809	0	2809	12172	0	0	12172	833322
1-Jun-05	Farmington	1	0	0	0	16683	0	12513	29196	331883
1-Jun-05	Farmington	3	0	0	0	9467	12380	3641	25489	370314
1-Jun-05	Farmington	4	364	0	364	17478	0	4005	21483	412187
15-Jun-05	Farmington	1	0	0	0	11470	19048	2867	33386	223254
15-Jun-05	Farmington	2	0	0	0	2913	0	0	2913	188434
15-Jun-05	Farmington	4	0	0	0	57759	37277	4916	99952	447326
27-Jun-05	Farmington	1	546	0	546	18570	10378	1639	30586	586601
27-Jun-05	Farmington	2	0	0	0	36048	5462	12016	53526	571582
27-Jun-05	Farmington	4	0	0	0	74281	0	0	74281	761199
13-Jul-05	Farmington	1	0	0	0	12453	28183	1311	41947	658043
13-Jul-05	Farmington	2	0	0	0	40782	27673	728	69183	761745
13-Jul-05	Farmington	4	0	0	0	26217	22940	3277	52434	590426
27-Jul-05	Farmington	1	0	1008	1008	0	39829	4538	44367	490054
27-Jul-05	Farmington	2	0	0	0	2458	0	0	2458	846314
27-Jul-05	Farmington	4	0	0	0	24578	85205	0	109783	826651
8-Aug-05	Farmington	3	936	0	936	5618	39325	936	45880	1045865
8-Aug-05	Farmington	4	1639	819	2458	4916	47518	3277	55711	838121
9-Aug-05	Farmington	1	0	0	0	2383	10725	1788	14896	649463
25-Aug-05	Farmington	1	1192	0	1192	4171	70905	1788	76863	635759
25-Aug-05	Farmington	2	819	0	819	13928	72916	819	87663	952820
25-Aug-05	Farmington	3	1873	0	1873	15917	119849	936	136702	1014031
10-Sep-05	Farmington	1	1192	0	1192	15492	237143	1192	253827	610734
12-Sep-05	Farmington	2	468	0	468	2341	193818	1873	198031	467221
13-Sep-05	Farmington	1	596	0	596	0	150747	0	150747	558299
13-Sep-05	Farmington	3	1639	0	1639	0	149108	0	149108	858602
2-Oct-05	Farmington	Causeway	0	10588	10588	0	25713	252	25965	254858
6-Oct-05	Farmington	2	0	0	0	3277	18024	273	21574	281831
20-Oct-05	Farmington	1	364	0	364	35320	38597	364	74281	379052
21-Oct-05	Farmington	1	0	3470	3470	3470	13880	0	17349	197011
22-Oct-05	Farmington	2	0	0	0	28183	0	1966	30149	329348
22-Oct-05	Farmington	3	0	0	0	17827	12322	1835	31985	259548
13-Nov-05	Farmington	1	0	0	0	0	49157	3745	52902	257955
13-Nov-05	Farmington	2	0	0	0	3575	36346	596	40517	286598
13-Nov-05	Farmington	3	0	0	0	3823	3277	0	7100	543454

Appendix 4 (con't)

Date Sampled	**Region**	**Station**	***Carteria* sp.**	***Dunaliella salina***	***Dunaliella viridis***	***Oocystis* sp.**	***Pediastrum* sp.**	**Scene-*desmus* sp.**	**Spermato-*zopsis* sp..**	**Chlorophyta Totals**
3-May-05	Gilbert	14	0	0	43845	4960	0	0	0	48805
3-May-05	Gilbert	15	0	66	53897	5753	0	0	0	59716
3-May-05	Gilbert	18	0	0	55380	113	0	0	0	55494
27-Jun-05	Gilbert	14	0	0	45971	1701	0	0	0	47671
27-Jun-05	Gilbert	15	0	0	55720	2324	0	0	0	58044
27-Jun-05	Gilbert	18	0	99	49102	2182	0	0	0	51384
27-Jul-05	Gilbert	14	0	0	51186	680	0	0	0	51866
27-Jul-05	Gilbert	15	0	13	9932	77	0	0	691	10713
9-Aug-05	Gilbert	14	0	0	15781	667	0	0	0	16449
9-Aug-05	Gilbert	18	0	0	10639	794	0	0	0	11432
13-Sep-05	Gilbert	14	0	159	71342	2778	0	0	0	74279
13-Sep-05	Gilbert	15	0	0	43696	1637	0	0	0	45333
13-Sep-05	Gilbert	18	0	0	30275	2579	0	0	0	32854
21-Oct-05	Gilbert	14	0	0	98701	2976	0	0	0	101677
21-Oct-05	Gilbert	15	0	0	52829	1360	0	0	0	54190
21-Oct-05	Gilbert	18	0	113	55494	1304	0	0	0	56911
13-Nov-05	Gilbert	18	0	25	23559	670	0	0	0	24254

Date Sampled	**Region**	**Station**	***Microcoleus* sp.**	***Nodularia* heterocyst**	***Nodularia* veg**	***Pseudoanabaena* sp.**	***Spirulina* sp.**	**Cyanophyta Totals**	***Amphora coffeaeformis***	***Chaetocerous* sp.**
3-May-05	Gilbert	14	0	0	0	0	0	0	0	0
3-May-05	Gilbert	15	0	0	0	0	0	0	0	0
3-May-05	Gilbert	18	0	0	0	0	0	0	0	0
27-Jun-05	Gilbert	14	0	0	0	0	0	0	0	0
27-Jun-05	Gilbert	15	0	0	0	0	0	0	0	0
27-Jun-05	Gilbert	18	0	0	0	0	0	0	0	0
27-Jul-05	Gilbert	14	0	0	0	0	0	0	57	0
27-Jul-05	Gilbert	15	0	230	1933	0	0	2163	0	0
9-Aug-05	Gilbert	14	0	0	0	0	0	0	0	0
9-Aug-05	Gilbert	18	0	0	0	0	0	0	0	0
13-Sep-05	Gilbert	14	238	159	2222	0	0	2619	79	0
13-Sep-05	Gilbert	15	0	99	694	0	0	794	0	0
13-Sep-05	Gilbert	18	0	317	3214	0	0	3531	0	0
21-Oct-05	Gilbert	14	0	0	0	0	0	0	0	0
21-Oct-05	Gilbert	15	0	0	0	0	0	0	0	0
21-Oct-05	Gilbert	18	0	0	0	0	0	0	0	0
13-Nov-05	Gilbert	18	0	0	0	0	0	0	0	0

Appendix 4 (con’t)

Date Sampled	**Region**	**Station**	**"Clear oval diatom"**	***Cyclotella* *sp.***	***Nitzschia palea***	***Navicula graciloides***	***Navicula tripuctata***	**Large *Navicula***	***Synedra sp.***	**Diatom Totals**
3-May-05	Gilbert	14	66	0	0	0	727	0	0	794
3-May-05	Gilbert	15	0	0	0	0	132	0	0	132
3-May-05	Gilbert	18	113	0	0	0	0	0	0	113
27-Jun-05	Gilbert	14	113	0	0	0	113	0	0	227
27-Jun-05	Gilbert	15	0	0	0	0	113	0	0	113
27-Jun-05	Gilbert	18	50	99	0	0	248	0	0	397
27-Jul-05	Gilbert	14	57	0	0	0	113	0	0	227
27-Jul-05	Gilbert	15	0	0	0	0	0	0	0	0
9-Aug-05	Gilbert	14	36	0	0	36	18	0	0	90
9-Aug-05	Gilbert	18	12	0	0	0	25	0	0	37
13-Sep-05	Gilbert	14	317	0	0	0	79	0	0	476
13-Sep-05	Gilbert	15	0	99	0	0	50	0	0	149
13-Sep-05	Gilbert	18	0	0	0	0	40	0	0	40
21-Oct-05	Gilbert	14	0	99	0	0	198	0	0	298
21-Oct-05	Gilbert	15	0	0	0	0	0	0	0	0
21-Oct-05	Gilbert	18	57	0	0	0	0	0	0	57
13-Nov-05	Gilbert	18	0	0	0	0	0	0	0	0

Date Sampled	**Region**	**Station**	***Euplotes sp.***	**Unknown ciliates**	**Protozoa Totals**	**"Chrysophytes"**	***Cryptomonas sp.***	***Glenodinium sp.***	**Pyrrophyta Totals**	**ALL TAXA**
3-May-05	Gilbert	14	0	0	0	18847	198	0	19046	68645
3-May-05	Gilbert	15	0	0	0	20170	529	0	20699	80547
3-May-05	Gilbert	18	0	0	0	9183	113	0	9296	64903
27-Jun-05	Gilbert	14	0	0	0	13094	1077	0	14171	62069
27-Jun-05	Gilbert	15	0	0	0	1077	340	0	1417	59574
27-Jun-05	Gilbert	18	0	0	0	3521	149	0	3670	55451
27-Jul-05	Gilbert	14	0	0	0	10146	170	0	10316	62409
27-Jul-05	Gilbert	15	0	0	0	0	0	0	0	12876
9-Aug-05	Gilbert	14	0	0	0	433	126	0	559	17098
9-Aug-05	Gilbert	18	0	0	0	298	0	0	298	11767
13-Sep-05	Gilbert	14	0	0	0	0	397	0	397	77771
13-Sep-05	Gilbert	15	0	0	0	2778	248	0	3026	49302
13-Sep-05	Gilbert	18	0	0	0	4801	238	0	5039	41464
21-Oct-05	Gilbert	14	0	0	0	4960	2083	0	7043	109018
21-Oct-05	Gilbert	15	0	0	0	510	453	0	964	55154
21-Oct-05	Gilbert	18	0	0	0	737	283	0	1020	57988
13-Nov-05	Gilbert	18	0	0	0	198	99	0	298	24552

Appendix 5: Algal Biovolumes (µm^3 mL^{-1}) collected during routine sampling. All data are results of single samples so variance estimates were not possible.

Date Sampled	Region	Station	*Carteria* sp.	*Dunaliella salina*	*Dunaliella viridis*	*Oocystis* sp.	*Pediastrum* sp.	*Scenedesmus* sp.	*Spermatozopsis* sp.	Chlorophyta Totals
3-May-05	Farmington	1	5144747	0	0	546039	0	1731283	397413	7819482
3-May-05	Farmington	2	0	0	0	1061491	0	3630133	1320889	6012514
3-May-05	Farmington	4	0	0	59070	652107	1018341	6524795	48632	8302945
17-May-05	Farmington	1	1565549	0	29685	966318	2516452	3124284	124624	8326912
17-May-05	Farmington	2	0	0	0	0	3299581	4400364	410122	8110067
17-May-05	Farmington	3	2241857	0	0	1379902	0	7568646	0	11190404
1-Jun-05	Farmington	1	0	0	18220	14570174	0	2457258	55752	17101403
1-Jun-05	Farmington	3	0	326207	20942	17395317	0	2004214	66343	19813023
1-Jun-05	Farmington	4	0	0	35196	29350256	675535	868827	56369	30986183
15-Jun-05	Farmington	1	0	0	7442	3690216	0	144497	13016	3855171
15-Jun-05	Farmington	2	0	0	0	6293752	0	65241	0	6358993
15-Jun-05	Farmington	4	0	0	17902	14670057	0	201400	47365	14936724
27-Jun-05	Farmington	1	0	0	22617	15595686	0	319683	2610	15940596
27-Jun-05	Farmington	2	0	0	17398	17188922	0	607959	16006	17830285
27-Jun-05	Farmington	4	0	0	0	33464394	1565734	1837621	21747	36889497
13-Jul-05	Farmington	1	0	0	45930	71765	0	0	0	117695
13-Jul-05	Farmington	2	0	0	44074	454033	0	148460	13396	659964
13-Jul-05	Farmington	4	0	0	208201	3506984	0	140921	15658	3871764
27-Jul-05	Farmington	1	0	0	32119	1107005	0	0	0	1139124
27-Jul-05	Farmington	2	0	0	0	2249261	0	0	0	2249261
27-Jul-05	Farmington	4	0	0	0	3330237	0	2455180	6524	5791941
8-Aug-05	Farmington	3	0	0	65614	629969	0	0	2982	698566
8-Aug-05	Farmington	4	0	0	82862	521931	0	0	2610	607402
9-Aug-05	Farmington	1	0	0	20877	45550	0	0	0	66428
25-Aug-05	Farmington	1	0	0	58418	91101	0	0	0	149519
25-Aug-05	Farmington	2	0	0	194305	208772	0	0	0	403077
25-Aug-05	Farmington	3	0	0	265399	0	0	0	0	265399
10-Sep-05	Farmington	1	0	0	49194	456393	0	0	5694	511281
12-Sep-05	Farmington	2	0	2625964	13980	467809	0	0	1491	3109245
13-Sep-05	Farmington	1	0	5205390	83701	772852	0	0	949	6062892
13-Sep-05	Farmington	3	0	0	160755	5576378	0	463939	5219	6206291
6-Oct-05	Farmington	2	0	2232653	160755	293093	0	0	0	2686500
20-Oct-05	Farmington	1	0	312579	181400	487776	0	0	5799	987553
21-Oct-05	Farmington	1	0	0	15965	139429	0	0	0	155394
22-Oct-05	Farmington	2	0	0	1073257	420885	0	0	46504	1540646
22-Oct-05	Farmington	3	0	2526145	38581	377042	0	0	20167	2961936
13-Nov-05	Farmington	1	0	0	137193	555735	0	0	0	692928
13-Nov-05	Farmington	2	0	513865	141827	10334390	0	0	0	10990081
13-Nov-05	Farmington	3	0	0	175369	503582	0	561180	129124	1369254

Appendix 5 (con't)

Date Sampled	Region	Station	*Microcoleus* sp.	*Nodularia* heterocyst	*Nodularia* veg	*Pseudoanabaena* sp.	*Spirulina* sp.	Cyanophyta Totals	*Amphora coffeaeformis*	*Chaetocerous* sp.
3-May-05	Farmington	1	0	3476686	111000000	0	0	114000000	0	0
3-May-05	Farmington	2	0	2170564	12969299	0	0	15139864	0	0
3-May-05	Farmington	4	0	0	0	20724	0	20724	0	17311
17-May-05	Farmington	1	0	9616555	78658257	0	0	88274812	0	0
17-May-05	Farmington	2	0	5895898	29053397	0	0	34949295	0	0
17-May-05	Farmington	3	0	4960833	30581885	0	0	35542718	0	0
1-Jun-05	Farmington	1	0	429169	4827606	0	0	5256775	0	345898
1-Jun-05	Farmington	3	0	789159	6513244	0	0	7302404	0	55866
1-Jun-05	Farmington	4	0	1844394	6195716	0	0	8040110	0	89250
15-Jun-05	Farmington	1	0	1007826	8458802	0	0	9466628	0	50995
15-Jun-05	Farmington	2	0	610659	5385485	0	0	5996144	0	0
15-Jun-05	Farmington	4	0	1186495	12048773	0	0	13235268	0	133947
27-Jun-05	Farmington	1	0	302043	2976258	0	0	3278302	0	16963
27-Jun-05	Farmington	2	0	1215446	14495689	0	0	15711136	0	31679
27-Jun-05	Farmington	4	0	86119	1315266	0	8699	1410083	0	0
13-Jul-05	Farmington	1	0	3405196	35644051	0	0	39049247	0	266429
13-Jul-05	Farmington	2	0	3937168	40578382	0	0	44515550	0	211191
13-Jul-05	Farmington	4	0	2596475	29893901	0	0	32490377	0	200040
27-Jul-05	Farmington	1	0	2247890	19298622	0	156579	21703092	0	0
27-Jul-05	Farmington	2	548027	3031210	28274787	0	0	31854024	0	190072
27-Jul-05	Farmington	4	1417042	3665364	23218990	132114	63610	28497120	0	0
8-Aug-05	Farmington	3	0	5662017	42188321	0	0	47850339	0	337381
8-Aug-05	Farmington	4	0	3835702	31161932	0	0	34997635	0	312951
9-Aug-05	Farmington	1	0	3564586	25206590	0	0	28771176	0	71417
25-Aug-05	Farmington	1	2916289	2532100	23767090	0	0	29215479	1793544	432372
25-Aug-05	Farmington	2	893089	4010973	32881642	0	0	37785704	0	522699
25-Aug-05	Farmington	3	715791	5451463	47875671	0	0	54042925	279606	854972
10-Sep-05	Farmington	1	178643	1196942	14518381	0	93948	15987913	0	1569351
12-Sep-05	Farmington	2	743528	363284	9847230	44737	0	10998778	369918	1411966
13-Sep-05	Farmington	1	4611971	262448	20573098	0	0	25447516	0	340620
13-Sep-05	Farmington	3	2086418	1221135	33133809	0	0	36441362	0	35230
6-Oct-05	Farmington	2	0	958265	10820115	0	260965	12039346	0	126715
20-Oct-05	Farmington	1	0	1404405	10414225	28271	215296	12062197	0	279158
21-Oct-05	Farmington	1	0	823975	6652813	0	0	7476788	0	100618
22-Oct-05	Farmington	2	0	575429	3338894	0	81421	3995744	0	4697
22-Oct-05	Farmington	3	0	873945	8281514	0	134560	9290020	0	234591
13-Nov-05	Farmington	1	0	962023	6862703	0	0	7824726	0	749139
13-Nov-05	Farmington	2	0	1514548	10729619	0	0	12244167	0	1163064
13-Nov-05	Farmington	3	0	3929559	32820576	0	412325	37162461	0	0

Appendix 5 (con’t)

Date Sampled	Region	Station	"Clear oval diatom"	*Cyclotella* sp.	*Nitzschia palea*	*Navicula graciloides*	*Navicula tripuctata*	Large Navicula	*Synedra* sp.	Diatom Totals
3-May-05	Farmington	1	0	407665	0	0	0	0	0	407665
3-May-05	Farmington	2	0	391448	0	0	0	146793	0	538241
3-May-05	Farmington	4	62056	0	0	0	0	0	0	79367
17-May-05	Farmington	1	0	559212	0	0	0	0	0	559212
17-May-05	Farmington	2	0	0	0	0	0	852487	0	852487
17-May-05	Farmington	3	0	0	0	0	0	0	0	0
1-Jun-05	Farmington	1	130779	1037693	0	0	0	65819	95150	1675340
1-Jun-05	Farmington	3	192951	217471	0	0	0	52423	15229	533940
1-Jun-05	Farmington	4	0	949721	0	0	0	46104	265817	1350892
15-Jun-05	Farmington	1	0	0	0	0	0	0	941990	992985
15-Jun-05	Farmington	2	0	0	0	0	0	1087	4174604	4175691
15-Jun-05	Farmington	4	0	744180	0	0	0	123306	1901424	2902856
27-Jun-05	Farmington	1	0	2398619	0	0	0	244655	62881548	65541785
27-Jun-05	Farmington	2	409838	0	0	0	0	281843	22740660	23464020
27-Jun-05	Farmington	4	361872	1060873	0	0	0	432961	69198860	71054565
13-Jul-05	Farmington	1	0	0	0	0	0	14092	109650	390171
13-Jul-05	Farmington	2	493225	0	0	0	0	0	110757	815173
13-Jul-05	Farmington	4	287642	883984	0	0	244655	224593	0	1840914
27-Jul-05	Farmington	1	0	439024	0	0	1084010	57814	3696188	5277036
27-Jul-05	Farmington	2	0	250527	0	0	0	101777	431122	973498
27-Jul-05	Farmington	4	0	0	0	0	0	244655	1846599	2091254
8-Aug-05	Farmington	3	111842	0	0	0	0	838817	469927	1757968
8-Aug-05	Farmington	4	89911	0	0	0	0	1382682	149522	1935065
9-Aug-05	Farmington	1	69749	0	0	0	0	533793	317168	992127
25-Aug-05	Farmington	1	303669	259423	0	0	0	4657603	8119507	15566119
25-Aug-05	Farmington	2	0	0	0	0	0	227774	3146196	3896668
25-Aug-05	Farmington	3	0	286316	0	0	0	1096055	1738729	4255679
10-Sep-05	Farmington	1	144124	355862	0	0	0	1270249	1754393	5093980
12-Sep-05	Farmington	2	0	4718348	753841	0	0	1119588	4752811	13126472
13-Sep-05	Farmington	1	39857	0	0	0	0	344474	0	724951
13-Sep-05	Farmington	3	0	0	0	0	0	733231	5915845	6684306
2-Oct-05	Farmington	Causeway	0	77085	0	0	327612	51595	5582599	6228964
6-Oct-05	Farmington	2	0	31927487	0	0	0	0	4188614	36242817
20-Oct-05	Farmington	1	0	73061678	0	0	0	0	8148183	81489019
21-Oct-05	Farmington	1	0	4367301	0	0	0	0	2397984	6865903
22-Oct-05	Farmington	2	0	4160632	0	146793	8028332	0	3077665	15418119
22-Oct-05	Farmington	3	0	5541252	0	230171	0	135284	2052640	8193939
13-Nov-05	Farmington	1	0	1145265	0	0	0	0	89001	1983406
13-Nov-05	Farmington	2	0	31108082	0	0	0	0	45310	32316455
13-Nov-05	Farmington	3	0	0	0	0	0	114825	0	114825

Appendix 5 (con't)

Date Sampled	Region	Station	*Euplotes* sp.	Unknown ciliates	Protozoa Totals	"Chrysophytes"	*Cryptomonas* sp.	*Glenodinium* sp.	Pyrrophyta Totals	ALL TAXA
3-May-05	Farmington	1	0	546039	0	1731283	397413	7819482	0	122530187
3-May-05	Farmington	2	0	1061491	0	3630133	1320889	6012514	0	21715672
3-May-05	Farmington	4	59070	652107	1018341	6524795	48632	8302945	0	9990588
17-May-05	Farmington	1	29685	966318	2516452	3124284	124624	8326912	0	104415142
17-May-05	Farmington	2	0	0	3299581	4400364	410122	8110067	0	51455489
17-May-05	Farmington	3	0	1379902	0	7568646	0	11190404	0	70695215
1-Jun-05	Farmington	1	18220	14570174	0	2457258	55752	17101403	0	26956265
1-Jun-05	Farmington	3	20942	17395317	0	2004214	66343	19813023	0	28585038
1-Jun-05	Farmington	4	35196	29350256	675535	868827	56369	30986183	0	42938695
15-Jun-05	Farmington	1	7442	3690216	0	144497	13016	3855171	0	14963518
15-Jun-05	Farmington	2	0	6293752	0	65241	0	6358993	0	16546739
15-Jun-05	Farmington	4	17902	14670057	0	201400	47365	14936724	0	32764309
27-Jun-05	Farmington	1	22617	15595686	0	319683	2610	15940596	0	91072657
27-Jun-05	Farmington	2	17398	17188922	0	607959	16006	17830285	0	59229706
27-Jun-05	Farmington	4	0	33464394	1565734	1837621	21747	36889497	0	109699120
13-Jul-05	Farmington	1	45930	71765	0	0	0	117695	0	39903737
13-Jul-05	Farmington	2	44074	454033	0	148460	13396	659964	0	47129459
13-Jul-05	Farmington	4	208201	3506984	0	140921	15658	3871764	0	39506896
27-Jul-05	Farmington	1	32119	1107005	0	0	0	1139124	0	30880547
27-Jul-05	Farmington	2	0	2249261	0	0	0	2249261	548027	35173268
27-Jul-05	Farmington	4	0	3330237	0	2455180	6524	5791941	1417042	39300416
8-Aug-05	Farmington	3	65614	629969	0	0	2982	698566	0	56873583
8-Aug-05	Farmington	4	82862	521931	0	0	2610	607402	0	43508311
9-Aug-05	Farmington	1	20877	45550	0	0	0	66428	0	30333448
25-Aug-05	Farmington	1	58418	91101	0	0	0	149519	2916289	48219174
25-Aug-05	Farmington	2	194305	208772	0	0	0	403077	893089	45331488
25-Aug-05	Farmington	3	265399	0	0	0	0	265399	715791	63432528
10-Sep-05	Farmington	1	49194	456393	0	0	5694	511281	178643	27869210
12-Sep-05	Farmington	2	13980	467809	0	0	1491	3109245	743528	36084443
13-Sep-05	Farmington	1	83701	772852	0	0	949	6062892	4611971	39735311
13-Sep-05	Farmington	3	160755	5576378	0	463939	5219	6206291	2086418	61069596
2-Oct-05	Farmington	Causeway	83701	32520	0	0	0	116221	15959	31421681
6-Oct-05	Farmington	2	160755	293093	0	0	0	2686500	0	51565373
20-Oct-05	Farmington	1	181400	487776	0	0	5799	987553	0	98088252
21-Oct-05	Farmington	1	15965	139429	0	0	0	155394	0	20592362
22-Oct-05	Farmington	2	1073257	420885	0	0	46504	1540646	0	21627096
22-Oct-05	Farmington	3	38581	377042	0	0	20167	2961936	0	21098446
13-Nov-05	Farmington	1	137193	555735	0	0	0	692928	0	20455268
13-Nov-05	Farmington	2	141827	10334390	0	0	0	10990081	0	56313236
13-Nov-05	Farmington	3	175369	503582	0	561180	129124	1369254	0	39180076

Appendix 5 (con't)

Date Sampled	**Region**	**Station**	***Carteria* sp.**	***Dunaliella salina***	***Dunaliella viridis***	***Oocystis* sp.**	***Pediastrum* sp.**	***Scenedesmus* sp.**	***Spermatozopsis* sp.**	**Chlorophyta Totals**
3-May-05	Gilbert	14	0	0	466360	275011	0	0	0	741371
3-May-05	Gilbert	15	0	0	486709	2539	0	0	0	489248
3-May-05	Gilbert	18	0	0	1168494	45259	0	0	0	1213754
27-Jun-05	Gilbert	14	0	0	832752	71622	0	0	0	904374
27-Jun-05	Gilbert	15	0	0	1811427	106399	0	0	0	1917826
27-Jun-05	Gilbert	18	0	0	965185	0	0	0	0	965185
27-Jul-05	Gilbert	14	0	0	1565855	47667	0	0	0	1613522
27-Jul-05	Gilbert	15	0	0	128490	0	0	0	1321	129811
9-Aug-05	Gilbert	14	0	0	175939	0	0	0	0	175939
9-Aug-05	Gilbert	18	0	0	128775	0	0	0	0	128775
13-Sep-05	Gilbert	14	0	0	773097	146187	0	0	0	919283
13-Sep-05	Gilbert	15	0	0	846738	49268	0	0	0	896006
13-Sep-05	Gilbert	18	0	0	510334	81147	0	0	0	591481
21-Oct-05	Gilbert	14	0	0	1509086	67283	0	0	0	1576369
21-Oct-05	Gilbert	15	0	0	490699	0	0	0	0	490699
21-Oct-05	Gilbert	18	0	0	935436	24564	0	0	0	960000
13-Nov-05	Gilbert	18	0	0	444933	13997	0	0	0	458930

Date Sampled	**Region**	**Station**	***Microcoleus* sp.**	***Nodularia* heterocyst**	***Nodularia* veg**	***Pseudoanabaena* sp.**	***Spirulina* sp.**	**Cyanophyta Totals**	***Amphora coffeaeformis***	***Chaetocerous* sp.**
3-May-05	Gilbert	14	0	0	0	0	0	0	0	0
3-May-05	Gilbert	15	0	0	0	0	0	0	0	0
3-May-05	Gilbert	18	0	0	0	0	0	0	0	0
27-Jun-05	Gilbert	14	0	0	0	0	0	0	0	0
27-Jun-05	Gilbert	15	0	0	0	0	0	0	0	0
27-Jun-05	Gilbert	18	0	0	0	0	0	0	0	0
27-Jul-05	Gilbert	14	0	0	0	0	0	0	82875	0
27-Jul-05	Gilbert	15	0	15781	66489	0	0	82270	0	0
9-Aug-05	Gilbert	14	0	0	0	0	0	0	0	0
9-Aug-05	Gilbert	18	0	0	0	0	0	0	0	0
13-Sep-05	Gilbert	14	0	24954	184093	0	0	209047	66354	0
13-Sep-05	Gilbert	15	62183	15596	59947	0	0	137727	0	0
13-Sep-05	Gilbert	18	0	58802	497973	0	0	556775	0	0
21-Oct-05	Gilbert	14	0	0	0	0	0	0	0	0
21-Oct-05	Gilbert	15	0	0	0	0	0	0	0	0
21-Oct-05	Gilbert	18	0	0	0	0	0	0	0	0
13-Nov-05	Gilbert	18	0	0	0	0	0	0	0	0

Appendix 5 (con't)

Date Sampled	Region	Station	"Clear oval diatom"	*Cyclotella* sp.	*Nitzschia palea*	*Navicula graciloides*	*Navicula tripuctata*	Large *Navicula*	*Synedra* sp.	Diatom Totals
3-May-05	Gilbert	14	32901	0	0	0	0	23461	0	56362
3-May-05	Gilbert	15	0	0	0	0	0	2844	0	2844
3-May-05	Gilbert	18	30037	0	0	0	0	0	0	30037
27-Jun-05	Gilbert	14	26051	0	0	0	0	7406	0	33456
27-Jun-05	Gilbert	15	0	0	0	0	0	14083	0	14083
27-Jun-05	Gilbert	18	9627	50795	0	0	0	21916	0	82338
27-Jul-05	Gilbert	14	12188	0	0	0	0	4604	0	99667
27-Jul-05	Gilbert	15	0	0	0	0	0	0	0	0
9-Aug-05	Gilbert	14	3926	0	0	0	397479	1357	0	402763
9-Aug-05	Gilbert	18	3703	0	0	0	0	93192	0	96895
13-Sep-05	Gilbert	14	112826	0	0	0	0	1138	0	180318
13-Sep-05	Gilbert	15	0	36384	0	0	0	1185	0	37569
13-Sep-05	Gilbert	18	0	0	0	0	0	17916	0	17916
21-Oct-05	Gilbert	14	0	43190	0	0	0	25594	0	68783
21-Oct-05	Gilbert	15	0	0	0	0	0	0	0	0
21-Oct-05	Gilbert	18	190430	0	0	0	0	0	0	190430
13-Nov-05	Gilbert	18	0	0	0	0	0	0	0	0

Date Sampled	Region	Station	*Euplotes* sp.	Unknown ciliates	Protozoa Totals	"Chrysophytes"	*Cryptomonas* sp.	*Glenodinium* sp.	Pyrrophyta Totals	ALL TAXA
3-May-05	Gilbert	14	0	0	0	73738	8777	0	82515	82529
3-May-05	Gilbert	15	0	0	0	78912	8614	0	87527	87542
3-May-05	Gilbert	18	0	0	0	29952	10055	0	40007	40025
27-Jun-05	Gilbert	14	0	0	0	35191	23133	0	58325	58339
27-Jun-05	Gilbert	15	0	0	0	6861	7383	0	14244	14259
27-Jun-05	Gilbert	18	0	0	0	11486	2365	0	13852	13870
27-Jul-05	Gilbert	14	0	0	0	64639	13000	0	77639	77653
27-Jul-05	Gilbert	15	0	0	0	0	0	0	0	15
9-Aug-05	Gilbert	14	0	0	0	946	1149	0	2095	2109
9-Aug-05	Gilbert	18	0	0	0	1896	0	0	1896	1914
13-Sep-05	Gilbert	14	0	0	0	0	14184	0	14184	14198
13-Sep-05	Gilbert	15	0	0	0	9060	10045	0	19104	19119
13-Sep-05	Gilbert	18	0	0	0	10491	7921	0	18412	18430
21-Oct-05	Gilbert	14	0	0	0	23034	57199	0	80233	80247
21-Oct-05	Gilbert	15	0	0	0	2738	3792	0	6530	6545
21-Oct-05	Gilbert	18	0	0	0	2883	7719	0	10602	10620
13-Nov-05	Gilbert	18	0	0	0	847	2098	0	2945	2963

Appendix 6: Nitrogen (N_2) fixation vertical profiles at station P1 measured during 2005. Top values are the mean rate at each date, followed in parentheses by the standard error and number of replicates.

Date	Depth (m)	N_2 Fixation (µg L^{-1} h^{-1})	Date	Depth (m)	N_2Fixation (µg L^{-1} h^{-1})	Date	Depth (m)	N_2Fixation (µg L^{-1} h^{-1})
3-May-05	0.25	45.5 (2.5, 2)	27-Jul-05	0.2	20.1 (0.6, 2)	21-Oct-05	0.2	3.4 (0.4, 2)
3-May-05	0.5	34.6 (1.3, 2)	27-Jul-05	0.4	16.8 (0.7, 2)	21-Oct-05	0.4	2.9 (0.4, 2)
3-May-05	0.75	23.9 (0.2, 2)	27-Jul-05	0.6	10.8 (0.6, 2)	21-Oct-05	0.6	2.1 (0.2, 2)
3-May-05	1	18.3 (0.2, 2)	27-Jul-05	0.8	8.4 (0.6, 2)	21-Oct-05	0.8	1.2 (0.1, 2)
17-May-05	0.2	2.0 (0.6, 2)	27-Jul-05	1	0.0 (0.0, 2)	21-Oct-05	1	0.0 (0.0, 2)
17-May-05	0.6	0.4 (0.0, 2)	27-Jul-05	1.2	0.0 (0.0, 2)	13-Nov-05	0.2	0.7 (0.1, 2)
17-May-05	1	0.2 (0.0, 2)	9-Aug-05	0.2	12.8 (0.8, 2)	13-Nov-05	0.6	0.6 (0.0, 2)
17-May-05	1.4	0.2 (0.0, 2)	9-Aug-05	0.4	12.3 (–, 1)	13-Nov-05	1	0.2 (0.0, 2)
15-Jun-05	0.2	1.7 (0.0, 2)	9-Aug-05	0.6	10.1 (0.2, 2)			
15-Jun-05	0.4	1.2 (0.0, 2)	9-Aug-05	0.8	1.0 (0.0, 2)			
15-Jun-05	0.6	1.1 (0.0, 2)	9-Aug-05	1	0.4 (0.1, 2)			
15-Jun-05	0.8	1.0 (0.0, 2)	9-Aug-05	1.2	0.1 (0.0, 2)			
15-Jun-05	1.2	0.3 (0.0, 2)	27-Aug-05	0.2	8.3 (0.2, 2)			
15-Jun-05	1.4	0.3 (0.0, 2)	27-Aug-05	0.4	4.1 (0.1, 2)			
27-Jun-05	0.2	3.0 (0.2, 2)	27-Aug-05	0.6	1.5 (0.1, 2)			
27-Jun-05	0.4	1.8 (0.1, 2)	27-Aug-05	0.8	0.6 (0.0, 2)			
27-Jun-05	0.6	2.1 (0.1, 2)	27-Aug-05	1	0.2 (0.0, 2)			
27-Jun-05	0.8	1.7 (0.1, 2)	13-Sep-05	0.2	1.4 (0.0, 2)			
27-Jun-05	1	1.1 (0.0, 2)	13-Sep-05	0.4	0.9 (0.0, 2)			
27-Jun-05	1.2	0.6 (0.0, 2)	13-Sep-05	0.6	0.9 (0.1, 2)			
27-Jun-05	1.4	0.3 (0.0, 2)	13-Sep-05	0.8	0.5 (0.0, 2)			
13-Jul-05	0.2	17.2 (1.2, 2)	13-Sep-05	1	0.0 (–, 1)			
13-Jul-05	0.4	14.6 (–, 1)	7-Oct-05	0.2	0.8 (0.0, 2)			
13-Jul-05	0.6	12.0 (0.2, 2)	7-Oct-05	0.4	0.4 (0.0, 2)			
13-Jul-05	0.8	9.0 (0.5, 2)	7-Oct-05	0.6	0.4 (0.0, 2)			
13-Jul-05	1	5.4 (0.1, 2)	7-Oct-05	0.8	0.3 (0.0, 2)			
13-Jul-05	1.2	0.0 (0.0, 2)	7-Oct-05	1	0.4 (–, 1)			
13-Jul-05	1.4	0.0 (0.0, 2)	7-Oct-05	0.6	0.4 (0.0, 2)			

Appendix 7: Zooplankton density (organisms L^{-1}) by taxa for each sampling date at each station.

Date Sampled	Region	Station	***Artemia franciscana*** **male**	***Artemia franciscana*** **female**	***Artemia franciscana*** **juvenile**	***Artemia franciscana*** **nauplii**	***Trichocorixa verticalis***	***Ephydra sp.*** **adult**	***Ephydra sp.*** **pupae**	***Ephdra sp.*** **larvae**
16-Apr	Farmington	Causeway	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
3-May	Farmington	1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
3-May	Farmington	2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
3-May	Farmington	4	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
15-May	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15-May	Farmington	2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
15-May	Farmington	4	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
17-May	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-Jun	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-Jun	Farmington	3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
1-Jun	Farmington	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
15-Jun	Farmington	1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
15-Jun	Farmington	2	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
15-Jun	Farmington	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Farmington	1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
27-Jun	Farmington	2	0.3	0.3	0.0	0.0	0.1	0.0	0.0	0.0
27-Jun	Farmington	4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
15-Jul	Farmington	1	0.0	0.0	0.0	0.0	0.7	0.0	0.2	0.0
15-Jul	Farmington	2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
27-Jul	Farmington	1	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
27-Jul	Farmington	2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
27-Jul	Farmington	4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
8-Aug	Farmington	3	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
8-Aug	Farmington	4	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0
9-Aug	Farmington	1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
25-Aug	Farmington	1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
25-Aug	Farmington	2	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0
25-Aug	Farmington	3	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0
12-Sep	Farmington	1	0.1	0.1	0.0	0.0	1.4	0.0	0.0	0.0
12-Sep	Farmington	2	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
12-Sep	Farmington	3	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0
6-Oct	Farmington	2	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
21-Oct	Farmington	1	0.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0
21-Oct	Farmington	2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
21-Oct	Farmington	3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
12-Nov	Farmington	1	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0
12-Nov	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 7 (con’t)

Date Sampled	Region	Station	*Diaptomus conexus*	Cyclopoid copepod	*Cletocampus albuquerquensis*	UNID Dipteran adult	UNID Dipteran pupae	UNID Dipteran larvae	*Moina* sp.
16-Apr	Farmington	Causeway	0.0	14.5	0.4	0.0	0.0	0.0	0.1
3-May	Farmington	1	0.3	0.0	24.1	0.0	0.0	0.0	163.6
3-May	Farmington	2	0.0	19.2	24.3	0.0	0.0	0.0	322.3
3-May	Farmington	4	0.0	50.5	2.4	0.0	0.0	0.0	1314.0
15-May	Farmington	1	0.0	26.0	9.5	0.0	0.0	0.0	74.7
15-May	Farmington	2	0.0	38.2	13.6	0.0	0.0	0.0	41.2
15-May	Farmington	4	0.0	77.1	0.8	0.0	0.0	0.0	102.1
17-May	Farmington	2	22.3	0.0	4.5	0.0	0.0	0.0	38.5
1-Jun	Farmington	1	9.4	3.5	4.9	0.0	0.0	0.0	32.3
1-Jun	Farmington	3	3.9	0.0	0.0	0.0	0.0	0.0	2.7
1-Jun	Farmington	4	7.1	4.3	2.0	0.0	0.0	0.0	15.7
15-Jun	Farmington	1	14.1	0.0	0.0	0.0	0.0	0.0	0.9
15-Jun	Farmington	2	9.7	0.8	0.0	0.0	0.0	0.0	1.5
15-Jun	Farmington	4	37.1	18.3	1.0	0.0	0.0	0.0	42.1
27-Jun	Farmington	1	178.0	0.2	0.0	0.0	0.0	0.0	12.9
27-Jun	Farmington	2	296.4	0.0	0.0	0.0	0.0	0.0	667.9
27-Jun	Farmington	4	164.9	2.7	0.3	0.0	0.0	0.0	31.2
15-Jul	Farmington	1	167.4	0.0	0.0	0.0	0.0	0.0	74.3
15-Jul	Farmington	2	323.9	0.0	0.0	0.0	0.0	0.0	225.5
27-Jul	Farmington	1	95.8	0.0	0.0	0.0	0.0	0.0	33.7
27-Jul	Farmington	2	188.5	0.0	0.0	0.0	0.0	0.0	83.3
27-Jul	Farmington	4	130.7	0.0	0.0	0.0	0.0	0.0	112.8
8-Aug	Farmington	3	9.8	0.0	0.0	0.0	0.0	0.0	228.6
8-Aug	Farmington	4	11.9	0.0	0.0	0.0	0.0	0.0	116.0
9-Aug	Farmington	1	28.0	0.0	0.0	0.0	0.0	0.0	40.8
25-Aug	Farmington	1	3.1	0.0	0.0	0.0	0.0	0.0	0.0
25-Aug	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-Aug	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6-Oct	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Farmington	2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
21-Oct	Farmington	3	0.0	0.1	0.6	0.0	0.0	0.0	0.0
12-Nov	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 7 (con't)

Date Sampled	Region	Station	*Artemia franciscana* male	*Artemia franciscana* female	*Artemia franciscana* juvenile	*Artemia franciscana* nauplii	*Trichocorixa verticalis*	*Ephydra sp.* adult	*Ephydra sp.* pupae	*Ephydra sp.* larvae
3-May	Gilbert	14	0.0	0.2	0.8	0.5	0.0	0.0	0.1	0.1
3-May	Gilbert	15	0.3	0.3	1.7	0.9	0.0	0.0	0.0	0.0
3-May	Gilbert	18	1.3	3.8	1.7	0.2	0.0	0.0	0.0	0.0
27-Jun	Gilbert	14	0.4	0.4	0.1	0.3	0.0	0.0	0.0	0.0
27-Jun	Gilbert	15	0.9	0.8	0.0	0.1	0.0	0.0	0.0	0.0
27-Jun	Gilbert	18	1.8	1.5	0.0	0.1	0.0	0.0	0.0	0.0
27-Jul	Gilbert	15	0.3	0.4	0.1	0.1	0.0	0.0	0.0	0.0
27-Jul	Gilbert	18	0.2	0.1	0.3	0.7	0.0	0.0	0.0	0.0
9-Aug	Gilbert	14	0.2	0.1	0.1	8.4	0.0	0.0	0.0	0.0
9-Aug	Gilbert	15	0.4	0.4	0.0	0.3	0.0	0.0	0.0	0.0
9-Aug	Gilbert	18	0.2	0.1	0.1	0.5	0.0	0.0	0.0	0.0
12-Sep	Gilbert	14	0.4	0.2	1.4	2.8	0.0	0.0	0.0	0.0
12-Sep	Gilbert	18	0.5	0.2	1.3	4.0	0.0	0.0	0.0	0.2
21-Oct	Gilbert	14	1.1	0.6	1.2	0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	15	1.6	2.4	1.0	0.8	0.0	0.0	0.0	0.0
21-Oct	Gilbert	18	0.3	0.3	2.4	0.1	0.0	0.0	0.0	0.0
12-Nov	Gilbert	18	0.2	0.1	0.2	0.1	0.0	0.0	0.0	0.0

Date Sampled	Region	Station	*Diaptomus conexus*	Cyclopoid copepod	*Cletocampus albuquerquensis*	UNID Dipteran adult	UNID Dipteran pupae	UNID Dipteran larvae	*Moina sp.*
3-May	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-May	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-May	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jul	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jul	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-Aug	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-Aug	Gilbert	15	0.9	0.0	0.0	0.0	0.0	0.0	0.4
9-Aug	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 8: Zooplankton biomass (µg L^{-1}) by taxa for each sampling date at each location.

Date Sampled	Region	Station	*Artemia franciscana* male	*Artemia franciscana* female	*Artemia franciscana* juvenile	*Artemia franciscana* nauplii	*Trichocorixa verticalis*	*Ephydra sp.* adult	*Ephydra sp.* pupae	*Ephydra sp.* larvae
16-Apr	Farmington	Causeway	0.0	2.7	0.6	0.2	0.0	0.0	0.0	28.4
3-May	Farmington	1	16.4	10.0	0.0	0.0	0.4	0.0	1.1	0.0
3-May	Farmington	2	13.1	44.3	0.0	0.0	0.9	0.0	0.0	0.0
3-May	Farmington	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15-May	Farmington	1	5.6	6.7	0.0	0.0	0.9	0.0	0.0	2.3
15-May	Farmington	2	3.3	6.1	0.0	0.0	4.3	0.0	0.0	5.0
15-May	Farmington	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
17-May	Farmington	2	0.0	3.4	0.0	0.0	0.5	0.0	0.0	0.8
1-Jun	Farmington	1	2.9	5.2	0.0	0.0	0.5	0.0	0.0	0.0
1-Jun	Farmington	3	22.4	27.4	1.8	0.1	1.9	0.0	0.0	0.0
1-Jun	Farmington	4	3.1	3.0	0.0	0.0	2.2	0.0	0.0	2.4
15-Jun	Farmington	1	32.8	16.5	0.0	1.5	4.8	0.2	0.5	0.0
15-Jun	Farmington	2	5.4	7.8	0.0	0.0	0.2	0.0	0	2.4
15-Jun	Farmington	4	0.0	0.0	0.0	0.0	0.4	0.0	3.6	3.7
27-Jun	Farmington	1	14.6	16.6	0.0	0.0	9.9	0.0	0.2	0.0
27-Jun	Farmington	2	146.3	203.2	0.0	0.0	9.0	0.0	0.0	1.9
27-Jun	Farmington	4	10.4	17.6	0.0	0.0	10.2	0.0	0.0	0.0
15-Jul	Farmington	1	0.7	0.0	0.0	0.0	57.9	0.0	47.5	0.0
15-Jul	Farmington	2	0.0	0.0	0.0	0.0	6.0	0.2	0.0	0.0
27-Jul	Farmington	1	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0
27-Jul	Farmington	2	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0
27-Jul	Farmington	4	0.0	0.0	0.0	0.0	31.8	0.0	0.0	0.0
8-Aug	Farmington	3	0.0	0.0	0.0	0.0	91.8	0.0	0.0	0.0
8-Aug	Farmington	4	0.0	0.0	0.0	0.0	57.6	0.0	0.0	0.2
9-Aug	Farmington	1	0.0	0.0	0.0	0.0	16.4	0.1	1.9	0.0
25-Aug	Farmington	1	0.7	0.4	0.0	0.0	98.8	0.3	0.0	0.0
25-Aug	Farmington	2	0.0	0.0	0.0	0.0	614.4	0.0	0.0	0.0
25-Aug	Farmington	3	0.0	0.0	0.0	0.0	71.0	0.0	0.0	0.0
12-Sep	Farmington	1	31.9	20.8	0.0	0.0	81.4	0.0	0.6	0.0
12-Sep	Farmington	2	9.4	6.8	0.0	0.0	74.8	0.0	0.0	0.0
12-Sep	Farmington	3	0.0	0.0	0.0	0.0	269.1	0.0	0.0	0.0
6-Oct	Farmington	2	0.0	5.2	0.0	0.0	151.9	0.0	0.0	0.0
21-Oct	Farmington	1	18.7	3.2	0.0	0.0	25.2	0.0	0.1	0.0
21-Oct	Farmington	2	8.0	6.0	0.0	0.0	12.8	0.0	0.0	0.0
21-Oct	Farmington	3	11.9	13.9	0.0	0.0	35.8	0.0	0.0	0.0
12-Nov	Farmington	1	5.9	4.2	0.0	0.4	0.1	0.0	0.0	0.4
12-Nov	Farmington	2	3.5	3.8	0.1	0.0	2.5	0.0	0.0	0.0
12-Nov	Farmington	3	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0

Appendix 8 (con't)

Date Sampled	Region	Station	*Diaptomus conexus*	Cyclopoid copepod	*Cletocampus albuquerquensis*	UNID Dipteran adult	UNID Dipteran pupae	UNID Dipteran larvae	*Moina* sp.
16-Apr	Farmington	Causeway	0.0	20.7	0.6	0.0	0.0	0.0	0.5
3-May	Farmington	1	1.8	0.0	61.0	0.0	0.0	0.0	403.1
3-May	Farmington	2	0.1	28.2	44.0	0.0	0.0	0.0	463.3
3-May	Farmington	4	0.0	97.3	3.8	0.0	0.0	0.0	3054.8
15-May	Farmington	1	0.0	45.7	12.5	0.4	0.2	0.0	300.4
15-May	Farmington	2	0.0	73.5	23.8	0.4	0.3	0.0	148.6
15-May	Farmington	4	0.2	180.1	1.5	0.0	0.0	0.0	299.3
17-May	Farmington	2	39.8	0.0	6.5	0.0	0.0	0.0	73.1
1-Jun	Farmington	1	39.1	5.8	9.2	0.0	0.0	0.0	47.7
1-Jun	Farmington	3	9.9	0.0	0.0	0.0	0.0	0.0	3.6
1-Jun	Farmington	4	24.3	7.8	3.6	0.3	0.0	0.0	38.8
15-Jun	Farmington	1	40.2	0.0	0.0	0.0	0.0	0.0	2.0
15-Jun	Farmington	2	27.0	2.2	0.0	0.6	0.0	0.0	3.7
15-Jun	Farmington	4	175.8	50.8	2.2	1.2	0.0	0.0	209.9
27-Jun	Farmington	1	540.2	0.4	0.0	0.0	0.0	0.0	49.4
27-Jun	Farmington	2	1231.6	0.0	0.0	3.0	0.0	0.0	1841.8
27-Jun	Farmington	4	914.5	6.5	0.4	1.1	2.4	0.8	81.7
15-Jul	Farmington	1	285.2	0.0	0.0	0.0	0.0	0.0	129.6
15-Jul	Farmington	2	1137.1	0.0	0.0	0.0	0.0	0.0	368.8
27-Jul	Farmington	1	228.2	0.0	0.0	0.0	0.0	0.0	87.6
27-Jul	Farmington	2	953.1	0.0	0.0	0.0	0.0	0.0	107.5
27-Jul	Farmington	4	634.7	0.0	0.0	0.0	0.0	0.0	139.9
8-Aug	Farmington	3	20.5	0.0	0.0	0.0	0.0	0.0	346.2
8-Aug	Farmington	4	45.0	0.0	0.0	0.0	0.0	0.0	140.2
9-Aug	Farmington	1	81.7	0.0	0.0	0.0	0.0	0.0	74.0
25-Aug	Farmington	1	11.5	0.0	0.0	0.0	0.0	0.0	0.0
25-Aug	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-Aug	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12-Sep	Farmington	1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6-Oct	Farmington	2	0.0	0.0	0.1	0.0	0.0	0.0	0.0
21-Oct	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Farmington	2	0.0	0.0	0.4	0.0	0.0	0.0	0.0
21-Oct	Farmington	3	0.0	0.2	1.6	0.0	0.0	0.0	0.0
12-Nov	Farmington	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Farmington	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Farmington	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 8 (con't)

Date Sampled	Region	Station	*Artemia franciscana* Male	*Artemia franciscana* Female	*Artemia franciscana* Juvenile	*Artemia franciscana* Nauplii	*Trichocorixa verticalis*	*Ephydra sp.* Adult	*Ephydra sp.* Pupae	*Ephydra sp.* Larvae
3-May	Gilbert	14	9.3	15.3	5.0	1.5	0.0	0.1	10.5	4.9
3-May	Gilbert	15	143.5	144.3	18.2	3.2	0.0	0.0	1.2	0.1
3-May	Gilbert	18	373.5	425.1	192.8	0.6	0.0	0.0	0.0	0.0
27-Jun	Gilbert	14	96.7	108.6	0.4	0.7	0.0	0.1	0.0	0.2
27-Jun	Gilbert	15	225.4	269.0	0.1	0.4	0.0	0.0	0.0	0.0
27-Jun	Gilbert	18	387.2	387.1	0.0	0.3	0.0	0.0	0.0	0.0
27-Jul	Gilbert	15	78.4	66.7	0.1	0.2	0.0	0.1	0.0	0.0
27-Jul	Gilbert	18	36.3	29.9	20.7	1.9	1.3	0.1	0.8	0.2
9-Aug	Gilbert	14	22.8	34.0	0.5	20.5	0.0	0.0	0.0	0.0
9-Aug	Gilbert	15	58.4	48.7	0.0	0.8	1.4	0.2	0.0	0.0
9-Aug	Gilbert	18	19.7	14.7	0.9	1.1	5.9	0.3	5.5	0.0
12-Sep	Gilbert	14	98.9	97.4	6.5	6.5	1.4	0.0	0.0	0.3
12-Sep	Gilbert	18	157.2	47.0	12.8	10.1	2.2	0.0	0.0	6.2
21-Oct	Gilbert	14	245.8	116.2	10.3	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	15	404.7	440.7	19.1	2.1	0.0	0.0	0.0	0.0
21-Oct	Gilbert	18	59.7	67.7	24.0	0.3	0.0	0.0	0.0	0.0
12-Nov	Gilbert	18	18.3	19.8	8.1	0.2	1.5	0.0	0.0	0.6

Date Sampled	Region	Station	*Diaptomus conexus*	Cyclopoid copepod	*Cletocampus albuquerquensis*	UNID Dipteran adult	UNID Dipteran pupae	UNID Dipteran larvae	*Moina sp.*
3-May	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-May	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-May	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Gilbert	14	0.1	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Gilbert	15	0.1	0.0	0.0	0.0	0.0	0.0	0.0
27-Jun	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jul	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Jul	Gilbert	18	0.1	0.0	0.0	0.0	0.0	0.0	0.0
9-Aug	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-Aug	Gilbert	15	1.4	0.0	0.0	0.0	0.0	0.0	0.5
9-Aug	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Sep	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21-Oct	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Nov	Gilbert	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 9: Macroinvertebrate densities on benthic brine fly substrates in Gilbert and Farmington Bays. Densities are the top number and are reported as organisms / m^2. Followed in parentheses are (1) the standard error of the station replicates and (2) the number of samples collected at each station.

Region	**Date**	**Station**	**Depth**	***Trichocorixa verticalis***	***Ephydra cinera* larvae**	***Ephydra cinera* pupae**	***Ephydra hians* larvae**	***Ephydra hians* pupae**	***Ephydra* Adult (both species)**
Gilbert	7-Sep-05	P14A	0.5M	18.5 (9.2, 3)	6325 (1463.7, 3)	8993.5 (370.4, 3)	0 (0, 3)	0 (0, 3)	2373 (231.4, 3)
Gilbert	7-Sep-05	P14A	1.0M	0 (0, 3)	1071.1 (374.8, 3)	249.3 (112, 3)	0 (0, 3)	0 (0, 3)	129.3 (75.6, 3)
Gilbert	7-Sep-05	P15A	0.5M	18.5 (9.2, 3)	4533.7 (1403.6, 3)	1071.1 (136, 3)	0 (0, 3)	0 (0, 3)	2197.6 (841.6, 3)
Gilbert	7-Sep-05	P15A	1.0M	0 (0, 3)	3037.9 (345, 3)	2760.8 (134.1, 3)	0 (0, 3)	0 (0, 3)	1071.1 (420.8, 3)
Gilbert	7-Sep-05	P18A	0.5M	9.2 (9.2, 3)	2613.1 (412.5, 3)	6546.6 (517.1, 3)	0 (0, 3)	0 (0, 3)	720.2 (27.7, 3)
Gilbert	7-Sep-05	P18A	1.0M	0 (0, 3)	3351.8 (983.4, 3)	7322.3 (1535.4, 3)	0 (0, 3)	0 (0, 3)	304.7 (99.9, 3)
Farmington	7-Sep-05	P1A	0.5M	5300 (1,281.7, 3)	0 (0, 3)	0 (0, 3)	46.2 (33.3, 3)	18.5 (18.5, 3)	0 (0, 3)
Farmington	7-Sep-05	P1A	1.0M	1911.4 (523.6, 3)	9.2 (9.2, 3)	0 (0, 3)	9.2 (9.2, 3)	9.2 (9.2, 3)	0 (0, 3)
Farmington	7-Sep-05	P2A	0.5M	3361 (1463.8, 3)	0 (0, 3)	0 (0, 3)	0 (0, 3)	0 (0, 3)	0 (0, 3)
Farmington	7-Sep-05	P2A	1.0M	2225.3 (501.3, 3)	0 (0, 3)	0 (0, 3)	18.5 (9.2, 3)	9.2 (9.2, 3)	9.2 (9.2, 3)

Appendix 10: Data collected during the 2005 synoptic surveys

Synoptic	Station Identity Code	Date Collected	LAT	LONG	Salinity %	Skin Temp	Temp at 0.2 m	Secchi (m)	Station Depth (m)	Chl a Field (ug/L)	Chllorphyll Extracted (ug/L)	CDOM (absorb./cm)	Phycocyanin (Fluoresence units)	Phycoerythrin (fluoresence units)	N_fixation (ug N/L/hr)
									Farmington Bay						
June	FB-10	3-Jun-05	40.910	-112.082	0.5	–	–	0.25	0.9	–	201	0.012	–	17.6	0.4
June	FB-11	3-Jun-05	40.923	-112.039	0.4	–	15.5	0.17	0.4	–	154	0.012	–	14.9	0.1
June	FB-9	1-Jun-05	40.930	-112.099	0.5	–	–	0.25	–		395	0.150	–	26.3	0.7
June	FB-8-F	1-Jun-05	40.964	-112.109	0.9	20.4	21.5	0.24	1.3	223	303	0.095	1199	18.4	8.2
June	FB-7-P	1-Jun-05	40.994	-112.122	1.3	19.6	20.9	0.28	0.8	220	221	0.008	853	20.7	5.3
June	FB-6-F	1-Jun-05	40.996	-112.140	1.6	18.9	20.5	0.27	0.9	157	186	0.008	594	16.5	2.7
June	FB-5-P	1-Jun-05	41.010	-112.130	1.0	21.2	22.6	0.22	0.8	241	311	0.010	1121	25.8	9.7
June	FB-4-P	1-Jun-05	41.030	-112.159	1.0	19.4	21.6	0.24	1.5	204	320	0.011	1309	18.6	3.8
June	FB-3-P	1-Jun-05	41.040	-112.155	1.0	20.8	23.2	0.24	1.3	220	303	0.012	1247	18.6	6.0
June	FB-2-F	1-Jun-05	41.050	-112.188	1.4	15.2	19.0	0.25	1.5	113	233	0.025	705	14.2	1.5
June	FB-1-F	1-Jun-05	41.060	-112.215	1.2	17.6	18.3	0.26	1.9	238	254	0.011	962	16.3	2.8
									Bear River Bay						
June	BRB	3-Jun-05	41.271	-112.355	0.2	–	18.3	–	–		17	0.004	–	39.8	0.0
									Gilbert Bay (with Ogden Bay--Sta FB12, 13)						
June	S-10-F	2-Jun-05	40.762	-112.258	13.2	19.2	20.5	2.30	7.4	0.1	0.4	0.004	6.2	–	–
June	S-8-P	2-Jun-05	40.793	-112.374	14.0	18.2	–	1.30	3.4	3.4	2.7	0.007	16.1	1.0	–
June	S-11-P	2-Jun-05	40.804	-112.202	13.6	19.2	–	2.40	7.2	-0.7	0.4	0.004	6.7	–	–
June	S-7-F	2-Jun-05	40.856	-112.403	14.0	19.3	19.7	2.70	6.3	1.2	0.5	0.006	7.7	-0.7	–
June	S-12-F	2-Jun-05	40.858	-112.246	13.8	18.8	20.0	3.00	8.5	0.4	0.4	0.004	5.9	0.7	–
June	S-13-P	2-Jun-05	40.899	-112.318	14.0	17.8	–	3.05	8.7	0.9	0.5	0.005	7.3	0.6	–
June	S-6-P	2-Jun-05	40.930	-112.448	13.6	18.2	–	2.90	6.0	-0.1	0.5	0.008	6.3	0.7	–
June	S-14-F	2-Jun-05	40.963	-112.291	13.2	19.8	21.8	2.55	7.7	2.5	1.1	0.004	12.2	0.4	–
June	S-15-P	2-Jun-05	41.007	-112.306	12.6	20.2	–	0.85	5.5	4.3	5.7	0.005	29.3	1.8	–
June	S-4-F	2-Jun-05	41.028	-112.494	13.8	18.0	19.4	2.55	6.0	1.8	1.5	0.005	10.7		–
June	S-1-F	2-Jun-05	41.038	-112.308	12.0	17.0	17.9	0.60	3.5	14.4	19.9	0.007	91.9	5.6	–
June	S-3-P	2-Jun-05	41.039	-112.421	13.1	17.8	–	2.00	8.9	1.0	2.9	0.005	15.0	0.9	–
June	N-11-F	31-May-05	41.046	-112.700	13.6	19.8	21.0	1.55	4.7	4.2	4.4	0.004	27.2	–	0.1
June	N-1-F	31-May-05	41.071	-112.274	13.6	18.8	19.7	0.75	2.3	4.4	3.0	0.004	18.1	–	0.1
June	N-2-P	31-May-05	41.071	-112.274	13.2	19.4	20.0	0.65	3.6	10.6	29.1	0.007	111.0		0.1
June	N-16-F	31-May-05	41.071	-112.331	13.7	20.2	20.4	2.10	2.5	1.9	0.4	0.007	7.0	–	0.1
June	N-15-P	31-May-05	41.072	-112.332	13.6	19.2	19.6	1.05	7.6	12.2	25.0	0.004	141.6	–	0.1
June	FB-12-F	1-Jun-05	41.073	-112.233	10.8	17.6	18.5	0.35	2.0	108.2	79.7	0.007	270.0	13.2	0.0
June	FB-13-P	1-Jun-05	41.104	-112.242	11.8	19.2	18.6	0.33	0.6	39.4	45.8	0.005	171.7	16.9	0.0
June	N-14-F	31-May-05	41.080	-112.384	13.8	19.2	19.8	1.65	7.8	6.1	5.4	0.007	34.1	–	0.1
June	N-12-P	31-May-05	41.089	-112.629	13.6	19.2	21.5	1.75	7.1	2.2	3.3	0.006	9.9	–	
June	N-13-F	31-May-05	41.092	-112.544	13.8	19.6	20.3	1.95	4.0	2.9	1.1	0.005	10.2	–	0.1
June	N-3-F	31-May-05	41.113	-112.359	13.6	17.6	19.2	0.93	5.3	10.1	28.0	0.006	84.0	-0.8	0.1
June	N-10-P	31-May-05	41.119	-112.729	13.6	20.4	21.0	2.05	4.6	1.1	2.2	0.004	12.8	–	
June	N-4-P	31-May-05	41.134	-112.403	13.6	18.4	19.2	0.69	5.6	11.1	29.7	0.004	100.5	–	0.1
June	N-5-P	31-May-05	41.166	-112.436	13.0	18.8	20.1	0.68	5.6	11.8	28.8	0.004	94.1	–	
June	N-9-F	31-May-05	41.167	-112.746	13.7	19.4	20.1	1.55	4.8	5.5	4.9	0.004	21.7	–	0.1
June	N-7-F	31-May-05	41.187	-112.503	11.4	19.8	20.3	0.38	4.0	27.5	40.0	0.005	190.5	–	0.1
June	N-8-P	31-May-05	41.193	-112.545	13.9	19.2	20.1	1.90	8.0	0.2	1.6	0.004	11.0	–	
June	N-6-F	31-May-05	41.199	-112.404	7.0	18.8	18.8	0.20	4.0	35.4	53.0	0.011	201.8	–	0.2

Appendix 10 (con't)

Synoptic	Station Identity Code	Date Collected	LAT	LONG	Salinity %	Skin Temp	Temp at 0.2 m	Secchi (m)	Station Depth (m)	Chl a Field (ug/L)	Chllorophyll Extracted (ug/L)	CDOM (absorb./cm)	Phycocyanin (Fluoresence units)	Phycoerythrin (fluoresence units)	N_fixation (ug N/L/hr)
Farmington Bay															
August	FB-10-P	8-Aug-05	40.913	-112.045	0.4	–	24.4	> depth	0.3	–	30	0.010	–	–	0
August	FB-11-F	8-Aug-05	40.925	-112.022	0.2	–	25.6	> depth	0.2	–	6	0.013	–	–	0.05
August	FB-9-P	8-Aug-05	40.934	-112.083	1.6	–	27.9	0.26	0.4	–	312	0.018	–	–	6.3
August	FB-8-F	8-Aug-05	40.964	-112.109	2.6	–	27.7	0.16	1.1	–	283	0.018	–	–	9.4
August	FB-7-P	8-Aug-05	40.976	-112.110	3.6	–	27.4	0.15	0.6	–	374	0.013	–	–	13.4
August	FB-6-F	8-Aug-05	40.996	-112.140	3.4	–	28.6	0.12	1.0	–	290	0.013	–	–	21.2
August	FB-5-P	8-Aug-05	41.008	-112.125	3.0	–	27.5	0.19	0.7	–	219	0.012	–	–	7.3
August	FB-4-P	8-Aug-05	41.018	-112.157	3.6	–	28.5	0.20	1.1	–	205	0.011	–	–	10
August	FB-3-P	8-Aug-05	41.041	-112.156	3.4	–	27.9	0.39	1.0	–	96	0.013	–	–	3.5
August	FB-2-F	9-Aug-05	41.050	-112.188	3.6	–	28.5	0.17	1.3	–	179	0.011	–	–	9.8
August	FB-1-F	8-Aug-05	41.060	-112.229	3.6	–	27.2	0.26	1.5	–	128	0.016	–	–	4.9
Gilbert Bay (with Ogden Bay--Sta FB12F)															
August	P14	9-Aug-05	41.014	-112.257	14.2	–	28.0	1.63	1.5	–	5.6	0.004	–	–	0
August	P15	9-Aug-05	40.926	-112.257	14.2	–	26.5	4.65	1.6	–	1.5	0.004	–	–	0
August	P18	9-Aug-05	40.976	-112.261	14.1	–	27.5	2.53	1.5	–	2.5	0.004	–	–	0
August	FB-12-F	8-Aug-05	41.069	-112.241	13.6	–	29.9	0.85	2.4	–	38.3	0.004	–	–	0
Farmington Bay															
October	FB-10-P	24-Oct-05	40.915	-112.050	0.5	–	11.3	> depth	0.2	–	26	0.009	–	–	0.1
October	FB-11-F	24-Oct-05	40.921	-112.030	0.4	–	14.4	> depth	0.1	–	20	0.007	–	–	0
October	FB-9-P	24-Oct-05	40.932	-112.088	0.6	–	15.0	> depth	0.5	–	36	0.011	–	–	0.3
October	FB-8-F	24-Oct-05	40.952	-112.104	1.0	–	15.2	0.75	0.9	–	88	0.011	–	–	2.1
October	FB-5-P	22-Oct-05	41.008	-112.131	3.2	–	14.8	0.59	0.5	–	44	0.012	–	–	2.4
October	FB-4-P	22-Oct-05	41.018	-112.157	3.2	–	10.3	0.60	0.8	–	113	0.010	–	–	10.6
October	FB-3-P	22-Oct-05	41.031	-112.160	4.1	–	11.5	0.59	1.0	–	41	0.010	–	–	0.9
October	FB-2-F	22-Oct-05	41.050	-112.189	4.2	–	15.8	0.50	1.1	–	62	0.012	–	–	5.2
October	FB-1-F	22-Oct-05	41.058	-112.222	4.4	–	16.0	0.60	1.3	–	46	0.011	–	–	2
October	FB-6-F	22-Oct-05	41.997	-112.141	3.8	–	12.0	0.45	0.7	–	63	0.014	–	–	2.1
Gilbert Bay (with Ogden Bay--Sta FB12F)															
October	P15	21-Oct-05	40.925	-112.257	15.0	–	15.0	1.40	1.5	–	12	0.003	–	–	–
October	P18	21-Oct-05	40.976	-112.260	15.2	–	15.2	1.40	0.9	–	17	0.003	–	–	–
October	P14	21-Oct-05	41.014	-112.258	15.3	–	15.6	0.69	1.2	–	27	0.005	–	–	–
October	FB-15-P	22-Oct-05	41.066	-112.293	14.7	–	16.9	0.80	2.0	–	18	0.004	–	–	0
October	FB-12-F	22-Oct-05	41.069	-112.240	14.5	–	17.3	0.80	1.8	–	20	0.005	–	–	0