LAKE TAHOE WATER QUALITY INVESTIGATIONS

ALGAL BIOASSAY • PHYTOPLANKTON • ATMOSPHERIC NUTRIENT DEPOSITION • PERIPHYTON •

FINAL REPORT:

JULY 1, 2010– JUNE 30, 2013

AGREEMENT NO. 10-031-160

SUBMITTED TO:

STATE WATER RESOURCES CONTROL BOARD
LAHONTAN REGIONAL WATER QUALITY CONTROL BOARD

SUBMITTED BY:

TAHOE ENVIRONMENTAL RESEARCH CENTER
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Project Overview

The following document is our Draft Final Report for work completed July 1, 2010 to June 30, 2013 for Agreement No. 10-031-160: Lake Tahoe Water Quality Investigations by the U.C. Davis – Tahoe Environmental Research Center (TERC).

Under terms of this contract TERC is to provide the SWRCB with water quality research and monitoring at Lake Tahoe to assess the progressive deterioration of the lake. This contract will accomplish the necessary research, monitoring and data collection for addition to the Lake Tahoe Interagency Monitoring Program (LTIMP). The State Water Board and other governmental entities will be provided with the hard scientific data needed to develop planning, management and enforcement strategies which will prevent future degradation of the lake's famous clarity and protect the surrounding watershed and streams.

The objective of this project is to continue monitoring critical ongoing long-term water quality parameters in Lake Tahoe. The primary research and monitoring tasks addressed in this project include:

Algal growth bioassay tests to assess nutrient limitation (Task 3). The purpose of this task is to determine the nutrient or nutrients which limit phytoplankton growth. These findings have been very important in current efforts toward lake restoration. They have highlighted the need for an expanded erosion control strategy. Bioassays are to be done four times per year using Lake Tahoe water containing natural phytoplankton, collected at the TERC's Index station along the west shore. The bioassay method to be used is described in detail in Hackley et al. (2007). It is similar to that published in Goldman et al. (1993) with the exception that14C uptake is not measured. In these bioassays, water is collected and composited from depths of 2,5,8,11,14,17 and 20m at TERC's Lake Tahoe Index Station following TERC standard protocol for sample collection (Hunter et al., 1993). The water sample is returned to the laboratory where treatments (made in triplicate) included: Control – no nutrient additions; N_{20} (add NH_4NO_3 to a final concentration of approximately 20 µg/l N); P_2 (add ortho-P to a final concentration of approximately 2 µg/l P); P_{10} (10 µg/l P); $N_{20}P_{10}$ (20 µg/l N + 10 µg/l P). Flasks of lake water and treatments are incubated under controlled laboratory conditions. Biomass accumulation over the course of the experiment is measured by *in vivo* fluorescence.

Enumeration and identification of phytoplankton and collection of zooplankton samples for archiving (Task 4). This task is particularly critical since changes in the biodiversity of the phytoplankton are both indicators of pollution and affect food-chain structure. Implementation of this task allows TERC to determine if new and undesirable species are colonizing the lake. In addition, the size and composition of particles, including phytoplankton cells in the water, have a significant effect on light transmittance, and hence affect the famed clarity of Lake Tahoe. Characterization of phytoplankton dynamics in Lake Tahoe fills a critical knowledge gap, allowing for more informed management decisions. Zooplankton are significant in the food chain structure of the lake. The zooplankton community is composed of both herbivorous species (which feed on phytoplankton) and predatory species (which feed on other zooplankton.)

Samples of both phytoplankton and zooplankton will be collected monthly from the Index and Mid-lake stations. At the Index station monthly phytoplankton samples will include: a 0-105m composite and discreet samples from depths of 5, 20, 40, 60, 75, 90m. At the Mid-lake station monthly phytoplankton samples will include: a 0-100m composite sample and a 150-450m composite. Phytoplankton samples are preserved with an iodine preservative (Lugol's reagent) and counted to the species level when feasible following established TERC protocol (e.g. Hunter et al., 1990; Hunter et al., 1993). Monthly samples of zooplankton will include: a 150m to surface tow at both the Index and Mid-lake stations. Zooplankton samples are preserved with formalin and archived.

Atmospheric deposition of nitrogen and phosphorus (Task 5). The purpose of this task is to provide ongoing information on nutrient loading to the lake via atmospheric deposition. The historical TERC data shows that atmospheric deposition of nitrogen, and to a lesser extent phosphorus, is an important source of nutrients to the lake. Atmospheric deposition also contributes fine particles directly to the lake surface. Atmospheric deposition data from TERC monitoring was utilized in the Tahoe TMDL to help determine estimates of wet deposition loads and to provide additional information on dry loading of nutrients to the lake. Data collected from collectors located on buoys on the lake has proved valuable in providing estimates of N and P loading directly to the lake. Continued collection of atmospheric deposition data is important for updating and applying the Tahoe lake clarity model. Atmospheric deposition monitoring will be continued at TERC's Lower Ward Valley station and on buoys on the lake. Approximately 35 dry bucket samples and 30 wet samples are to be collected over the year at Ward Lake level, 30 dry-bulk samples and approximately 15 snow tube samples are to be collected at the mid-lake station, and approximately 30 dry-bulk samples are to be collected at an additional lake buoy station i.e. TB-4. Samples are to be analyzed for NO_3-N, NH_4-N, TKN, DP and TP.

Monitoring of attached algae or periphyton along the shoreline (Task 6). The purpose of this monitoring is to assess levels of nearshore attached algae (periphyton) growth around the lake. Thick growths of periphyton coat the rocks in the spring in many areas around the lake and bright green filamentous algae occur along portions of the shoreline in the summer. The rate of periphyton growth is an indicator of local nutrient loading and long-term environmental changes. Monitoring trends in periphyton growth is important in assessing local and lake-wide nutrient loading trends. The near shore periphyton can significantly impact the aesthetic, beneficial use of the shore zone in areas where thick growth develops. Nine sites are to be monitored for periphyton biomass a minimum of five times per year. Three of the samplings are to be done between January and June when attached algae growth in the eulittoral zone (0.5m) is greatest; the remaining two samplings are to be done between July – December. Duplicate biomass samples will be taken from natural substrate at each site for a total of 90 samples per year. Biomass is to be reported as chlorophyll *a* and Ash Free Dry Weight (AFDW). Once a year, 39 additional sites will be visited and visual assessment of the level of growth visible near shore (ranking 1-5) will be done.

The additional tasks associated with this project include: project management (Task 1), quality assurance (Task 2), and reporting of data. The summary of % work completed based on a three-year granting period is shown in Table 1.

Table 1. The summary of % work completed (based on a 3 year granting period) for the period July 1, 2010 – June 30, 2013) for each task is listed below:

Task	**% Completion in Quarter** (for full 3 yr granting period)
1 – Project Management	100%
2 – Quality Assurance	100%
3 – Algal Growth Bioassays	100%
4 – Phytoplankton and Zooplankton Analysis	100%
5 – Atmospheric Deposition of Nutrients	100%
6 – Periphyton	100%
7 - Reporting	100%

Task 1. Project Management and Administration

1.1. Project oversight – Entailed sampling coordination, overall project coordination, discussions with staff, assist in data evaluation, interfacing with agency staff, and incorporation of data into other Basin research/monitoring projects.

1.2. Quarterly invoicing – Entails ensuring that contract requirements were met through completion of this quarterly status report and the report was submitted to the SWRCB Project Representative on schedule. Ensure that invoicing is properly carried out.

Task 2. Project Quality Assurance

Standardized QA/QC practices for components were followed as specified in the TRG QA/QC Manual (Janik et al., 1990). For QA/QC applied to periphyton monitoring see “Periphyton Quality Assurance Project Plan” in Hackley et al. (2004). QA/QC procedures for algal bioassays are described in Appendix 7 of Hackley et al. (2007).

A primary objective for the atmospheric deposition quality control samples was to check for potential contamination associated with field monitoring and equipment. Nutrient levels in field blanks were compared with the Method Detection Levels (MDLs) and the source (deionized water) blank sample concentrations to check for levels of contamination. Table 2 presents the results for analyses of atmospheric deposition field quality control samples back to July 1, 2010 and includes any revised or added data since the last report (Hackley et al., 2012). A total of 36 QA/QC samples were collected and analyzed during the period.

Levels of Nitrate nitrogen (NO_3-N) in QA/QC samples were generally very low. 30 of 36 QA/QC samples were at or below the NO_3-N Method Detection Level (MDL) (2 µg/l) and 4 additional samples were slightly elevated (1-2 µg/l above MDL). Two QA/QC samples showed slightly higher contamination: a source blank collected 7/14/10 (NO_3-N = 12 µg/l); and a 7/16/10 WLL Wet field blank (NO_3-N = 6 µg/l). Possible sources of contamination for these samples included: insufficient cleaning of the new sample bottles or Wet bucket or contamination at some stage during analysis. Subsequent to the 7/14/10 and 7/16/10 QA/QC samples, levels of NO_3-N contamination have been very low. Rigorous cleaning of equipment has been maintained and NO_3-N contamination has been very infrequent.

Ammonium nitrogen in atmospheric deposition QA/QC samples was also generally at or below the MDL in atmospheric deposition QA/QC samples. 24 of 36 samples were at or below the NH_4-N MDL of 3 µg/l. Eight samples had slightly elevated NH_4-N concentrations (1-3 µg/l above the MDL). QA/QC samples prepared 7/14/10-7/16/10 all had some level of NH_4-N contamination (ranging from 2 to 23 µg/l above MDL). There was a general source of NH_4-N contamination for this particular set of QA/QC samples. QA/QC samples have otherwise generally been very low with only one other QA/QC sample with a moderately elevated NH_4-N of 12 µg/l).

TKN in atmospheric deposition QA/QC samples was also generally low. 25 of 32 samples were at or below the MDL of 40 µg/l. One set of 4 QA/QC samples (collected 6/21/12-6/22/12) had roughly similarly elevated levels of TKN (ranging from 30-46 µg/l above the MDL). The deionized water or another common source of TKN may have contributed to this contamination. The problem did not persist however as a Field Blank run a week later showed no TKN contamination. Other QA/QC samples with elevated TKN included some samples collected 7/14/10-7/16/10 which also showed some NH_4-N contamination (e.g. a WLL Dry 7/15/10 field blank (TKN= 380 µg/l) and a TB-1 ST field blank (TKN= 46 µg/l)). A test was done 12/27/12, to check the impacts of different levels of bottle and equipment cleaning on Source Blank N and P concentrations. In this test, "Source Blank 1" in a new sample bottle pre-rinsed in 0.1N HCl and 7-8X with deionized water, had elevated TKN (97 µg/l, provisional data), whereas a new sample bottle further cleaned using a Liquinox soap scrubbing, had no TKN contamination. Though the test was limited in scope it suggested the possibility that some new bottles have TKN contamination which may be removed by scrubbing in Liquinox. However, overall, TKN contamination in samples has been infrequent in the past.

Levels of dissolved inorganic P (SRP) in QA/QC samples were very low to non-measurable, while DP and TP (which includes both inorganic + organic P) were slightly elevated in most QA/QC samples. Levels of SRP in 31 of 36 samples were at or below the MDL (1 µg/l). SRP in the remaining 5 QA/QC samples were only 1 µg/l above the MDL indicating very little SRP contamination overall.

In contrast, a large number of QA/QC samples had slightly elevated levels of DP and TP relative to the MDL (2 µg/l). 26 of 36 DP samples were elevated to 1-4 µg/l above the MDL and 31 of 36 TP samples were elevated 1-4 µg/l above the MDL. Most of the source blanks had slightly elevated DP and TP which may indicate that the either the deionized water or the sample bottles had some DP or TP contamination. Alternatively, low-level contamination during analysis is another possibility. The QA/QC test done 12/27/12 was not conclusive relative to DP and TP contamination sources. Source Blank #2 (which was scrubbed with Liquinox solution, then acid and deionized water rinsed) had slightly elevated DP, TP (3 µg/l), compared with Source Blank #1 (acid and deionized water rinsed) for which DP and TP were not elevated above MDL (2 µg/l). These small differences may not have been significant. Most of the discussion with respect to atmospheric deposition of P in this report focuses on loading of SRP, which has not shown similar low level contamination in QA/QC analyses.

Table 2. Quality Control samples collected for the atmospheric deposition monitoring July 14, 2010 to March 28, 2013 (shaded and underlined values >MDL).

QC Sample	Date	Type	Vol. liters	NO_3-N (µg/l)	NH_4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
Source Blk	7/14/10 11:10	Source Blk	-	12	5	29	1	2	6	1
FBWLLD	7/15/10 14:15	Field Blk	4.017	0	26	380	2	3	5	2
FBTB1D	7/15/10 13:50	Field Blk	4.015	1	9	0	1	2	3	3
FBTB1ST	7/15/10 13:30	Field Blk	0.5	1	6	46	2	3	1	4
FBWLLW	7/16/10 10:30	Field Blk	0.5	6	8	34	2	1	5	5
Source Blk	11/15/10 15:15	Source Blk	-	1	2	0	0	2	6	1
FBTB1D	11/16/10 15:00	Field Blk	4.0	1	2	0	0	3	4	3
FBWLLD	11/16/10 16:10	Field Blk	4.0	3	4	30	0	4	4	2
FBWLLW	11/17/10 10:45	Field Blk	0.5	2	3	0	0	4	3	6
Source Blk	11/30/10 15:15	Source Blk	-	2	3	8	0	2	5	1
FBWLLW	11/30/10 15:25	Field Blk	0.5	2	4	26	0	3	3	7
Source Blk	4/13/11 14:25	Source Blk		1	2	8	0	2	2	1
FBWLLD	4/14/11 15:45	Field Blk	4.0	3	3	12	1	5	5	2
FBTB1D	4/14/11 16:00	Field Blk	4.0	2	3	15	1	4	5	3
FBTB1ST	4/14/11 15:25	Field Blk	0.5	2	3	20	1	3	4	4
Source Blk	8/18/11 16:15	Source Blk	-	1	2	0	0	2	3	1
FBTB1D	8/19/11 18:15	Field Blk	4.0	1	3	0	0	3	3	2
FBTB1ST	8/19/11 18:30	Field Blk	0.5	4	3	2	0	3	3	3
Source Blk	3/14/12 14:30	Source Blk	-	1	1	5	0	3	3	1
FBWLLD	3/15/12 16:30	Field Blk	4.0	2	3	0	2	4	3	2
FBTB1D	3/15/12 16:50	Field Blk	4.0	2	4	18	1	3	4	3
FBTB1ST	3/15/12 16:00	Field Blk	0.5	1	12	17	2	4	4	4
Source Blk	6/21/12 16:00	Source Blk		1	4	66	0	4	4	1
FBWLLD	6/22/12 14:05	Field Blk	4.0	3	6	76	1	5	5	2
FBTB1D	6/22/12 13:15	Field Blk	4.0	1	3	63	0	5	5	3
FBTB1ST	6/22/12 13:45	Field Blk	0.5	2	3	60	0	5	5	4
FBWLLW	6/28/12 10:30	Field Blk	0.5	2	2	10	0	6	6	6
Source Blk1	12/27/12 13:15	Source Blk1		1	3	97	0	2	2	9
Source Blk2	12/27/12 13:30	Source Blk2		1	4	21	0	3	3	10
Source Blk3	12/27/12 13:45	Source Blk3		1	3	7	0	3	2	11
FBTB1D	12/28/12 12:00	Field Blk	4.0	1	3	15	0	2	2	12
FBTB1ST	12/28/12 12:35	Field Blk	0.5	2	3	33	0	2	3	13
Source Blk	3/26/13 12:00	Source Blk		1p	1p	NA	1p	3	3	
FBWLLD	3/28/13 17:05	Field Blk		1p	2	NA	1p	5	6	14
FBTB1D	3/28/13 16:35	Field Blk		1p	1	NA	0p	4	4	15
FBTB1ST	3/28/13 16:15	Field Blk		2p	1	NA	0p	4	4	16
MDL				2	3	40	1	2	2	8

Notes

1. Deionized water system source blank.
2. Ward Lake Level Dry Field Blank, ~4 liters deionized water to sealed Dry bucket for approx. 24 hours.
3. TB-1 Dry-Bulk Field Blank, ~4 liters deionized water to sealed Dry-Bulk bucket for approx. 24 hours.
4. TB-1 Snow Tube (ST) Field Blank, 0.5 liters deionized water to sealed ST for approx. 24 hours.

5. Ward Lake Level Wet Field Blank, 0.5 liters deionized water to Wet bucket in Aerochem Metrics sampler, overnight during dry period. Note, significant construction ongoing at station. Potential for impact on station results.
6. Ward Lake Level Wet Field Blank, 0.5 liters deionized water to Wet bucket in Aerochem Metrics sampler, for approximately 2 days during dry period.
7. Equipment cleaning blank, new intern cleaned bucket, then added 0.5 liters deionized water and processed.
8. MDL = Method Detection Limit
9. Source Blank 1, deionized water system blank to new 250ml HDPE bottles, rinsed 1X with 1N HCl, 7-8X with deionized water as usual.
10. Source Blank 2, deionized water system blank to new 250ml HDPE bottles, Liquinox soap-scrubbed then rinsed 1X with 1N HCl, 7-8X with deionized water.
11. Source Blank 3, deionized water system blank, portion for soluble nutrients filtered through precombusted GF/F filter, in cleaned filtration apparatus, then transferred to new 250ml HDPE bottles, Liquinox soap-scrubbed then rinsed 1X with 1N HCl, 7-8X with deionized water.
12. TB-1 Dry-Bulk Field Blank, ~4 liters deionized water to sealed Dry-Bulk bucket for approx. 24 hours, portion for soluble nutrients filtered through precombusted GF/F filter, samples placed in new 250ml HDPE bottles, Liquinox soap-scrubbed then rinsed 1X with 1N HCl, 7-8X with deionized water.
13. TB-1 Snow Tube (ST) Field Blank, 0.5 liters deionized water to sealed ST for approx. 24 hours, portion for soluble nutrients filtered through precombusted GF/F filter, samples placed in new 250ml HDPE bottles, Liquinox soap-scrubbed then rinsed 1X with 1N HCl, 7-8X with deionized water.

"p" – Provisional data, subject to revision.

Task 3. Algal Growth Bioassays

The response of Lake Tahoe water to nitrogen (N) and phosphorus (P) enrichment has been tested using algal growth bioassays since the 1960's. The record of bioassays for Lake Tahoe has proven extremely useful for evaluating long-term changes. When combined with lake chemistry data and information on atmospheric and watershed nutrient loading ratios, these simple enrichment bioassays allow us to better understand patterns of nutrient limitation in Lake Tahoe.

The response of Lake Tahoe water to nitrogen (N) and phosphorus (P) enrichment was tested using an algal growth bioassay procedure. In a typical bioassay, lake water is collected from the upper photic zone (0-20 m water was used for these bioassays), pre-filtered through 80 µm mesh netting to remove the larger zooplankton and returned to the lab. The water is distributed among experimental flasks to which small amounts of N (20 µg N/L) or P (at two different levels: 2 µg P/L and 10 µg P/L) or the combination of both N and P are added. One set of flasks is left as a "control" in which no nutrients are added and all treatments are replicated in triplicate. The flasks are then placed in a laboratory incubator under fluorescent lighting at ambient lake temperature and day length, and growth response of phytoplankton is measured over a period of six days. Relative growth was assessed by measuring changes in algal biomass (i.e. fluorescence or chlorophyll *a*). Treatments are "stimulatory" if the mean growth response exceeds the control at the $p \leq 0.05$ level of significance. (See Appendix 7 in the 2004-2007 Final Report (Hackley et al., 2007) for a more detailed description of the bioassay method).

Summary of Results 2010-2013

In this summary we present the results for all bioassay experiments done during the period July 1 2010 to May 1, 2013. Twelve total bioassays were done on a schedule of approximately one bioassay every three months, the data is summarized in Tables 3a-3l. Table 4 summarizes the results for all bioassays done 2002 to 2013.

Table 3a. Bioassay done using 2,5,8,11,14,17,20m lake water collected 8/17/10.

Treatment	Day 5 Mean Fluorescence	Std. Dev.	n	Day 5 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.216	0.008	3	100	
N(20)	0.307	0.020	3	142	*
P(2)	0.231	0.012	3	107	
P(10)	0.234	0.005	3	108	
N(20)P(2)	0.381	0.005	3	176	*
N(20)P(10)	0.388	0.091	3	179	*

Note – used Day 5 fluorescence results

Table 3b. Bioassay done using 2,5,8,11,14,17,20m lake water collected 11/9/10.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.261	0.010	3	100	
N(20)	0.338	0.006	3	130	*
P(2)	0.268	0.014	3	103	
P(10)	0.268	0.010	3	103	
N(20)P(2)	0.501	0.011	3	192	*
N(20)P(10)	0.646	0.008	3	248	*

Table 3c. Bioassay done using 2,5,8,11,14,17,20m lake water collected 1/21/11.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.502	0.004	3	100	
N(20)	0.517	0.008	3	103	
P(2)	0.564	0.008	3	112	*
P(10)	0.564	0.007	3	112	*
N(20)P(2)	0.870	0.009	3	173	*
N(20)P(10)	0.965	0.017	3	192	*

Table 3d. Bioassay done using 2,5,8,11,14,17,20m lake water collected 5/20/11.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.465	0.013	3	100	
N(20)	0.557	0.028	3	120	*
P(2)	0.479	0.034	3	103	
P(10)	0.455	0.015	3	98	
N(20)P(2)	0.784	0.027	3	169	*
N(20)P(10)	0.959	0.040	3	206	*

Table 3e. Bioassay done using 2,5,8,11,14,17,20m lake water collected 7/11/11.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.290	0.003	3	100	
N(20)	0.502	0.010	3	173	*
P(2)	0.292	0.003	3	101	
P(10)	0.306	0.008	3	106	
N(20)P(2)	0.841	0.009	3	290	*
N(20)P(10)	1.053	0.025	3	364	*

Note – used Day 5 fluorescence results

Table 3f. Bioassay done using 2,5,8,11,14,17,20m lake water collected 11/16/11.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.277	0.010	3	100	
N(20)	0.319	0.012	3	115	*
P(2)	0.254	0.003	3	92	
P(10)	0.279	0.028	3	101	
N(20)P(2)	0.380	0.008	3	137	*
N(20)P(10)	0.514	0.011	3	185	*

Table 3g. Bioassay done using 2,5,8,11,14,17,20m lake water collected 1/25/12.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.469	0.015	3	100	
N(20)	0.458	0.011	3	98	
P(2)	0.590	0.023	3	126	*
P(10)	0.589	0.035	3	126	*
N(20)P(2)	0.627	0.035	3	134	*
N(20)P(10)	0.612	0.019	3	131	*

Table 3h. Bioassay done using 2,5,8,11,14,17,20m lake water collected 4/23/12.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.530	0.012	3	100	
N(20)	0.580	0.008	3	109	*
P(2)	0.785	0.033	3	148	*
P(10)	0.774	0.012	3	146	*
N(20)P(2)	0.802	0.021	3	151	*
N(20)P(10)	0.772	0.024	3	146	*

Table 3i. Bioassay done using 2,5,8,11,14,17,20m lake water collected 7/26/12.

Treatment	Day 5 Mean Fluorescence	Std. Dev.	n	Day 5 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.253	0.012	3	100	
N(20)	0.342	0.038	3	138	*
P(2)	0.267	0.015	3	107	
P(10)	0.241	0.008	3	97	
N(20)P(2)	0.471	0.016	3	190	*
N(20)P(10)	0.497	0.020	3	200	*

Note – used day 5 results

Table 3j. Bioassay done using 2,5,8,11,14,17,20m lake water collected 10/17/12, Day 4.

Treatment	Day 4 Mean Fluorescence	Std. Dev.	n	Day 4 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.271	0.010	3	100	
N(20)	0.283	0.009	3	117	
P(2)	0.331	0.009	3	137	*
P(10)	0.404	0.011	3	167	*
N(20)P(2)	0.340	0.019	3	141	*
N(20)P(10)	0.419	0.013	3	173	*

Note – used day 4 results

Table 3k. Bioassay done using 2,5,8,11,14,17,20m lake water collected 2/4/13, Day 6.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.412	0.007	3	100	
N(20)	0.395	0.002	3	96	
P(2)	0.498	0.012	3	121	*
P(10)	0.498	0.012	3	121	*
N(20)P(2)	0.525	0.013	3	127	*
N(20)P(10)	0.520	0.022	3	126	*

Table 3l. Bioassay done using 2,5,8,11,14,17,20m lake water collected 4/25/13, Day 6.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response =“*”
Control	0.355	0.037	3	100	
N(20)	0.425	0.010	3	120	*
P(2)	0.343	0.008	3	97	
P(10)	0.343	0.008	3	97	
N(20)P(2)	0.749	0.022	3	211	*
N(20)P(10)	0.871	0.018	3	245	*

Table 4. Summary of N and P bioassay treatment responses as % of control done in: (a) 2002, (b) 2003, (c) 2004, (d) 2005, (e) 2006, (f) 2007, (g) 2008, (h) 2009, (i) 2010, (j) 2011, (k) 2012, (l) 2013. Treatment responses statistically significantly different from the control at the p≤.05 level are indicated with borders and shading.

Table 4a. 2002 Bioassays

	2/7/02	4/1/02	6/12/02	8/30/02	10/28/02	12/30/02
Control	100	100	100	100	100	100
N20	104	97	101	101	93	101
P2	154	-	-	108	-	116
P10	135	157	104	100	113	110
N20P2	139	-	-	157	151	118
N20P10	138	178	180	231	238	116

Table 4b. 2003 Bioassays

	1/30/03	2/26/03	4/8/03	5/21/03	6/16/03	7/10/03	8/29/03	10/20/03	12/3/03
Control	100	100	100	100	100	100	100	100	100
N20	101	98	102	138	116	141	129	101	107
P2	112	129	168	101	99	100	100	100	98
P10	114	134	181	98	104	106	105	106	104
N20P2	141	136	178	253	248	221	196	187	124
N20P10	159	147	190	264	297	317	280	334	142

Table 4c. 2004 Bioassays

	1/5/04	4/23/04	8/20/04	10/28/04	12/11/04
Control	100	100	100	100	100
N20	100	97	112	104	99
P2	133	112	101	103	134
P10	135	122	112	114	150
N20P2	132	153	210	127	161
N20P10	134	202	248	185	173

Table 4d. 2005 Bioassays

	2/16/05	4/15/05	6/10/05	8/15/05	10/20/05	12/15/05
Control	100	100	100	100	100	100
N20	99	97	109	105	109	113
P2	121	193	99	109	110	102
P10	122	233	105	105	121	108
N20P2	123	214	176	177	143	162
N20P10	127	241	239	258	193	190

Table 4e. 2006 Bioassays

	2/21/06	4/12/06	6/19/06	8/9/06	10/31/06
Control	100	100	100	100	100
N20	98	98	84	117	98
P2	181	155	85	113	100
P10	214	162	91	141	113
N20P2	195	155	153	120	135
N20P10	200	161	253	173	273

Table 4f. 2007 Bioassays

	1/9/07	3/2/07	4/13/07	6/12/07	9/27/07	11/9/07
Control	100	100	100	100	100	100
N20	99	100	97	100	143	114
P2	142	112	131	113	91	104
P10	143	112	136	93	89	108
N20P2	143	120	138	145	202	150
N20P10	146	118	136	176	284	180

Table 4g. 2008 Bioassays

	1/30/08	4/24/08	7/24/08	10/27/08
Control	100	100	100	100
N20	96	99	269	99
P2	121	104	109	102
P10	121	102	105	100
N20P2	127	99	293	124
N20P10	127	102	318	171

Table 4h. 2009 Bioassays

	1/30/09	5/1/09	8/17/09	11/13/09
Control	100	100	100	100
N20	98	100	178	124
P2	140	153	105	103
P10	144	166	109	103
N20P2	154	164	285	160
N20P10	159	182	338	207

Table 4i. 2010 Bioassays

	1/28/10	4/15/10	8/17/10*	11/9/10
Control	100	100	100	100
N20	100	100	142	130
P2	141	152	107	103
P10	144	162	108	103
N20P2	147	164	165	192
N20P10	150	171	172	248

Table 4j. 2011 Bioassays

	1/21/11	5/20/11	7/11/11*	11/16/11
Control	100	100	100	100
N20	103	120	173	115
P2	112	103	101	92
P10	112	98	106	101
N20P2	173	169	290	137
N20P10	192	206	364	185

Table 4k. 2012 Bioassays

	1/25/12	4/23/12	7/26/12	10/17/12
Control	100	100	100	100
N20	98	109	138	117
P2	126	148	107	137
P10	126	146	97	167
N20P2	134	151	190	141
N20P10	131	146	200	173

Table 4l. 2013 Bioassays

	2/4/13	4/25/13
Control	100	100
N20	98	120
P2	126	97
P10	126	97
N20P2	134	211
N20P10	131	245

***- Note: for 8/17/10, 7/11/11, 7/26/12 bioassays, Day 5 results were used to determine treatments statistically significantly different from the control; and for the 10/17/12 bioassay Day 4 results were used. For other bioassays Day 6 results were typically used.**

During the period July 2010 to April 2013, nitrogen (N) added alone stimulated phytoplankton growth more frequently than phosphorus (P) added alone, while the combination of N and P added together always increased phytoplankton growth. Nitrogen added alone increased phytoplankton growth in 8 of 12 bioassays, while phosphorus added alone increased growth in 5 of 12 bioassays. The combination of N+P added together enhanced phytoplankton growth in all bioassays done during the period (12 of 12 bioassays).

There were some consistent patterns for when N or P limitation occurred during the monitoring period (July 2010 to April 2013). P limitation consistently occurred during the winter- early spring period (January – early April). During this period, the addition of P alone enhanced phytoplankton growth in 3 of 3 bioassays. N limitation (where N added alone stimulated phytoplankton growth) occurred in all four bioassays done during the late spring –summer period (May-September).

Bioassay responses during two other periods (late April; and October – December) were variable. For bioassays done in late April, both N and P added individually stimulated growth in the 2012 bioassay, while in the late April 2013 bioassay, N alone was stimulatory. During the October – December period, the response to N or P alone was also variable, with N limiting growth in 2 of the bioassays and P limiting in one. These times of the year tend to be transition periods when lake stratification is developing (late April) or breaking down (October – December).

Over the longer time period of eleven years (2002-2012), the pattern of P limitation in the January – April period has remained consistent, but patterns for N and P limitation at other times of the year have been more variable. Figure 1 presents the results of bioassays done during this period, grouped by the time periods (January – April; May – September; October to December).

These periods roughly correspond to different conditions of lake stratification i.e.: January to April (no thermal stratification to early onset of stratification); May to September (continued development of stratification to fully stratified); October to December (breakdown of stratification). The presence of stratification has ramifications for distribution of nutrients and phytoplankton in the water column. For instance during periods of stratification, nutrients are less easily mixed upwards into surface waters to be accessible to the phytoplankton (it should be noted upwelling of nutrients can occur during summer winds in some areas). When stratification breaks down, nutrients and phytoplankton, located below the stratified layer may be mixed upwards in the water column. Patterns apparent from this longer-term data set show:

1) For 2002-2012 bioassays, during the period January – April, P limitation continues to be prevalent with P alone stimulatory in 95% percent of the bioassays.

2) During May to September, N limitation was more frequent (50% of bioassays) than P limitation (10% of bioassays). (N limitation during this period has occurred every year for the last five years). There have also been periods during May to September when neither N nor P added alone stimulated growth but a combination of N+P added together did (i.e. summers of 2002, 2004, 2005).

3) During October to December, P limitation occurred in 47% of the bioassays, N limitation occurred in 33% of the bioassays and the combination of N+P always increased growth.

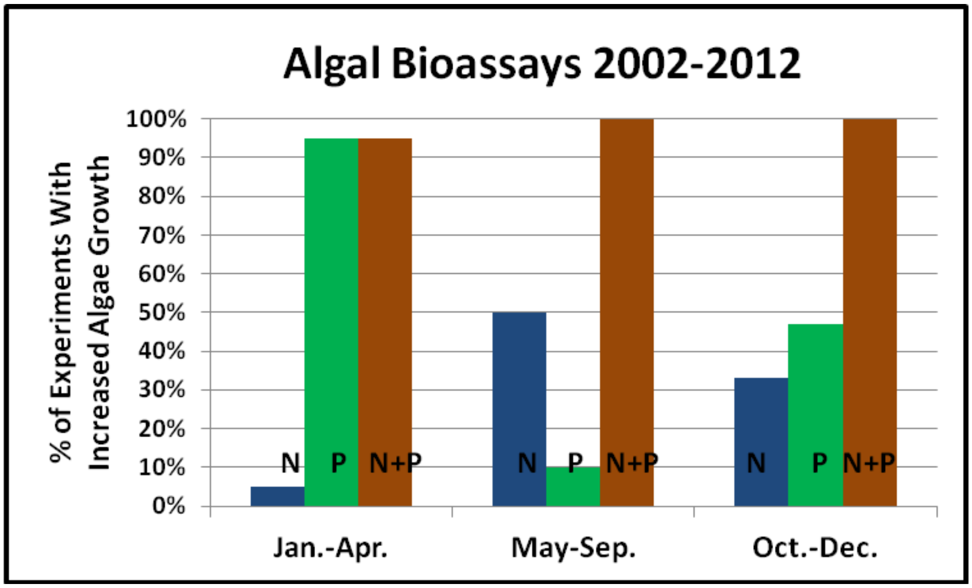


Figure 1. Percentage of bioassays done during three periods: Jan.-April (unstratified – onset of stratification period), May – Sept. (stratified period), and Oct. – Dec. (breakdown of stratification) in which N, P or N+P significantly increased phytoplankton growth.

The results of the Lake Tahoe bioassay monitoring through time shows that phytoplankton response to N or P can be dynamic, showing some variation through time. Goldman et al. (1993) observed a shift in bioassay response from apparent co-limitation by N and P in bioassays done in the 60’s and 70’s to apparent P limitation in the 1980’s. The data from the recent 2002-2013 period shows evidence of both N and P limitation at certain times of the year, with the combination of N + P added together nearly always stimulatory.

The bioassays have shown that the Lake Tahoe phytoplankton continue to be sensitive to additions of N and P. The combination of N+P nearly always increased phytoplankton growth during 2002-2013. This observation is strong evidence that nutrient load should be controlled as called for as part of the Lake Tahoe TMDL. Decisions on control of nutrient inputs to Lake Tahoe should not be made on the basis of these growth bioassays alone. Increased nutrient loading is also thought to affect the growth of attached algae (periphyton) on hard surfaces in the nearshore. The control of N and P input therefore is an important management strategy with respect to both the phytoplankton and periphyton.

Summary Points for Bioassay Monitoring 2011-2013

1. **During the period July 2010 to April 2013, either nitrogen or phosphorus added alone stimulated algal growth at various times during each year and the combination of N and P added together was always stimulatory. Nitrogen added alone stimulated phytoplankton growth in 8 of 12 bioassays, while phosphorus added alone increased growth in 5 of 12 bioassays. The combination of N+P added together stimulated phytoplankton growth in all bioassays done during the period (12 of 12 bioassays).**

2. **There appeared to be some seasonality to when N or P limitation occurred during July 2010 to April 2013. P limitation consistently occurred during the winter- early spring period (January – early April), as the addition of P alone stimulated phytoplankton growth in 3 of 3 bioassays. N limitation appeared to be prevalent in the late spring –summer period (May-September), as N added alone was stimulatory in 4 of 4 bioassays.**

3. **The results of the Lake Tahoe bioassay monitoring through time shows that phytoplankton response to N or P can be dynamic, showing some variation through time. Goldman et al. (1993) observed a shift in bioassay response from apparent co-limitation by N and P in bioassays done in the 60’s and 70’s to apparent P limitation in the 1980’s. The data from the recent 2002-2013 period shows evidence of both N and P limitation at certain times of the year, with the combination of N + P added together nearly always stimulatory.**

4. **The bioassays have shown that the Lake Tahoe phytoplankton continue to be sensitive to additions of N and P. The combination of N+P nearly always increased phytoplankton growth during 2002-2013. This observation is strong evidence that nutrient load should be controlled as called for as part of the Lake Tahoe TMDL. Decisions on control of nutrient inputs to Lake Tahoe should not be made on the basis of these growth bioassays alone. Increased nutrient loading is also thought to affect the growth of attached algae (periphyton) on hard surfaces in the nearshore. The control of N and P input therefore is an important management strategy with respect to both the phytoplankton and periphyton.**

Task 4. Enumeration and Identification of Phytoplankton

The phytoplankton community of Lake Tahoe is dynamic, changing seasonally and between years. Seasonal trends in the population are consistent and repeatable to some degree. However, there are other trends which remain elusive. Inter-annual variability blurs results and short-term analysis can often lead to incorrect conclusions. Long-term change can be seen over decades of data collection. This longer expanse of time leads to a higher degree of certainty and can answer questions about true change to the phytoplankton population.

Phytoplankton species composition predictably changes with the season. Annual species succession is triggered by both chemical and physical events in euphotic waters. The calendar year begins (January) with a low abundance, mixed population of diverse cells. Gradually throughout the early spring the diatoms begin to increase. The spring diatom peak can occur as early as April and as late as June. Diversity in the community begins to decrease as the summer approaches but diatoms remain dominant throughout the summer and into the fall. Once the lake starts mixing in the upper waters due to storm events (November), the phytoplankton community drastically changes with diatom dominance terminated. The early winter populations return to the low abundance but highly diverse community.

Tahoe's clarity and depth add another dimension to the phytoplankton community which most other lakes do not have. By July the lake is thermally stratified and the cells locked within definable vertical 'zones' are well adapted to life in that location. The upper waters of the lake provide the most challenging environment for cell survival. While sunlight is plentiful, often nutrients are not abundant. The community in the region above 20 m is less diverse. However, often the highest density of cells are found in this region of the water column. The small centric diatoms have physiological characteristics that are not deterred by lower nutrient concentrations and high light. They can capitalize on the fact that there is less competition for resources and perhaps less predation. Other groups represented in this region are chlorophytes and chrysophytes with a few dinoflagellates. From 40-60m the community is part of the deep chlorophyll maximum. There are more species representing more algal groups. The largest cells are located in this region, many of them flagellates. Even though the light regime is challenging, the phytoplankton have opted for a more nutrient-rich environment. Living cells can be found even in the deepest waters of Tahoe but most of the cells below 75m are mostly sinking populations from shallower waters.

Lake Tahoe phytoplankton abundance over the previous three years (Figure 2) has followed the patterns described above. The summer population of diatoms in 2012 was much less than the previous two years. This was a great example of inter-annual variability. Even though the basic group structure and inter-relationships in the assemblage changed very little from year to year, the abundance and species composition was variable. The small centric *Cyclotella spp*. dominated the populations throughout the peak periods in spring and continued throughout the summer. In June 2012 community abundance was equal in numbers to the previous years. However, by July the population of diatoms had crashed. This drop can't be explained by any other parameters which we measure, it remains a mystery. The diatom population recovered a bit in October but the abundance numbers for the entire year were lower. The other discrepancy seen in the population of 2012 was the timing of the peak chlorophytes. In 2010 and 2011 the green algae were abundant throughout the summer and autumn. Whereas in 2012-2013 the chlorophytes were highest in January – March.

The total phytoplankton bio-volume (Figure 3) is weighted in favor of cells that are larger in size. These cells are sometimes less plentiful and so analysis based solely on species density will not reflect their community impact. Larger cells can play an important role in the function of the community. The dinoflagellate group fits this description. In 2010 and 2011 this group of phytoplankton were present every month of the year. In 2012 the dinoflagellates were doing well during August but with much shorter longevity that the other two years. The two main dinoflagellates were the large *Gymnodinium fuscum* and the much smaller *Peridinium inconspicuum*.

During January and February 2011 the large centric diatom, *Stephanodiscus alpinus* was dominant. The next year, in January 2012, there was a bloom of the pennate diatom *Asterionella formosa*. The cells were colonial and once again relatively large. They contributed to the elevated bio-volume of diatoms during those months. By contrast, in January 2013, four diatom species shared dominance but their numbers were so low that they did not have large influences on the total sample bio-volume.

Cryptophyte importance was also highlighted in the bio-volume graphs, with proportionally more emphasis during the winter months of all three years. This would include the two main species, *Cryptomonas sp.* and *Rhodomonas lacustris*. Chrysophytes were also important to the overall bio-volume of the community. This group was represented every month of the year but at times (usually summer months) the population was an opportunistic bloomer. *Dinobryon sociale var. americanum* has an advantageous skill for nutrient uptake when the concentrations are very low.

Discussion

The last three years of tracking phytoplankton populations have generated some discussion about possible changes in the trophic status of Lake Tahoe. High abundance of the summer *Cyclotella spp*. was alarming because this cell density was rare in Lake Tahoe. Just when the alarms were about to sound, the summer of 2012 was rather mundane. This inter-annual variability is common in Tahoe because of its complexity: spatially, chemically, physically, and biologically.

One of the most important considerations when analyzing phytoplankton results is to allow for inter-annual variability and not try to formulate conclusions based on a collection of data with only a 3-5 years of observation. Additionally, it is important to consider the phytoplankton community at the species level because change can be subtle. The past three years have shown dramatic changes in phytoplankton abundance and bio-volume but the changes have not been consistent. The species involved have not always been the same and the overall impact on the community has not been lasting. It is only through thoughtful consideration of a long-term data set and observation at a detailed species level that trends which foretell lasting trophic changes can be made. It has been proposed that near-shore observations of the phytoplankton might yield quicker, more precise results and become a valuable tool for prediction. A lot of the perturbation happening in Tahoe’s waters come from land and shallow water areas. Phytoplankton and attached algae are the first producers in the food chain which respond to these disturbances. Even though the effect on the lake ‘proper’ is not clear, the response in the near-shore regions should be more intense. Indicator phytoplankton species could give clues to regional nutrient changes which could later trigger a problem in the entire lake.

Even in the deeper regions of Tahoe the algal groups in relation to one another have shifted over time (Figure 4). Since the early 1980's the proportion of diatoms has grown relative to the other groups. The chrysophyte populations have decreased. Chlorophytes have been variable but with some tendencies toward greater importance in the community. Cryptophytes and dinoflagellates remain fairly consistent.

The diatoms, being the dominant phytoplankton group for much of the year, deserves special scrutiny (Figure 5). Six genera of diatoms are the major players. Half of them have morphological characteristics which are long, narrow cells (or pennates). The remaining three genera are round, centric cells. In the last decade, fewer pennate diatoms like *Achnanthes, Asterionella, and Synedra* have been seen. Clearly, the centric diatoms, *Cyclotella* in particular, are on the increase. (See Figure 6 for photos of *Asterionella formosa*, *Cyclotella gordonensis* and other common Lake Tahoe phytoplankton).

Quite a bit of this re-organization can be attributed to the changing thermal structure of the water column where there is more resistance to mixing in the euphotic zone (Winder et al., 2009). There are longer and stronger periods of stratification, possibly due to climate change. These conditions favor cells which are good competitors for nutrients and can maintain their vertical position in the water column. Functionally, smaller cells, flagellates, colonial formations, filamentous strands, and cells with oil inclusion have been increasing. All of these morphological adaptations reduce sinking rates.

Cyclotella spp. are functionally adapted for maintaining their position in the water column. *C. glomerata* and *C. gordonensis* are small cells between 4-5 µm in size. With the lack of mixing, during the optimal growth period, these cells have exploited their opportunity and populations have dramatically increased over prior years.

Even though climate change may be the driving force behind long-term change, its effects will not always be reflected every year in the same manner. Monitoring algal changes using gross parameters like chlorophyll and biomass will not provide the information necessary to predict or interpret the results. The answers are in the community dynamics. Tahoe phytoplankton have changed over time but to reach this conclusion we had to look at the community level of organization. To find our answers, we've had to look smaller and examine a more detailed taxonomic level to find the reasons behind the change.

Task 4 b. Archiving of Zooplankton samples.

During the period July 1, 2010 to May 31, 2013, 59 zooplankton samples were collected and archived for possible later enumeration. These samples included thirty 150-0m tows at the Index station and twenty nine 150-0m tows at the Mid-lake station.

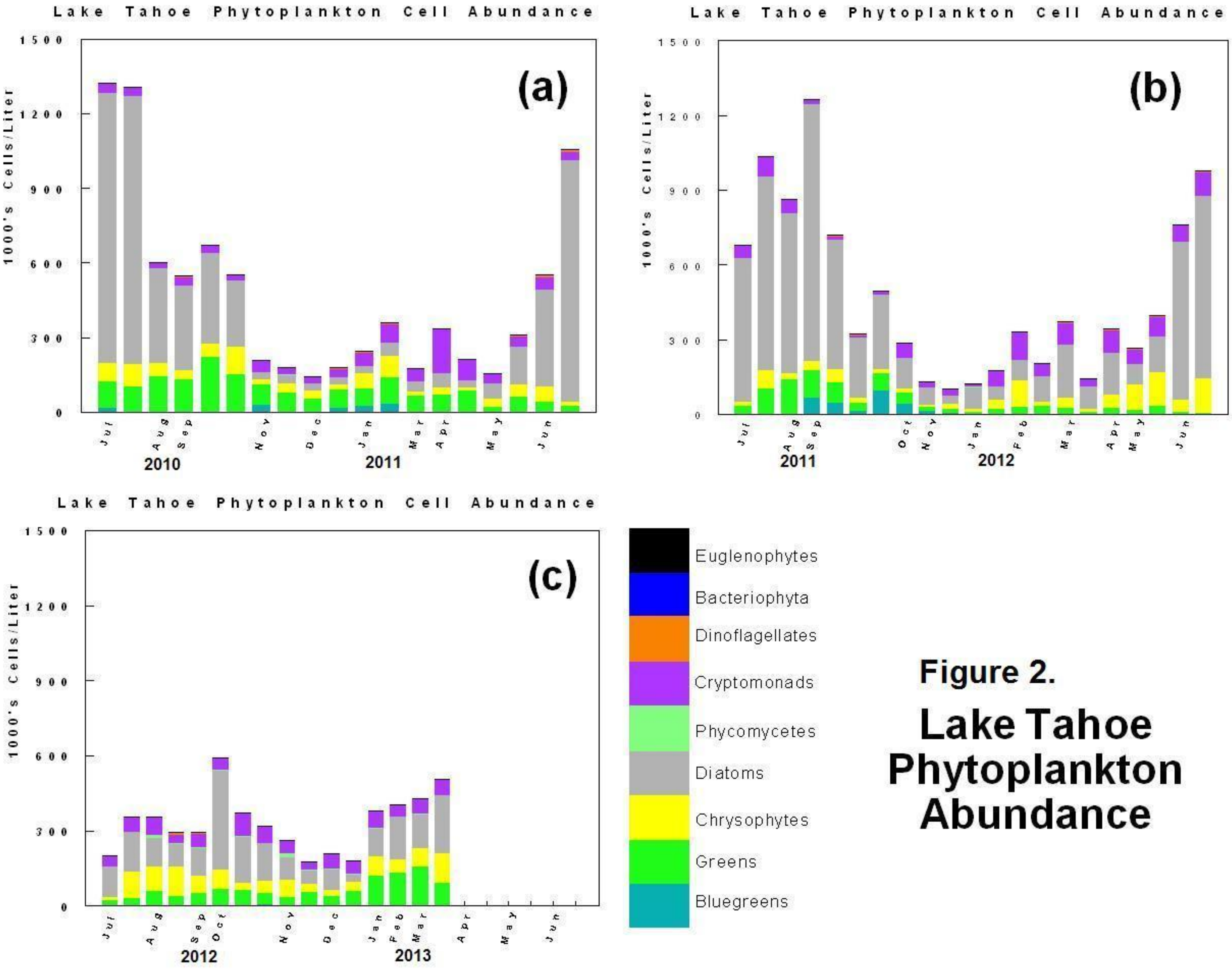


Figure 2.

Lake Tahoe Phytoplankton Abundance

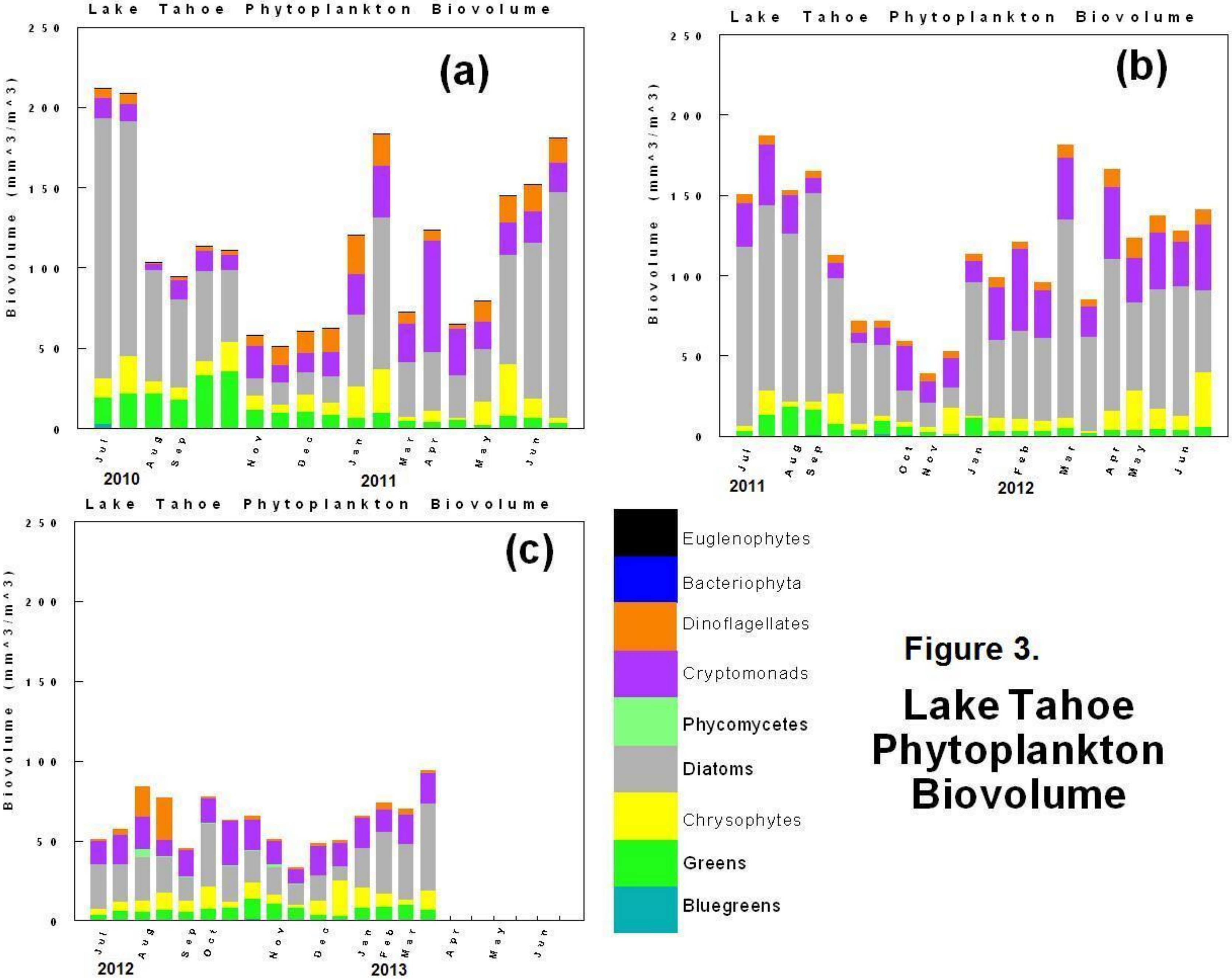


Figure 3.

Lake Tahoe Phytoplankton Biovolume

Figure 4. Algal Groups as a Fraction of Total Population

1982 to 2012

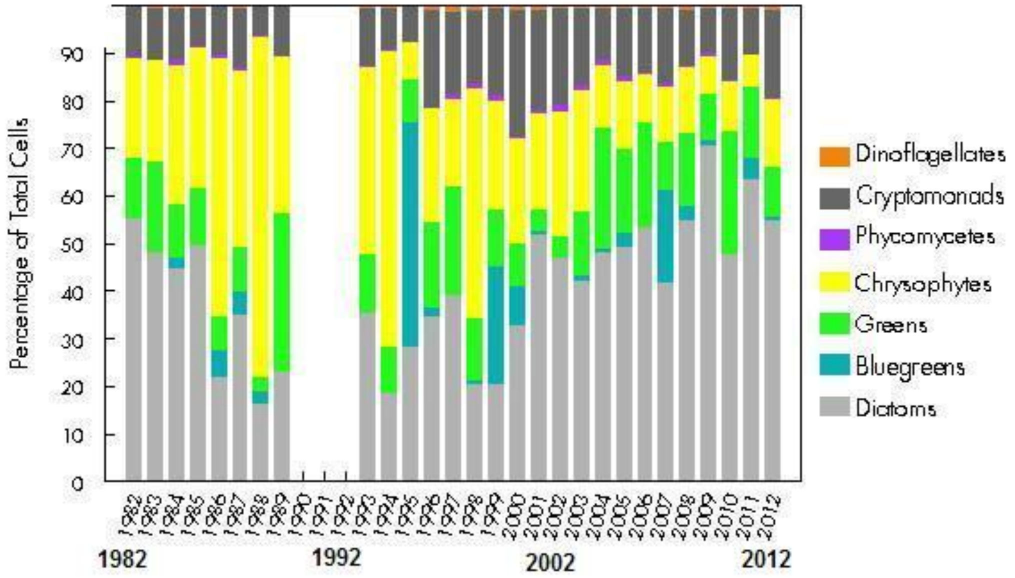
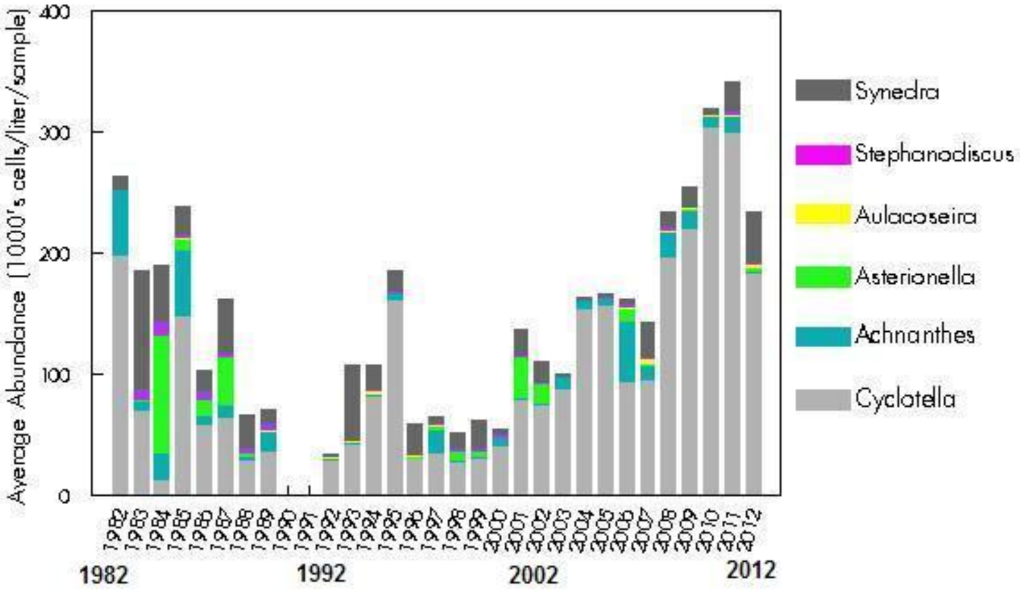
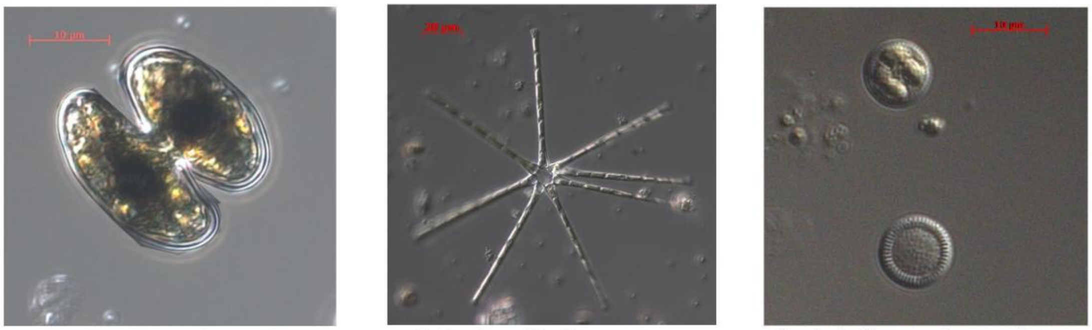


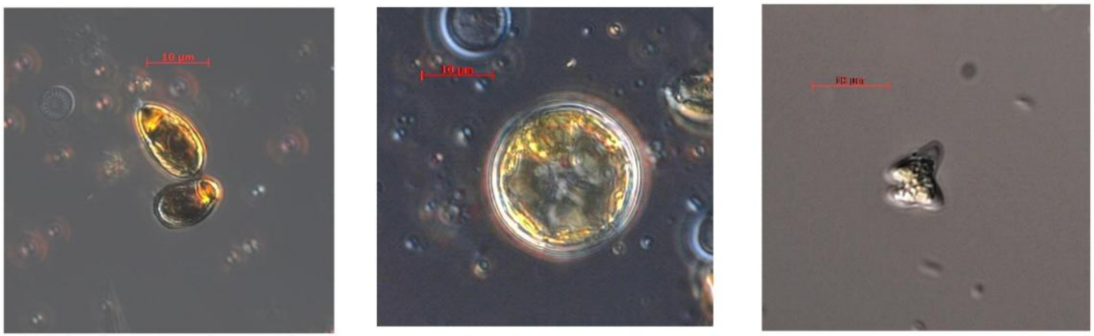
Figure 5. Abundance Changes in Dominant Diatom Species

1982 to 2012

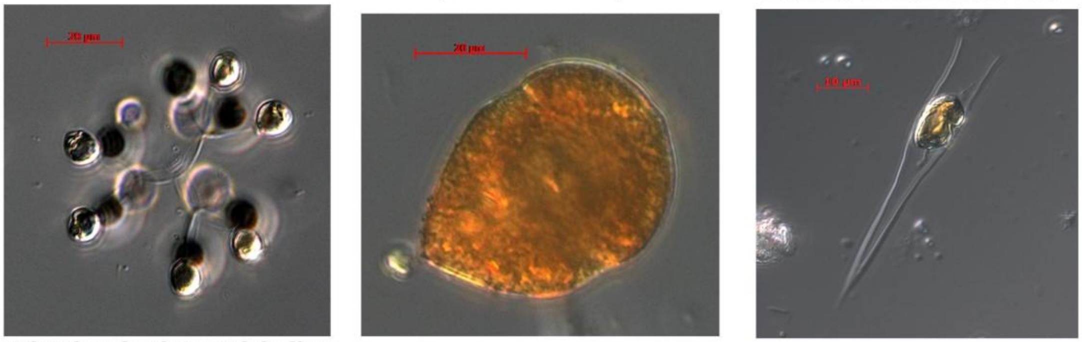




Cosmarium phaseolus *Asterionella formosa* *Cyclotella gordonensis*



Rhodomonas lacustris *Stephanodiscus alpinus* *Tetraedron minimum var.*



Dictylospherium pulchellum *Gymnodinium fuscum* *Dinobryon sociale v. americanum*

Planktonema lauterbornii

Figure 6.

Lake Tahoe Phytoplankton Typical Examples

Task 5. Atmospheric Deposition of Nitrogen and Phosphorus

Monitoring of atmospheric deposition remains crucial to understanding its role in degradation of the lake and for use in watershed management. Atmospheric deposition contributes nitrogen, phosphorus and fine particles which all impact lake clarity. Atmospheric deposition contributes about 55% of the total nitrogen, 15% of the total phosphorus and 15% of the total fine (<20µm) particles to the lake. A significant portion of the nitrogen, phosphorus and fine particles in the atmospheric deposition is thought to originate in the basin. Control of air pollutants generated within the basin is therefore potentially a tool for watershed managers to reduce pollutants which impact the clarity of the lake. The atmospheric deposition monitoring program of TERC provides basic information on nutrient loading from this source (atmospheric deposition both in the watershed on land and directly to the lake surface), as well as on precipitation timing and amounts. The data also provides information on past and current trends in atmospheric deposition.

The current contract provides for atmospheric monitoring at 3 primary stations: the lower Ward Lake Level station and two stations located on the lake: the Mid-lake buoy station (TB-1) and buoy station TB-4.

Stations and Methods

Lower Ward Valley Lake Level Station

This station is located slightly south of the Ward Creek mouth on an estate, approximately 75-100 m back from the lake edge. This station has an Aerochem Metrics model 301 wet/dry deposition sampler. This sampler contains two deposition collection buckets and moveable lid, which automatically covers one, or the other bucket depending on whether precipitation is detected by a sensor. A 3 ½ gallon standard HDPE plastic bucket is used in the Wet-side of the sampler. This “Wet bucket” is covered by the lid during dry periods and exposed when wet precipitation is detected during a storm event. The Dry-side contains a modified HDPE bucket with reduced side-wall height, filled with 4 liters of deionized water, (and contains a heater in winter). This “Dry-bucket” is exposed during dry periods and covered by the lid when precipitation is detected. Wet samples are collected from this station also on an event basis, or as wet buckets fill with snow. Dry samples are collected about every 7-10 days and collection is usually coordinated with lake buoy Dry-Bulk sample collection.

Mid-lake Buoy Station

This station is located in the northern middle portion of the lake. During the current study the station was located on a large buoy (TB-1) in the north central portion of the lake (coordinates 39° 09.180 N and 120° 00.020 W). The collector consists of a HDPE plastic bucket similar to the Aerochem Metrics modified dry collector. It is filled with 4 liters of deionized water when placed out. However, the bucket also contains plastic baffles to dampen splash from the bucket. Unlike the Dry bucket, this collector collects both wet and dry deposition and therefore is called a Dry-Bulk collector. The station also contains a Snow Tube for collection of wet precipitation. Sample collection from this station is done as much as possible on a regular basis (7-10 days if possible), however, lake conditions and weather govern frequency to a large extent. The buoy also has a variety of scientific instrumentation for NASA's studies on the lake in addition to the atmospheric deposition collectors.

Northwest Lake (TB-4) Station

Station TB-4 (coordinates 39° 09.300 N and 120° 04.330 W) was located between the mid-lake (TB-1) station and Tahoe City. This was desirable since it provided a second collection site to compare with Mid-lake data. The station contained a Dry-Bulk sampler similar to that used on the Mid-lake station. Samples were collected on the same frequency as the Mid-lake samples. The station was supported on a large buoy (TB-4). The buoy has a variety of scientific instrumentation for NASA's studies on the lake in addition to the atmospheric deposition collectors. (Note for more detailed methods at the different stations see the TERC's Standard Operating Procedures for precipitation monitoring).

Results

Data collected for this task include information on atmospheric deposition concentrations, precipitation amounts and timing. The nutrient concentration data was used to calculate atmospheric deposition loads and loading rates. The nutrient concentration and loading data for the period July 1, 2010 to the end of May 2013, for Lower Ward Valley Wet and Dry deposition, lake buoy TB1 Snow Tube Bulk deposition, Mid-lake buoy TB-1 Dry-bulk deposition and lake buoy TB-4 Dry-bulk deposition are presented in the report Appendices (1-5).

During July 1, 2010 through May, 2013, 351 samples were collected from the 3 primary stations (73 dry bucket and 114 wet bucket samples from the Lower Ward Valley station, 63 Dry-bulk samples and 39 snow tube samples from buoy TB-1 and 62 Dry-bulk samples from buoy TB-4). In addition, 36 QA/QC samples were collected during this period. Samples were analyzed for ammonium nitrogen (NH_4-N), nitrate nitrogen (NO_3-N), total Kjeldahl nitrogen (TKN), soluble reactive phosphorus (SRP), total dissolved phosphorus (DP) and total phosphorus (TP). In this report we present the results of all analyses, provide a basic summary of the results as well as make some general observations on recent trends. TERC is in the process of doing a more comprehensive analysis of the long term data.

<u>General Patterns for Precipitation July 1, 2010- May, 2013</u>

Figure 7 below shows the distribution of precipitation amounts for samples collected at the Lower Ward Valley station during July 1, 2010 – May 31, 2013. The period started off relatively dry as limited precipitation occurred (as rain from thunderstorms) during July-September, 2010. WY 2010 ended with a total of 38.64 inches having fallen at the Lower Ward station.

The following WY (2011) was extremely wet with 66.92 inches total precipitation. Precipitation was distributed over much of the period October 2010 to June 2011 with a distinct lull in the precipitation during January to mid-February 2011. Some of the more notable events Oct. to Dec. 2010 included: a late October storm with significant tropical moisture which dropped 7.21 inches of rain at the lower Ward Station, much of it occurring on 10/24/10; in November (11/18-11/23/10), a very cold, windy system which left 3-4 feet of snow at the Lower Ward station; in December, a major storm (12/17-12/20/10) which contributed over 8 inches of precipitation as rain/snow mix at the Lower Ward Valley station. After a lull in the storms January to mid-

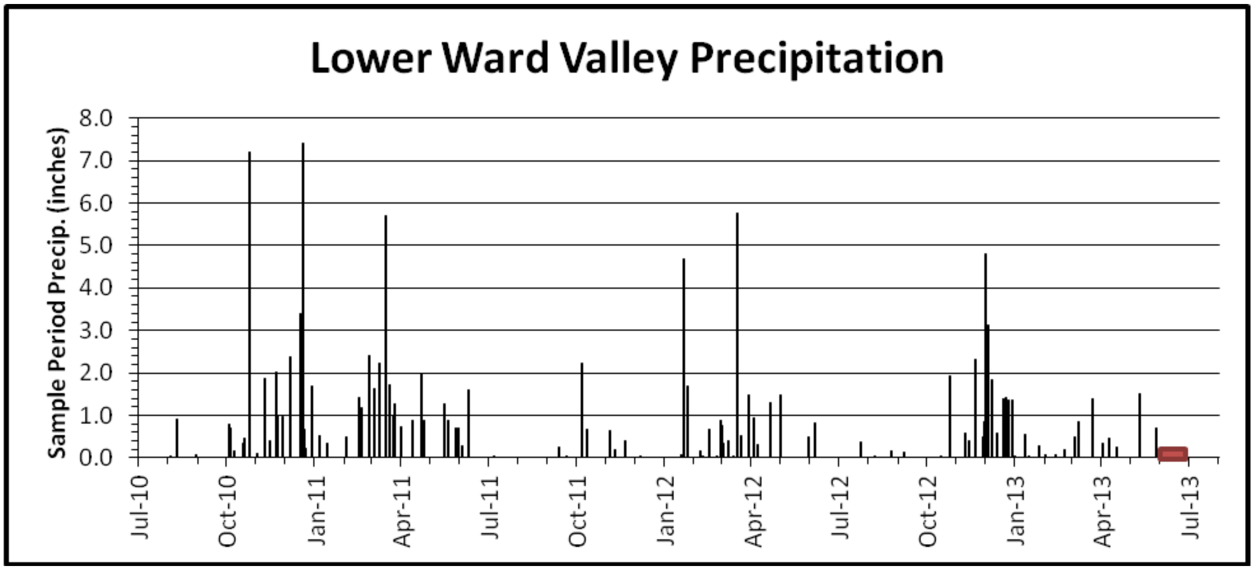


Figure 7. Precipitation amounts occurring at the Lower Ward Valley station from July 1, 2010 into May, 2013. Each vertical bar represents total amount of precipitation during a collection period for a sample – in some cases samples include multiple events, horizontal red bar indicates portion of reporting period not sampled yet.

February, a "wet" pattern re-developed with frequent storms and significant precipitation. Frequent snowstorms late in March helped build a very significant snowpack. Unsettled weather lasted into the first week of June. Overall WY 2011 precipitation (66.92 inches) at the Lower Ward Valley station was the second highest in the last 30 years (WY 1995 was the highest with 73.29 inches, followed by 2011, then WY 2006 (65.99 inches) and WY 1983 (65.46 inches)).

Some hydrologic impacts associated with the heavy precipitation in 2010-2011, included: (1) significant rises on the west shore streams during the Oct. 24, 2010 fall rain event - the increased flows on Blackwood Cr. during this event resulted in particularly noticeable erosion of the stream banks downstream, in the vicinity of the USGS gage; (2) the winter and spring of 2011 was very wet and cool, a significant snowpack developed and the major portion of the spring snowmelt was delayed until the second half of June into early July; (3) the rise in lake level elevation was very significant during WY2011, the lake level rose nearly five feet, from a minimum on Oct. 1, 2010 (6223.46 ft.) to a maximum of 6228.42 ft. on July 31, 2011.

The following WY, 2012, was a relatively dry year with 27.53 inches of precipitation occurring at the Lower Ward Valley station. After an early Oct. rain and snow storm dropped 2.23 inches of precipitation as rain and snow, limited (1.90 in.) precipitation occurred the rest of October and November, followed by only a trace of precipitation in December, 2011. Although precipitation was limited, several strong wind events during the period, a couple of the more notable among these were extremely strong winds from the SW and W on Nov. 18, 2011 and a period of very strong winds from the N and NE, Nov. 30-Dec. 1, 2011. Wind events can have an impact on lake mixing and may also impact attached algal communities if waves cause sloughing of growing periphyton from the rocks.

Significant precipitation returned later in January when an intense, windy, rain and snow event occurred Jan. 21-22, 2012. Storms became more frequent from late February through March with the most significant storm being a rain and snow event (with more than 5 inches of precipitation) occurring in mid-March. Warm temperatures in the second half of April initiated the spring snowmelt and peaks in west shore streams occurred late in the month associated with a rain event 4/25/26. The summer of 2012 was characterized by generally warm, dry weather with a few periods of thunderstorms interspersed.

WY 2013 started off very wet as much precipitation occurred in November and December, however unusually dry conditions have prevailed from January through May, 2013. During Oct. through Dec. 2012, over 23 inches of precipitation occurred at the Lower Ward Valley station. The first significant precipitation of the WY occurred in late October, with an early season snow storm which left 1-1 ½ ft of snow at the Lower Ward Valley station, and greater amounts at higher elevations. After several November snow or rain/snow mix events, during Nov. 28- Dec. 5, 2012 the region was impacted by a series of 4 wet storms associated with a moisture plume over the pacific (termed an "atmospheric river"). These storms ultimately dropped 10.7 inches of precipitation (with much of it rain) at the Lower Ward Valley station. The storms resulted in rapid rises on several of the west shore tributaries but no flooding. Later in December, a series of cold storms (December 21-26) dropped significant snow (6-7 feet of snow, approximately 5 inches of water) at the Lower Ward station and greater amounts of snow at higher elevations. Unusually dry weather then occurred in the basin from January through May 2013. Only about 7 inches of precipitation fell during this period as both rain and snow. The spring snowmelt began in early March and runoff through the period has been relatively light.

Annual Loading of Nitrogen and Phosphorus in Atmospheric Deposition

The atmospheric deposition monitoring in the Ward Creek watershed and on the lake at the buoy sampling locations provides data from which N and P deposition loading estimates are calculated. Appendices 1b-5b show the estimated loads (grams/hectare) of N and P associated with samples collected. Table 5 below presents estimated overall WY 2010-2012 N and P loading (expressed as a rate i.e. grams/hectare/day to facilitate station comparisons) at the Lower Ward Valley, Mid-lake buoy TB-1 and buoy TB4 stations.

Quite a range in precipitation amounts occurred during WY 2010-2013. Moderate precipitation occurred during WY 2010 (38.64 in.), significant precipitation occurred in 2011 (66.92 in.) and relatively light precipitation occurred during WY 2012 (27.53). So far in WY 2013, precipitation has been in lighter range with approximately 31 inches at the end of May.

The differences in WY precipitation amounts had an impact on Wet DIN and SRP loading at the Lower Ward Valley station. DIN loading was highest in the very wet WY, 2011 (4.18 g/ha/d), DIN loading was next highest in WY 2010 (2.92 g/ha/d) which had moderate precipitation, then lowest (2.45 g/ha/d) in WY2012. Wet deposition DIN has shown a general positive association with precipitation over the course of LTIMP monitoring (Figure 8).

Table 5. Comparison of loading rates (in grams/ hectare/ day) of N and P at the Lower Ward Valley and buoy stations TB-1 and TB-4 during Water Years 2010 through 2012.

	Prec. (in)	**NO_3-N** g/ha/d	**NH_4-N** g/ha/d	**DIN** g/ha/d	**TKN** g/ha/d	**SRP** g/ha/d	**DP** g/ha/d	**TP** g/ha/d
Lower Ward (Wet) WY'10	38.64	1.27[ab]	1.65[ab]	2.92[ab]	2.77[ab]	0.05[ab]	0.11[ab]	0.46[ab]
Lower Ward (Wet) WY'11	66.92	1.86[b]	2.33[b]	4.18[b]	3.57[b]	0.10[b]	0.24[b]	0.35[b]
Lower Ward (Wet) WY'12	27.53	1.02	1.43	2.45	2.75	0.06	0.13	0.20
Lower Ward (Dry) WY'10		0.99 [ab]	1.02 [ab]	2.01[ab]	11.38 [ab]	0.18 [ab]	0.29 [ab]	0.96 [ab]
Lower Ward (Dry) WY'11		1.11 [b]	1.10 [b]	2.20[b]	11.08[b]	0.15 [b]	0.27 [b]	0.86 [b]
Lower Ward (Dry) WY'12		0.83	0.89	1.71	12.77	0.18	0.41	1.22
Lower Ward (Wet+Dry) WY'10		2.26 [ab]	2.67 [ab]	4.93[ab]	14.15 [ab]	0.23 [ab]	0.40 [ab]	1.42 [ab]
Lower Ward (Wet+Dry) WY'11		2.97 [b]	3.43 [b]	6.38[b]	14.65 [b]	0.25 [b]	0.51 [b]	1.21 [b]
Lower Ward (Wet+Dry) WY'12		1.85	2.38	4.16	15.52	0.24	0.54	1.42
TB-4 (Dry-Bulk) WY'10		2.28	2.08	4.35	4.64	0.06	0.11	0.20
TB-4 (Dry-Bulk) WY'11		1.88	1.83	3.71	3.46	0.04	0.09	0.20
TB-4 (Dry-Bulk) WY'12		1.88	1.93	3.82	3.47	0.04	0.09	0.20
Mid-lake TB-1 (Dry-Bulk) WY'10		2.53	2.67	5.21	5.23	0.07	0.11	0.25
Mid-lake TB-1 (Dry-Bulk) WY'11		2.07	1.71	3.77	3.56	0.06	0.12	0.25
Mid-lake TB-1 (Dry-Bulk) WY'12		1.98	1.93	3.90	3.44	0.04	0.10	0.23

Notes: To determine a daily loading rate for Wet samples, the annual total load for a nutrient was first extrapolated by dividing the total load for samples analyzed by the proportion of total precipitation for the year analyzed. This annual load was then divided by number of days/year to estimate daily loading rate. To determine Dry deposition loading rate, the load for analyzed dry samples was divided by the total number of sampling days for the analyzed samples. Additional notes: "a" - In early October 2010 the power line to the station was removed during construction activities. The Wet and Dry buckets were continually exposed to deposition for 2-3 weeks. Both Wet and Dry deposition collected in the Wet buckets during storm events was included in the Wet total loading. "b" – during some periods in WY 2010, 2011 there were power interruptions and problems with dust due to construction on property at the Lower Ward Valley station, samples noted to be contaminated with significant amounts of silt or organic material were not used to determine annual loading rates.

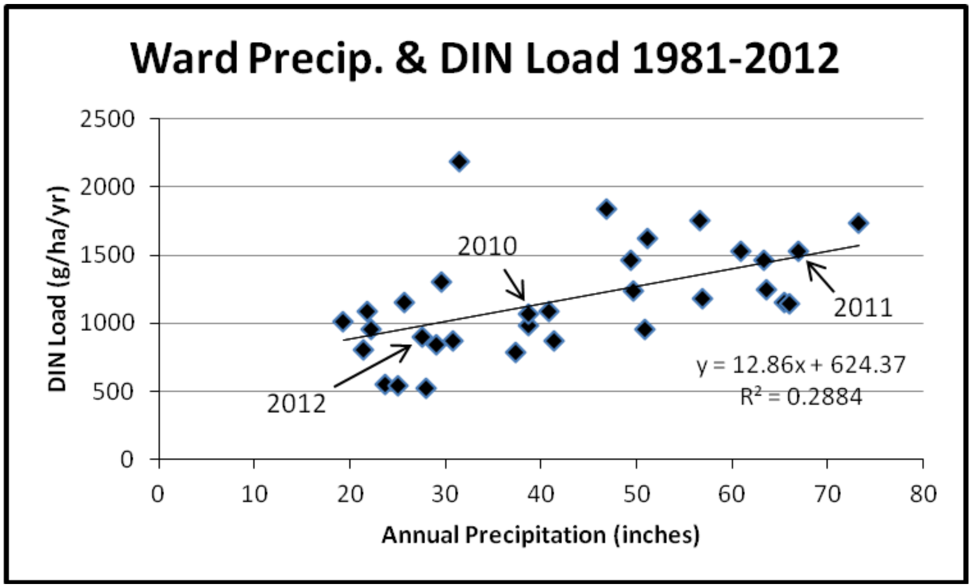


Figure 8. Positive association between DIN load in Wet deposition and annual precipitation at the Lower Ward Valley station 1981-2012. The association is stronger (r^2=0.46) if data from a single outlier with high DIN load and low precipitation (WY 1990) is excluded.

Soluble phosphorus (SRP) loading in Wet deposition was also notably higher in the wet year, WY 2011 (0.10 g/ha/d) while SRP loading in WY 2012 and WY 2010 was lower and nearly similar (0.06 g/ha/d and 0.05 g/ha/d respectively).

Loading of DIN in Dry deposition at the Lower Ward Station showed only slight differences during WY 2010-2012. DIN loading in Dry deposition was 1.71 g/ha/d in 2012, 2.01 g/ha/d in 2010 and 2.21 g/ha/d in 2011. Bulk (total Wet + Dry) loading of DIN at Lower Ward largely paralleled the wet contribution, with highest total DIN in WY 2011 (6.38 g/ha/d), next highest in WY2010 (4.93 g/ha/d) and lowest in WY 2012 (4.16 g/ha/d).

SRP loading in Dry deposition at the Lower Ward station was relatively consistent during WY 2010 to 2012 (ranging from 0.15 g/ha/d in WY 2011 to 0.18 g/ha/d in WY 2010, 2012). These values were approximately 1.5 to 3 times greater than SRP loading in wet deposition for the respective years. Bulk (total Wet + Dry) loading of SRP at Lower Ward was only slightly higher in WY 2011 (0.25 g/ha/d) than in WY 2010 (0.23 g/ha/d) and 2012 (0.24 g/ha/d).

Loading rates for Bulk (total Wet + Dry) deposition of DIN at buoys TB-4 and TB-1 were relatively close to values for bulk DIN loading at the Lower Ward station in two of three water years. Values for DIN loading at WLL, TB-4 and TB-1 were relatively close during low to moderate precipitation years, i.e.: in low precipitation year (WY2012) Bulk DIN loading at WLL, TB-4 and TB-1 respectively were (4.16, 3.82, 3.90 g/ha/d); and during a moderate precipitation year (WY2010) were (4.93, 4.35, 5.21 g/ha/d). However, during the high precipitation year (WY2012) bulk DIN loading at Lower Ward (6.38 g/ha/d) was much higher than at buoys TB-4 (3.71 g/ha/d) and TB-1 (3.77 g/ha/d). The precipitation along the west shore is typically much greater than at the buoys in the middle of the lake. The significant extra loading of DIN associated with wet precipitation at Lower Ward in WY 2011 likely resulted in the higher totals there relative to the lake buoys.

SRP loading in Bulk deposition at the Lower Ward Valley station was consistently higher than SRP loading on the lake at buoys TB-1 and TB-4. SRP loading at WLL (ranged from 0.23-0.25 g/ha/d) which was 3-5 times that at the buoys. The increased SRP in bulk deposition at WLL relative to the buoy stations may largely reflect terrestrial sources of SRP (associated with silt and organic matter) in proximity to WLL. The buoys are further removed from such sources which result in lowered levels (however silt and other particles still are frequently also observed in these collectors located well away from shore.

Patterns of Precipitation Amount, Dissolved Inorganic Nitrogen (DIN) Concentration and Load in Wet Deposition at Lower Ward Valley 1981-2012

The long-term (WY 1981- 2012) data for total precipitation, Dissolved Inorganic Nitrogen (DIN) annual average concentration and annual (WY) load in Wet deposition at the Lower Ward station is presented in Figure 9 to show trends through time (WY2013 not yet complete). As previously indicated, DIN loads in precipitation varied with precipitation amount in WY2010-2012 with relatively low DIN (895 g/ha/yr) in a relatively dry WY2012, moderate DIN (1065 g/ha/yr) in 2010, and relatively high DIN (1527 g/ha/yr) “wet” WY2011. In the long-term data, high DIN loading was observed in relatively wet WY 1989, and relatively dry 1990 (DIN loading 1842, 2183 g/ha/yr respectively) and during high precipitation years, WY 1995-99 (DIN loading range 1247-1750 g/ha/yr). Lowest DIN loading was observed in relatively dry years WY 1981 (551 g/ha/yr) and WY 2007, 2008 (525, 544 g/ha/yr respectively). WY 2010-2012 DIN average annual *concentrations* were intermediate between lowest and highest values during the 1981-2012 period.

Patterns of Precipitation Amount, Soluble Reactive Phosphorus (SRP) Concentration and Load in Wet Deposition at Lower Ward Valley 1981-2012

Figure 10 presents the WY 1981- 2012 data for total precipitation, Soluble Reactive Phosphorus (SRP) annual average concentration and annual (WY) SRP load in Wet deposition at the Lower Ward station to show trends through time. Since WY 2000 SRP loading has fluctuated within a fairly consistent range between about 17-37 g/ha/yr. SRP loads in precipitation 2010 to 2012 fell within this range with highest SRP loading in the high precipitation WY 2011 (36.18 g /ha/yr) and less SRP loading in WY 2010 (17.38 g/ha/yr) and 2012 (22.01 g/ha/yr). SRP average annual concentrations have remained relatively low the past 3 years ranging from 1.77 ppb (2010) to 3.15 ppb (2012).

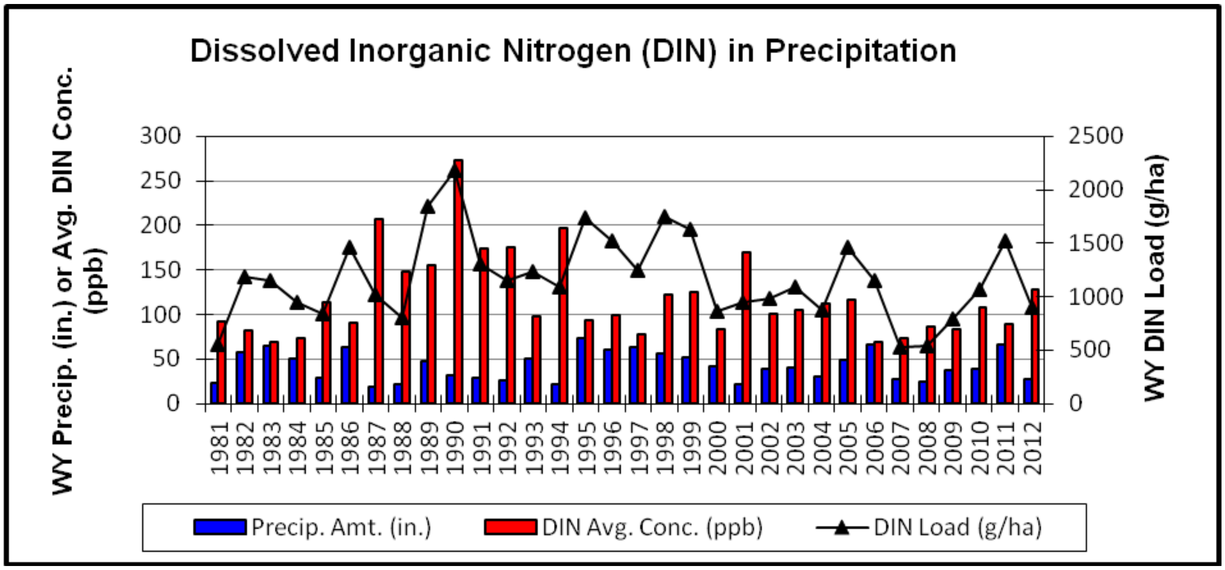


Figure 9. Summary plot of Water Year (WY) total precipitation (inches), average Dissolved Inorganic Nitrogen (DIN) concentration (ppb), and extrapolated annual DIN load (g/ha/yr) in Wet Deposition at the Ward Valley Lake Level station for WY 1981-2012. A Water Year begins Oct. 1 and ends Sept. 30 (i.e. WY 1981 ended 9/30/81).

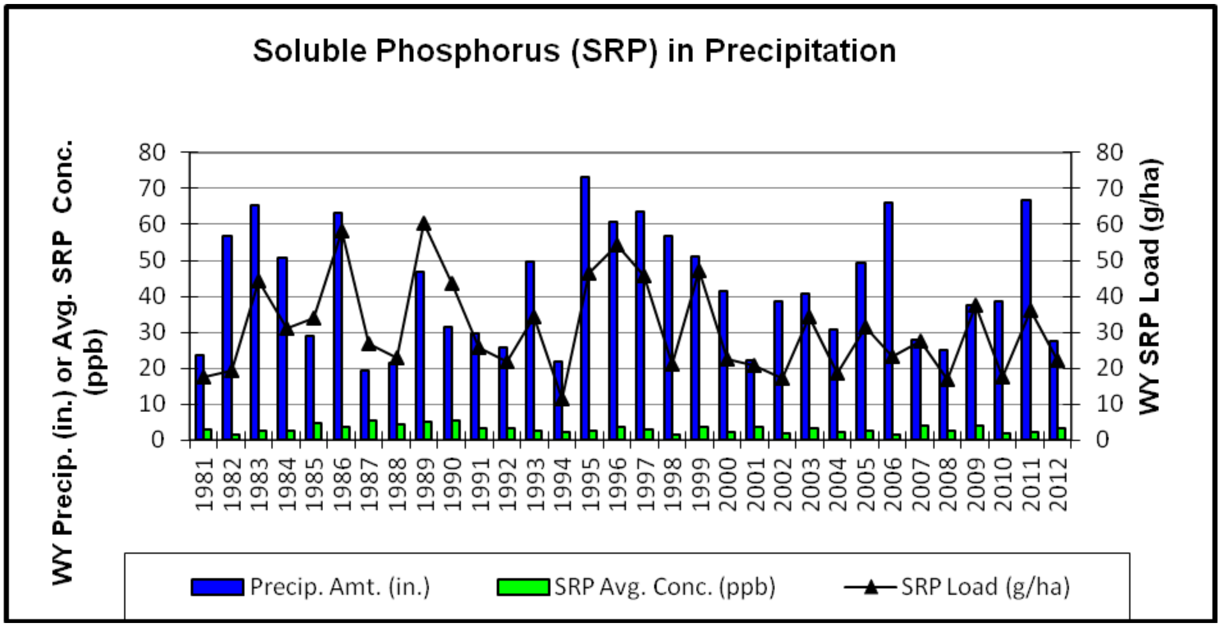


Figure 10. Summary plot of Water Year (WY) total precipitation (inches), average Soluble Reactive Phosphorus (SRP) concentration (ppb), and extrapolated annual SRP load (g/ha/yr) in Wet Deposition at the Ward Valley Lake Level station WY 1981-2012.

Summary Points for Atmospheric Deposition Monitoring WY2010-2013

1. **Precipitation amounts were relatively low in WY 2012 (27.53 in.), moderate in WY 2010 (38.64 in.) and high in WY 2011 (66.92 in.) at the Lower Ward Valley station. WY 2013 started out with significant precipitation and has been very dry since January with total precipitation through May of about 31 in.**
2. **DIN loads in precipitation during WY 2010 to 2012 varied with precipitation amount, from low precipitation (27.53 inches) and relatively low DIN (895 g/ha/yr) in WY 2012, to moderate precipitation (38.64 inches) and moderate DIN (1065 g/ha/yr) in WY 2010 to high precipitation (66.92 inches) and relatively high DIN (1527 g/ha/yr) in WY 2011.**
3. **Since WY 2000, SRP loading has fluctuated within a fairly consistent range between about 17-37 g/ha/yr. SRP loads in precipitation WY 2010 to 2012 fell within this range with highest SRP loading in WY 2011 (36.18 g /ha/yr) and less SRP loading in WY 2010 (17.38 g/ha/yr) and 2012 (22.01 g/ha/yr) which had less precipitation.**
4. **Loading rates for Bulk (Wet + Dry combined) deposition of DIN at buoys TB-4 and TB-1 were slightly higher in WY 2010 compared to WY 2011 and 2012. DIN loading during WY 2010 at TB-1 and TB-4 respectively were 5.21 g/ha/d and 4.35 g/ha/d. In WY 2011 and 2012 values ranged between 3.7-3.9 g/ha/d.**
5. **Comparing Bulk (Wet+Dry) loading of DIN onshore at the Lower Ward Valley (WLL) Station with Bulk loading directly on the lake at Buoys TB-1, TB-4, bulk DIN loading was relatively similar at all 3 stations during the low and moderate precipitation years (2012 and 2010 respectively), however, WLL had higher DIN loading than the buoys during a very high precipitation year (WY 2011).**
6. **Loading rates for SRP were fairly consistent at the buoys ranging from 0.04-0.07 g/ha/d.**
7. **SRP loading in Bulk deposition at the Lower Ward Valley station was consistently higher than SRP loading on the lake at buoys TB-1 and TB-4. SRP loading at WLL (ranged from 0.23-0.25 g/ha/d) which was 3-5 times that at the buoys.**
8. **Atmospheric deposition continues to be a significant source of nitrogen and phosphorus loading for the lake.**

Task 6. Periphyton

The purpose of the periphyton monitoring task is to assess the levels of nearshore attached algae (periphyton) growth around the lake. As for phytoplankton, nutrient availability plays a large role in promoting periphyton growth. The amount of periphyton growth can be an indicator of local nutrient loading and long-term environmental changes.

Periphyton grows in the littoral (shore) zone of Lake Tahoe, which may be divided into the eulittoral zone and the sublittoral zone, each with distinct periphyton communities. The eulittoral zone is the shallow area between the low and high lake level and is significantly affected by wave activity. It represents only a very small (<1%) of the total littoral area. Substrata within this region desiccate as the lake level declines, and periphyton must recolonize this area when lake level rises. The sublittoral zone extends from the bottom of the eulittoral to the maximum depth of the photoautotrophic growth. The sublittoral zone remains constantly submerged and represents the largest littoral benthic region of Lake Tahoe.

The eulittoral zone community is typically made up of filamentous green algae i.e. *Ulothrix sp, Zygnema sp* and stalked diatom species i.e. *Gomphoneis herculeana*. The attached algae in the eulittoral zone display significant growth allowing for rapid colonization. These algae are able to take advantage of localized soluble nutrients, and can establish a thick coverage over the substrate within a matter of months. Similarly, as nutrient concentrations diminish and shallow nearshore water temperatures warm with the onset of summer, this community rapidly dies back. The algae can slough from the substrate and disperse into the open water, as well as be washed ashore. In areas where biomass is high, the slimy coating over rocks and sloughed material accumulated along shore can be a nuisance. The eulittoral zone periphyton plays an important role in the aesthetic, beneficial use of the shorezone. It is the rapid growth ability of the eulittoral periphyton in response to nutrient inputs that lends particular value to monitoring this community as an indicator of localized differences in nutrient loading.

The sublittoral zone is made up of different algal communities down through the euphotic zone. Cyanophycean (blue-green) algal communities make up a significant portion of the uppermost sublittoral zone. These communities are slower growing and more stable than the filamentous and diatom species in the eulittoral zone.

Stations and Methods

Nine routine stations were monitored during Oct. 2010- June, 2013 (Rubicon Pt., Sugar Pine Pt., Pineland, Tahoe City, Dollar Pt., Zephyr Pt., Deadman Pt., Sand Pt and Incline West). These nine sites are located around the lake (Table 6) and represent a range of backshore disturbance levels from relatively undisturbed land (Rubicon Point and Deadman Point) to a developed urban center (Tahoe City).

Table 6. Locations of Routine Periphyton Monitoring Stations

SITE NAME	LOCATION
Rubicon	N38 59.52; W120 05.60
Sugar Pine Point	N39 02.88; W120 06.62
Pineland	N39 08.14; W120 09.10
Tahoe City	N39 10.24; W120 08.42
Dollar Point	N39 11.15; W120 05.52
Zephyr Point	N39 00.10; W119 57.66
Deadman Point	N39 06.38; W11957.68
Sand Point	N39 10.59; W119 55.70
Incline West	N39 14.83; W119 59.75

A detailed description of the sample collection and analysis procedures is given in Hackley et al. (2004). Briefly, the method entails collection while snorkeling of duplicate samples of attached algae from a known area of natural rock substrate at a depth of 0.5m, using a syringe and toothbrush sampler. These samples are transported to the laboratory where the samples are processed and split, with one portion of the sample analyzed for Ash Free Dry Weight (AFDW) and the other portion frozen for later analysis of Chlorophyll *a* concentration (both AFDW and chlorophyll *a* are used as measures of algal biomass). We also measure average filament length, % algal coverage, and estimate the visual score in field observations. The visual score is a subjective ranking (1-5) of the level of algal growth viewed underwater (as well as above water for a portion of the data) where 1 is least offensive appearing (usually natural rock surface with little or no growth) and 5 is the most offensive condition with very heavy growth.

Results

Monitoring at Routine Sites

In this report we summarize the data collected during the period October, 2010 to June, 2013. Nine routine sites were sampled. All sites were sampled five or more times during the period. Three of the five samplings were typically made during the spring when growth typically peaks (March-June), with additional sampling circuits made during January (when growth is often just starting to increase) and during the summer or fall. Table 7 presents the results for biomass (chlorophyll *a* and Ash Free Dry Weight (AFDW)) and field observations (visual score, average filament length, percent algal coverage, biomass index and basic algal types) at the nine routine periphyton sites for the period October 2010 through June, 2013. The results for periphyton Chlorophyll *a* biomass are also presented graphically in Figures 11 (a-i) together with earlier data collected since 2000.

During 2010-2013, certain patterns for biomass were apparent at the routine sites. Comparing the data by water year, the following patterns were present.

Water Year 2011 Patterns of Periphyton Biomass

In WY 2011 (Oct. 1, 2010 – Sept. 30, 2011) measurements of periphyton biomass were strongly affected by the significant increase in lake surface elevation. The lake rose nearly five feet, (from 6223.46ft minimum surface elevation in October, 2010 to 6228.42 ft in August 2011) (Figure 12) as a result of significant precipitation and runoff. Monitoring done during very low lake levels early in the WY (Oct. 2010 and Jan. 2011) and throughout a steady rise to high lake level in early summer showed interesting patterns for periphyton near the surface (0.5m).

During very low lake level in October 2010, significant biomass associated with the blue-green algae was present at the 0.5m sampling depth at many sites.[1] Biomass levels were at the peak for WY 2011 in October, 2010 at several sites, including: Rubicon Pt. (Chl *a*=133.34mg/m^2), Sugar

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[1] During years when lake surface elevation is very low, biomass associated with the stable deeper, blue-green algal communities may be located in proximity to the surface. This heavy biomass is not necessarily a consequence of high nutrient availability but rather is a consequence of the lowering lake level. Conversely, during years where lake level rapidly rises and substrate near the surface has been recently submerged, very little biomass may be present, due to the short period of time for colonization.

Table 7. Summary of eulittoral periphyton Chlorophyll *a* (Chlor.*a*), Ash Free Dry Weight (AFDW), visual score from above and below water, average filament length, percent algal coverage, and predominant algal types estimated visually underwater (where SD= stalked diatoms; FG= filamentous greens; CY= blue-green algae) for routine periphyton monitoring sites during July 2010-May 2013. Note for Chlorophyll *a* and AFDW, n=2 unless otherwise indicated (i.e. two replicate samples were taken). Visual score is a subjective ranking of the aesthetic appearance of algal growth ("above" viewed above water; "below" viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is Filament Length times % Algal Cover. Also,"NA" = not available or not collected; "NES" = not enough sample for analysis; "Var." = variable amount of cover. Sampling depth and corresponding sampling elevation are also indicated.

Site	Date	Sampling Depth/Elev (m/ ft)	Chlor. *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (g/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover (%)	Biomass Index	Algal Type
Rubicon Pt.	10/13/10	0.5/6221.89	133.34	43.27	89.98	12.88	2	3	1.0	70	0.70	CY
	1/5/11	0.5/6222.91	108.68	25.23	62.89	8.28	3	3.5	0.8	90	0.72	CY,FG
	3/28/11	0.5/6223.98	14.60	3.22	5.99	1.30	3	2.5	0.2	80	0.16	SD
	5/5/11	0.5/6224.51	11.50	1.35(n=3)	6.06	1.56(n=3)	4	3	1.2	50	0.6	SD
	5/13/11	0.59/6224.38	30.11	2.56(n=3)	18.18	4.72(n=3)	4	4	1.8	100	1.8	SD
	5/13/11	0.71/6224.02	-	-	-	-	-	-	2.0	100	2.0	SD
	5/13/11	1.03/6222.97	-	-	-	-	-	-	2.0	80	1.6	FG,SD
	10/28/11	0.5/6225.80	NES	NES	1.65	(n=1)	1	1.5	<0.1	50	<0.05	SD
	1/12/12	0.5/6225.02	3.73	(n=1)	NES	NES	3	2	0.2	50	0.10	SD
	3/19/12	0.5/6225.36	15.78	2.49	5.65	0.48	2	3	1.0	60	0.60	SD
	4/9/12	0.5/6225.45	74.15	22.21(n=3)	25.93	4.29(n=3)	4	4	2.0	90	1.80	SD,FG
	6/11/12	0.5/6225.96	168.62	82.41(n=3)	99.26	55.25(n=3)	4	5	4.0	90	3.6	SD
	8/27/12	0.5/6224.95	4.15	1.42	3.78	0.99	1	2	0.3	30	0.09	SD
	1/17/13	0.5/6224.41	25.19	7.12	10.45	2.79	2	3	0.5	80	0.40	SD,CY,FG
	2/28/13	0.5/6224.21	29.41	7.17	20.39	2.72	3	3	0.5	90	0.45	SD,CY,FG
	3/27/13	0.5/6224.29	38.17	11.41(N=3)	30.97	5.84(N=3)	3	3.5	1.1	90	0.99	SD,CY,FG
	6/21/13	0.5/6224.55	9.74	2.33	9.42	3.97	2	3	1.0	93	0.93	SD,FG
Sugar Pine Pt.	10/13/10	0.5/6221.89	27.85	14.58	24.89	11.80		2	0.2	80	0.16	CY
	1/5/11	0.5/6222.91	10.06	1.18	8.80	0.23	NA	2	0.2	50	0.10	CY,FG
	3/28/11	0.5/6223.98	7.35	1.15	2.89	1.19	2.5	2.5	0.3	90	0.27	SD
	4/29/11	0.5/6224.40	6.56	0.88	2.00	1.12	NA	3	0.3	80	0.24	SD
	6/30/11	0.5/6226.36	BLD	BLD	BLD	BLD	1	1	0.0	0	0.00	NA
	6/30/11	0.88/6225.11	NES	NES	0.00	0.00	1		0.0	0	0.00	SD
	6/30/11	1.1/6224.39	-	-	-	-	1	1	0.0	<1	0.00	NA
	10/28/11	0.5/6225.80	NES	NES	0.38	(n=1)	1	1	0.0	0	0.00	NA

Site	Date	Sampling Depth/Elev (m/ ft)	Chlor. *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (g/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover (%)	Bio. Index	Algal Type
Sugar Pine Pt.	1/12/12	0.5/6225.02	1.71	0.58	NES	NES	2	1	0.1	40	0.04	SD
	3/19/12	0.5/6225.36	5.71	0.78	2.42	0.62	NA	2	0.3	80	0.24	SD
	4/9/12	0.5/6225.45	3.89	2.04	3.57	(n=1)	2	2	0.1	90	0.09	SD
	6/11/12	0.5/6225.96	1.48	0.13	NES	NES	NA	2	0.2	50	0.10	SD
	8/27/12	0.5/6224.95	2.43	1.29	1.74	0.06	3	3	0.7	30	0.21	FG
	1/17/13	0.5/6224.41	6.83	0.82	3.36	1.60	NA	2	0.1	80	0.08	SD,CY
	2/28/13	0.5/6224.21	7.28	0.14	NA	NA	1	2	0.2	60	0.12	CY,FG
	3/27/13	0.5/6224.29	4.60	0.63	NA	NA	NA	2	0.2	70	0.14	FG
	6/21/13	0.5/6224.55	5.40	1.41	5.13	0.92	3.5	3.5	2.0	50	1.0	FG
Pineland	10/13/10	0.5/6221.89	37.41	2.10	33.90	8.68	2	2	0.3	70	0.21	CY
	1/5/11	0.5/6222.91	177.15	49.00	79.24	24.50	3.5	3	1.5	80	1.20	CY,SD,FG
	3/28/11	0.5/6223.98	67.43	30.39	56.28	35.80	5	5	3.0	100	3.00	SD
	4/29/11	0.5/6224.40	154.06*	78.56	91.31*	27.41	4	5	3.5	90	3.15	SD
	5/13/11	0.59/6224.38	68.22	19.06(n=3)	32.27	5.96 (n=3)		4	2.0	90	1.80	SD
	6/30/11	0.5/6226.36	1.76	(n=1)	3.81	(n=1)	2	2	0.2	70	0.14	SD
	6/30/11	0.85/6225.11	16.71	1.16	33.37	2.41		4	2.5	90	2.25	SD,FG
	6/30/11	1.3/6223.73	-	-	-	-	5	5	5.0	100	5.00	SD,FG
	10/28/11	0.5/6225.80	8.92	0.12	5.13	1.60	2	2	0.2	80	0.16	FG
	1/12/12	0.5/6225.02	38.97	0.58	19.47	1.20	1	2	0.5	80	0.40	SD,FG
	3/19/12	0.5/6225.36	128.51	29.17	67.66	9.42	NA	NA	2.5	90	2.25	SD,FG
	4/9/12	0.5/6225.45	173.32	81.48(n=3)	115.14	47.36(n=3)	5	5	3.0	100	3.00	SD,FG
	6/11/12	0.5/6225.96	162.20	62.39	70.60	16.57	2	3	1.0	70	0.70	SD,CY
	8/27/12	0.5/6224.95	7.17	1.51	4.98	1.03	1	2	0.2	50	0.10	SD
	1/17/13	0.5/6224.41	51.34	6.79	23.79	2.20	3	3	0.8	70	0.56	SD
	2/28/13	0.5/6224.21	74.68	14.43(n=3)	32.84	4.95(n=3)	3	3.5	0.7	70	0.49	SD
	3/27/13	0.5/6224.29	241.77	36.34(n=3)	99.85	27.60(n=3)	4	5	2.0	100	2.00	SD,FG
	6/21/13	0.5/6224.55	59.47	13.34	31.40	0.48	2	3	0.7	80	0.56	SD
Tahoe City	10/13/10	0.5/6221.89	18.66	0.19	20.10	2.55	1	2	0.1	50	0.05	SD
	1/5/11	0.5/6222.91	37.03	4.03	36.17	10.38	2	2.5	0.5	10	0.05	SD
	3/28/11	0.5/6223.98	24.91	2.85	14.65	0.66	2	3	0.4	90	0.36	SD
	4/29/11	0.5/6224.40	43.12	20.49	48.78	26.54(n=3)	4	4	3.0	90	2.70	SD
	5/9/11	0.56/6224.44	45.35	13.58(n=3)	65.15	19.54(n=3)	4	4	2.5	90	2.25	SD
	5/26/11	0.7/6224.40	-	-	-	-	-	-	0.6	Var.	NA	SD

Site	Date	Sampling Depth/Elev. (m/ ft)	Chlor. *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (g/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover (%)	Bio. Index	Algal Type
Tahoe City	6/30/11	0.5/6226.36	2.00	0.08	3.23	0.02	2	2	0.2	80	0.16	SD
	6/30/11	0.85/6225.21	4.59	0.78	7.49	0.15	NA	NA	0.3	50	0.15	SD
	6/30/11	1.1/6224.39	-	-	-	-	-	-	0.5	50	0.25	SD
	10/28/11	0.5/6225.80	43.77	6.22	37.46	0.96	2.5	2.5	0.2	80	0.16	SD
	1/12/12	0.5/6225.02	41.45	5.26	33.57	6.27	2	2	0.3	80	0.24	SD
	3/19/12	0.5/6225.36	105.88	7.74(n=3)	106.49	29.17(n=3)	4	4	1.6	80	1.28	SD
	4/11/12	0.5/6225.45	119.30	21.05(n=3)	94.16	14.96(n=3)	3	4	2.0	80	1.60	SD
	6/11/12	0.5/6225.96	19.96	2.81	23.25	3.58	2	3	0.5	60	0.30	SD
	8/27/12	0.5/6224.95	21.89	2.40	20.83	1.20	2	2	0.2	60	0.12	SD
	1/16/13	0.5/6224.41	64.58	23.12(n=3)	53.05	11.43(n=3)	3	3.5	0.8	90	0.72	SD
	2/28/13	0.5/6224.21	126.03	37.52	120.97	33.03	3.5	4	1.8	80	1.44	SD
	3/28/13	0.5/6224.30	74.39	35.11(n=3)	71.64	23.13(n=3)	4	5	2.7	99	2.67	SD
	6/21/13	0.5/6224.55	15.11	4.98	13.40	4.29	2	2	0.3	70	0.21	SD
Dollar Pt.	10/13/10	0.5/6221.89	14.77	5.32	17.41	3.54	1	1	0.1	40	0.04	SD or CY
	1/5/11	0.5/6222.91	34.35	(n=1)	35.79	(n=1)	2	2	0.2	60	0.12	SD,FG
	3/31/11	0.5/6224.00	13.08	1.61	4.98	0.59	2	2	0.1	70	0.07	SD
	4/29/11	0.5/6224.40	67.71	14.31	67.00	15.70	3	3.5	1.5	80	1.20	SD
	5/9/11	0.56/6224.44	-	-	-	-	-	3.5	1.0	90	0.90	SD
	5/9/11	0.69/6224.02	-	-	-	-	-	-	1.8	90	1.62	SD
	5/9/11	1.0/6223.00	-	-	-	-	-	-	3.0	100	3.0	SD
	7/1/11	0.5/6226.40	2.49	0.08	3.83	0.51	1.5	2	0.1	90	0.09	SD
	7/1/11	0.85/6225.25	5.31	2.36	9.46	1.27	-	2	0.3	70	0.21	SD
	7/1/11	1.15/6224.27	-	-	-	-	-	2.5	0.5	10	0.05	SD
	10/28/11	0.5/6225.80	10.24	3.32	NES	NES	3	2	0.1	80	0.08	SD,FG
	1/13/12	0.5/6225.01	12.42	1.34	2.05	1.30	1	1	<0.1	5	<0.01	NA
	3/19/12	0.5/6225.36	35.91	16.15	20.48	9.22	2	2	0.4	90	0.36	SD
	4/9/12	0.5/6225.45	33.36	8.44(n=3)	23.71	7.09(n=3)	3	4	1.8	90	1.62	SD
	6/11/12	0.5/6225.96	7.90	1.77	8.82	0.26	2	2	0.2	40	0.08	SD
	8/27/12	0.5/6224.95	9.68	1.45	5.87	0.17	1	1.5	<0.1	70	<0.07	SD
	1/16/13	0.5/6224.41	28.51	5.69	14.55	6.56	3	2	0.2	60	0.12	SD,FG
	2/28/13	0.5/6224.21	58.00	2.48	25.13	0.58	3	3.5	0.8	95	0.76	SD,FG
	3/28/13	0.5/6224.30	99.69	9.59	55.25	4.24	NA	3	1.3	60	0.78	SD
	6/21/13	0.5/6224.55	48.95	5.60	37.13	7.98	2	2	0.3	80	0.24	SD

Site	Date	Sampling Depth/Elev. (m/ ft)	Chlor. *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (g/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover (%)	Bio. Index	Algal Type
Incline West	10/13/10	0.5/6221.89	38.69	4.57	43.95	5.13	2	3	0.4	90	0.36	CY,FG
	1/5/11	0.5/6222.91	62.46	(n=1**)	66.09	n=1**	2	3	0.7	90	0.63	CY,FG
	3/31/11	0.5/6224.00	15.42	3.27	7.37	1.01	2	2	0.3	90	0.27	SD
	5/6/11	0.54/6224.38	38.08	3.80	16.58	1.20	2	3	2.0	30	0.60	SD
	5/6/11	0.65/6224.02	-	-	-	-	-	4	2.5	60	1.5	SD
	5/6/11	0.98/6223.06	-	-	-	-	-	3	1.6	90	1.44	SD
	7/1/11	0.5/6226.40	2.22	0.13	NES	NES	1.5	2	0.1	70	0.07	SD
	7/1/11	0.85/6225.25	3.49	0.41	5.81	1.41	-		0.5	60	0.30	SD
	7/1/11	1.1/6224.43	-	-	-	-	-	3	1.5	60	0.90	CY,FG,SD
	10/28/11	0.5/6225.80	7.61	0.83	4.82	0.46	1	1	0.1	70	<0.07	SD
	1/13/12	0.5/6225.01	10.57	1.00	6.04	0.30	2	2	0.2	70	0.14	CY,FG
	3/19/12	0.5/6225.36	19.48	0.36	12.42	0.18	3	3	0.3	80	0.24	CY,FG
	4/20/12	0.5/6225.52	13.56	1.14	8.43	0.59	3.5	3.5	0.4	80	0.32	SD,CY,FG
	6/11/12	0.5/6225.96	15.46	2.55	17.07	0.58	4	4	1.2	80	0.96	SD,CY,FG
	8/27/12	0.5/6224.95	13.58	0.24	11.83	0.99	3	2	0.2	50	0.10	FG
	1/16/13	0.5/6224.41	19.91	2.65(n=3)	15.32	1.27(n=3)	NA	3	0.4	75	0.30	CY,FG
	2/28/13	0.5/6224.21	25.78	1.66	21.54	1.71	2	3	0.7	90	0.63	SD,CY
	4/12/13	0.5/6224.38	36.77	8.55	26.77	2.27	2.5	3	0.6	86	0.52	SD,CY,FG
	6/21/13	0.5/6224.55	42.21	3.41	39.47	5.68	3	3	1.0	87	0.87	SD,CY
Sand Pt.	10/13/11	0.5/6221.89	53.69	3.76	70.01	0.88	3	3	0.8	80	0.64	CY,FG
	1/5/11	0.5/6222.91	40.24	5.03	34.81	4.35	2	2	0.4	50	0.20	CY,FG
	3/31/11	0.5/6224.00	BLD	BLD	BLD	BLD	1	1	0.0	0	0.00	none
	5/6/11	0.54/6224.38	4.07	1.11	3.68	N=1	3	3	0.8	60	0.48	SD
	7/1/11	0.5/6226.40	NES	NES	NES	NES	1	1	0.0	0	0.00	none
	7/1/11	0.85/6225.25	NES	NES	NES	NES	1	1	0.0	0	0.00	none
	10/28/11	0.5/6225.80	NES	NES	2.68	0.50	1	2	0.2	50	0.10	FG
	1/13/12	0.5/6225.01	4.41	0.00	NES	NES	3	2	0.2	60	0.12	FG
	3/19/12	0.5/6225.36	NES	NES	0.28	0.40	2	2	0.1	40	0.04	SD,FG
	4/20/12	0.5/6225.52	3.96	0.31	3.99	1.50	2	2	0.1	70	0.07	SD
	6/11/12	0.5/6225.96	9.13	0.34	9.38	1.75	3.5	3	0.6	70	0.42	FG
	8/27/12	0.5/6224.95	10.64	0.87	10.70	0.97	3	3	0.2	60	0.12	FG
	1/17/13	0.5/6224.41	7.38	0.73	5.40	1.00	2	2	0.2	40	0.08	CY,FG
	2/28/13	0.5/6224.21	5.24	0.11	6.33	0.02	2	2	0.1	50	0.05	CY,FG
	4/12/13	0.5/6224.38	10.62	0.02	10.79	0.49	2.5	2.5	0.2	70	0.14	CY,FG
	6/21/13	0.5/6224.55	12.11	1.63	14.18	4.52	3	3	0.4	83	0.33	CY,FG

Site	Date	Sampling Depth/Elev. (m/ ft)	Chlor. *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (g/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover (%)	Bio. Index	Algal Type
Deadman Pt.	10/13/10	0.5/6221.89	40.83	2.63	51.24	0.46	3.5	3	0.6	75	0.45	CY,FG
	1/5/11	0.5/6222.91	22.28	5.22	26.48	3.84	2	2	0.3	50	0.15	CY
	3/31/11	0.5/6224.00	BLD	BLD	5.62	5.01	1	1	0.0	0	0.00	none
	5/6/11	0.54/6224.38	BLD	BLD	1.82	0.90	1	1	0.0	0	0.00	none
	5/6/11	0.65/6224.02	-	-	-	-	1	1	0.0	0	0.00	none
	5/6/11	0.98/6223.06	-	-	-	-	-	3	0.5	90	0.45	CY,FG
	10/28/11	0.5/6225.80	3.69	0.45	NES	NES	2	2	0.2	70	0.14	FG
	1/13/12	0.5/6225.01	3.50	0.11	NES	NES	1	2	0.1	60	0.06	FG
	3/19/12	0.5/6225.36	4.19	0.66	NES	NES	2	2	0.1	95	0.10	FG
	4/20/12	0.5/6225.52	7.39	0.39	4.49	0.60	2	2	0.2	60	0.12	FG
	5/11/12	0. 5/6225.86	6.78	0.72	6.39	1.11	3	3	0.2	90	0.18	FG
	6/11/12	0.5/6225.96	11.30	3.00	14.34	6.99	3	3	1.0	50	0.50	CY,FG
	8/27/12	0.5/6224.95	7.10	0.20	9.06	0.61	3	3	0.2	70	0.14	FG
	1/17/13	0.5/6224.41	5.47	0.82	5.37	0.92	2	3	0.3	80	0.24	BG
	2/28/13	0.5/6224.21	4.96	1.40	6.60	0.01	2	2	0.2	50	0.10	CY,FG
	4/12/13	0.5/6224.38	9.63	1.08	10.84	1.15	2.5	2	0.2	80	0.16	CY,FG
	6/21/13	0.5/6224.55	8.95	2.69	8.65	2.69	3	3	0.3	100	0.30	CY,FG
Zephyr Pt.	10/13/10	0.5/6221.89	28.95	11.05	25.86	10.20	3	3	0.6	70	0.42	CY,FG
	1/5/11	0.5/6222.91	34.25	20.71	28.51	17.59	2	2	1.0	70	0.70	SD
	3/31/11	0.5/6224.00	21.93	6.03	8.96	5.26	3	3	0.4	100	0.40	SD
	5/5/11	0.5/6224.51	15.39	2.64	6.98	1.66(n=3)	3	3	0.5	90	0.45	SD
	5/23/11	0.67/6224.40	12.90	2.22(n=3)	10.16	2.60(N=3)	3	3	0.7	90	0.63	SD
	7/1/11	0.5/6226.40	BLD	BLD	NES	NES	-	1.5	<0.1	0	0.00	none
	7/1/11	0.85/6225.25	1.61	0.01	NES	NES	-	-	<0.1	1	0.00	SD
	7/1/11	1.1/6224.43	-	-	-	-	-	-	0.5	30	0.15	SD
	10/28/11	0.5/6225.80	4.55	1.24	3.20	1.36	1	2	0.2	50	0.10	SD
	1/13/12	0.5/6225.01	5.40	2.03	4.64	2.83	2	2.5	0.2	80	0.16	FG
	3/19/12	0.5/6225.36	7.35	1.50	1.73	0.19	2	2.5	0.2	50	0.10	SD,FG
	4/20/12	0.5/6225.52	19.53	10.45	12.22	9.38	2	3	0.8	60	0.48	SD,FG
	5/11/12	0. 5/6225.86	8.67	1.05	5.90	0.60	2.5	2.5	0.4	80	0.32	SD,FG
	6/11/12	0.5/6225.96	12.81	0.72	9.71	0.85	3	3	0.4	100	0.40	SD
	8/27/12	0.5/6224.95	5.03	0.18	3.82	(n=1)	2	1.5	<0.1	20-50	<.02-.05	NA
	1/17/13	0.5/6224.41	12.69	3.34	8.25	2.19	1	2	0.2	80	0.16	SD,FG

Site	Date	Sampling Depth/Elev. (m/ ft)	Chlor. *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (g/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover (%)	Bio. Index	Algal Type
Zephyr Pt.	2/28/13	0.5/6224.21	10.28	5.69	7.97	1.09	NA	2	0.2	60	0.12	SD
	4/12/13	0.5/6224.38	7.62	5.20	8.11	(n=1)	1.5	1.5	<0.1	10	<.01	CY,FG
	6/21/13	0.5/6224.55	27.03	1.28	24.75	5.19	3.5	3.5	1.4	78	1.09	SD,CY,FG

Notes - * -One Pineland biomass sample replicate had anomalously high chlorophyll *a* = 478.17 mg/m^2 and AFDW= 224.31 g/m^2 and was not included in the Pineland chlorophyll *a* and AFDW means for 4/29/11; **-one Incline West biomass sample replicate (1/5/11) was anomalously high based on the observations of growth at the site ranking and biomass index, (chlorophyll *a* = 227.41 mg/m2), this sample was not included in totals for chlorophyll *a* and AFDW.

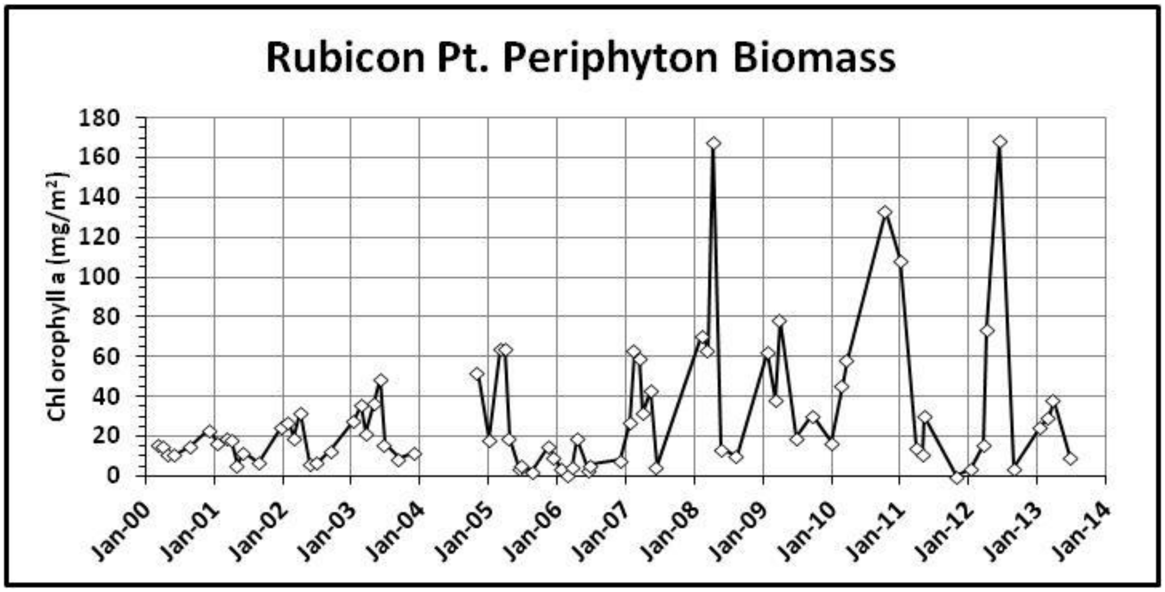

Figure 11 a. Rubicon Pt. periphyton biomass (chlorophyll *a*) 2000-2013.

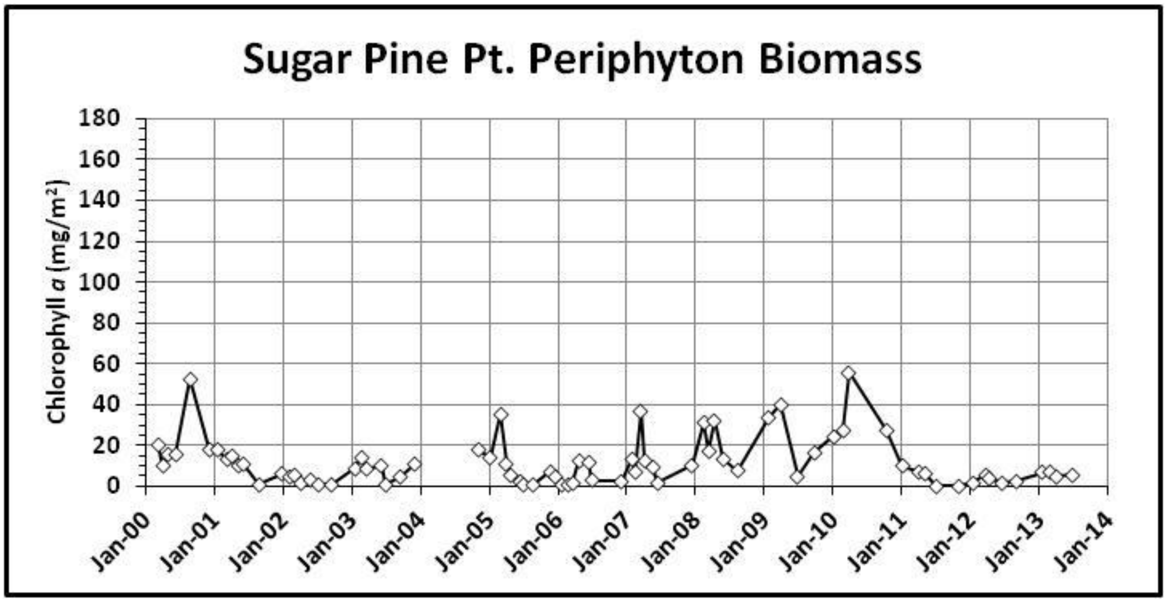

Figure 11 b. Sugar Pine Pt. periphyton biomass (chlorophyll *a*) 2000-2013.

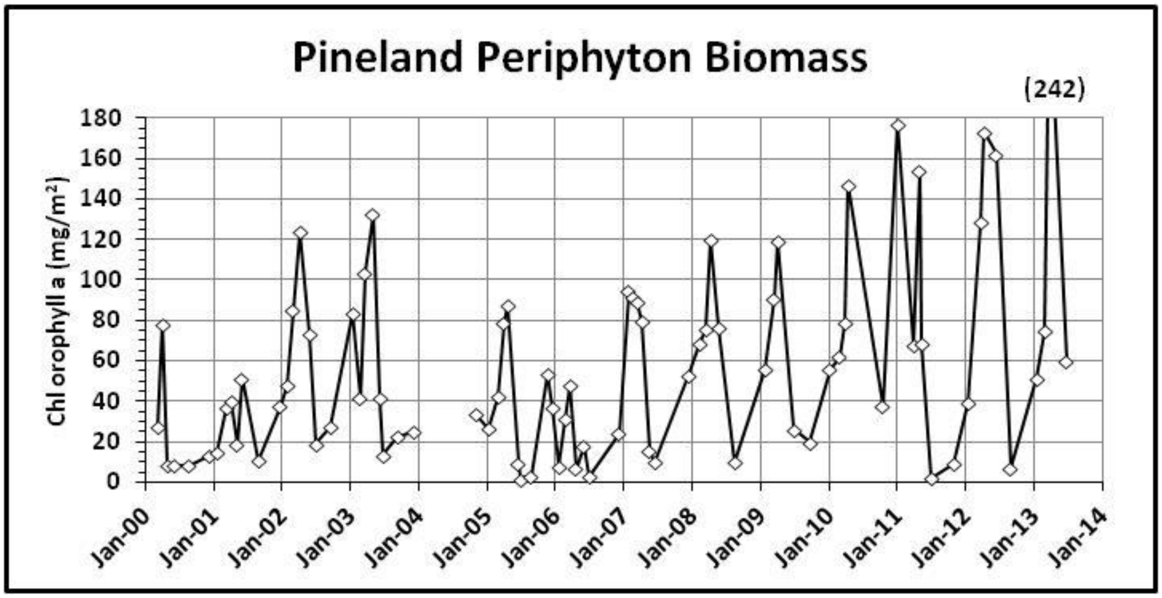

Figure 11 c. Pineland periphyton biomass (chlorophyll *a*) 2000-2013.

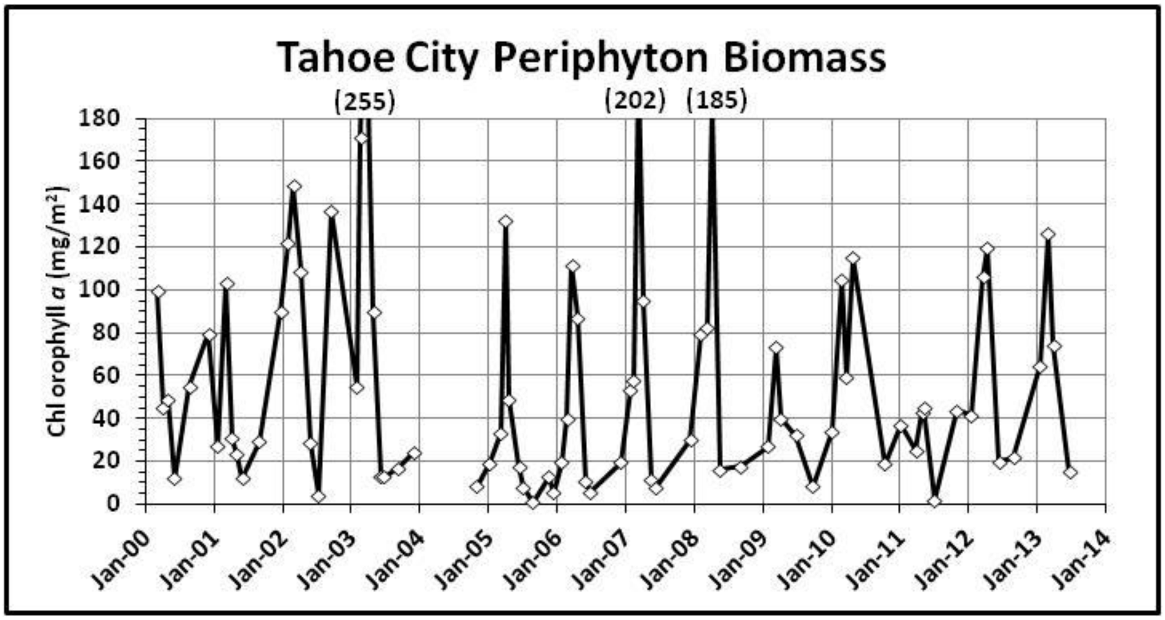

Figure 11 d. Tahoe City periphyton biomass (chlorophyll *a*) 2000-2013.

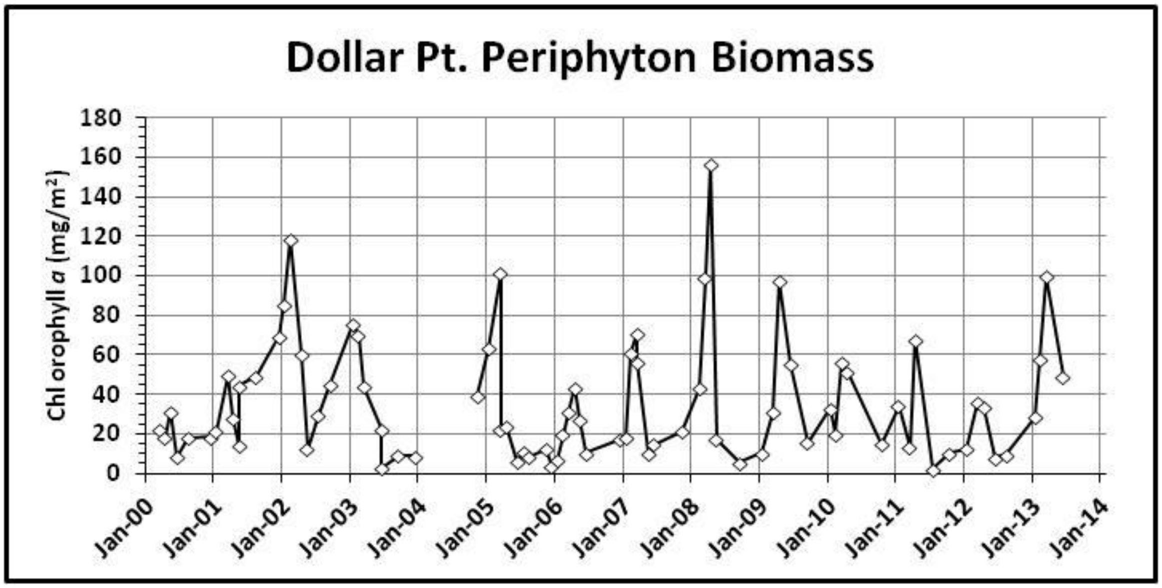

Figure 11 e. Dollar Pt. periphyton biomass (chlorophyll *a*) 2000-2013.

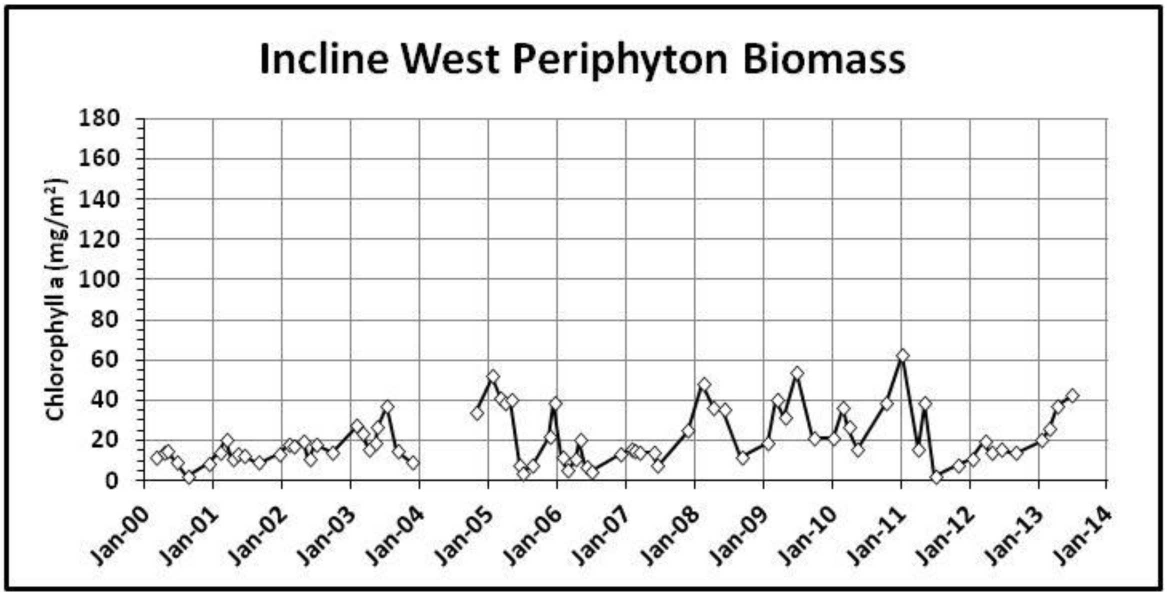

Figure 11 f. Incline West periphyton biomass (chlorophyll *a*) 2000-2013.

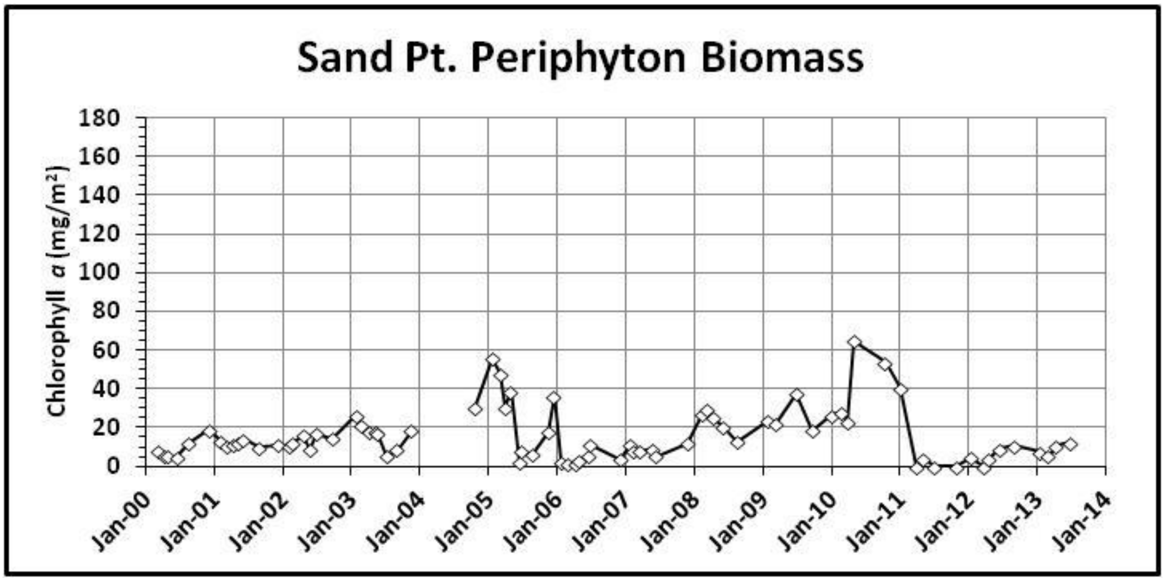

Figure 11 g. Sand Pt. periphyton biomass (chlorophyll *a*) 2000-2013.

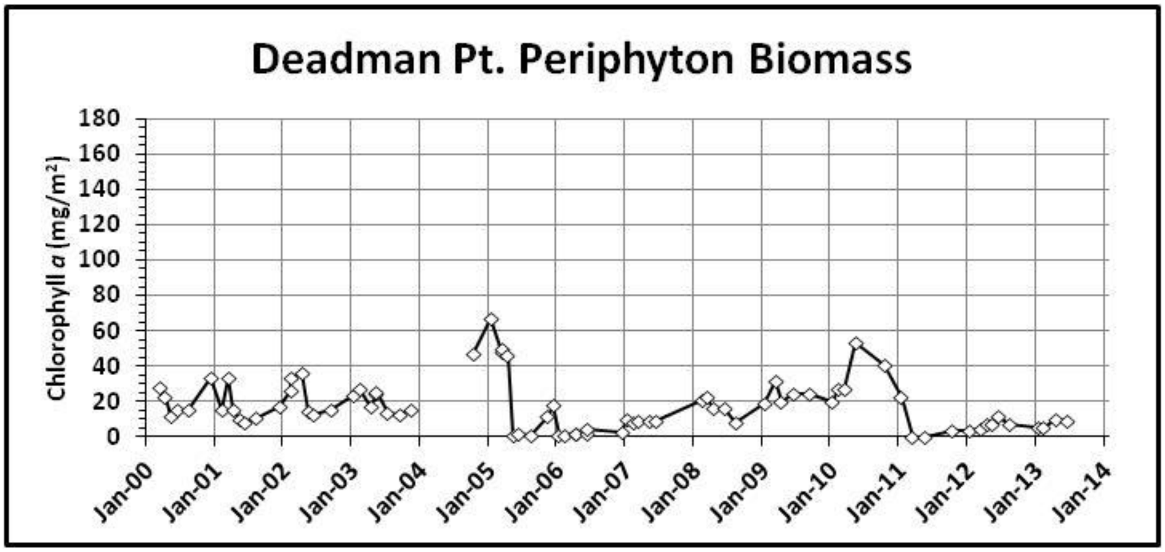

Figure 11 h. Deadman Pt. periphyton biomass (chlorophyll *a*) 2000-2013.

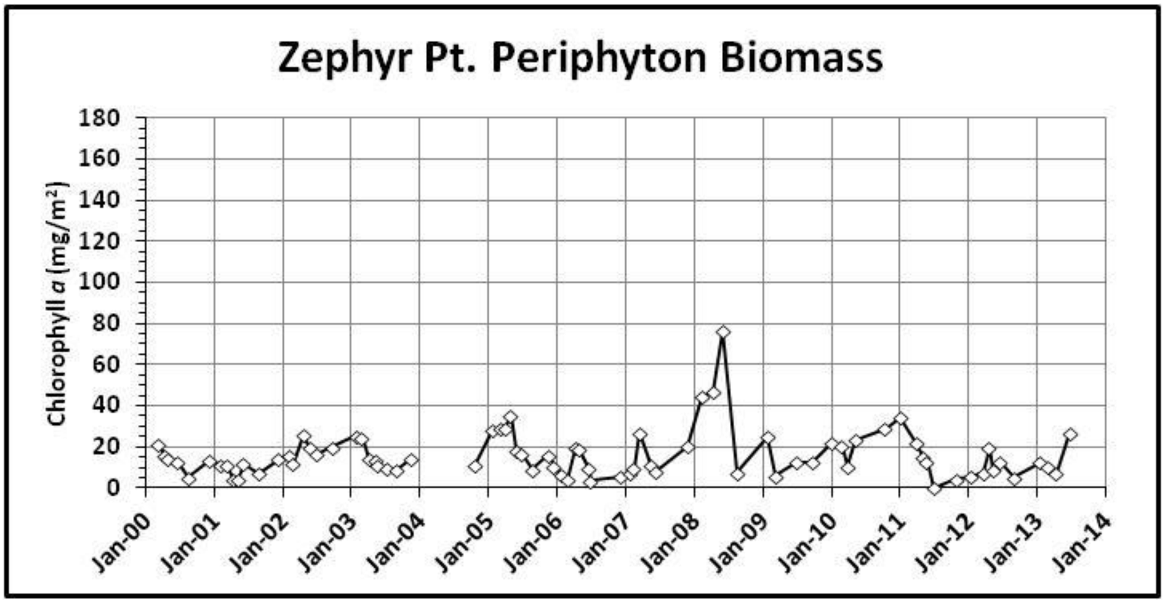

Figure 11 i. Zephyr Pt. periphyton biomass (chlorophyll *a*) 2000-2013.

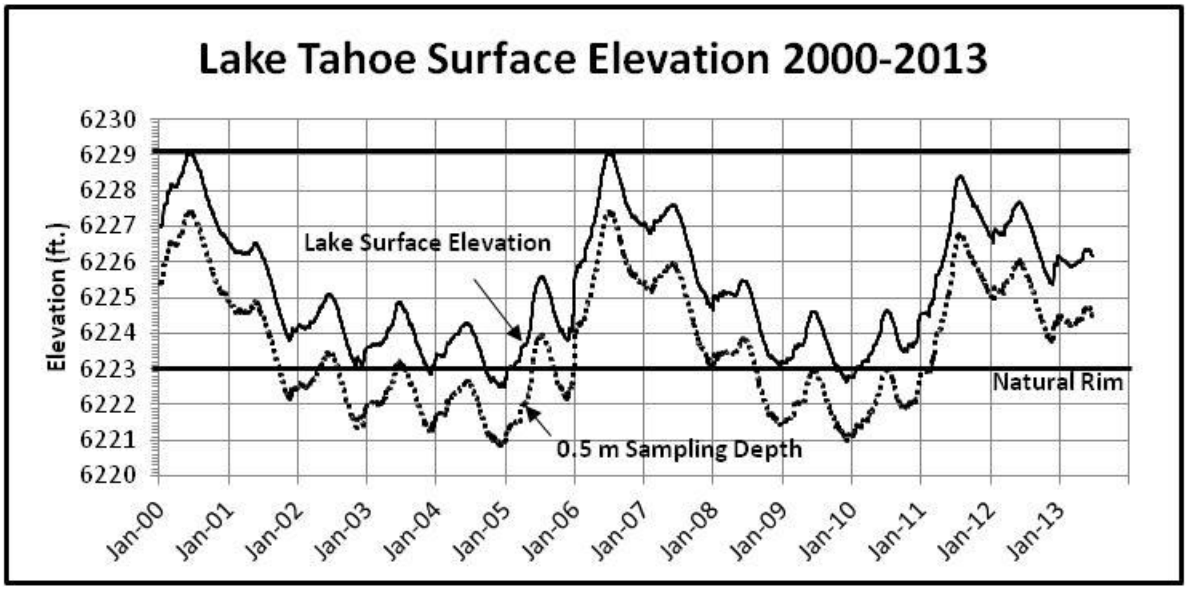

Figure 12. Fluctuation in Lake Tahoe surface elevation 1/1/00-7/1/13. Periphyton samples were typically collected during the period at a depth of 0.5m below the surface on natural rock substrata. The 0.5m sampling depth (shown as a dotted line) fluctuates with the lake surface elevation. The elevation of the natural rim of Lake Tahoe is 6223 ft. The top 6.1 ft. of the lake above the natural rim (to 6229.1 ft.) is operated as a reservoir. Lake level data is from USGS web site (http://nwis.waterdata.usgs.gov).

Pine Pt. (27.85 mg/m^2), Sand Pt. (53.69 mg/m^2) and Deadman Pt. (40.83 mg/m^2). Again these high biomasses were largely due to lowered lake level and presence of blue-green algae in the sampling zone and were not likely a consequence of high nutrient availability of these sites.

After a wet Oct. to December and a rise in lake level of about a foot, by January, 2011, heavy stalked diatom growth over blue-green algae had developed at Pineland. This heavy periphyton growth at Pineland occurred earlier than usual, possibly due to nutrient inputs and other effects of storms the previous 3 months. The January chlorophyll *a* biomass was 177.15 mg/m^2 there which was it's peak for WY 2011. Peak WY biomass was also observed at: Incline West (62.46 mg/m^2) in January, associated with filamentous green algae and blue-green algae growth.

After a distinct lull in the storms during January to mid-February, significant precipitation returned and the lake level began to steadily rise. During the period mid-February to early May, 2011, the lake rose about 1.5 ft. Moderate to heavy amounts of stalked diatom biomass were measured at several westshore sites during this period. Moderate levels of stalked diatom biomass were observed at Tahoe City (43.12 mg/m^2), Dollar Pt. (67.71 mg/m^2), and Rubicon Pt. (30.11 mg/m^2). Chlorophyll *a* biomass was heavy at Pineland (154.06 mg/m^2) at the end of April. The level of stalked diatom biomass was also moderate at Incline West (38.08 mg/m^2) in the northern portion of the lake and Zephyr Pt along the south east shore (21.93 mg/m^2). In contrast, sites along the northeast shore and Sugar Pine Pt. along the west shore had very little or no periphyton biomass during the same period. Maximum chlorophyll *a* levels for these sites during March through early May included: Sand Pt. (4.07 mg/m^2), Deadman Pt. (0 mg/m^2) and Sugar Pine Pt. (7.35 mg/m^2).

By early May, the steady rise in lake level resulted in a layer of recently submerged rock with lighter growth at 0.5m and above, and thicker stalked diatom growth from earlier in the season beneath that. The samples for early May were generally collected slightly deeper than 0.5m, within the layer of thicker biomass from spring growth.

Very little periphyton growth was readily apparent near the surface at most sites by early summer. While in some areas this was due to die-back and sloughing of growth from earlier in the year, which typically occurs in late spring, the rapid rise in lake level also played a significant role in obscuring heavy algae still present in other areas. The lake level continued to rise (nearly another 0.5m) between mid-May and the end of June. By the end of June and start of July the substrate with thicker algae (last sampled in May) was deeper than 1m. Biomass was very light (chlorophyll $a \leq 5$ mg/m^2) at 6 of 7 sites measured at 0.5m and 0.85m. Only Pineland had light-moderate stalked diatom growth at 0.85m (16.71 mg/m^2) with very light growth at 0.5m. Significant stalked diatom growth (PBI=5.0) was still observed at 1.3m at Pineland on 6/30/11. However, at Tahoe City and Dollar Pt. the deeper biomass had either died back or sloughed. At 1m and below at these sites the PBI was low, i.e.: Tahoe City (PBI=0.25), Dollar Pt. (PBI=0.05).

Water Year 2012 Patterns of Periphyton Biomass

Very low periphyton biomass was present in the fall and early winter of WY 2012. Rocky substrate was nearly free of periphyton growth at Rubicon Pt., Sugar Pine Pt. and Sand Pt., while very low chlorophyll *a* biomass was measured at Deadman Pt. (3.69 mg/m^2), Zephyr Pt. (4.55 mg/m^2), Incline West (7.61 mg/m^2), Pineland (8.92 mg/m^2) and Dollar Pt. (10.24 mg/m^2). The exception was Tahoe City where a moderate amount of algal biomass (43.77 mg/m^2) was present as a mixture of old stalked diatom material, sand and silt. Periphyton biomass remained low at most sites through early winter (January) 2012. Exceptions were Tahoe City (where biomass stayed moderately high) and Pineland (where a biomass of 38.97 mg/m^2 in January indicated growth was beginning to increase.

During spring or early summer 2012 significant peaks in periphyton biomass occurred at several of the West Shore monitoring stations, while biomass along the north and east shores remained relatively low. The most significant peaks in periphyton biomass occurred along the northwest shore at Pineland (173.32 mg/m^2) and Tahoe City (119.30 mg/m^2) and along the southwest shore at Rubicon Pt. (168.62 mg/m^2). Peak biomass at Dollar Pt. was less pronounced (35.91 mg/m^2). Periphyton biomass at Sugar Pine Pt. remained very low (maximum chlorophyll *a* = 5.71 mg/m^2) throughout WY 2012. Relatively small spring peaks in biomass were measured at Incline West (19.48 mg/m^2) along the north shore and Zephyr Pt. (19.53 mg/m^2) along the south east shore. Biomass remained very low through most of the spring and was a maximum in June at Sand Pt. (9.13 mg/m^2) and Deadman Pt. (11.30 mg/m^2). The low biomass observed at east and north shore sites in 2012 may have been due to a combination of low nutrient inputs (the east shore receives much less precipitation than the west shore) and slow colonization of substrate submerged the previous year.

It was interesting that heavy biomass developed at Rubicon Pt., Pineland and Tahoe City in WY 2012 despite relatively low overall WY precipitation and associated runoff. Though precipitation was reduced overall in 2012, storms were frequent during late February through March. Storms with significant rain and snow occurred in late January and mid-March. The peak runoff for west shore streams occurred late in April as runoff from a storm combined with spring snowmelt runoff. The timing of these storms during the period when periphyton growth typically increases may have contributed to the elevated periphyton biomass along the west shore. As has been indicated in previous reports a combination of factors likely contributes to periphyton biomass patterns. These factors may include: nutrient inputs (from surface runoff, enhanced inputs from urban/disturbed areas, groundwater, lake mixing/upwelling/ currents), lake level, substrate availability and wind/wave events which may affect periphyton loss from the rocks. The growth in 2012 was also likely due to a combination of these factors, with some factors likely playing more of a role than others.

Water Year 2013 Patterns of Periphyton Biomass

A sampling circuit was done during August 2012, to check levels of biomass during the summer, when the nearshore is most heavily utilized. Low periphyton biomass was present at most sites. Sites with low levels of periphyton chlorophyll *a* biomass included: Sugar Pine Pt. (2.43 mg/m^2), Rubicon Pt. (4.15 mg/m^2), Zephyr Pt. (5.03 mg/m^2), Deadman Pt. (7.10 mg/m^2), Pineland (7.10 mg/m^2), Dollar Pt. (9.68 mg/m^2) and Sand Pt. (10.64 mg/m^2). Slightly higher biomass was measured at Incline West (13.58 mg/m^2). Light-moderate periphyton biomass was present at Tahoe City (21.89 mg/m^2) as old stalked diatom material. These levels were fairly similar to those observed in 2008 when monitoring was also done in August (see Hackley et al., 2010).

The results of spring 2013 monitoring indicated moderate to high biomass at several of the routine sites along the west and north shore. Moderate spring maximum biomass was observed at Rubicon Pt. (38.17 mg/m^2) associated with a mix of stalked diatoms, blue-green and filamentous green algae and Incline West (42.21 mg/m^2) associated with stalked diatoms and blue-green algae. High biomass was observed at Dollar Pt. (99.69 mg/m^2) and Tahoe City (126.03 mg/m^2) associated predominantly with stalked diatoms. Very high spring biomass was observed at Pineland (241.77 mg/m^2) as a mix of stalked diatoms and filamentous green algae. The pattern of heaviest biomass in the north west portion of the lake (Pineland, Tahoe City and Dollar Pt.) observed in 2013, was also observed in several other years including: spring 2011, 2006, 2007. In 2008 and 2012 these sites along with Rubicon Pt. had the highest biomass. The Tahoe City, Pineland and Dollar Pt. sites are located near urban zones and/or areas of nutrient input.

The peak biomass at Pineland in spring 2013, was actually the heaviest in the last 11 years. Reuter (In: Heyvaert et al., 2013) analyzed trends in the periphyton biomass at the routine monitoring sites using all available chlorophyll *a* data 2000-2011 and found a statistically significant trend of increasing biomass at Pineland during that period. The high peak biomass in 2013 may indicate this trend is continuing.

Maximum spring biomass at Sugar Pine Pt. and most sites along the east shore was low. Low maximum chlorophyll *a* biomasses through June 2013 included: Sand Pt. (12.11 mg/m^2), Deadman Pt. (9.63 mg/m^2) and Sugar Pine Pt. (7.28 mg/m^2). Biomass at these sites has remained very low with generally only slight increases since the end of WY 2011. Zephyr Pt chlorophyll *a* was light to moderate by June (27.03 mg/m^2).

WY 2013 so far has been somewhat unusual with respect to the pattern of occurrence of precipitation, however, patterns of periphyton biomass at several west shore sites have been similar to typical seasonal and regional patterns observed in previous years. WY 2013 was characterized by a very “wet” November and December followed by an unusually dry period from January through May. Much of the nutrient delivery to the nearshore may have occurred early in the WY associated with the storms and runoff. Despite the early season nutrient inputs and a relatively light spring runoff, the periphyton biomass showed a typical increase to peak biomass in spring at Pineland, Tahoe City and Dollar Pt. The regional pattern of increased biomass in northwest portion of the lake and low biomass along the east shore was also observed in WY 2013.

Annual Maximum Biomass

WY 2010-2013 annual maximum biomass values as estimated by chlorophyll *a* (Figure 13) showed some consistent patterns among sites. Pineland consistently had the highest biomass during this period. The spring peak biomass there ranged from (147-242 mg Chlorophyll *a* /m^2) and increased each year. (It is interesting to note that periphyton biomass at Pineland appears to have increased over the last decade. Reuter (In: Heyvaert et al., 2013) found a statistically significant trend of increasing biomass at Pineland 2000-2011.) Another fairly consistent pattern observed was that sites in the northwest region of the lake (Pineland, Tahoe City and Dollar Pt.) tended to have higher spring periphyton maximum biomasses compared with the other sites. This was true in WY 2013 and in the spring of 2011. In WY2012 Rubicon Pt. periphyton biomass was also high. In WY2010 spring periphyton biomass was highest at Pineland and Tahoe City with moderate biomass present at the other routine sites. The Tahoe City, Pineland and Dollar Pt. sites are located near urban zones and/or areas of nutrient input. Nutrient inputs (from surface runoff, enhanced inputs from urban/disturbed areas, groundwater, lake mixing/upwelling/ currents), as well as substrate availability and wind/wave events are factors which likely contribute to observed patterns of periphyton biomass around the lake. A third pattern was that sites along the east shore and Sugar Pine Pt. along the west shore typically had lower spring peak biomass except in years when lake level was very low and significant blue-green algal biomass was near the surface. This was true for Sand Pt., Deadman Pt. and Zephyr Pt. and Sugar Pine Pt. during the spring of 2011, 2012 and 2013. During 2010 and early in 2011, low lake levels and presence of blue-green algae resulted in moderate biomasses at these sites.

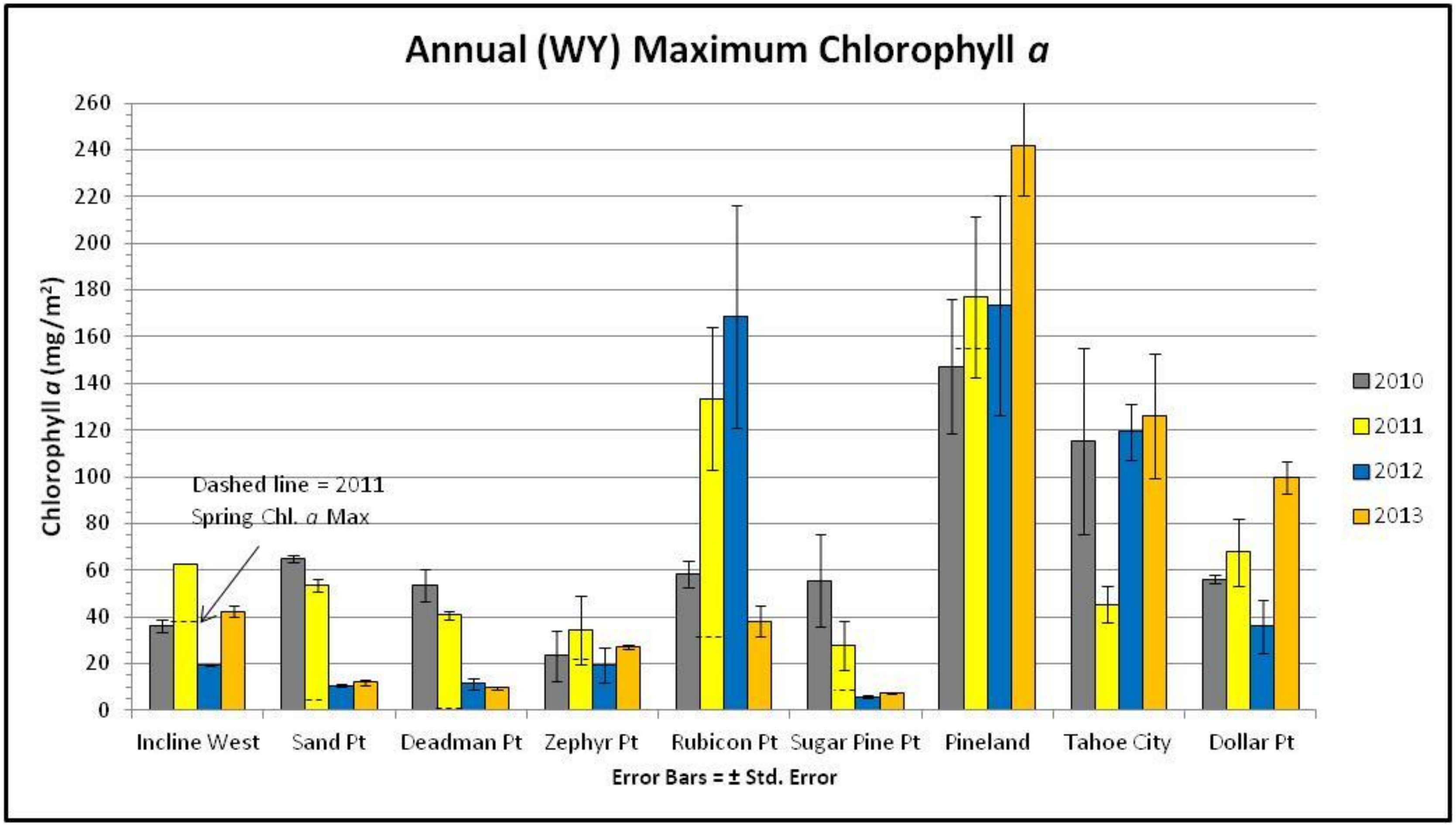

Figure 13. Maximum periphyton Chlorophyll *a* for Water Years 2010-2013 at the nine routine periphyton monitoring sites at 0.5m (note -WY 2013 in progress at time of this report – data through June presented here). (Note, in WY 2011 (Oct. 1, 2010-Sept. 30, 2011), a significant lake level rise of nearly five feet occurred. While biomass often peaks in the spring, during 2010-2011 peak biomass was observed at some sites in Oct. 2010 or Jan. 2011 associated with the low lake level. As the lake rose rapidly in 2011, little colonization of periphyton occurred on newly submerged substrate at many sites, and peak spring growth (shown by dashed lines) was lower than earlier in the year; however at Pineland, Tahoe City and Dollar Pt. the spring peak was near or at the annual max.)

Spring Synoptic Monitoring 2010-2013

While the nine routine sampling sites provide data from many different regions around the lake with differing levels of backshore development and disturbance, the limited number of these sites does not provide enough resolution to determine periphyton biomass on a whole-lake scale. For this reason synoptic sampling was done in the spring periods of 2011-2013 in which 43-44 additional sites along with the nine routine sites were monitored for level of periphyton growth. Table 8 presents the names and locations of these synoptic sites. This synoptic monitoring was timed as much as possible to correspond to peak periphyton growth in each region of the lake. It is important to note that due to variable timing of growth and subsequent die-off of periphyton at various locations around the lake and also the rapid lake level rise in some years, this synoptic data is best considered as supplemental to the routine seasonal monitoring. Conclusions related to the ability of a specific site to support periphyton should be tempered by these considerations.

Several measurements were made while snorkeling at each site to assess the level of biomass during these synoptics. At all sites, measurements of average algal filament length, % algal coverage over substrate, above and below water visual ranking, and observations on main algal types present were made. For a portion of the sites, biomass samples (chlorophyll *a* and Ash Free Dry Weight (AFDW)) were also collected to check the relation between measured biomass and biomass estimated using a rapid assessment method for periphyton biomass, the “Periphyton Biomass Index” (PBI).

2011-2013 Biomass to Periphyton Biomass Index Relationship

At all Spring Synoptic sites, a “Periphyton Biomass Index (PBI)” was calculated for each date to approximate the level of biomass present. During 2011-2013 we did not collect biomass samples at all spring synoptic monitoring sites due to time constraints. It was desirable to be able to estimate biomass rapidly in the field based on measurable features of the algae growth. During this period we continued to experiment with use of a “Biomass Index” to estimate levels of biomass present. The Biomass Index was calculated by multiplying the average filament length (cm) of the periphyton present at 0.5m by the % coverage of algae over the rock. Higher biomass should be associated with more material over the rock surface.

The mean chlorophyll *a* values for samples collected on 2011-2013 samples were compared with Periphyton Biomass Index values at the same site and a fairly strong association was found (R^2= 0.73) (Figure 14). The PBI appeared to behave similarly to measured biomass during the period and provided a valid method to rapidly assess the levels of periphyton biomass at the synoptic sites. The maps produced for the synoptic sampling (Figures 15, 16, 17) are based on the PBI values and show how biomass varied in the nearshore at 0.5m around the lake.

Table 8. Periphyton Spring Synoptic monitoring locations.

SITE DESIGNATION	WEST SHORE	LOCATION
A	Cascade Creek	N38 57.130; W120 04.615
B	S. of Eagle Point	N38 57.607; W120 04.660
C	E.Bay/Rubicon	N38 58.821; W120 05.606
D	Gold Coast	N39 00.789; W120 06.796
E	S. Meeks Point	N39 01.980; W120 06.882
F	N. Meeks Bay	N39 02.475; W120 07.194
G	Tahoma	N39 04.199; W120 07.771
H	S. Fleur Du Lac	N39 05.957; W120 09.774
I	Blackwood Creek	N39 06.411; W120 09.424
	Kaspian Pt.	(Point near Elizabeth Dr.)
J	Ward Creek	N39 07.719; W120 09.304
K	N. Sunnyside	N39 08.385; W120 09.135
L	Tavern Point	N39 08.806; W120 08.628
TCT	Tahoe City Tributary	(adjacent to T.C. Marina)
M	TCPUD Boat Ramp	N39 10.819; W120 07.177
N	S. Dollar Point	N39 11.016; W120 05.888
O	S. Dollar Creek	N39 11.794; W120 05.699
P	Cedar Flat	N39 12.567; W120 05.285
Q	Garwood’s	N39 13.486; W120 04.974
R	Flick Point	N39 13.650; W120 04.155
S	Stag Avenue	N39 14.212; W120 03.710
T	Agatam Boat Launch	N39 14.250; W120 02.932
	EAST SHORE	
E1	South side of Elk Point	N38 58.965; W119 57.399
E2	North Side of Elk Point	N38 59.284; W119 57.341
E3	South Side of Zephyr Point	N38 59.956; W119 57.566
E4	North Zephyr Cove	N39 00.920; W119 57.193
E5	Logan Shoals	N39 01.525; W119 56.997
E6	Cave Rock Ramp	N39 02.696; W119 56.935
E7	South Glenbrook Bay	N39 04.896;W119 56.955
E8	South Deadman Point	N39 05.998; W119 57.087
E9	Skunk Harbor	N39 07.856; W119 56.597
E10	Chimney Beach	N39 09.044; W119 56.008
E11	Observation Point	N39 12.580; W119 55.861
	NORTH SHORE	
E12	Hidden Beach	N39 13.263; W119 55.832
E13	Burnt Cedar Beach	N39 14.680; W119 58.132
	Incline Condo	N39 14.90; W119 59.63
	Old Incline West	(100 yds No. Incline West)
E14	Stillwater Cove	N39 13.789; W120 00.020
E15	North Stateline Point	N39 13.237; W120 00.193
E16	Brockway Springs	N39 13.560; W120 00.829
E17	Kings Beach Ramp Area	N39 14.009; W120 01.401
	SOUTH SHORE	
S1	Tahoe Keys Entrance	N38 56.398; W120 00.390
S2	Kiva Point	N38 56.555; W120 03.203
	Timber Cove Rocks	Rocks west T. Cove Pier

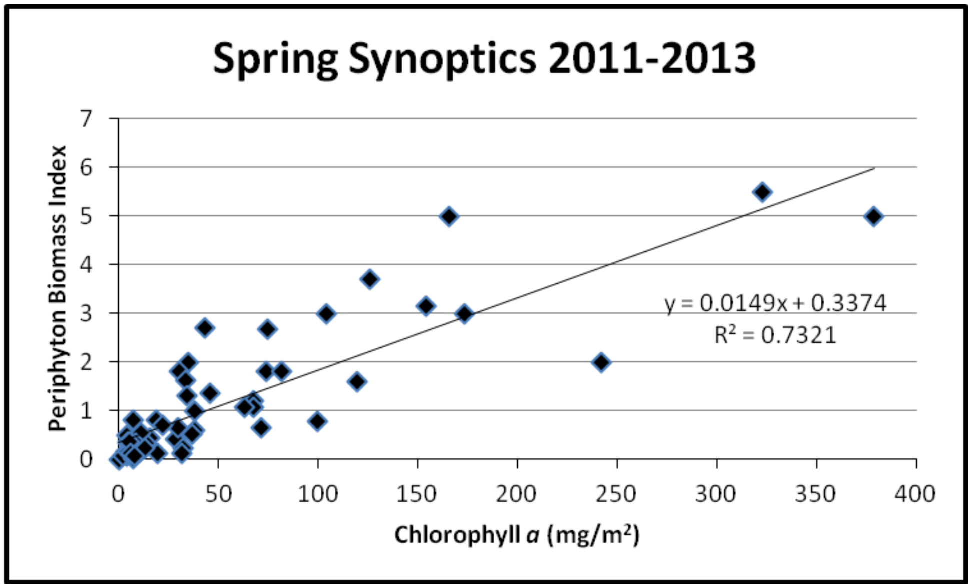

Figure 14. Relation between periphyton chlorophyll *a* and Periphyton Biomass Index for sites where both were measured on spring synoptics 2011-2013. Note when the samples with high chlorophyll *a* (>200 mg/m^2) are excluded, the association remains strong (R^2 = 0.7184) and the equation equation is Y=0.021X+0.1415.

Results of Spring Synoptic Monitoring 2011

During the spring 2011 synoptic, 43 sites were monitored in addition to the routine sites during April 12-May 13. Measurements of filament length, % coverage, above and below water visual ranking, and observations on main algal types present were made. In addition biomass samples (chlorophyll *a* and AFDW were collected at 7 of the sites). Data collected for the spring synoptic monitoring 2011 is summarized in Table 9. Figure 15 presents a map showing the general distribution of periphyton biomass (as Biomass Index) around the lake in spring 2011.

The 2011 spring synoptic monitoring was done when lake level was increasing rapidly and significant stalked diatom growth was still present at 0.5m. Sites at South Shore were sampled slightly earlier (on 4/12/11) than other sites (spring biomass often peaks earlier there than at the other sites.) The remaining spring synoptic sites as well as routine sites were sampled during the period 4/29/11 to 5/13/11. Due to rapid lake level rise, after 5/5/11, a fixed sampling elevation of ~6224.40 ft. was used for monitoring to help assure algae had colonized substrate for approximately the same length of time.

During the spring of WY 2011, periphyton biomass was heavier along the west shore, with heaviest growth in the northwest portion of the lake from Tahoma to Dollar Creek. There were also areas of heavier growth in the Kings Beach/Brockway Springs areas, and Incline Condominium site in the northern portion of the lake and at the southwest and southeast corners of the lake. Growth was lighter along most of the east shore with one area of heavier growth at Chimney Beach. The periphyton appeared to be dominated by the stalked diatom *Gomphoneis herculeana* at most sites in the spring. At a couple sites, Garwood's and Timber Cove there was also some filamentous green algae present.

It is likely a combination of many factors affected patterns of periphyton biomass in WY2011. These factors include nutrient inputs with surface runoff, enhanced inputs from urban/disturbed areas, groundwater, lake mixing/upwelling/currents), lake level, substrate availability and wind/wave events which may affect periphyton loss from the rocks. WY 2011 was a particularly heavy precipitation year. The contribution of nutrients from surface and tributary runoff from the many wet storms in WY 2011 may have had more of an impact on nearshore periphyton growth compared with years with less precipitation. Several sites with very high biomass in spring 2011, were in regions that were likely influenced by tributaries and surface runoff, including: the Ward Cr., Tahoe City Tributary and South Dollar Cr. sites; the Pineland site which may be influenced also by Ward Cr.; and the Kings Beach site which is near an urban inflow). Upwelling of NO3-N during frequent storms early in this WY may also have contributed to patterns of biomass observed. Interestingly, much of the heavy biomass that developed at sites in the spring was not readily apparent near the surface by early summer. In some areas this was due to die-back and sloughing of the algae. However, significant periphyton was still present in some areas and the significant rise in lake elevation associated with runoff, submerged this biomass to depths closer to a meter where it was less readily apparent.

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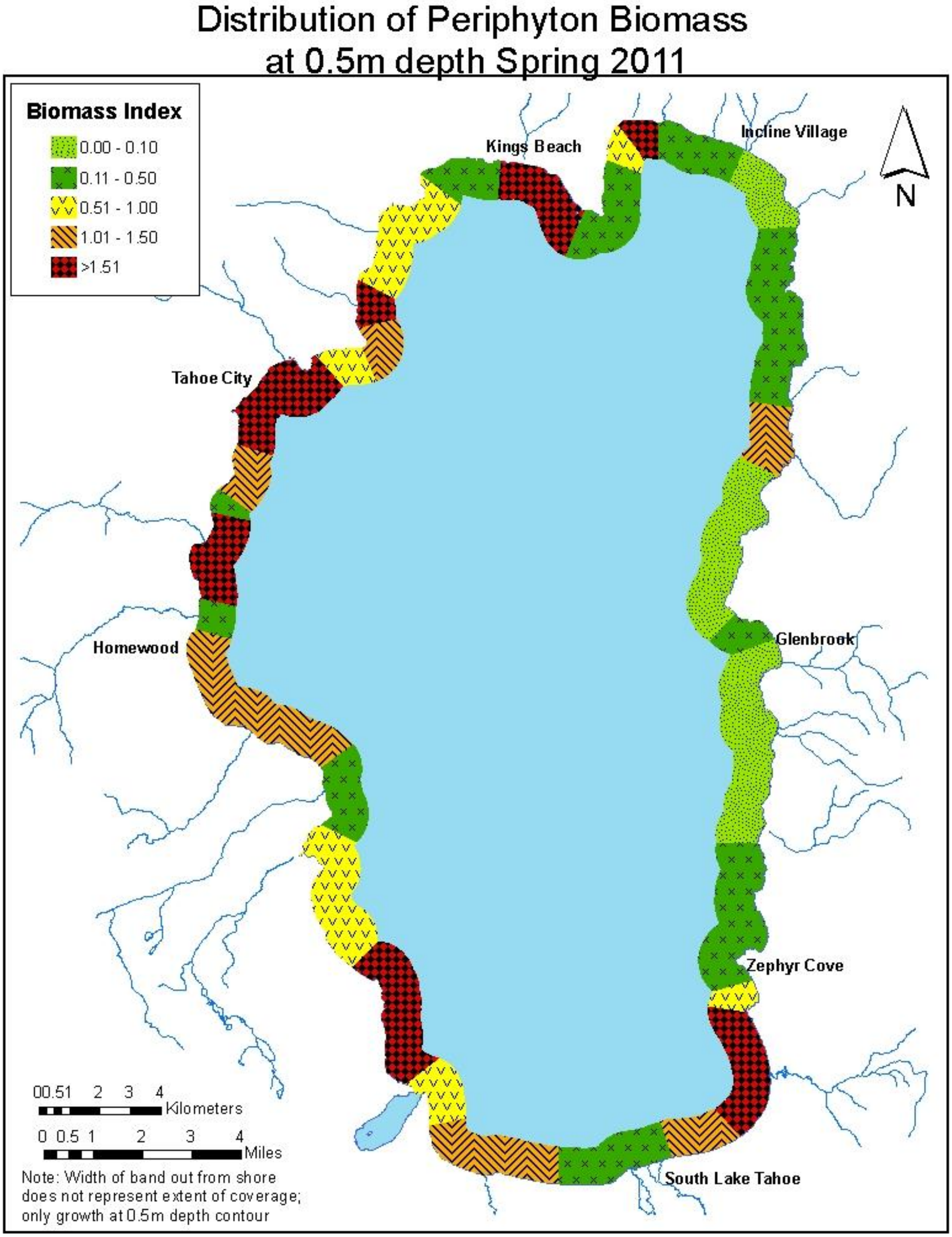


Note: Width of band out from shore does not represent extent of coverage; only growth at 0.5m depth contour

Figure 15. Extrapolated regional distribution of periphyton biomass measured as Biomass Index (Avg. Filament Length x % Area Covered with Algae) April 12 – May 13, 2011.

Table 9. Summary of 0.5m periphyton Chlorophyll *a*, Ash Free Dry Weight (AFDW), visual score, avg. filament length and % algal coverage, predominant algae present based on visual observations while snorkeling (FG=filamentous greens; SD=stalked diatoms; CY= blue green algae), for routine sites (shaded) and Spring Synoptic monitoring sites during 2011. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated. Visual score is a subjective ranking of the aesthetic appearance of algal growth (viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is Filament Length times % Algal Cover. "NA" = not available or not collected; "NES" = not enough sample for analysis. Sampling depth and corresponding sampling elevation are also indicated.

Site	Site Name	Date	Sampling Depth/Elev (m/ ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
A	Cascade Creek	5/13/11	0.59/6224.38					3	4	2.5	60%	1.50	SD
B	S. of Eagle Point	5/13/11	0.59/6224.38					2	3	1.2	70%	0.84	SD
C	E.Bay/Rubicon	5/13/11	0.59/6224.38	34.62	8.86	14.55	9.74	4	4	2.2	90%	1.98	SD
	Rubicon Pt.	5/13/11	0.59/6224.38	30.11	2.56(n=3)	18.18	4.72(n=3)	4	4	1.8	100	1.8	SD
D	Gold Coast	5/13/11	0.59/6224.38					2	3	1.0	60%	0.60	SD
E	S. Meeks Point	5/13/11	0.59/6224.38					2.5	3	1.4	60%	0.84	SD
F	N. Meeks Bay	5/13/11	0.59/6224.38					3	3	1.0	70%	0.70	SD
	Sugar Pine Pt.	4/29/11	0.5/6224.40	6.56	0.88	2.00	1.12	NA	3	0.3	80%	0.24	SD
G	Tahoma	4/29/11	0.5/6224.40					NA	5	1.5	80%	1.20	SD
H	S. Fleur Du Lac	4/29/11	0.5/6224.40					NA	4	1.4	90%	1.26	SD
I	Blackwood Creek	4/29/11	0.5/6224.40					NA	2	0.2	60%	0.12	SD
	Kaspian Pt.	4/29/11	0.5/6224.40					NA	5	3.0	90%	2.70	SD
J	Ward Creek	4/29/11	0.5/6224.40	323.10*	92.54	431.81	156.86	NA	5	5.5	100%	5.50	SD
	Pineland	4/29/11	0.5/6224.40	154.06*	78.56	91.31*	27.41	4	5	3.5	90%	3.15	SD
K	N. Sunnyside	4/29/11	0.5/6224.40					NA	4	0.5	90%	0.45	SD
L	Tavern Pt.	4/29/11	0.5/6224.40					4	4	1.5	90%	1.35	SD
	Tahoe City	4/29/11	0.5/6224.40	43.12	20.49	48.78	26.54(n=3)	4	4	3.0	90%	2.70	SD
TCT	Tahoe City Trib.	4/29/11	0.5/6224.40					5	5	3.0	90%	2.70	SD
M	TCPUD Boat Ramp	4/29/11	0.5/6224.40					NA	4	2.0	80%	1.60	SD
N	S. Dollar Pt.	4/29/11	0.5/6224.40					2	3	1.0	90%	0.90	SD
	Dollar Pt.	4/29/11	0.5/6224.40	67.71	14.31	67.00	15.70	3	3.5	1.5	80%	1.20	SD
O	S. Dollar Creek	4/29/11	0.5/6224.40					3	4	2.0	80%	1.60	SD
P	Cedar Flat	4/29/11	0.5/6224.40					3.5	3.5	1.2	80%	0.96	SD
Q	Garwood's	5/9/11	0.56/6224.44					3.5	4	1.0	90%	0.90	SD,FG
R	Flick Point	5/6/11	0.54/6224.38					2	3	1.0	60%	0.60	SD
S	Stag Avenue	5/9/11	0.56/6224.44					3	3	0.5	60%	0.30	SD
T	Agatam Boat R.	5/9/11	0.56/6224.44					3	3.5	1.0	50%	0.50	SD

Site	Site Name	Date	Sampling Depth/Elev (m/ ft)	Chl a (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
E17	Kings Beach	5/9/11	0.56/6224.44					3.5	4	2.0	95%	1.90	SD
E16	Brockway Springs	5/6/11	0.54/6224.38					4	5	2.8	90%	2.52	SD
E15	No. Stateline Point	5/6/11	0.54/6224.38	3.64	0.53	NES	NES	4	2	0.2	80%	0.16	SD
E14	Stillwater Cove	5/6/11	0.54/6224.38					3	2	1.0	50%	0.50	SD
	Old Incine West	5/6/11	0.54/6224.38					3	3	0.9	60%	0.54	SD
	Incline West	5/6/11	0.54/6224.38	38.08	3.80	16.58	1.20	2	3	2.0	30%	0.60	SD
	Incline Condo	5/6/11	0.54/6224.38					3	4.5	2.6	70%	1.82	SD
E13	Burnt Cedar Beach	5/6/11	0.54/6224.38					2.5	2.5	0.5	70%	0.35	SD
E12	Hidden Beach	5/6/11	0.54/6224.38					1.5	1.5	0.1	40%	0.04	SD
E11	Observation Point	5/9/11	0.56/6224.44					3	3	0.6	70%	0.42	SD
	Sand Pt.	5/6/11	0.54/6224.38	4.07	1.11	3.68	N=1	3	3	0.8	60%	0.48	SD
E10	Chimney Beach	5/6/11	0.54/6224.38					2	3.5	1.5	100%	1.50	SD
E9	Skunk Harbor	5/6/11	0.54/6224.38					1	1	0.0	0%	0.00	none
	Deadman Pt.	5/6/11	0.54/6224.38	BLD	BLD	1.82	0.90	1	1	0.0	0%	0.00	none
E8	So. Deadman Point	5/6/11	0.54/6224.38					3	3	0.7	40%	0.28	SD
E7	So. Glenbrook Bay	5/6/11	0.54/6224.38					1	1.5	0.1	60%	0.06	SD
E6	Cave Rock Ramp	5/5/11	0.5/6224.51					2	2	0.2	50%	0.10	SD
E5	Lincoln Park	5/5/11	0.5/6224.51					2	2	0.2	80%	0.16	SD
E4	No. Zephyr Cove	5/5/11						2	2	0.3	40%	0.12	SD
E3	So. Zephyr Pt.	5/5/11	0.5/6224.51					2	3	1.0	50%	0.50	SD
	Zephyr Pt.	5/5/11	0.5/6224.51	15.39	2.64	6.98	1.66(n=3)	3	3	0.5	90%	0.45	SD
E2	No. Elk Pt.	5/5/11	0.5/6224.51	7.05	1.52(n=3)	4.93	0.13(n=3)	2	3	1.0	80%	0.80	SD
E1	So. Elk Point	5/5/11	0.5/6224.51					3	4	2.0	80%	1.60	SD
	Timber Cove Rock	4/12/11	0.50/6224.12	67.28	18.99(n=3)	38.40	10.02(n=3)	NA	4	1.2	90%	1.08	SD,FG
S1	T. Keys Entrance	4/12/11	0.50/6224.12	28.18	5.91(n=3)	12.72	3.51(n=3)	4.5	3	0.7	60%	0.42	SD
S2	Kiva Point	4/12/11	0.50/6224.12	62.93	22.14(n=3)	40.75	13.46(n=3)	3	4	1.2	90%	1.08	SD

Note - * -One Pineland biomass sample replicate had anomalously high chlorophyll *a* = 478.17 mg/m^2 and AFDW= 224.31 g/m^2 and was not included in the Pineland chlorophyll *a* and AFDW means for 4/29/11.

Spring Synoptic Monitoring 2012

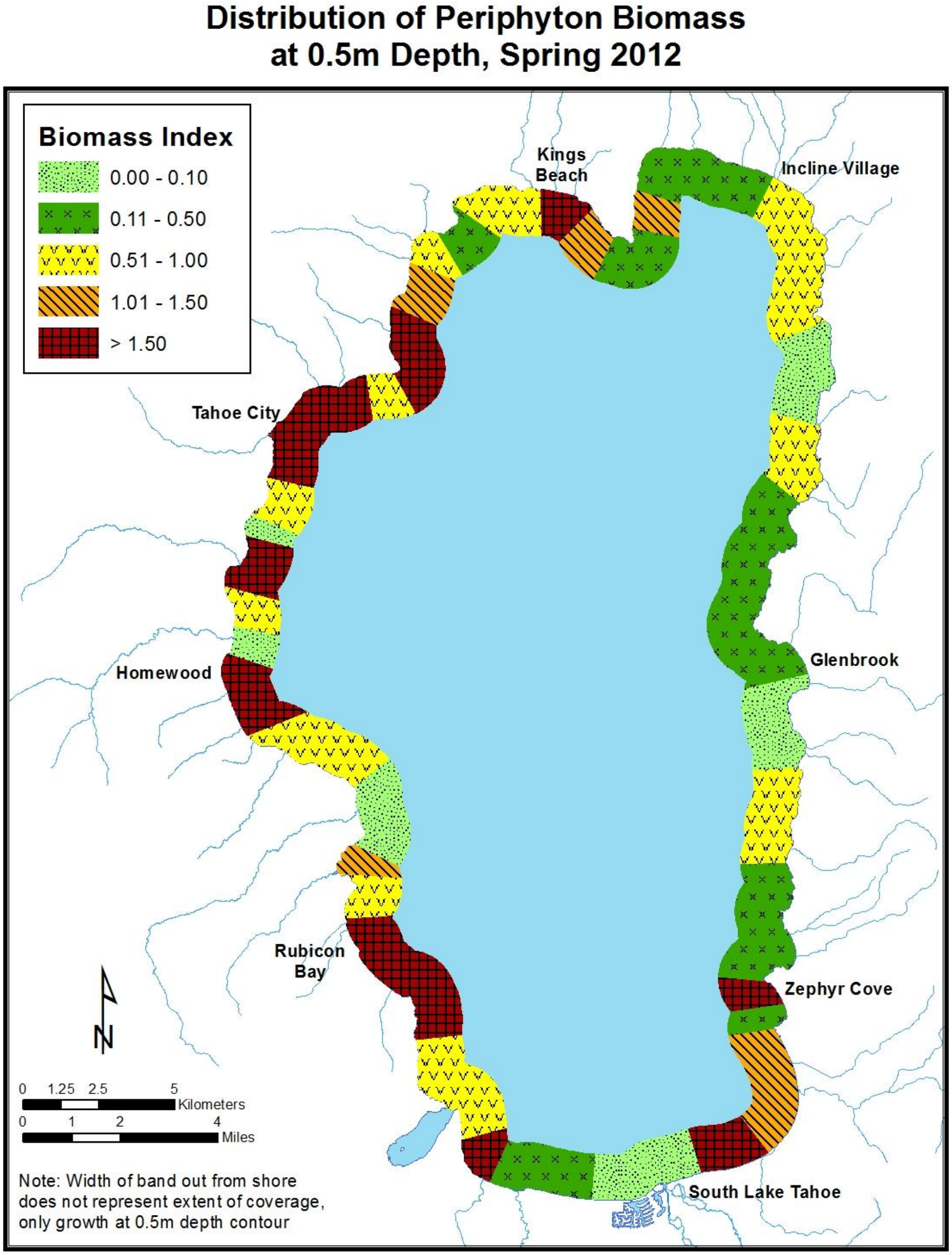
During the spring 2012 synoptic, 45 sites were monitored in addition to the routine sites during April 3-May 13. Data collected for the expanded monitoring 2012 is summarized in Table 10. Figure 16 presents a map showing the general distribution of periphyton biomass (as Periphyton Biomass Index (PBI)) around the lake in spring 2012. Although this monitoring captured peak biomass at many sites, peaks may have been missed at sites along the southwest shore (which tend to peak early in the spring) and along some north and east shore sites which showed additional growth into June.

During the spring synoptic, WY 2012, periphyton biomass was moderate to heavy along the southwest and northwest shores with some areas of light growth interspersed. Biomass was light to moderate along portions of the north and east shores. Along the south east shore biomass ranged from moderate to heavy in the south east corner, to light in the southwest. The periphyton appeared to be dominated by the stalked diatom *Gomphoneis herculeana* at most sites in the spring.

Many of the same sites that had high PBI in 2011 also had high PBI in 2012. These included sites that were in regions that were likely influenced by tributaries and surface runoff, including: the Ward Cr., Tahoe City Tributary, South Dollar Cr., Pineland and Kings Beach. Biomass was high in both years in much of the northwest portion of McKinney Bay extending around Dollar Pt. to South Dollar Creek.

For the first time in recent years observations of biomass were made near Lake Forest Island. A thick coverage stalked diatoms over the rocky substrate was observed there. In several past years, accumulations of sloughed periphyton have washed up along shore in the Lake Forest area. Nearby production of biomass likely contributes to this accumulation of sloughed material onshore.

The development of moderate to heavy periphyton biomass in WY2012 for many of the west shore synoptic and routine sites is of interest, as this was a relatively low precipitation year. Though precipitation was reduced overall in 2012, storms were frequent during late February through March. Storms with significant rain and snow occurred in late January and mid-March. The peak runoff for west shore streams occurred late in April as runoff from a storm combined with spring snowmelt runoff. The timing of these events during the period when periphyton growth is typically increasing may have contributed to the elevated periphyton growth along the west shore. As has been indicated in previous reports a combination of factors likely contributes to periphyton biomass patterns. These factors may include: nutrient inputs (from surface runoff, enhanced inputs from urban/disturbed areas, groundwater, lake mixing/upwelling/currents), lake level, substrate availability and wind/wave events which may affect periphyton loss from the rocks. The growth in 2012 was also likely due to a combination of these factors, with some factors likely playing more of a role than others.



Note: Width of band out from shore does not represent extent of coverage, only growth at 0.5m depth contour

Figure 16. Extrapolated regional distribution of periphyton biomass measured as Biomass Index (Avg. Filament Length x % Area Covered with Algae) 4/3-5/12/12.

Table 10. Summary of 0.5m periphyton Chlorophyll *a*, Ash Free Dry Weight (AFDW), visual score, avg. filament length and % algal coverage, predominant algae present based on visual observations while snorkeling (FG=filamentous greens; SD=stalked diatoms; CY= blue green algae), for spring synoptic 2012. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated. Visual score is a subjective ranking of the aesthetic appearance of algal growth (viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is Filament Length times % Algal Cover. “NA” = not available or not collected; “NES” = not enough sample for analysis. Sampling depth and corresponding sampling elevation are also indicated.

Site	Site Name	Date	Sampling Depth/Elev (m/ ft)	Chl *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
A	Cascade Creek	4/9/12	0.5/6225.45					3	3.5	1.8	95	1.71	SD
B	S. of Eagle Point	4/9/12	0.5/6225.45					3	3	0.8	90	0.72	SD
C	E.Bay/Rubicon	4/9/12	0.5/6225.45					3	3	0.8	75	0.6	SD
	Rubicon Pt.	4/9/12	0.5/6225.45	74.15	22.21(n=3)	25.93	4.29(n=3)	4	4	2.0	90	1.80	SD,FG
D	Gold Coast	4/9/12	0.5/6225.45					3.5	4	2.0	90	1.8	SD,FG
E	S. Meeks Point	4/9/12	0.5/6225.45					3.5	3	1.0	90	0.90	SD
F	N. Meeks Bay	4/9/12	0.5/6225.45					3	3.5	1.5	85	1.28	SD,FG
	Sugar Pine Pt.	4/9/12	0.5/6225.45	3.89	2.04	3.57	(n=1)	2	2	0.1	90	0.09	SD
G	Tahoma	4/9/12	0.5/6225.45					2.5	3	1.3	60	0.78	SD
H	S. Fleur Du Lac	4/9/12	0.5/6225.45					3	4	2.0	90	1.80	SD,FG
I	Blackwood Creek	4/9/12	0.5/6225.45					1	2	0.1	80	0.08	SD
	Kaspian Pt.	4/9/12	0.5/6225.45					3	3	1.0	100	1.00	SD
J	Ward Creek	4/9/12	0.5/6225.45	165.58	115.68(n=3)	118.74	27.58 (n=3)	-	5	5.0	100	5.00	SD
	Pineland	4/9/12	0.5/6225.45	173.32	81.48(n=3)	115.14	47.36(n=3)	5	5	3.0	100	3.00	SD,FG
K	N. Sunnyside	4/9/12	0.5/6225.45					1	1	0	0	0	-
L	Tavern Pt.	4/9/12	0.5/6225.45					2	2.5	0.8	70	0.56	SD
	Tahoe City	4/11/12	0.5/6225.45	119.30	21.05(n=3)	94.16	14.96(n=3)	3	4	2.0	80	1.60	SD
TCT	Tahoe City Trib.	4/11/12	0.5/6225.45					4	5	3.0	90	2.70	SD
M	TCPUD Boat Ramp	4/11/12	0.5/6225.45					-	4	1.7	95	1.62	SD
	Lake Forest Island	4/11/12	0.5/6225.45					4	5	3.5	90	3.15	SD
N	S. Dollar Pt.	4/9/12	0.5/6225.45					2	2.5	0.8	80	0.64	SD
	Dollar Pt.	4/9/12	0.5/6225.45	33.36	8.44(n=3)	23.71	7.09(n=3)	3	4	1.8	90	1.62	SD
O	S. Dollar Creek	4/23/12	0.5/6225.58	104.06	24.81(n=3)	114.60	19.92(n=3)	4.5	5	3.0	100	3.00	SD
P	Cedar Flat	4/23/12	0.5/6225.58					3	3.5	1.3	90	1.17	SD
Q	Garwood’s	4/11/12	0.5/6225.45	71.71	2.48	43.51	6.27	-	3.5	0.8	80	0.64	SD
Q	Garwood’s	4/23/12	0.5/6225.58	32.55	10.18	15.07	5.19	2.5	3.0	0.4	60	0.24	SD
R	Flick Point	4/23/12	0.5/6225.58					2.5	2.5	0.5	50	0.25	SD

Site	Site Name	Date	Sampling Depth/Elev (m/ ft)	Chl *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
S	Stag Avenue	4/23/12	0.5/6225.58	29.78	6.86	16.37	2.06	3	3.5	0.8	80	0.64	SD
T	Agatam Boat R.	4/23/12	0.5/6225.58					-	3.5	1.0	70	0.70	SD
E17	Kings Beach	4/23/12	0.5/6225.58					3.5	4	1.8	90	1.62	SD
E16	Brockway Springs	4/23/12	0.5/6225.58	33.94	4.85	21.05	3.05	4	4	2.0	65	1.30	SD
E15	No. Stateline Point	4/20/12	0.5/6225.52					4	3.5	0.5	80	0.40	SD
E14	Stillwater Cove	4/20/12	0.5/6225.52					3	3	1.2	90	1.08	SD
	Old Incline West	4/20/12	0.5/6225.52	4.46	1.14	3.84	0.09	3	3	0.4	80	0.32	SD
	Incline West	4/20/12	0.5/6225.52	13.56	1.14	8.43	0.59	3.5	3.5	0.4	80	0.32	SD,CY,FG
	Incline Condo	4/20/12	0.5/6225.52	4.46	1.14	3.84	0.09	3	3	0.4	90	0.36	SD,CY
E13	Burnt Cedar Beach	4/20/12	0.5/6225.52					3.5	3.5	0.5	90	0.45	SD
E12	Hidden Beach offsh.	4/20/12	0.5/6225.52					3	3	0.8	70	0.56	SD
	Hidden Beach insh.	4/20/12	0.5/6225.52					3.5	4	1.7	90	1.53	SD
E11	Observation Point	4/20/12	0.5/6225.52					4	3.5	0.9	90	0.81	SD
	Sand Pt.	4/20/12	0.5/6225.52	3.96	0.31	3.99	1.50	2	2	0.1	70	0.07	SD
E10	Chimney Beach	4/20/12	0.5/6225.52					2.5	3	1.0	60	0.60	SD
E9	Skunk Harbor	4/20/12	0.5/6225.52					2	2	0.2	70	0.14	SD,FG
	Deadman Pt.	4/20/12	0.5/6225.52	19.53	10.45	4.49	0.60	2	2	0.2	60	0.12	FG
E8	So. Deadman Point	4/20/12	0.5/6225.52					3	3	0.6	70	0.42	SD
E8	So. Deadman Point	5/12/12	0.5/6225.88					3	3	0.4	80	0.32	SD
E7	So. Glenbrook Bay	4/20/12	0.5/6225.52					-	-	0.1	50	0.05	SD
E6	Cave Rock Ramp	5/12/12	0.5/6225.88	10.89	2.21	9.09	1.31	3	3	0.6	90	0.54	SD
E5	Lincoln Park	5/12/12	0.5/6225.88					3	3	0.6	80	0.48	-
E4	No. Zephyr Cove	5/12/12	0.5/6225.88					2.5	3	0.6	70	0.42	SD
E3	So. Zephyr Pt.	5/12/12	0.5/6225.88					2	4	2.0	90	1.80	SD
	Zephyr Pt.	5/11/12	0. 5/6225.86	8.67	1.05	5.90	0.60	2.5	2.5	0.4	80	0.32	
E2	No. Elk Pt.	5/12/12	0.5/6225.88					2.5	2.5	0.4	70	0.28	SD
E1	So. Elk Point	4/20/12	0.5/6225.52					3	4	1.6	90	1.44	SD
E1	So. Elk Point	5/12/12	0.5/6225.88	19.08	7.83	13.41	5.71	-	3.5	0.9	90	0.81	SD,FG
	Timber Cove Rock	4/3/12	0.5/6225.46	81.66	8.29	45.22	5.52	-	4	1.8	100	1.80	SD
S1	T. Keys Entrance	4/3/12	0.5/6225.46	1.88	0.66	0.00	(n=1)	3	2	0.2	40	0.08	SD
S2	Kiva Point	4/3/12	0.5/6225.46	7.02	1.42	4.18	1.58	2	3	0.2	60	0.12	SD

Spring Synoptic Monitoring 2013

During the spring 2013 synoptic, 45 sites were monitored in addition to the routine sites during March 27-April 12. Data collected for the expanded monitoring 2013 is summarized in Table 11 and Figure 17 presents the map of PBI. Although this monitoring captured peak biomass along the west shore, peaks may have been missed at sites along the southwest shore (which tend to peak early in the spring) and possibly along some north and east shore sites which can peak later in the spring.

During the spring synoptic, WY 2013, there were fewer areas of very heavy biomass compared to the previous two years. Areas of heaviest biomass included: sites along the northwest shore (near the mouth of Ward Cr., Pineland, Tahoe City, Tahoe City Tributary, Lake Forest Island and near Dollar Cr.) and an area of very heavy growth at the Garwood's site. Biomass was generally moderate along the southwest shore with some areas of light biomass. There were a few areas of moderate biomass along the north shore interspersed with areas of light biomass. Biomass was light to very light along the northeast, east and south shores, with one notable area of elevated biomass occurred at Timber Cove Rocks. The predominant algae in the periphyton were more varied around the lake in 2013. Stalked diatoms were prevalent along the south, south west, north west and north shores. However many of those sites also had filamentous green algae, some also had Blue-green algae. Along the east shore Filamentous green algae and Blue-green algae dominated the light biomass.

Many of the same sites that had high PBI in 2011 and 2012 also had high PBI in 2013 suggesting they are generally more productive areas in the spring. These included: Ward Cr. mouth, Pineland, Tahoe City, Tahoe City Tributary, South Dollar Cr. Many of these sites are influenced by tributaries and/or surface runoff. However, biomass was low at the Kings Beach site in 2013 compared with high biomass observed the past two years.

Overall, WY 2013 peak periphyton biomass was less than observed the previous two years at many sites. Fewer areas of very heavy biomass were observed and these were concentrated along the northwest shoreline. Biomass along the east shore was uniformly light. WY 2013 was characterized by a very "wet" November and December followed by an unusually dry period from January through May. Much of the nutrient delivery to the nearshore may have occurred early in the WY associated with the storms and runoff. Although the spring runoff began early in March and it has been very light. The dry January- May may have contributed to lower spring periphyton biomass along much of the shoreline. However, high biomass was observed areas of the north-west shore. It's possible the significant storms in November and December had some impact at those sites on the level of spring biomass. Other factors described previously may also be contributing to the development of heavy biomass.

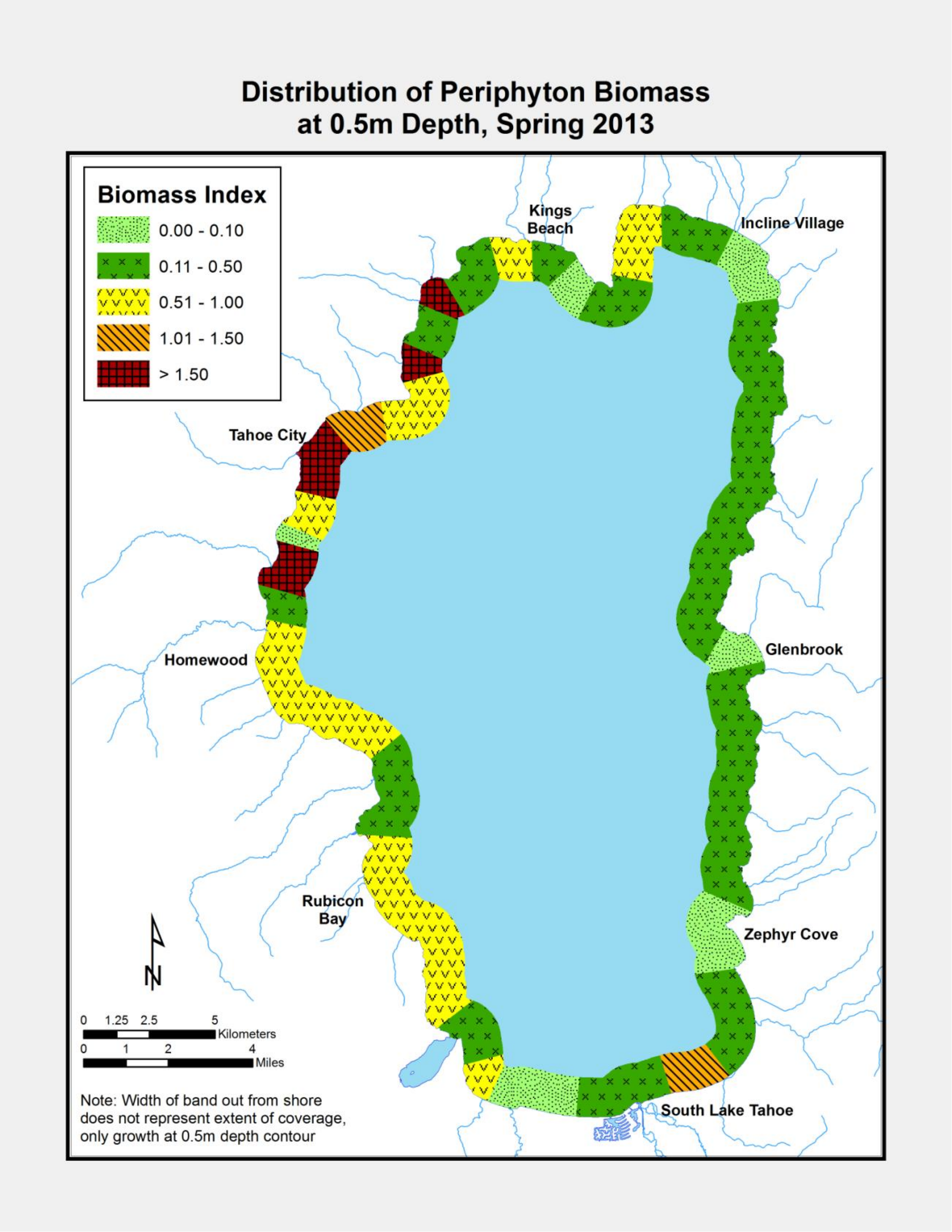


Figure 17. Extrapolated regional distribution of periphyton biomass measured as Biomass Index (Avg. Filament Length x % Area Covered with Algae) 3/27/13-4/12/13.

Table 11. Summary of 0.5m periphyton Chlorophyll *a*, Ash Free Dry Weight (AFDW), visual score, avg. filament length and % algal coverage, predominant algae present based on visual observations while snorkeling (FG=filamentous greens; SD=stalked diatoms; CY= blue green algae), for spring synoptic 2013. Note for chlorophyll *a* and AFDW, n=2 unless otherwise indicated. Visual score is a subjective ranking of the aesthetic appearance of algal growth (viewed underwater) where 1 is the least offensive and 5 is the most offensive. Biomass Index is Filament Length times % Algal Cover. “NA” = not available or not collected; “NES” = not enough sample for analysis. Sampling depth and corresponding sampling elevation are also indicated.

Site	Site Name	Date	Sampling Depth/Elev (m/ ft)	Chl *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
A	Cascade Creek	3/27/13	0.5/6224.29	22.06	5.11	12.28	1.78	2	3	0.8	86	0.69	SD
B	S. of Eagle Point	3/27/13	0.5/6224.29					2	2.5	0.4	72	0.29	SD,FG
C	E.Bay/Rubicon	3/27/13	0.5/6224.29					3	3.5	0.7	96	0.67	SD,FG
	Rubicon Pt.	3/27/13	0.5/6224.29	38.17	11.41(n=3)	30.97	5.84(n=3)	3	3.5	1.1	90	0.99	SD,FG,CY
D	Gold Coast	3/27/13	0.5/6224.29					3	3.5	1.2	60	0.72	SD,FG
E	S. Meeks Point	3/27/13	0.5/6224.29					3.5	3.5	0.6	92	0.55	SD,FG
F	N. Meeks Bay	3/27/13	0.5/6224.29					3	3	0.5	85	0.43	SD,FG
	Sugar Pine Pt.	3/27/13	0.5/6224.29	4.60	0.63	NA	NA	NA	2	0.2	70	0.14	FG
G	Tahoma	3/27/13	0.5/6224.29					3	3	0.8	80	0.64	FG
H	S. Fleur Du Lac	3/27/13	0.5/6224.29					2	3	0.7	78	0.55	SD,FG
I	Blackwood Creek	3/27/13	0.5/6224.29					2	4	3.0	30	0.90	SD
	Kaspian Pt.	3/27/13	0.5/6224.29					2	3	0.5	100	0.5	SD,FG,CY
J	Ward Creek	3/27/13	0.5/6224.29	378.98	159.93(n=3)	190.74	31.92 (n=3)	4	5	5.0	100	5.00	SD
	Pineland	3/27/13	0.5/6224.29	241.77	36.34(n=3)	99.85	27.60(n=3)	4	5	2.0	100	2.00	SD,FG
K	N. Sunnyside	3/27/13	0.5/6224.29					1	1	0.0	0	0	-
L	Tavern Pt.	3/27/13	0.5/6224.29					2	3	1.5	50	0.75	SD
	Tahoe City	3/28/13	0.5/6224.30	74.39	35.11(n=3)	71.64	23.13(n=3)	4	5	2.7	99	2.67	SD
TCT	Tahoe City Trib.	3/28/13	0.5/6224.30					4	5	2.5	95	2.38	SD
M	TCPUD Boat Ramp	3/28/13	0.5/6224.30					4	3	2.0	57	1.14	SD
	Lake Forest Island	3/28/13	0.5/6224.30					4	4	2.5	58	1.45	SD
N	S. Dollar Pt.	3/28/13	0.5/6224.30					2	3	1.2	75	0.90	SD
	Dollar Pt.	3/28/13	0.5/6224.30	99.69	9.59	55.25	4.24	NA	3	1.3	60	0.78	SD
O	S. Dollar Creek	3/28/13	0.5/6224.30					5	5	3.0	90	2.70	SD,FG
P	Cedar Flat	3/28/13	0.5/6224.30					NA	3	0.5	80	0.40	SD,FG
Q	Garwood’s	4/2/13	0.5/6224.35	125.79	50.08	93.47	20.64	5	5	3.7	100	3.70	SD
R	Flick Point	3/28/13	0.5/6224.30					NA	2	0.4	30	0.12	SD

Site	Site Name	Date	Sampling Depth/Elev (m/ ft)	Chl *a* (mg/m^2)	Std Dev (mg/m^2)	AFDW (g/m^2)	Std Dev (mg/m^2)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Cover. %	Biomass Index	Algal Type
S	Stag Avenue	4/2/13	0.5/6224.35					2.5	3	0.4	95	0.38	SD,FG,CY
T	Agatam Boat R.	4/2/13	0.5/6224.35					2.5	3	1.1	52	0.57	SD
E17	Kings Beach	4/2/13	0.5/6224.35	31.64	13.24	16.87	5.73	2.5	2	0.25	50	0.13	SD
E16	Brockway Springs	3/28/13	0.5/6224.30					1	2	0.2	40	0.08	SD
E15	No. Stateline Point	4/13/13	0.5/6224.37					2	3	0.3	80	0.24	FG,CY
E14	Stillwater Cove	4/12/13	0.5/6224.38					3	3	0.7	76	0.53	SD,FG,CY
	Incline West	4/12/13	0.5/6224.38	36.77	8.55	26.77	2.27	2.5	3	0.6	86	0.52	SD,FG,CY
	Incline Condo	4/12/13	0.5/6224.38					2.5	3	0.6	95	0.57	SD,FG,CY
E13	Burnt Cedar Beach	4/12/13	0.5/6224.38					2	2	0.2	90	0.18	SD
E12	Hidden Beach offsh.	4/12/13	0.5/6224.38					NA	2	<0.1	90	<0.09	CY
	Hidden Beach insh.	4/12/13	0.5/6224.38	5.56	1.26	4.35	(n=1)	2	2.5	0.7	50	0.35	SD
E11	Observation Point	4/12/13	0.5/6224.38					2.5	2.5	0.3	78	0.23	FG
	Sand Pt.	4/12/13	0.5/6224.38	10.62	0.02	10.79	0.49	2.5	2.5	0.2	70	0.14	FG,CY
E10	Chimney Beach	4/12/13	0.5/6224.38					2.5	2.5	0.3	58	0.17	FG,CY
E9	Skunk Harbor	4/12/13	0.5/6224.38					2.5	3	0.4	66	0.26	FG,CY
	Deadman Pt.	4/12/13	0.5/6224.38	9.63	1.08	10.84	1.15	2.5	2	0.2	80	0.16	FG,CY
E8	So. Deadman Point	4/12/13	0.5/6224.38					2	2	0.3	30	0.09	FG
E7	So. Glenbrook Bay	4/12/13	0.5/6224.38					2	2	0.3	75	0.23	FG,CY
E6	Cave Rock Ramp	4/12/13	0.5/6224.38	13.13	1.12	12.57	3.86	2	2	0.3	80	0.24	FG,CY
E5	Lincoln Park	4/12/13	0.5/6224.38					2	2	0.2	74	0.15	FG,CY
E4	No. Zephyr Cove	4/12/13	0.5/6224.38					2	2	0.2	75	0.15	FG,CY
E3	So. Zephyr Pt.	4/12/13	0.5/6224.38					1	1.5	0.3	30	0.09	SD
	Zephyr Pt.	4/12/13	0. 5/6224.38	7.62	5.20	8.11	(n=1)	1.5	1.5	<0.1	10	<0.01	FG,CY
E2	No. Elk Pt.	4/12/13	0.5/6224.38					1.5	1.5	0.2	10	0.02	FG
E1	So. Elk Point	4/12/13	0.5/6224.38	6.20	4.14			1	1.5	0.3	40	0.12	SD,FG
	Timber Cove Rock	3/29/13	0.5/6224.31	45.79	17.33(n=3)	26.67	8.72(n=3)	NA	4	1.6	85	1.36	FG
S1	T. Keys Entrance	3/29/13	0.5/6224.31					2.5	2	0.2	70	0.14	SD
S2	Kiva Point	3/29/13	0.5/6224.31	7.99	0.10	5.16	1.05	2.5	2	0.3	26	0.08	SD

Summary Points for Periphyton Monitoring

1. **The periphyton monitoring program continues to provide valuable data on levels of periphyton in the nearshore. This monitoring adds to a significant historical data base on periphyton for Lake Tahoe, from which informed decisions can be made. The use of information from this monitoring program was of great importance in the compilation of the recent Draft Lake Tahoe Nearshore Evaluation and Monitoring Framework (Heyvaert et al., 2013).**

2. **Pineland consistently had the highest biomass during 2011-2013. The spring peak Chlorophyll *a* biomass there ranged from 154 mg/m^2 in 2011 to 242 mg/m^2 in 2013. The peak biomass at Pineland in spring 2013, was actually the heaviest in the last 11 years. Periphyton biomass at Pineland appears to have increased over the last decade. Reuter (In: Heyvaert et al., 2013) found a statistically significant trend of increasing biomass at Pineland 2000-2011.**

3. **Sites in the northwest region of the lake (Pineland, Tahoe City and Dollar Pt.) tended to have higher spring periphyton maximum biomasses compared with the other sites. The Tahoe City, Pineland and Dollar Pt. sites are located near urban zones and/or areas of nutrient input.**

4. **Sites along the east shore and Sugar Pine Pt. along the west shore typically had lower spring peak biomass except in years when lake level was very low and significant blue-green algal biomass was near the surface. The east shore is less urbanized than the west shore and typically receives less precipitation. Sugar Pine Pt. on the west shore is located adjacent to Sugar Pine Point State Park (non-urban area).**

5. **In WY 2011, levels of periphyton biomass near the surface were impacted by a significant rise (nearly 5 ft.) in lake elevation associated with the very "wet" year. When the lake level was lowest early in the WY, moderate to high biomass associated with blue-green algae (which are normally deeper when lake level is higher), was found at some sites (including some east shore sites). During spring (early May), after a lake level rise of 3 feet, moderate to heavy amounts of stalked diatom biomass were measured at several west shore sites slightly deeper than 0.5 m, with less growth above. By late June, after an additional 1.5 ft. rise in the lake, very little periphyton growth was readily apparent from the surface at most sites in late June. Natural die-back and sloughing of algae late in the season, as well as the rapid rise and submergence of algae to depths of 1m or more resulted in little periphyton right near the surface.**

6. **WY 2012 precipitation was relatively low, however, significant spring or early summer peaks in periphyton biomass occurred at several of the West Shore monitoring stations. Biomass along the north and east shores**

remained relatively low. The timing of storms in WY 2012 when periphyton growth was increasing may have had an impact on the level of biomass observed. However, as has been indicated in previous reports a combination of factors likely contributes to periphyton biomass patterns. These factors may include: nutrient inputs (from surface runoff, enhanced inputs from urban/disturbed areas, groundwater, lake mixing/upwelling/ currents), lake level, substrate availability and wind/wave events which may affect periphyton loss from the rocks. The growth in 2012 was also likely due to a combination of these factors, with some factors likely playing more of a role than others.

7. **The results of spring 2013 monitoring indicated moderate to high biomass at several of the routine sites along the west and north shore. High biomass was observed at Dollar Pt. (99.69 mg/m^2) and Tahoe City (126.03 mg/m^2). Very high spring biomass was observed at Pineland (241.77 mg/m^2). Periphyton biomass along the east shore remained low in 2013.**

8. **The spring synoptic monitoring has been useful for showing patterns of growth around the lake with greater resolution than the routine site monitoring. Generally peak periphyton biomass has been higher along the west shore than along the east shore. Many of the same northwest shore sites had high spring peak biomasses in each year, 2011-2013. These included: Ward Cr. mouth, Pineland, Tahoe City, Tahoe City Tributary, South Dollar Cr. Many of these sites are influenced by tributaries and/or surface runoff.**

9. **A thick coverage of rocks with stalked diatoms was observed near Lake Forest on the northwest shore in measurements during spring 2012, 2013. In many past years, accumulations of sloughed periphyton have washed up along shore in the Lake Forest area. Nearby production of biomass likely contributes to this accumulation of sloughed material onshore.**

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Appendix Table 1.a. Precipitation amounts, N and P concentrations in wet deposition at the Ward Valley Lake Level Station 7/1/10-5/28/13.

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
1	8/3/10 10:25	0.01	R	WET	0.01	54	6	78	1	2	5	A1
2	8/10/10 16:30	0.91	R+H	WET	0.91	213	262	507	4	9	23	A2
3	8/30/10 16:50	0.08	R	WET	0.08	44	48	75	5	8	12	A3
	10/3/10 16:45	NA	R	D	NA							
4	10/4/10 09:20	0.70	R+DF	W+D	0.70	254	365	460	3	3	4	A18
5	10/5/10 16:15	0.60	R+S+DF	W+D	0.60	97	70	111	4	6	15	A19
6	10/8/10 11:20	0.16	R+DF	W+D	0.16	259	361	627	6	9	36	A19
7	10/19/10 14:35	0.46	R+DF	W+D	0.46	70	155	190	3	4	5	A20
8	10/25/10 17:20	7.21	RS	WET	7.21	17	46	35	2	7	9	A21
9	11/2/10 10:25	0.11	R	WET	0.11	17	23	52	3	6	6	A22
10	11/9/10 10:35	1.87	RS	WET	1.87	29	37	106	0	5	4	A23
11	11/15/10 16:50	0.40		WET	0.40	48	78	123	1	4	7	
12	11/21/10 17:45	2.02+	S	WET	2.02	60	82	106	2	5	7	A24
13	11/22/10 17:30	0.47+	S	WET	0.47	21	25	52	1	4	6	
14	11/23/10 19:10	1.00	S	WET	1.00	18	18	28	1	4	5	A25
15	11/28/10 13:00	0.97	S	WET	0.97	20	20	28	0	4	6	A26
16	12/6/10 17:15	2.38	RS	WET	2.38	48	9	28	2	8	11	
17	12/16/10 10:50	3.39	RS	WET	3.39	24	7	13	1	NA	4	A27
18	12/19/10 15:40	7.40	RS	WET	7.40	28	8	8	1	3	3	A28
19	12/20/10 13:10	0.66	S+DF	WET	0.66	43	16	54	2	4	6	A29
20	12/22/10 11:00	0.21	S+DF	WET	0.21	59	31	157	3	5	6	A30
21	12/28/10 10:30	0.51	RS	WET	0.51	23	14	70	1	3	7	A31
22	12/29/10 14:40	1.70	S	WET	1.70	10	6	85	0	8	8	A32
23	1/6/11 11:35	0.52	S	WET	0.52	19	12	25	3	4	5	
24	1/14/11 11:10	0.35	RS	WET	0.35	10	10	79	1	4	17	

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
25	2/3/11 10:30	0.49	S	WET	0.49	20	10	36	1	4	6	
26	2/16/11 16:00	1.43	S	WET	1.43	46	79	106	2	4	8	A47
27	2/17/11 12:10	0.66	S	WET	0.66	22	22	34	1	3	4	A48
28	2/18/11 11:40	1.17+	S	WET	1.17	12	21	25	1	3	3	A49
29	2/19/11 14:30	1.16	S	WET	1.17	37	14	36	1	3	4	A50
30	2/26/11 11:30	2.40e	S	WET	1.13+	29	17	33	1	3	5	A54
31	3/4/11 18:45	1.64	RS	WET	1.64	40	54	58	2	4	5	
32	3/9/11 10:00	2.22	RS	WET	2.22	23	23	39	2	5	6	
33	3/16/11 13:05	5.69	RS	WET	5.69	34	33	54	1	4	3	A55
35	3/19/11 11:35	1.71	S	WET	1.71	37	53	96	3	5	7	A56
36	3/20/11 16:50	1.48	S	WET	1.48	12	8	42	2	4	5	A57
37	3/24/11 11:00	1.01	S	WET	1.01	46	44	83	1	4	11	A58
38	3/25/11 14:15	1.27+	S	WET	1.27	15	17	41	1	5	34	A59
39	4/1/11 10:35	0.72	S	WET	0.72	21	34	78	1	2	8	
40	4/13/11 09:50	0.89	S	WET	0.89	132	NA	340	9	14	26	
41	4/22/11 13:35	1.98	RS	WET	1.98	92	183	247	4	7	13	A67
42	4/25/11 13:05	0.88	RS	WET	0.88	78	226	205	3	6	8	
43	5/16/11 17:10	1.28	RS	WET	1.28	81	125	132	4	9	13	
44	5/20/11 11:20	0.88	RSG	WET	0.88	55	55	68	4	6	8	
45	5/28/11 11:00	0.70	S	WET	0.70	187	326	344	8	13	21	
46	5/31/11 15:45	0.69	S	WET	0.69	34	53	56	2	6	7	
47	6/3/11 11:30	0.29	RS	WET	0.29	99	146	119	5	4	6	
48	6/10/11 11:30	1.60	RS	WET	1.69	25	34	69	3	3	3	
49	7/6/11 17:15	0.02+	R	WET	0.02+	20	44	141	8	6	9	A68
50	7/6/11 20:20	0.03	R	WET	0.03	41	44	199	5	6	18	A80
51	9/12/11 08:00	0.26	R	WET	0.26	221	276	582	20	26	40	A81
52	9/13/11 11:40	0.15e	R	WET	0.15e	204	323	437	10	14	15	A82
	9/20/11 10:30	T	NA	WET	0	NA	NA	NA	NA	NA	NA	A83
53	10/6/2011 18:25	2.23	R+S+DF	WET	2.23	39	50	95	4	8	9	A99

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
54	10/11/2011 9:50	0.66+	R+DF	WET	0.66+	23	40	56	2	2	4	A100
55	11/4/2011 17:15	0.63	S	WET	0.63	196	193	363	12	19	35	A101
56	11/10/2011 10:15	0.2	S	WET	0.2	19	26	28	4	8	11	
57	11/21/2011 15:10	0.41+	S	WET	0.41+	78	40	136	6	10	16	A102
	12/7/2011 11:00	T	S	WET	T	NA	NA	NA	NA	NA	NA	A103
58	1/18/2012 10:40	0.06	S	WET	0.06	18	12	28	1	7	7	A117
59	1/21/2012 15:10	4.67	R+S	WET	4.67	14	10	94	2	6	6	
60	1/24/2012 10:15	1.7	S	WET	1.7	20	14	77	1	6	7	A118
61	2/7/2012 10:10	0.16	R+S	WET	0.16	87	51	174	12	17	23	
62	2/10/2012 11:15	0.01	S	WET	0.01	4	5	130	1	3	4	A119
63	2/16/2012 11:00	0.66	S	WET	0.66	67	104	126	2	6	6	
64	2/24/2012 17:10	0.01	S	WET	0.01	2	3	47	1	4	6	A119
65	2/28/2012 10:00	0.88	S	WET	0.88	50	109	114	2	6	8	
66	2/29/2012 12:15	0.75+	S	WET	0.75+	29	63	86	2	5	13	A120
67	3/2/2012 10:30	0.34+	S	WET	0.34+	21	53	209	1	5	11	A121
68	3/7/2012 9:20	0.39	S	WET	0.39	67	57	110	2	6	17	A122
69	3/13/2012 17:20	0.02	S	WET	0.02	11	11	215	1	3	4	A123
70	3/17/2012 17:50	5.77	R+S	WET	5.77	25	35	51	3	6	6	
71	3/20/2012 9:15	0.52	S	WET	0.52	32	38	157	3	6	7	
72	3/29/2012 11:30	1.47	R+S	WET	1.47	52	68	157	1	6	7	
73	4/3/2012 15:00	0.95	R+S	WET	0.95	58	113	147	2	6	16	
74	4/7/2012 16:30	0.3	R+S	WET	0.3	60	48	76	2	7	9	
75	4/20/2012 15:30	1.31	R+S	WET	1.31	NA	96	99	2	5	7	
76	5/1/2012 10:05	1.47	R+S	WET	1.47	85	151	176	3	5	6	
77	5/30/2012 17:00	0.48	R+S	WET	0.48	139	407	948	1	6	67	
78	6/6/2012 9:40	0.81	R+S	WET	0.81	52	33	178	4	7	7	
79	7/24/12 12:40	0.37	R+H	W	0.37	353	646	878	16	30	47	144
80	8/7/12 10:50	0.01	R	W	0.01	57	76	135	3	6	10	145
81	8/24/12 09:20	0.15	R+H?	W	0.15	482	378	572	4	6	34	146

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
82	9/7/12 10:20	0.15	R	W	0.15	670	933	843	21	29	42	147
83	10/15/12 09:50	0.02	R	W	0.02	NA	NA	NA	NA	NA	NA	157
84	10/25/12 09:50	1.94+	S	W	1.94+	45	72	124	4	11	16	158
85	11/9/12 12:30	0.51	R+S	W	0.51	67	97	214	1	6	12	159
86	11/9/12 12:31	0.57	S	W	0.57	31	41	19	3	8	11	160
87	11/13/12 11:50	0.39	S	W	0.39	25	26	55	1	7	8	
88	11/20/12 08:00	2.33	R+S	W	2.33	23	22p	7	1	8	7	
89	11/28/12 11:02	0.50	R	W	0.50	32	46	107	4	10	16	
90	11/29/12 10:05	0.86	R+S	W	0.86	46	99	196	4	8	8	
91	12/1/12 19:28	4.80	R+S	W	4.80	19	14	36	1	4	12	161
92	12/4/12 09:50	3.12	R+S	W	3.12	18	8	137	6	10	12	162
93	12/7/12 10:10	1.83	R	W	1.83	31	6	45	2	6	8	163
94	12/13/12 09:45	0.59	S	W	0.59	52	13	189	1	3	5	
95	12/19/12 10:15	1.40	R+S	W	1.40	14	2	8	1	3	4	
96	12/22/12 15:40	1.43+	S	W	1.43+	15	18	97	1	4	6	164
97	12/23/12 11:05	0.76	S	W	0.76	20	18	69	1	3	4	
98	12/24/12 13:15	1.37	S	W	1.37	12	13	29	1	2	3	165
99	12/28/12 10:00	1.36	S	W	1.36	7	2	4	1	2	3	
100	12/31/12 13:45	T	S	W	T	NA	NA	NA	NA	NA	NA	
101	1/11/13 10:05	0.55	S	W	0.55	107	30	125	4	5	10	
102	1/15/13 10:10	0.04	S	W	0.04	5	7	NA	1	4	4	
103	1/25/13 09:45	0.27	R+S	W	0.27	67	40	84	1	5	7	
104	2/1/13 17:00	0.07		W	0.07	6	10	69	0	5	6	177
105	2/12/13 09:45	0.08	S	W	0.08	14	9	25	2	1	382	178
106	2/21/13 09:45	0.18	S	W	0.18	242	299	299	4	5	17	179
107	3/4/13 16:45	0.50	R+S	W	0.50	281	564	2048	4	5	7	
108	3/8/13 10:45	0.85	S	W	0.85	45	88	95	2	3	7	180
109	3/22/13 17:00	1.38	R+S	W	1.38	35	56	77	2	4	4	
110	4/2/13 11:10	0.35	R+S+H	W	0.35	146	278	291p	4	7	9	

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
111	4/9/13 09:55	0.47	R+S	W	0.47	94	149	210	2	4	9	
112	4/17/13 13:30	0.25	S	W	0.25	92	154	226p	6	11	27p	
113	5/10/13 15:15	1.50	R+S	W	1.50	152p	300p	350p	2p	3p	13p	187
114	5/28/13 14:30	0.71	R	W	0.71	80p	82p	NA	1p	2p	7p	

Appendix Table 1.b. Precipitation loads of N and P in wet deposition at the Ward Valley Lake Level Station 7/1/10-5/28/13.

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	8/3/10 10:25	0.01	R	WET	0.01	4.22	0.44	6.09	0.07	0.19	0.41	A1
2	8/10/10 16:30	0.91	R+H	WET	0.91	49.27	60.56	117.08	0.94	2.16	5.39	A2
3	8/30/10 16:50	0.08	R	WET	0.08	3.41	3.77	5.85	0.37	0.65	0.97	A3
	10/3/10 16:45	NA	R	D	NA	NA	NA	NA	NA	NA	NA	
4	10/4/10 09:20	0.70	R+DF	W+D	0.70	45.23	64.91	81.76	0.48	0.49	0.76	A18
5	10/5/10 16:15	0.60	R+S+DF	W+D	0.60	14.74	10.61	16.85	0.62	0.98	2.24	A19
6	10/8/10 11:20	0.16	R+DF	W+D	0.16	10.53	14.66	25.48	0.23	0.38	1.48	A19
7	10/19/10 14:35	0.46	R+DF	W+D	0.46	8.18	18.14	22.14	0.37	0.47	0.58	A20
8	10/25/10 17:20	7.21	RS	WET	7.21	31.04	84.83	64.19	4.52	12.42	16.37	A21
9	11/2/10 10:25	0.11	R	WET	0.11	1.36	1.84	4.11	0.23	0.51	0.51	A22
10	11/9/10 10:35	1.87	RS	WET	1.87	13.98	17.47	50.34	0.21	2.34	1.90	A23
11	11/15/10 16:50	0.40		WET	0.40	4.83	7.88	12.47	0.09	0.45	0.67	
12	11/21/10 17:45	2.02+	S	WET	2.02	31.02	41.88	54.33	1.05	2.41	3.69	A24
13	11/22/10 17:30	0.47+	S	WET	0.47	2.54	2.97	6.16	0.08	0.52	0.71	
14	11/23/10 19:10	1.00	S	WET	1.00	4.66	4.63	7.00	0.17	1.11	1.27	A25
15	11/28/10 13:00	0.97	S	WET	0.97	4.85	4.97	7.01	0.11	1.00	1.46	A26
16	12/6/10 17:15	2.38	RS	WET	2.38	29.11	5.65	16.96	0.95	4.84	6.93	
17	12/16/10 10:50	3.39	RS	WET	3.39	21.00	5.61	11.54	0.97	NA	3.19	A27
18	12/19/10 15:40	7.40	RS	WET	7.40	52.95	14.91	14.12	2.54	6.37	5.21	A28
19	12/20/10 13:10	0.66	S+DF	WET	0.66	7.28	2.67	9.04	0.38	0.62	1.03	A29
20	12/22/10 11:00	0.21	S+DF	WET	0.21	3.14	1.65	8.38	0.16	0.28	0.35	A30
21	12/28/10 10:30	0.51	RS	WET	0.51	2.92	1.79	9.05	0.15	0.40	0.88	A31
22	12/29/10 14:40	1.70	S	WET	1.70	4.32	2.53	36.73	0.00	3.26	3.52	A32
23	1/6/11 11:35	0.52	S	WET	0.52	2.54	1.62	3.27	0.39	0.53	0.65	
24	1/14/11 11:10	0.35	RS	WET	0.35	0.86	0.93	7.05	0.12	0.36	1.49	

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
25	2/3/11 10:30	0.49	S	WET	0.49	2.47	1.22	4.52	0.17	0.50	0.73	
26	2/16/11 16:00	1.43	S	WET	1.43	16.71	28.87	38.49	0.66	1.37	2.97	A47
27	2/17/11 12:10	0.66	S	WET	0.66	3.66	3.66	5.67	0.15	0.53	0.69	A48
28	2/18/11 11:40	1.17+	S	WET	1.17	3.48	6.37	7.35	0.27	0.84	1.03	A49
29	2/19/11 14:30	1.16	S	WET	1.17	10.80	4.07	10.70	0.33	0.83	1.21	A50
30	2/26/11 11:30	2.40e	S	WET	1.13+	17.65	10.50	20.08	0.41	1.54	3.07	A54
31	3/4/11 18:45	1.64	RS	WET	1.64	16.53	22.46	24.29	0.76	1.68	1.95	
32	3/9/11 10:00	2.22	RS	WET	2.22	12.77	13.14	21.72	0.90	2.63	3.33	
33	3/16/11 13:05	5.69	RS	WET	5.69	48.68	47.92	78.39	1.97	5.82	4.93	A55
35	3/19/11 11:35	1.71	S	WET	1.71	16.27	22.82	41.57	1.48	2.15	3.23	A56
36	3/20/11 16:50	1.48	S	WET	1.48	4.47	2.85	15.80	0.85	1.40	1.75	A57
37	3/24/11 11:00	1.01	S	WET	1.01	11.69	11.41	21.20	0.35	1.11	2.71	A58
38	3/25/11 14:15	1.27+	S	WET	1.27	4.98	5.35	13.27	0.36	1.50	10.91	A59
39	4/1/11 10:35	0.72	S	WET	0.72	3.79	6.25	14.29	0.21	0.40	1.41	
40	4/13/11 09:50	0.89	S	WET	0.89	29.80	NA	76.93	1.95	3.09	5.90	
41	4/22/11 13:35	1.98	RS	WET	1.98	46.04	92.23	124.13	1.94	3.59	6.39	A67
42	4/25/11 13:05	0.88	RS	WET	0.88	17.50	50.54	45.74	0.61	1.32	1.73	
43	5/16/11 17:10	1.28	RS	WET	1.28	26.35	40.68	42.88	1.32	2.90	4.30	
44	5/20/11 11:20	0.88	RSG	WET	0.88	12.34	12.20	15.10	0.91	1.40	1.89	
45	5/28/11 11:00	0.70	S	WET	0.70	33.25	57.97	61.16	1.46	2.39	3.79	
46	5/31/11 15:45	0.69	S	WET	0.69	5.88	9.21	9.86	0.44	1.04	1.20	
47	6/3/11 11:30	0.29	RS	WET	0.29	7.30	10.78	8.74	0.34	0.30	0.41	
48	6/10/11 11:30	1.60	RS	WET	1.69	10.27	13.95	27.93	1.19	1.39	1.39	
49	7/6/11 17:15	0.02+	R	WET	0.02+	1.58	3.44	10.96	0.64	0.43	0.72	A68
50	7/6/11 20:20	0.03	R	WET	0.03	3.18	3.45	15.54	0.43	0.48	1.40	A80
51	9/12/11 08:00	0.26	R	WET	0.26	14.57	18.21	38.44	1.30	1.71	2.64	A81
52	9/13/11 11:40	0.15e	R	WET	0.15e	7.77	12.29	16.66	0.37	0.54	0.59	A82
	9/20/11 10:30	T	NA	WET	T	NA	NA	NA	NA	NA	NA	A83
53	10/6/2011 18:25	2.23	R+S+DF	WET	2.23	21.92	28.50	53.59	2.44	4.38	4.92	A99

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
54	10/11/2011 9:50	0.66	R+DF	WET	0.66	3.78	6.72	9.41	0.30	0.41	0.62	A100
55	11/4/2011 17:15	0.63	S	WET	0.63	31.33	30.84	58.03	1.91	3.08	5.56	A101
56	11/10/2011 10:15	0.2	S	WET	0.2	0.97	1.30	1.43	0.22	0.41	0.57	
57	11/21/2011 15:10	0.41+	S	WET	0.41+	8.12	4.15	14.15	0.66	1.03	1.67	A102
	12/7/2011 11:00	T	S	WET	T	NA	NA	NA	NA	NA	NA	A103
58	1/18/2012 10:40	0.06	S	WET	0.06	1.37	0.91	2.21	0.11	0.56	0.56	A117
59	1/21/2012 15:10	4.67	R+S	WET	4.67	16.16	12.37	111.35	2.16	6.63	6.63	
60	1/24/2012 10:15	1.7	S	WET	1.7	8.63	5.86	33.44	0.39	2.40	3.20	A118
61	2/7/2012 10:10	0.16	R+S	WET	0.16	3.53	2.06	7.06	0.49	0.70	0.92	
62	2/10/2012 11:15	0.01	S	WET	0.01	0.35	0.39	10.10	0.05	0.27	0.29	A119
63	2/16/2012 11:00	0.66	S	WET	0.66	11.25	17.38	21.14	0.38	1.04	0.99	
64	2/24/2012 17:10	0.01	S	WET	0.01	0.19	0.21	3.63	0.05	0.29	0.48	A119
65	2/28/2012 10:00	0.88	S	WET	0.88	11.20	24.29	25.40	0.41	1.25	1.87	
66	2/29/2012 12:15	0.75+	S	WET	0.75+	5.61	12.06	16.39	0.35	0.94	2.54	A120
67	3/2/2012 10:30	0.34+	S	WET	0.34+	1.85	4.58	18.06	0.12	0.40	0.94	A121
68	3/7/2012 9:20	0.39	S	WET	0.39	6.61	5.61	10.94	0.23	0.58	1.66	A122
69	3/13/2012 17:20	0.02	S	WET	0.02	0.88	0.89	16.80	0.05	0.27	0.31	A123
70	3/17/2012 17:50	5.77	R+S	WET	5.77	37.28	50.67	74.26	4.98	9.50	9.50	
71	3/20/2012 9:15	0.52	S	WET	0.52	4.26	5.08	20.75	0.36	0.86	0.94	
72	3/29/2012 11:30	1.47	R+S	WET	1.47	19.57	25.55	58.68	0.34	2.19	2.77	
73	4/3/2012 15:00	0.95	R+S	WET	0.95	14.09	27.38	35.42	0.44	1.34	3.95	
74	4/7/2012 16:30	0.3	R+S	WET	0.3	4.61	3.66	5.75	0.17	0.52	0.69	
75	4/20/2012 15:30	1.31	R+S	WET	1.31	NA	31.85	32.83	0.68	1.65	2.17	
76	5/1/2012 10:05	1.47	R+S	WET	1.47	31.83	56.32	65.80	1.02	1.75	2.33	
77	5/30/2012 17:00	0.48	R+S	WET	0.48	16.98	49.59	115.58	0.11	0.76	8.21	
78	6/6/2012 9:40	0.81	R+S	WET	0.81	10.72	6.83	36.72	0.89	1.53	1.53	
79	7/24/12 12:40	0.37	R+H	W	0.37	33.03	60.40	82.18	1.52	2.79	4.44	A144
80	8/7/12 10:50	0.01	R	W	0.01	4.46	5.90	10.52	0.27	0.46	0.81	A145
81	8/24/12 09:20	0.15	R+H?	W	0.15	18.18	14.25	21.59	0.14	0.24	1.29	A146

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
82	9/7/12 10:20	0.15	R	W	0.15	25.07	34.91	31.56p	0.79	1.07	1.57	A147
83	10/15/12 09:50	0.02	R	W	0.02	NA	NA	NA	NA	NA	NA	157
84	10/25/12 09:50	1.94+	S	W	1.94+	22.41	35.31	61.04	1.90	5.48	7.77	158
85	11/9/12 12:30	0.51	R+S	W	0.51	8.69	12.59	27.77	0.12	0.80	1.53	159
86	11/9/12 12:31	0.57	S	W	0.57	4.47	5.96	2.75	0.43	1.17	1.53	160
87	11/13/12 11:50	0.39	S	W	0.39	2.49	2.59	5.48	0.09	0.64	0.80	
88	11/20/12 08:00	2.33	R+S	W	2.33	13.78	13.26p	3.99	0.81	4.77	4.04	
89	11/28/12 11:02	0.50	R	W	0.50	4.08	5.86	13.60	0.52	1.26	2.09	
90	11/29/12 10:05	0.86	R+S	W	0.86	10.13	21.71	42.81	0.80	1.68	1.82	
91	12/1/12 19:28	4.80	R+S	W	4.80	23.18	17.63	43.48	1.67	4.89	14.29	161
92	12/4/12 09:50	3.12	R+S	W	3.12	13.93	6.71	108.76	4.87	7.82	9.53	162
93	12/7/12 10:10	1.83	R	W	1.83	14.45	2.59	20.93	0.74	3.01	3.73	163
94	12/13/12 09:45	0.59	S	W	0.59	7.74	1.99	28.38	0.10	0.51	0.79	
95	12/19/12 10:15	1.40	R+S	W	1.40	5.13	0.64	2.80	0.40	1.21	1.43	
96	12/22/12 15:40	1.43+	S	W	1.43+	5.28	6.67	35.12	0.41	1.57	2.02	164
97	12/23/12 11:05	0.76	S	W	0.76	3.85	3.38	13.31	0.13	0.54	0.77	
98	12/24/12 13:15	1.37	S	W	1.37	4.02	4.39	10.17	0.39	0.64	1.18	165
99	12/28/12 10:00	1.36	S	W	1.36	2.45	0.55	1.40	0.24	0.75	0.96	
100	12/31/12 13:45	T	S	W	T	NA	NA	NA	NA	NA	NA	
101	1/11/13 10:05	0.55	S	W	0.55	14.98	4.25	17.49	0.57	0.74	1.35	
102	1/15/13 10:10	0.04	S	W	0.04	0.06	0.53	NA	0.09	0.29	0.31	
103	1/25/13 09:45	0.27	R+S	W	0.27	4.62	2.71	5.78	0.06	0.36	0.51	
104	2/1/13 17:00	0.07		W	0.07	0.10	0.77	5.38	0.00	0.41	0.43	177
105	2/12/13 09:45	0.08	S	W	0.08	0.29	0.72	1.98	0.19	0.07	29.89	178
106	2/21/13 09:45	0.18	S	W	0.18	11.05	13.68	13.69	0.19	0.23	0.79	179
107	3/4/13 16:45	0.50	R+S	W	0.50	35.74	71.57	260.11	0.47	0.68	0.88	
108	3/8/13 10:45	0.85	S	W	0.85	9.65	19.04	20.55	0.54	0.73	1.59	180
109	3/22/13 17:00	1.38	R+S	W	1.38	12.33	19.56	26.93	0.63	1.50	1.50	
110	4/2/13 11:10	0.35	R+S+H	W	0.35	12.95	24.68	25.88p	0.32	0.60	0.84	

Samp. No.	Ward Valley Wet Collection Date-Time	Lake Level Precip. (in)	Precip. Form	Collector Type	Wet Bkt Amt. (in)	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
111	4/9/13 09:55	0.47	R+S	W	0.47	11.25	17.79	25.06p	0.19	0.52	1.11	
112	4/17/13 13:30	0.25	S	W	0.25	5.84	9.79	14.36p	0.41	0.67	1.70p	
113	5/10/13 15:15	1.50	R+S	W	1.50	57.89p	114.41p	133.25p	0.69p	1.29p	4.93p	187
114	5/28/13 14:30	0.71	R	W	0.71	14.49p	14.81p	NA	0.21p	0.39p	1.22p	

Appendix Table 2.a. N and P concentrations in dry deposition at the Ward Valley Lake Level Station 6/26/10-5/7/13.

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
1	6/26/2010 20:35	7/2/2010 10:40	3.03	DF	DRY	24	72	945	5	7	20	
2	7/2/2010 10:40	7/16/2010 10:30	1.918	DF	DRY	C	C	C	C	C	C	A4
3	7/16/2010 10:30	7/23/2010 13:55	2.664	DF	DRY	11	8	824	5	8	23	A5
4	7/23/2010 13:55	8/3/2010 10:25	2.295	DF	DRY	15	8	56	2	6	65	A15
5	8/3/2010 10:25	8/12/2010 12:00	2.81	DF	DRY	28	6	287	2	5	27	A6
6	8/16/2010 14:00	9/2/2010 16:55	1.576	DF	DRY	15	8	1661	3	7	100	A7
7	9/2/2010 16:55	9/23/2010 10:40	1.755	DF	DRY	C	C	C	C	C	C	A8
	9/23/2010 10:40	10/14/2010 14:45	5.342	R+S+DF	DRY	C	C	C	C	C	C	A33
9	10/14/2010 14:45	10/22/2010 14:40	3.626	R+DF	DRY	25	30	382	4	6	8	A34
10	10/22/2010 14:40	11/2/2010 10:25	3.764	DF	DRY	3	7	485	6	6	23	A35
11	11/2/2010 10:25	11/17/2010 10:45	3.744	DF	DRY	18	58	346	7	11	10	A36
12	11/17/2010 10:45	12/1/2010 16:45	4.025	S+DF	DRY	43	62	277	5	5	10	A37
13	12/1/2010 16:45	12/22/2010 11:00	4.079	R+S+DF	DRY	22	18	28	3	4	22	A38
14	12/22/2010 11:00	1/6/2011 11:35	4.4	S+DF	DRY	12	18	18	3	6	12	A39
15	1/6/2011 11:35	1/14/2011 11:10	3.375	DF	DRY	21	41	72	1	4	5	A60
16	1/14/2011 11:10	1/24/2011 11:45	2.88	DF	DRY	14	28	98	4	6	23	
17	1/24/2011 11:45	2/13/2011 10:45	1.968	DF	DRY	28	19	108	7	10	98	A61
18	2/13/2011 10:45	3/4/2011 18:45	2.975	DF	DRY	48	8	74	2	4	19	
19	3/4/2011 18:45	3/18/2011 16:00	2.877	DF	DRY	35	29	144	5	7	18	
20	3/18/2011 16:00	4/13/2011 9:50	1.67	DF	DRY	96	55	190	1	5	48	
21	4/13/2011 9:50	4/25/2011 13:05	2.972	DF	DRY	47	57	116	2	5	11	
22	4/25/2011 13:05	5/16/2011 17:10	0.5	DF	DRY	C	C	C	C	C	C	A69
23	5/16/2011 17:10	6/15/2011 17:00	NA	DF	DRY	C	C	C	C	C	C	
24	6/15/2011 17:00	6/30/2011 16:10	3.345	DF	DRY	C	C	C	C	C	C	A70
25	6/30/2011 16:10	7/22/2011 17:45	0.902	DF	DRY	C	C	C	C	C	C	A84

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
26	7/22/2011 17:45	8/4/2011 14:45	2.4	DF	DRY	14	11	661	5	10	54	A85
27	8/4/2011 14:45	8/22/2011 17:45	1.822	DF	DRY	12	3	828	3	18	55	A86
28	8/22/2011 17:45	9/12/2011 8:00	2.288	DF+R	DRY-BULK	C	C	C	C	C	C	A87
29	9/12/2011 8:00	9/20/2011 10:30	3.55	DF+R	DRY-BULK	30	5	378	2	5	11	A88
30	9/20/2011 10:30	10/4/2011 16:00	2.91	DF+R	DRY-BULK	20	6	640	2	7	24	A89
31	10/4/2011 16:00	10/14/2011 12:20	4.046	DF+R	DRY-BULK	10	12	415	7	11	14	A104
32	10/14/2011 12:20	10/27/2011 11:00	3.3	DF	DRY	C	C	C	C	C	C	A105
33	10/27/2011 11:00	11/10/2011 10:15	3.47	DF	DRY	14	31	317	13	17	23	A106
34	11/10/2011 10:15	12/7/2011 11:15	NA	DF	DRY-BULK	C	C	C	C	C	C	A107
35	12/7/2011 11:15	12/21/2011 11:20	3.539	DF	DRY	11	6	236	1	7	9	A108
36	12/21/2011 11:20	12/26/2011 15:10	3.502	DF	DRY	4	5	3	3	7	11	A109
37	12/26/2011 15:10	1/6/2012 18:00	2.84	DF	DRY	12	20	72	2	6	9	
38	1/6/2012 18:00	1/18/2012 10:40	3.037	DF	DRY	11	26	209	2	8	22	A124
39	1/18/2012 10:40	2/7/2012 10:10	2.48	DF	DRY	24	19	67	7	14	35	A125
40	2/7/2012 10:10	2/16/2012 11:00	2.854	DF	DRY	18	24	85	7	8	9	A126
41	2/16/2012 11:00	2/24/2012 17:10	2.824	DF	DRY	6	23	122	2	7	14	
42	2/24/2012 17:10	3/9/2012 10:30	2.906	DF	DRY	37	47	174	4	10	24	A127
43	3/9/2012 10:30	3/27/2012 10:30	2.127	DF	DRY	64	122	429	1	8	22	
44	3/27/2012 10:30	4/7/2012 16:30	2.292	DF	DRY	44	37	100	1	5	21	
45	4/7/2012 16:30	4/20/2012 15:30	2.14	DF	DRY	NA	53	335	1	7	24	A132
46	4/20/2012 15:30	5/2/2012 18:10	2.007	DF	DRY	31	7	124	3	10	22	
47	5/2/2012 18:10	5/18/2012 10:45	1.125	DF	DRY	20	38	1503	24	40	98	A133
48	5/18/2012 10:45	5/30/2012 17:00	0.785	DF	DRY	C	C	C	C	C	C	A134
49	5/30/2012 17:00	6/15/2012 9:25	2.24	DF	DRY	26	20	NA	0	9	28	A135
50	6/15/2012 9:25	6/27/2012 9:45	2.15	DF	DRY	14	2	733	3	18	132	
51	6/27/2012 9:45	7/16/2012 10:00	0.725	DF	DRY	23	37	786	C	66	333	
52	7/16/2012 10:00	8/2/2012 12:10	1.9	DF	DRY	13	14	611	3	5	44	
53	8/2/2012 12:10	8/13/2012 14:20	2.285	DF	DRY	21	7	324	3	9	44	

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
54	8/13/2012 14:20	8/30/2012 17:40	1.841	DF	DRY	31	24	1033	2	9	63	
55	8/30/12 09:20	9/12/12 10:25	2.619	DF	DRY	40	7	306	5	8	17	
56	9/12/12 10:25	9/21/12 09:55	2.901	DF	DRY	19	12	494	0.5	5	11	
57	9/21/12 09:55	10/5/12 10:45	2.613	DF	DRY	14	7	82	1	6	21	166
58	10/5/12 10:45	10/16/12 11:30	3.270	DF	DRY	13	30	327	2	7	13	
59	10/16/12 11:30	10/30/12 10:00	3.868	DF	DRY	15	5	265	15	23	35	167
60	10/30/12 10:00	11/15/12 10:00	3.616	DF	DRY	11	24	409	47	57	70	168
61	11/15/12 10:00	11/28/12 11:02	1.975	DF	DRY	7	12	392	39	49	78	169
62	11/28/12 11:02	12/13/12 09:45	1.480	DF	DRY	140	138	259	2	3	12	170
63	12/13/12 09:45	12/19/12 17:30	3.147	DF	DRY	10	15	89	0	3	6	171
64	12/19/12 17:30	12/31/12 13:45	3.672	DF	DRY	10	4	47	5	7	18	170
65	12/31/12 13:45	1/11/13 10:05	3.593	DF	DRY	14	14	45	4	6	14	
66	1/11/13 10:05	1/25/13 09:45	3.390	DF	DRY	19	16	26	3	7	32	
67	1/25/13 09:45	2/6/13 14:20	3.448	DF	DRY	15	26	65	3	8	23	181
68	2/6/13 14:20	2/21/13 09:45	3.342	DF+S	DRY	26	33	33	4	4	18	179
69	2/21/13 09:45	3/4/13 16:45	2.992	DF	DRY	47	74	2852	6	8	19	
70	3/4/13 16:45	3/15/13 17:20	3.320	DF	DRY	45	74	78	4	5	15	
71	3/15/13 17:20	4/2/13 11:10	2.320	DF	DRY	42	65	252p	4	8	20	
72	4/2/13 11:10	4/24/13 10:00	1.320	DF	DRY	63p	17p	176p	1p	8p	39p	187
73	4/24/13 10:00	5/7/13 16:30	2.082	DF	DRY	42p	84p	393p	45p	60p	73p	

Appendix Table 2.b. N and P loads in dry deposition at the Ward Valley Lake Level Station 6/26/10-5/7/13.

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/26/2010 20:35	7/2/2010 10:40	3.03	DF	DRY	14.15	43.11	565.03	3.15	4.29	11.77	
2	7/2/2010 10:40	7/16/2010 10:30	1.918	DF	DRY	C	C	C	C	C	C	A4
3	7/16/2010 10:30	7/23/2010 13:55	2.664	DF	DRY	5.72	4.24	432.96	2.83	4.24	12.08	A5
4	7/23/2010 13:55	8/3/2010 10:25	2.295	DF	DRY	6.57	3.73	25.30	0.93	2.53	29.36	A15
5	8/3/2010 10:25	8/12/2010 12:00	2.81	DF	DRY	15.52	3.36	159.31	1.25	2.76	14.84	A6
6	8/16/2010 14:00	9/2/2010 16:55	1.576	DF	DRY	4.51	2.61	516.47	0.92	2.22	31.02	A7
7	9/2/2010 16:55	9/23/2010 10:40	1.755	DF	DRY	NA	NA	NA	NA	NA	NA	A8
	9/23/2010 10:40	10/14/2010 14:45	5.342	R+S+DF	DRY	C	C	C	C	C	C	A33
9	10/14/2010 14:45	10/22/2010 14:40	3.626	R+DF	DRY	9.73	3.26	251.00	2.53	3.74	4.99	A34
10	10/22/2010 14:40	11/2/2010 10:25	3.764	DF	DRY	2.21	5.07	360.00	4.34	4.81	17.17	A35
11	11/2/2010 10:25	11/17/2010 10:45	3.744	DF	DRY	13.34	42.62	255.49	5.01	8.32	7.40	A36
12	11/17/2010 10:45	12/1/2010 16:45	4.025	S+DF	DRY	33.77	49.58	219.68	3.75	3.66	7.58	A37
13	12/1/2010 16:45	12/22/2010 11:00	4.079	R+S+DF	DRY	17.64	14.17	22.67	2.17	3.23	17.62	A38
14	12/22/2010 11:00	1/6/2011 11:35	4.4	S+DF	DRY	10.73	15.40	15.73	2.54	4.83	10.72	A39
15	1/6/2011 11:35	1/14/2011 11:10	3.375	DF	DRY	14.01	27.22	47.86	0.91	2.48	3.31	A60
16	1/14/2011 11:10	1/24/2011 11:45	2.88	DF	DRY	7.85	15.65	55.62	2.45	3.18	13.23	
17	1/24/2011 11:45	2/13/2011 10:45	1.968	DF	DRY	10.77	7.50	41.86	2.64	3.83	38.06	A61
18	2/13/2011 10:45	3/4/2011 18:45	2.975	DF	DRY	28.31	4.94	43.47	0.93	2.37	10.96	
19	3/4/2011 18:45	3/18/2011 16:00	2.877	DF	DRY	19.80	16.65	81.75	3.09	4.22	10.04	
20	3/18/2011 16:00	4/13/2011 9:50	1.67	DF	DRY	31.70	17.99	62.75	0.45	1.64	15.87	
21	4/13/2011 9:50	4/25/2011 13:05	2.972	DF	DRY	27.85	33.58	67.80	0.93	3.09	6.54	
22	4/25/2011 13:05	5/16/2011 17:10	0.5	DF	DRY	NA	NA	NA	NA	NA	NA	A69
23	5/16/2011 17:10	6/15/2011 17:00	NA	DF	DRY	NA	NA	NA	NA	NA	NA	
24	6/15/2011 17:00	6/30/2011 16:10	3.345	DF	DRY	NA	NA	NA	NA	NA	NA	A70
25	6/30/2011 16:10	7/22/2011 17:45	0.902	DF	DRY	NA	NA	NA	NA	NA	NA	A84

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
26	7/22/2011 17:45	8/4/2011 14:45	2.4	DF	DRY	6.74	5.09	313.30	2.48	4.67	25.53	A85
27	8/4/2011 14:45	8/22/2011 17:45	1.822	DF	DRY	4.45	1.21	297.84	0.98	6.32	19.64	A86
28	8/22/2011 17:45	9/12/2011 8:00	2.288	DF+R	DRY-BULK	NA	NA	NA	NA	NA	NA	A87
29	9/12/2011 8:00	9/20/2011 10:30	3.55	DF+R	DRY-BULK	20.75	3.21	264.69	1.11	3.25	7.59	A88
30	9/20/2011 10:30	10/4/2011 16:00	2.91	DF+R	DRY-BULK	12.12	3.55	386.72	1.23	4.09	14.31	A89
31	10/4/2011 16:00	10/14/2011 12:20	4.046	DF+R	DRY-BULK	8.02	10.21	348.88	5.70	8.83	11.67	A104
32	10/14/2011 12:20	10/27/2011 11:00	3.3	DF	DRY	C	C	C	C	C	C	A105
33	10/27/2011 11:00	11/10/2011 10:15	3.47	DF	DRY	10.27	22.63	228.59	9.57	12.51	16.75	A106
34	11/10/2011 10:15	12/7/2011 11:15	NA	DF	DRY-BULK	C	C	C	C	C	C	A107
35	12/7/2011 11:15	12/21/2011 11:20	3.539	DF	DRY	7.84	4.39	173.43	0.50	5.22	6.80	A108
36	12/21/2011 11:20	12/26/2011 15:10	3.502	DF	DRY	3.26	3.58	2.41	1.98	5.16	7.63	A109
37	12/26/2011 15:10	1/6/2012 18:00	2.84	DF	DRY	7.12	11.71	42.69	1.20	3.65	5.11	
38	1/6/2012 18:00	1/18/2012 10:40	3.037	DF	DRY	6.70	16.24	131.76	1.29	5.08	13.67	A124
39	1/18/2012 10:40	2/7/2012 10:10	2.48	DF	DRY	12.24	9.68	34.72	3.73	7.16	17.98	A125
40	2/7/2012 10:10	2/16/2012 11:00	2.854	DF	DRY	10.74	14.32	50.65	4.43	4.96	5.33	A126
41	2/16/2012 11:00	2/24/2012 17:10	2.824	DF	DRY	3.54	13.26	71.44	1.20	4.18	8.17	
42	2/24/2012 17:10	3/9/2012 10:30	2.906	DF	DRY	22.27	28.62	105.08	2.47	5.96	14.71	A127
43	3/9/2012 10:30	3/27/2012 10:30	2.127	DF	DRY	28.38	53.83	189.31	**0.50**	3.55	9.68	
44	3/27/2012 10:30	4/7/2012 16:30	2.292	DF	DRY	20.77	17.52	47.65	0.32	2.22	10.07	
45	4/7/2012 16:30	4/20/2012 15:30	2.14	DF	DRY	NA	23.57	148.65	0.51	3.17	10.74	A132
46	4/20/2012 15:30	5/2/2012 18:10	2.007	DF	DRY	12.81	3.11	51.47	1.14	4.03	9.11	
47	5/2/2012 18:10	5/18/2012 10:45	1.125	DF	DRY	4.62	8.80	351.07	5.65	9.35	22.99	A133
48	5/18/2012 10:45	5/30/2012 17:00	0.785	DF	DRY	C	C	C	C	C	C	A134
49	5/30/2012 17:00	6/15/2012 9:25	2.24	DF	DRY	12.23	9.36	NA	0.11	4.03	13.11	A135
50	6/15/2012 9:25	6/27/2012 9:45	2.15	DF	DRY	6.28	0.90	327.17	1.31	8.17	58.74	
51	6/27/2012 9:45	7/16/2012 10:00	0.725	DF	DRY	3.51	5.54	118.35	C	9.90	50.08	

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
52	7/16/2012 10:00	8/2/2012 12:10	1.9	DF	DRY	5.25	5.60	241.20	1.16	1.82	17.49	
53	8/2/2012 12:10	8/13/2012 14:20	2.285	DF	DRY	10.03	3.54	153.87	1.50	4.37	20.71	
54	8/13/2012 14:20	8/30/2012 17:40	1.841	DF	DRY	11.72	9.26	394.63	0.61	3.30	24.07	
55	8/30/12 09:20	9/12/12 10:25	2.619	DF	DRY	21.72	4.02	166.40	2.96	4.08	9.35	
56	9/12/12 10:25	9/21/12 09:55	2.901	DF	DRY	11.17	7.20	297.35	0.27	2.99	6.35	
57	9/21/12 09:55	10/5/12 10:45	2.613	DF	DRY	7.61	4.01	44.66	0.61	3.34	11.35	166
58	10/5/12 10:45	10/16/12 11:30	3.270	DF	DRY	8.65	20.39	221.72	1.54	5.03	9.02	
59	10/16/12 11:30	10/30/12 10:00	3.868	DF	DRY	11.98	3.66	212.90	12.00	18.36	28.03	167
60	10/30/12 10:00	11/15/12 10:00	3.616	DF	DRY	8.08	17.78	306.75	35.51	42.84	52.62	168
61	11/15/12 10:00	11/28/12 11:02	1.975	DF	DRY	3.06	4.93	160.71	15.96	19.97	31.79	169
62	11/28/12 11:02	12/13/12 09:45	1.480	DF	DRY	43.16	42.31	79.62	0.49	1.04	3.61	170
63	12/13/12 09:45	12/19/12 17:30	3.147	DF	DRY	6.40	10.00	57.87	0.15	1.82	3.63	171
64	12/19/12 17:30	12/31/12 13:45	3.672	DF	DRY	7.99	2.97	36.16	4.01	5.41	13.89	170
65	12/31/12 13:45	1/11/13 10:05	3.593	DF	DRY	10.55	10.79	33.47	3.23	4.18	10.67	
66	1/11/13 10:05	1/25/13 09:45	3.390	DF	DRY	13.11	11.03	18.55	2.24	5.23	22.21	
67	1/25/13 09:45	2/6/13 14:20	3.448	DF	DRY	10.72	18.76	46.48	2.10	5.54	16.17	181
68	2/6/13 14:20	2/21/13 09:45	3.342	DF+S	DRY	18.07	22.74	22.76	2.93	3.04	12.38	179
69	2/21/13 09:45	3/4/13 16:45	2.992	DF	DRY	29.46	46.15	1771.46	3.71	5.06	11.67	
70	3/4/13 16:45	3/15/13 17:20	3.320	DF	DRY	30.92	51.23	53.48	2.50	3.60	10.15	
71	3/15/13 17:20	4/2/13 11:10	2.320	DF	DRY	20.43	31.34	121.60p	1.75	3.83	9.44	
72	4/2/13 11:10	4/24/13 10:00	1.320	DF	DRY	17.17p	4.55p	48.12p	0.31p	2.28p	10.64p	187
73	4/24/13 10:00	5/7/13 16:30	2.082	DF	DRY	17.95p	36.11p	169.87p	19.56p	25.86p	31.72p	

Appendix Table 3.a. Precipitation amounts, N and P concentrations in bulk deposition collected in Snow Tube collector at the Mid-lake Buoy (TB-1) Station 6/3/10-5/31/13.

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
1	6/3/10 09:37	7/2/10 08:05	0.04	R	ST	C	C	C	C	C	C	A10
2	7/2/10 08:05	7/20/10 10:35	0.01	R	ST	C	C	C	C	C	C	A11
	7/20/10 10:35	8/3/10 09:30	0		ST	NA	NA	NA	NA	NA	NA	
3	8/3/10 09:30	8/12/10 09:50	0.08	R	ST	186	20	502	5	15	71	A12
	8/12/10 09:50	8/31/10 10:30	0		ST	NA	NA	NA	NA	NA	NA	
	8/31/10 10:30	9/9/10 09:40	T	R	ST	NA	NA	NA	NA	NA	NA	
	9/9/10 09:40	9/22/10 09:15	0		ST	NA	NA	NA	NA	NA	NA	
4	9/22/10 09:15	10/13/10 09:40	1.67	R	ST	504	535	940	39	48	83	A40
5	10/13/10 09:40	10/20/10 15:24	0.36+	R	ST	127	139	137	6	9	12	A41
6	10/20/10 15:24	11/9/10 09:02	0.07	R+S	ST	21	13	232	0	3	3	A42
	11/9/10 09:02	11/17/10 07:25	NA	NA	NA	NA	NA	NA	NA	NA	NA	A43
	11/17/10 07:25	12/1/10 10:45	NA	NA	NA	NA	NA	NA	NA	NA	NA	A44
	12/1/10 10:45	12/15/10 13:50	NA	NA	NA	NA	NA	NA	NA	NA	NA	A45
7	12/15/10 13:50	1/4/11 09:57	2.73+	R+S	ST	44	20	63	2	4	6	A46
8	1/4/11 09:57	2/11/11 11:07	0.14	RS	ST	50	7	106	1	4	6	A62
	2/11/11 11:07	3/1/11 08:30	NA		ST	NA	NA	NA	NA	NA	NA	A63
9	3/1/11 08:30	3/28/11 09:55	2.89	RS	ST	54	45	153	1	2	4	A64
	3/28/11 09:55	4/22/11 10:15	NA		ST	NA	NA	NA	NA	NA	NA	A71
10	4/22/11 10:15	6/7/11 14:35	2.36+	RS	ST	140	160	387	4	4	10	A72
11	6/7/11 14:35	7/2/11 12:25	0.30	RS	ST	NA	NA	NA	NA	NA	NA	A73
12	7/2/11 12:25	7/23/11 11:22	0.29	R	ST	C	C	C	C	C	C	A90
	7/23/11 11:22	8/4/11 11:10	0		ST	NA	NA	NA	NA	NA	NA	
	8/4/11 11:10	8/26/11 10:30	0		ST	NA	NA	NA	NA	NA	NA	
	8/26/11 10:30	9/8/11 10:02	0		ST	NA	NA	NA	NA	NA	NA	

	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
No.												
13	9/8/11 10:02	9/21/11 09:13	0.03	R	ST	150	109	313	8	13	24	A91
14	9/21/11 09:13	10/12/11 15:12	0.17+	RS	ST	111	66	271	7	14	31	A110
	10/12/11 15:12	10/27/11 10:48	0		ST	NA	NA	NA	NA	NA	NA	
15	10/27/11 10:48	11/16/11 09:46	.0025	S	ST	63	48	138	1	5	7	A111
	11/16/11 09:46	12/9/11 09:54	0		ST	NA	NA	NA	NA	NA	NA	
	12/9/11 09:54	12/27/11 10:39	0		ST	NA	NA	NA	NA	NA	NA	
-	12/27/11 10:39	1/5/12 09:09	0		ST	NA	NA	NA	NA	NA	NA	
	1/5/12 09:09	1/13/12 09:35	0		ST	NA	NA	NA	NA	NA	NA	
	1/13/12 09:35	1/26/12 09:50			ST	NA	NA	NA	NA	NA	NA	A128
16	1/13/12 09:35	1/30/12 10:05	2.72	RS	ST	154	54	182	3	11	15	
17	1/30/12 10:05	2/16/12 16:28	0.01	S	ST	16	14	78	1	5	5	A129
	2/16/12 16:28	3/9/12 13:10	T	S	ST	NA	NA	NA	NA	NA	NA	
18	3/9/12 13:10	3/20/12 11:15	0.94	RS	ST	172	184	325	10	16	27	
19	3/20/12 11:15	4/3/12 10:20	0.24	RS	ST	134	153	514	4	10	13	A130
20	4/3/12 10:20	4/20/12 09:25	0.02	RS	ST	31	21	106	1	5	8	A136
21	4/20/12 09:25	5/11/12 10:00	0.18	RS	ST	180	128	354	0	6	74	A137
22	5/11/12 10:00	6/5/12 09:45	0.33	RS	ST	365	425	1434	15	31	125	A138
	6/5/12 09:45	7/2/12 09:25	0		ST	NA	NA	NA	NA	NA	NA	
23	7/2/12 09:25	7/24/12 13:06	0.05	RH	ST	345	235	695	NA	NA	NA	149
	7/24/12 13:06	8/6/12 14:09	0		ST							
24	8/6/12 14:09	8/17/12 09:25	0.01	R	ST	99	78	407	7	11	13	
	8/17/12 09:25	8/27/12 09:26	0		ST							
25	8/27/12 09:26	9/11/12 11:35	0.11	R	ST	244	183	502	4	8	13	150
	9/11/12 11:35	9/28/12 10:28	0		ST							
	9/28/12 10:28	10/8/12 09:08	0		ST							
26	10/8/12 09:08	10/17/12 12:03	0.14	R	ST	279	93	419	1	9	23	172
27	10/17/12 12:03	11/2/12 09:15	0.28	R+S	ST	NA	NA	912	NA	NA	NA	
28	11/2/12 09:15	11/15/12 13:52	0.03	S	ST	26	14	48	2	7	9	173
29	11/15/12 13:52	11/27/12 14:00	0.40	R+S	ST	288	115	319	3	14	23	

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
30	11/27/12 14:00	12/14/12 09:25	0.67	R+S	ST	80	29	162p	1	4	8	
	12/14/12 09:25	1/4/13 12:52	NA	S	ST							174
31	1/4/13 12:52	1/17/13 09:27	0.01	S	ST	31	14	38	1	4	5	182
32	1/17/13 09:27	2/4/13 09:10	0.13	R+S+H	ST	129	68	144	2	7	9	183
33	2/4/13 09:10	2/22/13 10:19	T		ST							
34	2/22/13 10:19	3/19/13 10:21	0.24	R+S	ST	286	445	712p	2	3	10	184
35	3/19/13 10:21	4/12/13 09:30	0.41	R+S+H	ST	5	417	1003p	1	9	38	
36	4/12/13 09:30	4/25/13 08:41	0.01	S	ST	7p	8p	59p	3p	9p	8p	188
37	4/25/13 08:41	5/7/13 09:14	1.09	R+S	ST	297p	738p	1216p	27p	36p	80p	
38	5/7/13 09:14	5/20/13 16:35	0.18	R	ST	44p	101p	NA	1p	5p	9p	193
39	5/20/13 16:35	5/31/13 12:00	0.12	R	ST	55p	76p	NA	6p	8p	13p	194

Appendix Table 3.b. Precipitation amounts, N and P loads in bulk deposition collected in Snow Tube collector at the Mid-lake Buoy (TB-1) Station 6/3/10-5/31/13.

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/3/10 09:37	7/2/10 08:05	0.04	R	ST	C	C	C	C	C	C	A10
2	7/2/10 08:05	7/20/10 10:35	0.01	R	ST	C	C	C	C	C	C	A11
	7/20/10 10:35	8/3/10 09:30	0		ST	NA	NA	NA	NA	NA	NA	
3	8/3/10 09:30	8/12/10 09:50	0.08	R	ST	28.62	3.02	77.33	0.70	2.35	10.98	A12
	8/12/10 09:50	8/31/10 10:30	0		ST	NA	NA	NA	NA	NA	NA	
	8/31/10 10:30	9/9/10 09:40	T	R	ST	NA	NA	NA	NA	NA	NA	
	9/9/10 09:40	9/22/10 09:15	0		ST	NA	NA	NA	NA	NA	NA	
4	9/22/10 09:15	10/13/10 09:40	1.67	R	ST	213.77	226.75	398.62	16.58	20.31	35.11	A40
5	10/13/10 09:40	10/20/10 15:24	0.36+	R	ST	24.75	27.01	27.67	1.14	1.34	2.36	A41
6	10/20/10 15:24	11/9/10 09:02	0.07	R+S	ST	3.26	1.98	35.69	0.07	0.43	0.53	A42
	11/9/10 09:02	11/17/10 07:25	NA	NA	NA	NA	NA	NA	NA	NA	NA	A43
	11/17/10 07:25	12/1/10 10:45	NA	NA	NA	NA	NA	NA	NA	NA	NA	A44
	12/1/10 10:45	12/15/10 13:50	NA	NA	NA	NA	NA	NA	NA	NA	NA	A45
7	12/15/10 13:50	1/4/11 09:57	2.73+	R+S	ST	30.75	13.63	44.03	1.41	2.78	4.06	A46
8	1/4/11 09:57	2/11/11 11:07	0.14	RS	ST	7.78	1.11	16.33	0.17	0.57	1.00	A62
	2/11/11 11:07	3/1/11 08:30	NA		ST	NA	NA	NA	NA	NA	NA	A63
9	3/1/11 08:30	3/28/11 09:55	2.89	RS	ST	39.50	32.97	112.64	0.67	1.81	2.95	A64
	3/28/11 09:55	4/22/11 10:15	NA		ST	NA	NA	NA	NA	NA	NA	A71
10	4/22/11 10:15	6/7/11 14:35	2.36+	RS	ST	83.77	95.97	231.89	2.58	2.42	5.78	A72
11	6/7/11 14:35	7/2/11 12:25	0.30	RS	ST	NA	NA	NA	NA	NA	NA	A73
12	7/2/11 12:25	7/23/11 11:22	0.29	R	ST	C	C	C	C	C	C	A90
	7/23/11 11:22	8/4/11 11:10	0		ST	NA	NA	NA	NA	NA	NA	
	8/4/11 11:10	8/26/11 10:30	0		ST	NA	NA	NA	NA	NA	NA	
	8/26/11 10:30	9/8/11 10:02	0		ST	NA	NA	NA	NA	NA	NA	

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
13	9/8/11 10:02	9/21/11 09:13	0.03	R	ST	23.07	16.83	48.17	1.16	2.04	3.75	A91
14	9/21/11 09:13	10/12/11 15:12	0.17+	RS	ST	17.04	10.18	41.72	1.08	2.19	4.76	A110
	10/12/11 15:12	10/27/11 10:48	0		ST	NA	NA	NA	NA	NA	NA	
15	10/27/11 10:48	11/16/11 09:46	.0025	S	ST	9.69	7.47	21.23	0.17	0.76	1.14	A111
	11/16/11 09:46	12/9/11 09:54	0		ST	NA	NA	NA	NA	NA	NA	
	12/9/11 09:54	12/27/11 10:39	0		ST	NA	NA	NA	NA	NA	NA	
-	12/27/11 10:39	1/5/12 09:09	0		ST	NA	NA	NA	NA	NA	NA	
	1/5/12 09:09	1/13/12 09:35	0		ST	NA	NA	NA	NA	NA	NA	
	1/13/12 09:35	1/26/12 09:50			ST	NA	NA	NA	NA	NA	NA	A128
16	1/13/12 09:35	1/30/12 10:05	2.72	RS	ST	106.26	37.16	125.91	2.03	7.48	10.47	
17	1/30/12 10:05	2/16/12 16:28	0.01	S	ST	2.43	2.16	12.01	0.18	0.72	0.81	A129
	2/16/12 16:28	3/9/12 13:10	T	S	ST	NA	NA	NA	NA	NA	NA	
18	3/9/12 13:10	3/20/12 11:15	0.94	RS	ST	41.02	43.99	77.56	2.33	3.83	6.41	
19	3/20/12 11:15	4/3/12 10:20	0.24	RS	ST	20.62	23.58	79.23	0.59	1.57	1.95	A130
20	4/3/12 10:20	4/20/12 09:25	0.02	RS	ST	4.76	3.25	16.31	0.14	0.76	1.24	A136
21	4/20/12 09:25	5/11/12 10:00	0.18	RS	ST	27.78	19.66	54.62	0.07	0.96	11.36	A137
22	5/11/12 10:00	6/5/12 09:45	0.33	RS	ST	30.57	35.60	120.16	1.22	2.63	10.45	A138
	6/5/12 09:45	7/2/12 09:25	0		ST	NA	NA	NA	NA	NA	NA	
23	7/2/12 09:25	7/24/12 13:06	0.05	RH	ST	53.16	36.15	107.12	NA	6.36	NA	149
	7/24/12 13:06	8/6/12 14:09	0		ST	NA	NA	NA	NA	NA	NA	
24	8/6/12 14:09	8/17/12 09:25	0.01	R	ST	15.30	12.02	62.73	1.05	1.71	1.95	
	8/17/12 09:25	8/27/12 09:26	0		ST	NA	NA	NA	NA	NA	NA	
25	8/27/12 09:26	9/11/12 11:35	0.11	R	ST	37.55	28.27	77.37	0.56	1.16	1.98	150
	9/11/12 11:35	9/28/12 10:28	0		ST	NA	NA	NA	NA	NA	NA	
	9/28/12 10:28	10/8/12 09:08	0		ST							
26	10/8/12 09:08	10/17/12 12:03	0.14	R	ST	43.02	14.32	64.57	0.10	1.33	3.52	172
27	10/17/12 12:03	11/2/12 09:15	0.28	R+S	ST	NA	NA	64.88	NA	NA	NA	
28	11/2/12 09:15	11/15/12 13:52	0.03	S	ST	4.06	2.19	7.44	0.32	1.15	1.39	173
29	11/15/12 13:52	11/27/12 14:00	0.40	R+S	ST	29.27	11.65	32.43	0.30	1.45	2.33	

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
30	11/27/12 14:00	12/14/12 09:25	0.67	R+S	ST	13.62	4.88	27.51p	0.19	0.68	1.42	
	12/14/12 09:25	1/4/13 12:52	NA	S	ST							174
31	1/4/13 12:52	1/17/13 09:27	0.01	S	ST	4.82p	2.15	5.79	0.18	0.62	0.77	182
32	1/17/13 09:27	2/4/13 09:10	0.13	R+S+H	ST	19.87	10.53	22.13	0.31	1.15	1.38	183
33	2/4/13 09:10	2/22/13 10:19	T		ST							
34	2/22/13 10:19	3/19/13 10:21	0.24	R+S	ST	44.06	68.59	109.75	0.28	0.47	1.47	184
35	3/19/13 10:21	4/12/13 09:30	0.41	R+S+H	ST	0.48	43.38	104.48p	0.12	0.90	4.01	
36	4/12/13 09:30	4/25/13 08:41	0.01	S	ST	1.14p	1.24p	9.13p	0.52p	1.38p	1.28p	188
37	4/25/13 08:41	5/7/13 09:14	1.09	R+S	ST	82.01p	204.13p	336.26p	7.45p	9.89p	22.08p	196
38	5/7/13 09:14	5/20/13 16:35	0.18	R	ST	6.82p	15.56p	NA	0.21p	0.76p	1.37p	193
39	5/20/13 16:35	5/31/13 12:00	0.12	R	ST	8.43p	11.70p	NA	0.98p	1.23p	1.94p	194

Appendix Table 4.a. N and P concentrations in dry-bulk deposition (buoy bucket) at Mid-lake Buoy (TB-1) Station 6/3/10-5/31/13.

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
1	6/3/10 9:37	7/2/10 8:05	0.5	DF+R	DRY-BULK	300	194	1123	21	127	NA	A13
2	7/2/10 8:05	7/20/10 10:35	0.5	DF+R	DRY-BULK	219	27	870	31	39	155	A14
3	7/20/10 10:35	8/3/10 9:30	0.5	DF	DRY-BULK	204	96	235	2	11	46	A14
4	8/3/10 9:30	8/12/10 9:50	0.365	DF+R	DRY-BULK	745	928	1541	7	15	34	
5	8/12/10 9:50	8/31/10 10:30	0.5	DF	DRY-BULK	246	21	499	7	11	41	A14
6	8/31/10 10:30	9/9/10 9:40	0.5	DF+T	DRY-BULK	322	671	935	10	12	24	A16
7	9/9/10 9:40	9/22/10 9:15	0.5	DF	DRY-BULK	433	802	1126	2	5	15	A17
8	9/22/10 09:15	10/13/10 09:40	1.895	DF+R	DRY-BULK	396	372	465	12	17	29	
9	10/13/10 9:40	10/20/10 15:24	2.192	DF+R	DRY-BULK	103	172	296	2	4	4	
10	10/20/10 15:24	11/9/10 9:02	0.47	DF+R+S	DRY-BULK	496	386	960	5	13	26	
11	11/9/10 9:02	11/17/10 7:25	1.76	DF+S?	DRY-BULK	57	30	46	1	4	4	
12	11/17/10 7:25	12/1/10 10:45	0.735	DF+S	DRY-BULK	220	202	343	3	5	8	
13	12/1/10 10:45	12/15/10 13:50	2.351	DF+R+S	DRY-BULK	81	19	33	2	3	3	
14	12/15/10 13:50	1/4/11 9:57	0.958	DF+R+S	DRY-BULK	90	19	36	2	3	7	
15	1/4/11 9:57	2/11/11 11:07	0.275	DF+R+S	DRY-BULK	46	463	352	17	18	27	
16	2/11/11 11:07	3/1/11 8:30	0.833	S	DRY-BULK	119	118	179	2	5	10	
17	3/1/11 8:30	3/28/11 9:55	1.77	DF+R+S	DRY-BULK	111	98	116	2	4	9	A65
18	3/28/11 9:55	4/22/11 10:15	0.5	DF+R+S	DRY-BULK	488	555	1030	10	16	27	A74
19	4/22/11 10:15	6/7/11 14:35	2.14	DF+R+S	DRY-BULK	180	133	243	14	15	22	A75
20	6/7/11 14:35	7/2/11 12:25	0.5	DF+R+S	DRY-BULK	189	87	NA	34	61	131	A76
21	7/2/11 12:25	7/23/11 11:22	0.5	DF+R+S	DRY-BULK	129	189	579	32	63	149	A92
22	7/23/11 11:22	8/4/11 11:10	0.5	DF	DRY-BULK	323	376	886	8	25	93	A93
23	8/4/11 11:10	8/26/11 10:30	0.5	DF	DRY-BULK	134	73	312	8	14	52	A94
24	8/26/11 10:30	9/8/11 10:02	0.5	DF	DRY-BULK	228	215	288	3	10	19	A95
25	9/8/11 10:02	9/21/11 9:13	0.433	DF+R	DRY-BULK	642	93	979	4	9	15	
26	9/21/11 9:13	10/12/11 15:12	0.5	DF+R+S	DRY-BULK	822	575	991	5	12	28	

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
27	10/12/11 15:12	10/27/11 10:48	1.090	DF	DRY-BULK	189	167	186	1	5	7	
28	10/27/11 10:48	11/16/11 09:46	0.375	DF+S	DRY-BULK	603	736	1209	26	33	58	
29	11/16/11 09:46	12/9/11 09:54	0.500	DF+S	DRY-BULK	176	80	272	4	8	26	A113
30	12/9/11 09:54	12/27/11 10:39	1.220	DF	DRY-BULK	137	59	181	3	6	21	
31	12/27/11 10:39	1/5/12 08:50	1.812	DF	DRY-BULK	35	16	53	1	5	4	
32	1/5/12 08:50	1/13/12 09:35	2.182	DF	DRY-BULK	20	23	49	1	6	7	
33	1/13/12 09:35	1/26/12 09:50	2.955	DF+R+S	DRY-BULK	64	69	193	2	8	8	
34	1/26/12 09:50	2/16/12 16:28	0.685	DF+S	DRY-BULK	174	233	307	3	7	19	
35	2/16/12 16:28	3/9/12 13:10	0.690	DF+S	DRY-BULK	229	199	262	4	8	13	
36	3/9/12 13:10	3/20/12 11:15	2.193	DF+R+S	DRY-BULK	43	94	152	2	5	6	
37	3/20/12 11:15	4/3/12 10:20	0.500	DF+R+S	DRY-BULK	334	504	589	4	9	24	A131
38	4/3/12 10:20	4/20/12 09:25	0.415	DF+R+S	DRY-BULK	248	326	453	8	13	14	
39	4/20/12 09:25	5/11/12 10:00	0.500	DF+R+S	DRY-BULK	258	240	516	6	11	31	A139
40	5/11/12 10:00	6/5/12 09:45	0.500	DF+R+S	DRY-BULK	368	110	698	27	45	136	A140
41	6/5/12 09:45	7/2/12 09:25	0.500	DF	DRY-BULK	129	69	599	20	29	104	A141
42	7/2/12 09:25	7/24/12 13:06	0.500	DF+R+H	DRY-BULK	459	325	759	7	34	96	151
43	7/24/12 13:06	8/6/12 14:09	0.500	DF	DRY-BULK	400	449	668	2	7	29	152
44	8/6/12 14:09	8/17/12 09:25	0.415	DF+R	DRY-BULK	545	403	672	4	9	16	
45	8/17/12 09:25	8/27/12 09:26	0.500	DF	DRY-BULK	359	482	560	4	9	16	153
46	8/27/12 09:26	9/11/12 11:35	0.500	DF+R	DRY-BULK	658	665	758	5	10	22	154
47	9/11/12 11:35	9/28/12 10:28	0.500	DF	DRY-BULK	403	437	610	5	8	26	154
48	9/28/12 10:28	10/8/12 09:08	1.283	DF	DRY-BULK	147	143	371	1	4	15	
49	10/8/12 09:08	10/17/12 12:03	1.535	DF+R	DRY-BULK	120	155	188	2	6	10	
50	10/17/12 12:03	11/2/12 09:15	NA	DF+R+S	DRY-BULK	NA	NA	912	NA	NA	NA	175
51	11/2/12 09:15	11/15/12 13:52	1.870	DF+S	DRY-BULK	64	58	81	2	7	7	
52	11/15/12 13:52	11/27/12 14:00	1.475	DF+R+S	DRY-BULK	80	88	109	1	6	7	
53	11/27/12 14:00	12/14/12 09:25	2.095	DF+R+S	DRY-BULK	74	28	105	1	3	4	176
54	12/14/12 09:25	1/4/12 12:52	1.560	DF+S	DRY-BULK	71	23	79	2	2	7	
55	1/4/12 12:52	1/17/13 09:27	1.893	DF+S	DRY-BULK	62	19	32	1	4	5	

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
56	1/17/13 09:27	2/4/13 09:10	2.034	DF+R,S,H	DRY-BULK	91	55	107	1	5	10	
57	2/4/13 09:10	2/22/13 10:19	0.840	DF+T	DRY-BULK	215	164	176p	1	3	6	
58	2/22/13 10:19	3/19/13 10:21	0.282	DF+R+S	DRY-BULK	1020	1876	2168p	16	20	96	189
59	3/19/13 10:21	4/12/13 09:30	0.500	DF+R,S,H	DRY-BULK	530	601	1044	12	22	38	190
60	4/12/13 09:30	4/25/13 08:41	0.394	DF+R	DRY-BULK	248p	333p	479p	9p	15p	31p	
61	4/25/13 08:41	5/7/13 09:14	2.596	DF+R+S	DRY-BULK	191p	392p	471p	14p	17p	29p	
62	5/7/13 09:14	5/20/13 16:35	0.443	DF+R	DRY-BULK	397p	400p	NA	2p	11p	35p	
63	5/20/13 16:35	5/31/13 12:00	0.500	DF+R	DRY-BULK	264p	500p	NA	18p	24p	43p	195

Appendix Table 4.b. N and P loads in dry-bulk deposition (buoy bucket) at the Mid-lake Buoy (TB-1) Station 6/3/10-5/31/13.

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/3/10 9:37	7/2/10 8:05	0.5	DF+R	DRY-BULK	C	C	C	C	C	C	A13
2	7/2/10 8:05	7/20/10 10:35	0.5	DF+R	DRY-BULK	21.62	2.66	85.83	3.06	3.80	15.29	A14
3	7/20/10 10:35	8/3/10 9:30	0.5	DF	DRY-BULK	20.17	9.46	23.16	0.18	1.10	4.50	A14
4	8/3/10 9:30	8/12/10 9:50	0.365	DF+R	DRY-BULK	53.66	66.83	111.01	0.49	1.10	2.42	
5	8/12/10 9:50	8/31/10 10:30	0.5	DF	DRY-BULK	24.24	2.07	49.21	0.65	1.13	4.02	A14
6	8/31/10 10:30	9/9/10 9:40	0.5	DF+T	DRY-BULK	31.75	66.22	92.24	0.99	1.23	2.33	A16
7	9/9/10 9:40	9/22/10 9:15	0.5	DF	DRY-BULK	42.68	79.11	111.15	0.16	0.52	1.50	A17
8	9/22/10 09:15	10/13/10 09:40	1.895	DF+R	DRY-BULK	148.16	139.26	174.08	4.31	6.24	10.74	
9	10/13/10 9:40	10/20/10 15:24	2.192	DF+R	DRY-BULK	44.34	74.45	128.05	0.97	1.61	1.75	
10	10/20/10 15:24	11/9/10 9:02	0.47	DF+R+S	DRY-BULK	45.98	35.79	89.03	0.42	1.23	2.37	
11	11/9/10 9:02	11/17/10 7:25	1.76	DF+S?	DRY-BULK	19.85	10.38	16.10	0.24	1.41	1.41	
12	11/17/10 7:25	12/1/10 10:45	0.735	DF+S	DRY-BULK	31.87	29.28	49.77	0.46	0.67	1.20	
13	12/1/10 10:45	12/15/10 13:50	2.351	DF+R+S	DRY-BULK	37.47	8.24	15.51	0.84	1.29	1.43	
14	12/15/10 13:50	1/4/11 9:57	0.958	DF+R+S	DRY-BULK	16.99	3.51	6.84	0.30	0.64	1.40	
15	1/4/11 9:57	2/11/11 11:07	0.275	DF+R+S	DRY-BULK							
16	2/11/11 11:07	3/1/11 8:30	0.833	S	DRY-BULK	19.50	19.38	29.42	0.37	0.78	1.66	
17	3/1/11 8:30	3/28/11 9:55	1.77	DF+R+S	DRY-BULK	38.63	34.40	40.37	0.63	1.40	3.24	A65
18	3/28/11 9:55	4/22/11 10:15	0.5	DF+R+S	DRY-BULK	48.18	54.74	101.61	1.01	1.62	2.66	A74
19	4/22/11 10:15	6/7/11 14:35	2.14	DF+R+S	DRY-BULK							A75
20	6/7/11 14:35	7/2/11 12:25	0.5	DF+R+S	DRY-BULK	18.69	8.60	NA	3.37	6.02	12.95	A76
21	7/2/11 12:25	7/23/11 11:22	0.5	DF+R+S	DRY-BULK	12.70	18.64	57.10	3.13	6.20	14.71	A92
22	7/23/11 11:22	8/4/11 11:10	0.5	DF	DRY-BULK	31.86	37.13	87.38	0.76	2.49	9.18	A93
23	8/4/11 11:10	8/26/11 10:30	0.5	DF	DRY-BULK	13.19	7.24	30.82	0.81	1.36	5.15	A94
24	8/26/11 10:30	9/8/11 10:02	0.5	DF	DRY-BULK	22.51	21.18	28.45	0.34	1.00	1.91	A95
25	9/8/11 10:02	9/21/11 9:13	0.433	DF+R	DRY-BULK	54.86	7.94	83.63	0.35	0.79	1.29	
26	9/21/11 9:13	10/12/11 15:12	0.5	DF+R+S	DRY-BULK	81.11	56.72	97.76	0.51	1.22	2.75	

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
27	10/12/11 15:12	10/27/11 10:48	1.090	DF	DRY-BULK	40.70	35.97	39.97	0.15	1.07	1.60	
28	10/27/11 10:48	11/16/11 09:46	0.375	DF+S	DRY-BULK	44.60	54.51	89.50	1.94	2.47	4.32	
29	11/16/11 09:46	12/9/11 09:54	0.500	DF+S	DRY-BULK	17.38	7.86	26.84	0.36	0.76	2.59	A113
30	12/9/11 09:54	12/27/11 10:39	1.220	DF	DRY-BULK	33.00	14.31	43.50	0.71	1.56	5.13	
31	12/27/11 10:39	1/5/12 08:50	1.812	DF	DRY-BULK	12.37	5.78	19.12	0.48	1.77	1.44	
32	1/5/12 08:50	1/13/12 09:35	2.182	DF	DRY-BULK	8.73	9.75	21.26	0.39	2.40	3.07	
33	1/13/12 09:35	1/26/12 09:50	2.955	DF+R+S	DRY-BULK	37.36	39.99	112.34	1.06	4.69	4.87	
34	1/26/12 09:50	2/16/12 16:28	0.685	DF+S	DRY-BULK	23.55	31.47	41.45	0.43	1.01	2.60	
35	2/16/12 16:28	3/9/12 13:10	0.690	DF+S	DRY-BULK	31.24	27.04	35.67	0.56	1.09	1.72	
36	3/9/12 13:10	3/20/12 11:15	2.193	DF+R+S	DRY-BULK	18.80	40.63	65.95	0.69	2.14	2.80	
37	3/20/12 11:15	4/3/12 10:20	0.500	DF+R+S	DRY-BULK	33.00	49.73	58.12	0.43	0.88	2.41	A131
38	4/3/12 10:20	4/20/12 09:25	0.415	DF+R+S	DRY-BULK	20.31	26.71	37.13	0.63	1.09	1.12	
39	4/20/12 09:25	5/11/12 10:00	0.500	DF+R+S	DRY-BULK	25.49	23.66	50.90	0.59	1.11	3.05	A139
40	5/11/12 10:00	6/5/12 09:45	0.500	DF+R+S	DRY-BULK	36.35	10.89	68.91	2.67	4.41	13.44	A140
41	6/5/12 09:45	7/2/12 09:25	0.500	DF	DRY-BULK	12.71	6.76	59.10	1.96	2.82	10.29	A141
42	7/2/12 09:25	7/24/12 13:06	0.500	DF+R+H	DRY-BULK	45.28	32.06	74.93	0.74	3.40	9.46	A151
43	7/24/12 13:06	8/6/12 14:09	0.500	DF	DRY-BULK	39.48	44.31	65.91	0.22	0.70	2.82	A152
44	8/6/12 14:09	8/17/12 09:25	0.415	DF+R	DRY-BULK	53.80	39.81	66.27	0.40	0.88	1.61	
45	8/17/12 09:25	8/27/12 09:26	0.500	DF	DRY-BULK	35.39	47.60	55.26	0.36	0.85	1.55	A153
46	8/27/12 09:26	9/11/12 11:35	0.500	DF+R	DRY-BULK	64.94	65.62	74.80	0.54	0.96	2.13	A154
47	9/11/12 11:35	9/28/12 10:28	0.500	DF	DRY-BULK	39.79	43.11	60.24	0.51	0.82	2.61	A154
48	9/28/12 10:28	10/8/12 09:08	0.500	DF	DRY-BULK	37.17	36.28	93.90	0.17	1.09	3.91	
49	10/8/12 09:08	10/17/12 12:03	1.535	DF+R	DRY-BULK	36.34	47.09	56.85	0.55	1.87	3.91	
50	10/17/12 12:03	11/2/12 09:15	NA	DF+R+S	DRY-BULK						2.90	175
51	11/2/12 09:15	11/15/12 13:52	1.870	DF+S	DRY-BULK	23.65	21.47	29.83	0.59	2.52		
52	11/15/12 13:52	11/27/12 14:00	1.475	DF+R+S	DRY-BULK	23.27	25.62	31.71	0.20	1.80	2.63	
53	11/27/12 14:00	12/14/12 09:25	2.095	DF+R+S	DRY-BULK	30.59	11.75	43.56	0.28	1.41	2.08	176
54	12/14/12 09:25	1/4/12 12:52	1.560	DF+S	DRY-BULK	21.82	7.02	24.20	0.71	0.76	1.66	
55	1/4/12 12:52	1/17/13 09:27	1.893	DF+S	DRY-BULK	23.01	7.00	11.96	0.25	1.51	2.09	

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
56	1/17/13 09:27	2/4/13 09:10	2.034	DF+R,S,H	DRY-BULK	36.62	22.07	42.93	0.27	1.99	3.85	
57	2/4/13 09:10	2/22/13 10:19	0.840	DF+T	DRY-BULK	35.59	27.24	29.14	0.11	0.57	0.99	
58	2/22/13 10:19	3/19/13 10:21	0.282	DF+R+S	DRY-BULK	56.79	104.38	82.82p	0.88	1.11	5.36	189
59	3/19/13 10:21	4/12/13 09:30	0.500	DF+R,S,H	DRY-BULK	52.30	59.26	103.05p	1.21	2.14	3.70	190
60	4/12/13 09:30	4/25/13 08:41	0.394	DF+R	DRY-BULK	19.27p	25.91p	37.27p	0.71p	1.15p	2.37p	
61	4/25/13 08:41	5/7/13 09:14	2.596	DF+R+S	DRY-BULK	97.94p	200.86p	241.37p	7.07p	8.85p	14.85p	
62	5/7/13 09:14	5/20/13 16:35	0.443	DF+R	DRY-BULK	34.73p	35.01p	NA	0.16p	0.99p	3.04p	
63	5/20/13 16:35	5/31/13 12:00	0.500	DF+R	DRY-BULK	26.09p	49.37p	NA	1.75p	2.40p	4.22p	195

Table 5.a. N and P concentrations in dry-bulk deposition (buoy bucket) at the Northwest Buoy (TB-4) Station 6/3/10-5/31/13.

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
1	6/3/2010 9:18	7/2/2010 8:20	0.5	DF+R	DRY-BULK	253	40	1045	48	65	NA	A13
2	7/2/2010 8:20	7/20/2010 10:16	0.5	DF+R	DRY-BULK	137	27	544	22	30	70	A9
3	7/20/2010 10:16	8/3/2010 9:07	0.5	DF	DRY-BULK	192	136	226	2	8	25	A14
4	8/3/2010 9:07	8/12/2010 10:14	0.485	DF+R	DRY-BULK	697	175	2085	24	30	47	
5	8/12/2010 10:14	8/31/2010 14:05	0.5	DF	DRY-BULK	235	17	523	6	9	33	A14
6	8/31/2010 14:05	9/9/2010 9:20	0.685	DF+R	DRY-BULK	254	288	367	3	6	11	A13
7	9/9/2010 9:20	9/22/2010 8:55	0.32	DF	DRY-BULK	583	621	1465	3	7	15	A9
8	9/22/2010 8:55	10/13/2010 9:40	1.232	DF+R	DRY-BULK	496	538	793	2	10	16	A14
9	10/13/2010 9:40	10/20/2010 15:24	2.374	DF+R	DRY-BULK	112	138	204	2	3	3	
10	10/20/2010 15:24	11/9/2010 9:02	0.818	DF+R+S	DRY-BULK	303	375	315	1	7	22	A14
11	11/9/2010 9:02	11/17/2010 7:25	1.515	DF+S?	DRY-BULK	70	36	88	1	3	4	
12	11/17/2010 7:25	12/1/2010 10:45	1.131	DF+S	DRY-BULK	154	159	264	1	4	15	
13	12/1/2010 10:45	12/15/2010 13:50	2.775	DF+R+S	DRY-BULK	57	15	18	1	3	3	
14	12/15/2010 13:50	1/4/2011 9:40	1.35	DF+R+S	DRY-BULK	93	25	134	1	2	3	
15	1/4/2011 9:40	2/11/2011 10:46	0.5	DF+R+S	DRY-BULK	639	283	454	7	8	28	
16	2/11/2011 10:46	3/1/2011 8:48	0.627	S	DRY-BULK	143	139	176	2	5	33	
17	3/1/2011 8:48	3/28/2011 9:25	1.828	DF+R+S	DRY-BULK	114	96	144	2	4	9	
18	3/28/2011 9:25	4/22/2011 9:19	0.5	DF+R+S	DRY-BULK	501	717	1013	11	19	50	
19	4/22/2011 9:19	6/7/2011 15:08	1.869	DF+R+S	DRY-BULK	168	147	182	11	11	15	
20	6/7/2011 15:08	7/2/2011 11:45	0.5	DF+R+S	DRY-BULK	171	68	581	16	46	65	A66
21	7/2/2011 11:45	7/23/2011 10:54	0.5	DF+R	DRY-BULK	151	92	569	17	38	110	
22	7/23/2011 10:54	8/4/2011 10:25	0.5	DF	DRY-BULK	254	315	382	7	16	48	
23	8/4/2011 10:25	8/26/2011 10:05	0.5	DF	DRY-BULK	82	78	193	5	10	24	A77
24	8/26/2011 10:05	9/8/2011 9:19	0.5	DF	DRY-BULK	187	206	478	4	10	25	A78
25	9/8/2011 9:19	9/21/2011 9:33	0.5	DF+R	DRY-BULK	187	250	1015	4	9	13	A79

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
26	9/21/2011 9:33	10/12/2011 15:37	0.5	DF+R+S	DRY-BULK	754	672	895	2	8	16	A96
27	10/12/2011 15:37	10/27/2011 10:31	0.892	DF	DRY-BULK	256	251	253	1	5	7	
28	10/27/2011 10:31	11/16/2011 10:06	0.5	DF+S	DRY-BULK			887			57	A115
29	11/16/2011 10:06	12/9/2011 15:56	0.5	DF+S	DRY-BULK	137	62	128	2	7	18	A116
30	12/9/2011 15:56	12/27/2011 10:20	0.777	DF	DRY-BULK	212	146	526	4	8	13	
31	12/27/2011 10:20	1/5/2012 8:50	1.812	DF	DRY-BULK	41	21	107	1	4	5	
32	1/5/2012 8:50	1/13/2012 9:20	2.13	DF	DRY-BULK	39	35	123	1	6	7	
33	1/13/2012 9:20	1/26/2012 9:15	3.542	DF+R+S	DRY-BULK	42	63	164	1	7	6	
34	1/26/2012 9:15	2/16/2012 16:10	0.525	DF+S	DRY-BULK	224	310	361	3	8	36	
35	2/16/2012 16:10	3/9/2012 13:25	0.45	DF+S	DRY-BULK	331	421	391	5	9	13	
36	3/9/2012 13:25	3/20/2012 11:32	2.645	DF+R+S	DRY-BULK	46	104	136	2	5	9	
37	3/20/2012 11:32	4/3/2012 10:00	0.405	DF+R+S	DRY-BULK	428	688	373	5	10	23	A131
38	4/3/2012 10:00	4/20/2012 9:05	0.315	DF+R+S	DRY-BULK	457	655	1014	5	9	40	
39	4/20/2012 9:05	5/11/2012 9:18	0.5	DF+R+S	DRY-BULK	358	441	717	7	13	31	A142
40	5/11/2012 9:18	6/5/2012 8:55	0.5	DF+R+S	DRY-BULK	419	105	459	32	39	151	A143
41	6/5/2012 8:55	7/2/2012 9:25	0.5	DF	DRY-BULK	130	66	267	12	15	53	A141
42	7/2/2012 9:00	7/24/2012 13:40	0.5	DF+R+H	DRY-BULK	C	C	C	C	C	C	A155
43	7/24/2012 13:40	8/6/2012 14:44	0.5	DF	DRY-BULK	200	206	441	4	10	24	A154
44	8/6/2012 14:44	8/17/2012 8:54	0.5	DF+R	DRY-BULK	533	462	827	4	17	17	A156
45	8/17/2012 8:54	8/27/2012 9:07	0.5	DF	DRY-BULK	253	238	463	5	9	19	A154
46	8/27/2012 9:07	9/11/2012 12:27	0.5	DF+R	DRY-BULK	458	404	680	7	11	27	A154
47	9/11/2012 12:27	9/28/2012 10:28	0.5	DF	DRY-BULK	369	314	405	5	9	24	A154
48	9/28/2012 10:05	10/8/2012 8:52	0.88	DF	DRY-BULK	210	244	327	1	5	5	
49	10/8/12 08:52	10/17/12 12:23	1.031	DF+R	DRY-BULK	184	280	298	7	13	16	
50	10/17/12 12:23	11/2/12 08:59	0.320	DF+R+S	DRY-BULK			1514				
51	11/2/12 08:59	11/15/12 14:32	1.435	DF+S	DRY-BULK	103	135	191	2	7	7	
52	11/15/12 14:32	11/27/12 14:00	1.650	DF+R+S	DRY-BULK	73	98	121	1	6	11	
53	11/27/12 14:00	12/14/12 09:25	1.761	DF+R+S	DRY-BULK	89	35	76p	1	3	3	176

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
54	12/14/12 09:25	1/4/13 12:30	1.218	DF+S	DRY-BULK	78	29	83	3	3	12	
55	1/4/13 12:30	1/17/13 0910	1.862	DF+S	DRY-BULK	60	20	64	1	4	6	
56	1/17/13 0910	2/4/13 08:50	2.120	DF+R,S,H	DRY-BULK	95	61	116	1	6	6	
	2/4/13 08:50	2/22/13 09:53	NA	DF+T	DRY-BULK	267	231	948	3	5	11	
57	2/22/13 09:53	3/19/13 10:05	0.165	DF+R+S	DRY-BULK	559	1192	2852	5	6	14	186
58	3/19/13 10:05	4/12/13 09:10	0.500	DF+R+S	DRY-BULK	581	806	968p	9	13	34	191
59	4/12/13 09:10	4/25/13 08:23	0.394	DF+S	DRY-BULK	204p	295p	NA	5p	11p	34p	192
60	4/25/13 08:23	5/7/13 08:55	2.668	DF+R+S	DRY-BULK	169p	373p	NA	11p	14p	25p	
61	5/7/13 08:55	5/20/13 16:17	0.452	DF+R	DRY-BULK	413p	801p	NA	46p	52p	94p	
62	5/20/13 16:17	5/31/13 12:17	0.500	DF	DRY-BULK	251p	597p	NA	9p	13p	19p	197

Appendix Table 5.b. N and P loads in dry-bulk deposition (buoy bucket) at the Northwest Buoy (TB-4) Station 6/3/10-5/31/13.

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/3/2010 9:18	7/2/2010 8:20	0.5	DF+R	DRY-BULK	C	C	C	C	C	C	A13
2	7/2/2010 8:20	7/20/2010 10:16	0.5	DF+R	DRY-BULK	13.49	2.64	53.69	2.15	3.00	6.86	A9
3	7/20/2010 10:16	8/3/2010 9:07	0.5	DF	DRY-BULK	18.93	13.44	22.31	0.18	0.83	2.51	A14
4	8/3/2010 9:07	8/12/2010 10:14	0.485	DF+R	DRY-BULK	66.70	16.74	199.54	2.30	2.89	4.50	
5	8/12/2010 10:14	8/31/2010 14:05	0.5	DF	DRY-BULK	23.19	1.65	51.57	0.56	0.92	3.22	A14
6	8/31/2010 14:05	9/9/2010 9:20	0.685	DF+R	DRY-BULK	34.30	38.88	49.66	0.40	0.80	1.43	A13
7	9/9/2010 9:20	9/22/2010 8:55	0.32	DF	DRY-BULK	36.85	39.22	92.51	0.21	0.45	0.96	A9
8	9/22/2010 8:55	10/13/2010 9:40	1.232	DF+R	DRY-BULK	120.52	130.75	192.81	0.61	2.48	3.83	A14
9	10/13/2010 9:40	10/20/2010 15:24	2.374	DF+R	DRY-BULK	52.64	64.51	95.58	0.84	1.31	C	
10	10/20/2010 15:24	11/9/2010 9:02	0.818	DF+R+S	DRY-BULK	48.98	60.48	50.86	0.22	1.14	3.52	A14
11	11/9/2010 9:02	11/17/2010 7:25	1.515	DF+S?	DRY-BULK	21.06	10.82	26.25	0.20	1.01	1.31	
12	11/17/2010 7:25	12/1/2010 10:45	1.131	DF+S	DRY-BULK	34.46	35.39	58.99	0.30	0.89	3.29	
13	12/1/2010 10:45	12/15/2010 13:50	2.775	DF+R+S	DRY-BULK	31.38	7.68	9.93	0.74	1.69	1.86	
14	12/15/2010 13:50	1/4/2011 9:40	1.35	DF+R+S	DRY-BULK	24.78	6.54	35.71	0.36	0.41	0.91	
15	1/4/2011 9:40	2/11/2011 10:46	0.5	DF+R+S	DRY-BULK							
16	2/11/2011 10:46	3/1/2011 8:48	0.627	S	DRY-BULK	17.68	17.18	21.75	0.28	0.62	4.09	
17	3/1/2011 8:48	3/28/2011 9:25	1.828	DF+R+S	DRY-BULK	40.96	34.60	51.94	0.74	1.34	3.35	
18	3/28/2011 9:25	4/22/2011 9:19	0.5	DF+R+S	DRY-BULK	49.46	70.71	99.93	1.12	1.90	4.95	
19	4/22/2011 9:19	6/7/2011 15:08	1.869	DF+R+S	DRY-BULK							
20	6/7/2011 15:08	7/2/2011 11:45	0.5	DF+R+S	DRY-BULK	16.86	6.67	57.33	1.60	4.51	6.44	A66
21	7/2/2011 11:45	7/23/2011 10:54	0.5	DF+R	DRY-BULK	14.87	9.12	56.19	1.68	3.77	10.85	
22	7/23/2011 10:54	8/4/2011 10:25	0.5	DF	DRY-BULK	25.02	31.08	37.68	0.65	1.58	4.71	
23	8/4/2011 10:25	8/26/2011 10:05	0.5	DF	DRY-BULK	8.08	7.66	19.09	0.54	0.96	2.41	A77
24	8/26/2011 10:05	9/8/2011 9:19	0.5	DF	DRY-BULK	18.42	20.35	47.21	0.38	0.94	2.46	A78
25	9/8/2011 9:19	9/21/2011 9:33	0.5	DF+R	DRY-BULK	18.41	24.71	100.13	0.36	0.91	1.24	A79

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
26	9/21/2011 9:33	10/12/2011 15:37	0.5	DF+R+S	DRY-BULK	74.41	66.35	88.28	0.22	0.79	1.58	A96
27	10/12/2011 15:37	10/27/2011 10:31	0.892	DF	DRY-BULK	45.11	44.22	44.55	0.16	0.82	1.26	
28	10/27/2011 10:31	11/16/2011 10:06	0.5	DF+S	DRY-BULK			87.56			5.61	A115
29	11/16/2011 10:06	12/9/2011 15:56	0.5	DF+S	DRY-BULK	13.52	6.16	12.68	0.22	0.70	1.77	A116
30	12/9/2011 15:56	12/27/2011 10:20	0.777	DF	DRY-BULK	32.48	22.38	80.73	0.56	1.28	2.04	
31	12/27/2011 10:20	1/5/2012 8:50	1.812	DF	DRY-BULK	14.66	7.57	38.13	0.32	1.44	1.66	
32	1/5/2012 8:50	1/13/2012 9:20	2.13	DF	DRY-BULK	16.38	14.88	51.84	0.57	2.47	2.99	
33	1/13/2012 9:20	1/26/2012 9:15	3.542	DF+R+S	DRY-BULK	29.25	44.04	114.63	0.80	5.19	4.54	
34	1/26/2012 9:15	2/16/2012 16:10	0.525	DF+S	DRY-BULK	23.19	32.13	37.38	0.35	0.84	3.76	
35	2/16/2012 16:10	3/9/2012 13:25	0.45	DF+S	DRY-BULK	29.39	37.38	34.67	0.48	0.82	1.12	
36	3/9/2012 13:25	3/20/2012 11:32	2.645	DF+R+S	DRY-BULK	23.90	54.08	71.20	0.83	2.58	4.83	
37	3/20/2012 11:32	4/3/2012 10:00	0.405	DF+R+S	DRY-BULK	34.20	54.99	29.82	0.43	0.81	1.80	A131
38	4/3/2012 10:00	4/20/2012 9:05	0.315	DF+R+S	DRY-BULK	28.37	40.71	63.06	0.34	0.54	2.50	
39	4/20/2012 9:05	5/11/2012 9:18	0.5	DF+R+S	DRY-BULK	35.36	43.51	70.76	0.70	1.29	3.05	A142
40	5/11/2012 9:18	6/5/2012 8:55	0.5	DF+R+S	DRY-BULK	41.37	10.36	45.26	3.18	3.83	14.87	A143
41	6/5/2012 8:55	7/2/2012 9:25	0.5	DF	DRY-BULK	12.87	6.49	26.31	1.14	1.44	5.27	A141
42	7/2/2012 9:00	7/24/2012 13:40	0.5	DF+R+H	DRY-BULK							A155
43	7/24/2012 13:40	8/6/2012 14:44	0.5	DF	DRY-BULK	19.75	20.33	43.51	0.40	0.94	2.34	A154
44	8/6/2012 14:44	8/17/2012 8:54	0.5	DF+R	DRY-BULK	52.63	45.57	81.57	0.40	1.71	1.71	A156
45	8/17/2012 8:54	8/27/2012 9:07	0.5	DF	DRY-BULK	24.99	23.48	45.67	0.47	0.85	1.83	A154
46	8/27/2012 9:07	9/11/2012 12:27	0.5	DF+R	DRY-BULK	45.23	39.89	67.07	0.69	1.11	2.62	A154
47	9/11/2012 12:27	9/28/2012 10:28	0.5	DF	DRY-BULK	36.41	30.94	39.98	0.51	0.91	2.34	A154
48	9/28/2012 10:05	10/8/2012 8:52	0.88	DF	DRY-BULK	36.56	42.34	56.76	0.12	0.80	0.91	
49	10/8/12 08:52	10/17/12 12:23	1.031	DF+R	DRY-BULK	37.38	57.00	60.56	1.52	2.58	3.27	
50	10/17/12 12:23	11/2/12 08:59	0.320	DF+R+S	DRY-BULK							
51	11/2/12 08:59	11/15/12 14:32	1.435	DF+S	DRY-BULK	29.08	38.27	54.14	0.45	1.93	1.93	
52	11/15/12 14:32	11/27/12 14:00	1.650	DF+R+S	DRY-BULK	23.88	31.79	39.26	0.30	2.02	3.64	
53	11/27/12 14:00	12/14/12 09:25	1.761	DF+R+S	DRY-BULK	31.05	12.09	26.51p	0.39	0.97	1.18	

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Conc.) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
54	12/14/12 09:25	1/4/13 12:30	1.218	DF+S	DRY-BULK	18.73	6.86	20.04	0.60	0.74	2.82	
55	1/4/13 12:30	1/17/13 0910	1.862	DF+S	DRY-BULK	22.13	7.21	23.55	0.33	1.48	2.29	
56	1/17/13 0910	2/4/13 08:50	2.120	DF+R,S,H	DRY-BULK	39.91	25.52	48.50	0.48	2.33	2.46	
	2/4/13 08:50	2/22/13 09:53	NA	DF+T	DRY-BULK							
57	2/22/13 09:53	3/19/13 10:05	0.165	DF+R+S	DRY-BULK	55.12	117.62	281.42	0.51	0.64	1.36	186
58	3/19/13 10:05	4/12/13 09:10	0.5	DF+R+S	DRY-BULK	57.33	79.58	95.51p	0.90	1.29	3.34	191
59	4/12/13 09:10	4/25/13 08:23	0.394	DF+S	DRY-BULK	15.87p	22.92p	NA	0.41p	0.84p	2.64p	192
60	4/25/13 08:23	5/7/13 08:55	2.668	DF+R+S	DRY-BULK	89.24p	196.52p	NA	5.84p	7.47p	13.32p	
61	5/7/13 08:55	5/20/13 16:17	0.452	DF+R	DRY-BULK	36.83p	71.45p	NA	4.08p	4.61p	8.42p	
62	5/20/13 16:17	5/31/13 12:17	0.500	DF	DRY-BULK	24.74p	58.86p	NA	0.87p	1.30p	1.88p	197

Table Legend:

Precipitation Form: (S=snow; R=rain; DF= dry fall (Dry deposition); H=hail; G=graupel; NA=information on type not available; T=trace of precip.)

Collector Type: (ST= 8 in. dia. Snow tube; TBG= 8 in. dia. Electrically heated tipping bucket rain and snow gauge; Wet= Aerochem Metrics Wet Bucket; Dry= Dry-Bulk bucket with 4 liter deionized water added, placed in dry-side of Aerochem Metrics sampler; Dry-Bulk= Aerochem Metrics bucket with reduced side height, filled with 4 liters of deionized H2O)

pH: (NES= not enough sample); C= sample contaminated; NA= not measured; “p” – Provisional data, subject to revision.

Nutrient Concentrations: (C= sample contamination; NA= Not available or not enough sample for analysis; note units are micrograms/liter; TBA= data not yet available).

Table Notes

(A1)Small amount of precipitation from thunderstorms, 20ml sample + 480 ml deionized water; (A2) localized thunderstorm on 8/7/10 which caused rise on Ward Cr.; (A3) 125ml precipitation + 375 ml deionized water; (A4) much pollen and large dead crane fly in dry sample, possible contamination, not used for loading; (A5) dry bucket had much pollen, small amount of sample spilled in transit; (A6) removed Aerochem Metrics sampler on 8/12/10 12:00 to paint tower; (A7) thunderstorm this period, Dry bucket had much debris and dust, still construction on property and unpaved road, thunderstorm this period also, construction may have led to unusual silt resuspension, don’t use data for loading, also approximate start time when Aerochem Metrics station back up and running; (A8) couple aspen leaves, much debris, silt and organic matter in sample, grading and logging on property during period, don’t use this sample; (A9) much pollen and a few very small bugs in dry bucket; (A10) 32ml + 468ml deionized water, much pollen, many dead bugs in ST; (11) added 495ml deionized water to 5ml of sample; (12) 70ml of precipitation from thunderstorms added to 430ml of deionized water; (13) dry bucket out for very long period, 500ml deionized water to process; (A14) bucket dry, 500ml deionized water added to process; (A15) bucket dry, much pollen, 500 ml deionized water added to process; (A16) 220ml sample + 280ml deionized water;(A17) 10ml of sample + 490ml deionized water; (A18) no power to station, contractor disconnected power cord both Wet and Dry buckets open this period, lid removed; (A19)Aerochem Metrics lid removed, Wet + Dry buckets exposed during period; (A20) Aerochem Metrics lid over Wet part of period, shifted manually over Dry at 10/18/10 at 0900; (A21) 10/22/10 1440 extension cord connected to station, Aerochem Metrics working properly during storm, storm mostly rain from intense rain/ tropical moisture event; (A22) 185ml sample + 320ml deionized water; (A23) 2 aspen leaves in sample; (A24) bucket collected 11/20/10 13:25 with snow 3-4 inches above rim, was combined with bucket collected 11/21/10 17:45 with snow 10-12 inches above rim, snow compacted down for both, melt water added together, lid stuck over dry so bucket collected some dry deposition also, very cold; (A25) very cold arctic low pressure system with gusty winds, about 15-18 inches of snow from storm, snow may have blown off over-topped snow, only ½ inch snow above rim of bucket, area more open now due to removal of trees near the lake on the property; (A26) snow 3-4 inches above rim, compacted down; (A27) very wet storm with much rain at lower elevations, heavy snow, approximately 1 foot at end of storm; (A28) much water in bucket, snow also accumulated 1 inch above rim, strong winds had blown snow roof off Aerochem Metrics lid, rain and snow this storm, stationary low pressure system merging cold air and tropical moisture from near Hawaii, power off to station, Wet side open; (A29) Wet bucket collected some dry deposition, windy this period; (A30) power off, ground-fault interrupter tripped during storm, Wet caught some Dry deposition; (A31) Dry bucket may have caught some precipitation; (A32) snow 1 ½ feet above rim bucket compacted down, heavy wet snow from strong storm; (A33) no power to station, contractor removed disconnected power cord, both Wet and Dry buckets open this period, lid removed 10/3/10, dry bucket caught precipitation during storm 10/2/10; Wet + Dry buckets exposed during period; (A34) Dry bucket open during period until10/18/10 0900 when manually shifted lid to cover, Dry closed the rest of the period; (A35) many aspen leaves in Dry bucket; (A36) Dry bucket had ice in it, no heater in place; (A37) snow and ice accumulated on screen over Dry bucket, no heater in place; (A38) power was cut to station sometime during period, estimate 12/15/10, ground fault interrupter tripped, likely in heavy snow or rain, lid loose over dry during power outage; (A39) Dry bucket frozen with some snow on it, connected heater to timer for next Dry collection; (A40) precip rain from thunderstorms; (A41) ST leaked, 61 ml caught in another bag, added 268ml deionized water to 232ml sample remaining in ST;(A42) 55ml sample + 445 ml deionized H2O; (A43) ST bag had leak, re-sealed and placed back out; (A44) ST bag leaked, sample lost; (A45) no ST in place this period; (A46) ST had a leak, some sample lost, amount low, ST cap gone; (A47) snow accumulated 6-8 inches above rim, compacted down; (A48) snow accumulated ~4 inches above rim; (A49) ~2 feet new light snow at station, compacted into bucket; (A50) snow accumulated ~4 inches above rim, compacted down; (A51-53) no notes; (A54) 1 wet bucket spilled, ~2 feet snow accumulated, collected snow by coring down to wet bucket with another wet bucket, precip spilled out of one bucket in transit to the lab, estimated amount by using SNOTEL Ward 3 precipitation accumulated during period 3.6 inches of water divided by 1.5 (approximate factor Ward #3 is greater than Lower Ward Valley station; (A55)~15 inches new snow; (A56) snow accumulated 1 ft. above rim, used 2nd bucket to core down to bucket in sampler; (57) used clean bucket to core approximately 1 foot to wet bucket in sampler, combined buckets; (58) snow 1 inch above bucket rim; (A59) used 2nd bucket to core down to bucket in sampler, strong windy storm with heavy snow, bucket likely did not collect all snow due to strong winds which may have blown snow from top of sample away; (A60) Dry bucket frozen on surface portion of the period; (A61) much silt in sample; (A62) 117ml of precip + 383ml deionized water; (A63) no ST cap, bag blew upwards preventing collection of precip; (A64) no cap, but ST still collected precip; (A65) small pc of green organic matter in TB Dry; (A66) bucket dry, added 500ml deionized water to process; (A67) last storm very windy; (A68) power cut to station, house which had been source of power is being torn down, dry bucket caught most of the precipitation, 29ml of sample + 471ml deionized water; (A69) 145 ml of sample + 355 ml deionized water; (A70) much pollen and organic matter in sample; (A71) no ST or ST cap out this period; (A72) ST may have leaked; (A73) ST had many dead flies in it, measured volume and discarded water; (A74) bucket dry, added 500ml deionized water to process; (A75) bucket may have gone dry during portion of the period; (A76) dry bucket had trace of precipitation in it, much pollen in dry bucket; (A77) 50ml of sample + 450ml deionized water; (A78) bucket may have gone dry during portion of the period; (A79) 285 ml sample + 215ml deionized sample; (80) 56ml sample + 444ml deionized water, manually switched lid back over wet bucket, had switched over dry bucket at 1715 with onset of precipitation, power to station out, house which was source of power has been torn down; (A81) lid on Aerochem Metrics sampler removed 9/11/11 at 1505 prior to thunderstorms (1730-1930) – note there was heavy rain and Tahoe Vista from thunderstorms, a few sprinkles occurred the previous day and were caught in the dry bucket, after changing wet bucket, left lid off sampler; (A82) collected precip from wet bucket and left out, collected in new 250 HDPE bottle rinsed 4-5 times with sample; (A83) no precipitation or trace, had evaporated; (A84) much silt and pollen in sample, roadhouse demolished now, 1 aspen leaf in sample, diluted 60ml of filtered water with 180ml of deionized water due to very slow filtration; raw water was not diluted; (A85) bucket very dirty, still much construction on property, may be stirring up dust; (A86) many particles on filter; (A87) dry bucket lid had been removed from Aerochem sampler the previous day 9/11/11 at 1505, so dry bucket also caught precip 9/11/11 1730-1930; (A88) Aerochem Metrics lid removed so Dry bucket caught some precipitation as did Wet bucket; (A89) Dry bkt collected after about ½ hour of rain, replaced with Wet bucket, still no power to station; (A90) many small black bugs in ST sample, added 242 ml of sample to 258ml deionized water; (A91) ST had 22ml or precip to which added 478ml deionized water; (A92) bucket dry although precip during period, added 500ml to process, much pollen in sample; (A93) 48ml sample + 452ml deionized water; (A94) bucket dry, added 500ml deionized water to process, many plastic flakes; (A95) bucket dry, added 500ml deionized water to process; (A96) bucket dry added 500ml deionized water to process, much pollen; (A97) bucket dry, added 500ml deionized water to process; (A98) 190 ml sample + 310ml deionized water; (x) additional 2 liters deionized water added, small amount spilled in transit; (z) pine needles, seeds, sprouts in sample, contamination, long collection period, don't use sample; (y) many pieces of organic matter in sample, don't use; (v) bucket out long period, sample caught wet and dry, unable to separate wet contribution from dry in calculations, use Wet bucket estimates of Wet+ Dry during collection periods ending 10/3/10 16:45, 10/4/10 09:20, 10/5/10 16:15; 10/8/10 11:20, do not use 10/14/10 dry sample; (w) in calculation of loading and loading rate, subtracted the contribution from the wet sample collected 10/19/11 to estimate the dry contribution; (A99) no power to station yet, has been raining about ½ hour, collected dry bucket which had collected initial part of storm, replaced with wet bucket, at end of storm, wet bucket exposed to dry deposition for about 3-4 hours prior to collection an placement of new dry bucket on 10/6/11 at 18:25; (A100) replaced dry bucket with wet bucket at 1025 on 10/10/11 after 0.01-0.02 inches of precipitation, replaced dry bucket after storm on 10/11/11 0950; (101) station now hooked up to power from the adjoining property, Wet/Dry sampler worked this storm; (A102) Wet bucket may not have caught all precipitation, Dry may have caught second storm; (A103) trace amount of snow, bucket dry; (A104) Dry bucket replaced with Wet during portion of period when rain occurring (Wet placed 10/10/11 10:25-10/11/11 09:50), Dry caught small amount of precipitation at beginning of storm (~0.01-0.02 inches); Dry bucket had about 10-15 aspen leaves in it, probable contamination, power to station now from adjoining property; (A106) no heater in place, Dry bucket water frozen; (A107) Dry bucket may have caught precipitation from second of two storms, many old aspen leaves and pine needles from wind storms, water discolored, probable contamination; (A108) no heater, bucket frozen; (109) bucket partially thawed around edges, placed out bucket with heater in it; (A110) pin-hole leak in ST corner, volume likely low; (A111) 1 small dead gnat in sample, added 4ml sample to 496ml deionized water to process; (A112) bucket dry, added 500ml deionized water to process; (A113) Dry-Bulk bucket dry, added 500ml deionized water to process; (A114) trace of precipitation in Dry-Bulk bucket, added 500ml deionized water to process, many plastic flakes; (A115) 165ml sample added to 335ml deionized water; (A116) Dry-Bulk bucket dry, added 500ml deionized water to process; (117) added 395 ml deionized water to 105ml of sample; (A118) snow 2 inches above bucket rim, compacted down; (A119) added 490 ml deionized water to 10ml sample to process; (A120) snow 3 inches above rim, very windy, blowing snow off top of bucket; (A121) dry bucket may have caught some precipitation; (A122) sample very dirty with silt; (A123) added 465ml deionized water to 35ml of sample; (A124) dry bucket partially frozen; (A125) dry bucket frozen, heater removed during pd.; (A126) dry bucket had small amount of ice; (A127) dry bucket partially frozen part of period; dry bucket may have caught some precipitation this period; exchanged Aerochem Metrics motor with serviced motor from NADP program; (A128) rough lake conditions, couldn't change ST, left out, much rain and snow during period; (A129) added 490 ml deionized water to 10 ml of sample to process; (A130) added 300ml of deionized water to 200ml of sample and processed; (A131) very windy storm during period; (A132) small amount of sample spilled from Dry bucket; (A133) many seeds and sprouts in bucket water; (A134) bird feces on dry bucket bug screen, contaminated, discarded; (A135) pollen in sample; (A136) 15ml of sample + 485 ml deionized water for processing; (A137) 145 ml sample + 355ml deionized water to process; (A138) many small bugs in ST sample, possible contamination; (A139) bucket dry although precipitation during period, added 500ml deionized water to process; (A140) 145 ml sample + 355ml deionized water, many plastic flakes in dry bucket sample; (A141) bucket dry, added 500ml deionized water to process; (A142) bucket dry, added 500ml DIW to process; (A143) 215ml sample +285 ml deionized water to process; (A144) thunderstorms on 7/23/12 early AM to evening, filtration filter very dirty with silt and pollen; (A145) added 485ml deionized water to 15 ml of sample, precipitation from thunderstorms; (A146) precipitation from thunderstorms; (A147) filtration filter very dirty with brown silt; (A148) bucket sat out for long period, much pollen and wind-blown debris in bucket, some small bugs; (A149) 45 ml sample + 455ml deionized water to process; (150) 90 ml sample + 410ml deionized water; (A151) 50ml sample + 450ml deionized water; (A152) 75ml sample + 425ml deionized water; (A153) bucket dry, added 500ml deionized water to process; (A154) bucket dry, added 500ml deionized water to process; (A155) 95ml sample + 405ml deionized water; (A156) 145ml sample + 355ml deionized water; (157) sample spilled in transit, used TCH Wet : WLL Wet relation to estimate WLL precipitation amount i.e. WLL Wet = 1.2948x TCH amount (inches) + 0.029 (158) Aerochem Metrics lid partially closed over 3-4 inches of snow topping wet bucket, sampler motor not functioning and needed replacement; (159) precipitation from storm on 11/1/12, Aerochem Metrics lid froze over Wet 1 bucket after the storm, had replaced Aerochem motor on 10/30 with used motor; (160) approximately 10 inches of snow accumulated over Dry bucket screen, removed into Wet 2 bucket; (161) precipitation mostly rain, some sleet; (162) precipitation rain, snow, sleet from third intense storm, much wind-blown debris in bucket, including piece of incense cedar leaf; (163) precipitation rain from last in series of storms; (164) approximately 20 inches of new snow, about 10 inches above rim, removed snow above rim into cleaned Snow Tube bag, small amount lost; (165) snow about 5 inches above rim compacted down; (166) 1 aspen leaf on screen; (167) many leaves on screen; (168) bucket frozen, replaced with bucket with heater and no screen; (169) some ice in bucket and 2 aspen leaves, water turbid and slow-filtering; (170) dry bucket frozen; (171) heater on continuously during period, added 2 liters of deionized water during period; (172) 118ml of sample + 382ml deionized water; (173) 25 ml sample + 475 ml deionized water; (174) snow tube leaked, no sample; (175) significant portion of sample spilled, sample not used; (176) much ice in bucket; (177) 107 ml sample + 393ml deionized water to process; (178) 130 ml sample + 372 ml deionized water; (179) Dry bucket collected some snow during period; (180) Aerochem Metrics motor stopped working, Dry bucket may have caught small amount of snow; (181) moderate dust and silt in sample; (182) 12 ml of sample + 488 ml deionized water to process; (183) 105ml sample + 395 ml deionized water; (184) 197ml sample + 303 ml deionized water to process; (185) many plastic flakes in sample, also much brown silt; (186) 165ml sample + 335ml deionized water; (187) brown silt in sample; (188) 10ml sample + 490ml deionized water; (189) many plastic flakes and silt in sample, filter clogged with brown silt; (190) 53ml sample + 447ml deionized water; (191) 40ml sample + 460ml deionized water; (192) 167ml sample + 333ml deionized water; (193) 150ml of sample + 350ml deionized water; (194) 95ml sample + 405ml deionized water; (195) 200ml sample + 300ml deionized water; (196) 3 small flies in ST sample, much brown silt and some pollen; (197) 182ml sample + 318ml deionized water;