Lake Tahoe Water Quality Investigations

Algal Bioassay • Phytoplankton • Atmospheric Nutrient Deposition • Periphyton • Angora Fire Water Quality Monitoring Task Conclusions[1]

Final Report:

July 1, 2007– June 30, 2010

Agreement No. 07-024-160-0

Submitted to:

State Water Resources Control Board
Lahontan Regional Water Quality Control Board

Submitted by:

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Note (1) – For the full Angora Fire Water Quality Monitoring Report see: Reuter et al., 2010. "Water quality conditions following the 2007 Angora wildfire in the Lake Tahoe Basin."

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Acknowledgments

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Project Overview

The following document is our Final Report for work completed July 1, 2007 to June 30, 2010 for Agreement No. 07-024-160-0: 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 research and data will support the Lake Tahoe Interagency Monitoring Program (LTIMP). The State Water Board will be provided with 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:

<u>Algal growth bioassay tests to assess nutrient limitation (Task 3)</u>. 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).

<u>Enumeration and identification of phytoplankton and zooplankton species (Task 4)</u>. The purpose of this task is to provide ongoing information on phytoplankton and zooplankton species present in the water column. 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. Monthly samples of zooplankton will include: a 150m to surface tow at both the Index and Mid-lake stations. Phytoplankton analysis is to include species present, cell numbers and biovolume measurements. Zooplankton analysis will include species present and numbers.

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. In addition more information is needed on particle deposition to the lake. In Task 5, 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. In addition, a pilot program for determining the feasibility of collecting atmospheric deposition particles in collectors on the lake will be initiated. A literature search investigating feasibility of using simple buckets as collectors will be done by TERC. If determined to be feasible by the State Water Board's Contract Manager, initial tests of the method will be done at the TERC lab.

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. 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. Seven sites are to be monitored for periphyton biomass a minimum of five times per year in this project. 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 70 samples per year. Biomass is to be reported as chlorophyll *a* and Ash Free Dry Weight (AFDW). Twice a year, 39 additional sites will be visited and an above water visual assessment of the level of growth visible near shore (ranking 1-5) will be done.

Water Quality Conditions following the 2007 Angora Wildfire (Task 7). Work in Task 7 was added to the Lake Tahoe Water Quality Investigations work for 2007-2010 to address many of the questions surrounding the impacts of the Angora Fire on water quality. The final results of the two-year monitoring program are presented in a separate report: Reuter et al (2010), "Water Quality Conditions Following the 2007 Angora Wildfire in the Lake Tahoe Basin." The reader is referred to that report for complete presentation of data and findings. A brief background on the Angora Fire, the goals of the water quality post-fire monitoring program and the main conclusions, from Reuter et al (2010) are presented in this report. The Angora Creek monitoring design was intended to address the following:

- Water quality impacts to Angora Creek within the burned watershed
- Comparison to post-fire conditions
- Influence of urban runoff on downstream water quality
- Effect of passage through the Washoe Meadows (natural grass) ecosystem on downstream water quality
- Time needed for burned area to return to pre-fire conditions, vis-à-vis, pollutant loading on water quality conditions
- Change in pollutant loading characteristics to Lake Tahoe, via the Upper Truckee River

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, 2007 – June 30, 2010) 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 – Water Quality Conditions after Angora Wildfire	100%
8 - 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. Table 2 presents the results for analyses of atmospheric deposition field quality control samples collected July 2007 to April 2010. Nutrient levels in field and container blank samples were compared with the source blank samples to check for levels of contamination. Levels of N and P very low in the majority of deionized water "DIW Blk" source blanks with many samples below the method detection level (MDL). N and P levels were also very low in the majority of container blank and field blank samples with many below or close to the MDL.

Due to typically very low levels of P in atmospheric deposition samples (i.e. WY 2009 average concentrations of near 4.0 µg/l for SRP, 5.0 µg/l for DP and 9.0 µg/l for TP in the Ward Wet bucket samples), any sample contamination introduced in the field sampling or bucket cleaning can impact estimates of P loads for individual samples. Many of the container of field blanks were below the MDL but when they did have levels of phosphorus above the MDL, they typically were only slightly elevated (SRP typically elevated by 1-2 µg/l above the MDL and levels of DP, TP typically within 1-3 µg/l of the MDL). It should be stressed these values were very near the lower limits for the P analyses. The source blank water was also occasionally elevated above the MDL and higher at times then container or field blanks using this water. Atmospheric deposition samples using DIW as part of the collection system, i.e. for Dry and Dry-bulk samples, may slightly overestimate P loading when P is present in this DIW water. Overall, the amounts of P introduced to samples as a result of cleaning or field sampling appear to be low.

A few QA/QC samples had obviously elevated levels of N or P. One lab carboy blank had elevated TP (27 µg/l), however, the TP in equipment blank using this same water was 3.19 µg/l, so the contamination may have been contributed from the sample bottle or possibly have occurred in analysis. For field blanks, the WLL Wet field blank collected 3/6/08, had unusually high NH_4-N (84 µg/l; rerun = 70 µg/l) in the filtered sample. The TKN results for unfiltered water of the same sample indicated NH_4-N must have been much lower (TKN in the unfiltered water was 48 µg/l, slightly above the TKN MDL; since TKN = Organic N + NH_4-N, the NH_4-N had to be $\leq$ 48 µg/l). The NH_4-N contamination in this filtered sample may have been introduced during filtration or also resulted from sample bottle contamination. This was the only sample with significant contamination in the QA/QC samples. Finally, TP in one Snow Tube container blank was slightly elevated (12 µg/l). Critical attention will continue to be applied toward avoidance of contamination during sample preparation and sample collection.

Table 2. Quality Control samples collected for the atmospheric deposition monitoring July 1, 2007 to April 1, 2010.

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
DIW Blk	7/25/2007 19:35	Source Blk	-	4.28	MDL	MDL	NA	NA	3.19	1
Lab Carboy Blk	7/25/2007 20:15	Container Blk	-	2.74	MDL	MDL	NA	NA	27.43	2
Grad. Cyl.	7/26/2007 10:18	Equip. Blk	-	MDL	MDL	MDL	NA	NA	3.19	3
DIW Blk	9/21/2007 11:00	Source Blk	-	2.22	MDL	MDL	4.75	6.70	3.83	1
FBWLLD	9/21/2007 10:15	Container Blk	4.000	4.28	MDL	42.83	3.62	6.06	4.78	4
FBTB1ST	9/21/2007 10:40	Container Blk	0.5	2.74	6.30	MDL	4.08	5.10	5.42	5
DIW Blk	9/27/2007 11:40	Source Blk	-	MDL	MDL	MDL	1.38	4.32	7.41	1
FBWLLW	9/28/2007 10:10	Field Blk	0.5	MDL	7.48	MDL	1.62	5.86	4.62	6
DIW Blk	12/28/07 12:50	Source Blk		MDL	3.72	MDL	NA	3.39	3.36	1
FBWLLD	12/28/07 12:05	Container Blk	3.990	MDL	3.72	MDL	MDL	4.64	3.66	4
FBTB1D	12/28/07 11:40	Container Blk	3.997	NA	NA	NA	NA	NA	NA	7
FBTB1ST	12/28/07 11:50	Container Blk	0.500	MDL	6.74	NA	MDL	4.97	12.43	5
DIW Blk	3/5/08 12:35	Source Blk		MDL	4.09	MDL	2.37	3.09	3.09	1
Carboy Blk	3/5/08 14:25	Container Blk		MDL	5.55	MDL	1.80	4.17	3.40	
FBWLLW	3/6/08 17:20	Field Blk	0.5	3.40	84/70*	47.67	2.71	5.82	3.09	6,9
FBWLLD	3/26/08 14:15	Container Blk	3.977	MDL	4.45	MDL	MDL	4.59	5.51	4
FBTB1D	3/26/08 14:35	Container Blk	4.000	MDL	5.77	49.94	MDL	4.59	4.90	7
FBTB1ST	3/26/08 15:05	Container Blk	0.500	MDL	4.67	MDL	MDL	3.06	3.67	5
DIW Blk	1/13/09 16:30	Source Blk	-	MDL	MDL	MDL	MDL	MDL	MDL	1
FBWLLW	1/16/09 15:00	Field Blk	0.5	MDL	4.59	MDL	MDL	MDL	MDL	8
FBWLLD	1/14/09 17:25	Container Blk	4.000	MDL	3.45	MDL	MDL	MDL	MDL	4
FBTB1D	1/14/09 16:35	Container Blk	4.000	MDL	MDL	MDL	MDL	MDL	MDL	7
FBTB1ST	1/14/09 17:05	Container Blk	0.5	MDL	3.04	MDL	MDL	MDL	MDL	5
Source Blk	9/30/09 13:20	Source Blk	-	MDL	MDL	MDL	3.31	MDL	MDL	1
FBWLLW	10/2/09 10:45	Field Blk	0.5	MDL	3.67	MDL	1.57	3.04	4.56	10
FBWLLD	10/1/09 16:40	Field Blk	4.0	2.93	MDL	47.72	MDL	3.13	3.13	4
FBTB1D	10/1/09 16:25	Field Blk	4.0	MDL	MDL	MDL	1.32	3.13	2.81	7
FBTB1ST	10/1/09 15:55	Field Blk	0.5	MDL	3.45	MDL	1.10	3.75	2.5	5
Source Blk	12/29/09 16:50	Source Blk		MDL	MDL	MDL	MDL	MDL	2.46	1
FBWLLD	1/6/10 12:35	Field Blk	4.0	MDL	MDL	NA	MDL	MDL	2.16	6
FBTB1D	12/30/09 17:45	Field Blk	4.0	MDL	MDL	MDL	MDL	MDL	3.7	7
FBTB1ST	12/30/09 17:30	Field Blk	0.5	MDL	MDL	MDL	MDL	2.46	2.46	5
Source Blk	3/23/10 12:55	Source Blk		MDL	MDL	NA	MDL	MDL	MDL	1
FBWLLW	3/24/10 13:00	Field Blk	0.5	MDL	MDL	NA	MDL	MDL	MDL	6*
FBWLLD	3/24/10 17:55	Field Blk	4.0	MDL	MDL	NA	MDL	MDL	3.98	4
FBTB1D	3/24/10 18:15	Field Blk	4.0	MDL	MDL	NA	MDL	MDL	2.14	7
FBTB1ST	3/24/10 17:45	Field Blk	0.5	MDL	MDL	NA	1.13	MDL	MDL	5
MDL				2	3	40	1	2	2	12

Notes:

1- Deionized water system source blank.
2- Deionized water system water from storage carboy in lab.
3- Equipment check, deionized water ran through graduated cylinder on boat.

4- Ward Lake Level Dry Field Blank, 4 liters deionized water to sealed Dry bucket for approx. 24 hours.
5- TB-1 Snow Tube (ST) Field Blank, 0.5 liters deionized water to sealed ST for approx. 24 hours.
6- Ward Lake Level Wet Field Blank, 0.5 liters deionized water to Wet bucket in Aerochem Metrics sampler, overnight during dry period.
7- TB-1 Dry-Bulk Field Blank, 4 liters deionized water to sealed Dry-Bulk bucket for approx. 24 hours.
8- Ward Lake Level Wet Field Blank, 0.5 liters deionized water to Wet bucket in Aerochem Metrics sampler, overnight during dry period, note small green thread in sample noted when collected
9- FBWLLW 3/6/08 value of 84µg/l was re-run and again was very high. Note TKN in unfiltered water was much lower (48 µg/l), TKN=Organic N + NH_4-N, therefore NH_4-N had to be ≤ 48. Contamination may have come from bottle, filtration or another source. Note, only new HDPE bottles are used and these are pre-cleaned with 0.1N HCl, and deionized water.
10- Ward Lake Level Wet Field Blank, 0.5 liters deionized water to Wet bucket in Aerochem Metrics sampler, overnight during dry period. Note, significant new land excavation occurring adjacent to station associated with construction of new home, workers trying to minimize dust with H2O spray, but still dust. Potential for impact on station results.
11- Ward Lake Level Dry Field Blank, 4 l deionized water to sealed Dry Bucket, new Marineland plastic core heater on for 1.5hrs, bucket in cold room overnight.
12- MDL = Method Detection Limit

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.

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 2007-2010

In this summary we present the results for all bioassay experiments done during the period July 1 2007 to May 1, 2010. Twelve total bioassays were done on a schedule of approximately one bioassay every three months. Table 3 (a-l) presents the results for each of the individual bioassays; Table 4 presents the results for all bioassays done during the period 2002-2010 and Figure 1 summarizes the 2002-2009 results for bioassays based on 3 periods: Jan.-April, May-Sep. and Oct.-Dec.

During the period July 2007 to April 2010, phosphorus (P) limitation occurred with similar frequency as (N) limitation however, the combination of N and P added together nearly always increased phytoplankton growth. Phosphorus added alone (at least one of the P2 or P10 treatments) was stimulatory in 5 of 12 (or 42%) of the bioassays. Nitrogen added alone was also stimulatory in 42% of the bioassays (5 bioassays) and for two bioassays neither N or P was stimulatory when added alone. The N+P treatments were stimulatory in 11 of 12 (or 92%) of the bioassays.

Seasonal patterns in limitation showed some differences when compared with the previous three years. Nitrogen limitation was prevalent during the summer to fall (July - November) period during 2007- 2009 with 5of 6 bioassays showing N stimulation. In contrast, during 2004 – 2007 no nitrogen limitation was observed during the summer – fall period. During summer – fall 2004-2007 the phytoplankton tended to be either co-limited by N and P, or P limited.

Some consistent patterns were present when comparing data from 2007-2010 with 2004-2007 data. Phosphorus limitation was prevalent during the mid-winter to spring period (Jan. to April) both in 2004-2007 and 2007-2010. The combination of N+P was nearly always stimulatory during both periods, the exception was one bioassay done in April, 2008, after an upwelling event along the west shore.

The data for all bioassays done during the period 2002-2009 is included in Table 4. The results were grouped in Figure 1 based on time of year and typical lake stratification patterns: 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). Some patterns are readily apparent:

1) During the period January – April, P limitation was prevalent and the combination of N+P was stimulatory over 90 percent of the time.

2) During May to September, N limitation was more frequent than P limitation (largely due to pattern of frequent N limitation the last three years). Co-limitation by N and P frequently occurred during this period. The combination of N+P always increased growth.

3) During October to December, P limitation was more prevalent than N limitation and the combination of N+P always increased growth.

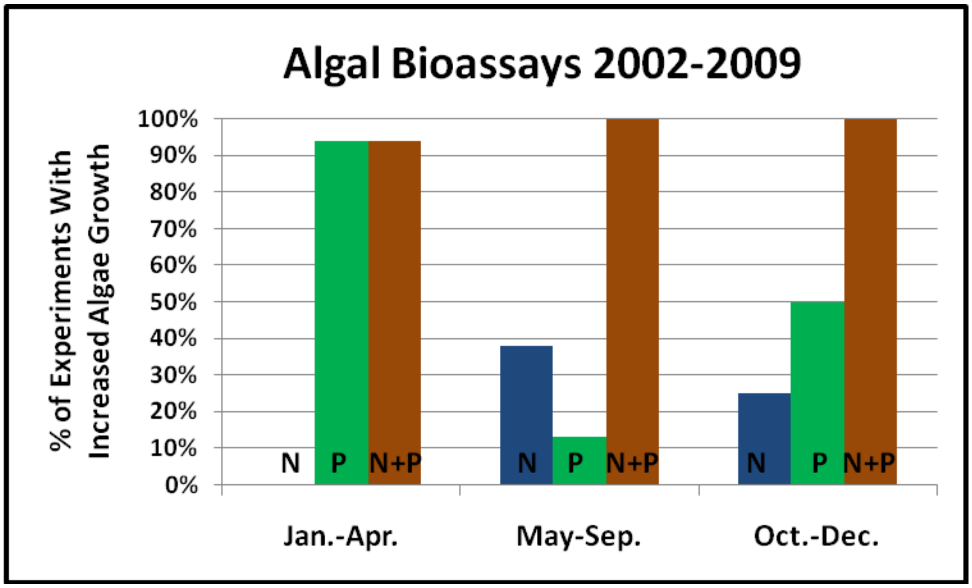


Figure 1. Percentage of bioassays done during three periods: Jan.-April (unstratified – onset of stratification period), May – Sept. (stratified period), and Oct. – Dec. (breakdown of stratification) in which N, P or N+P significantly increased phytoplankton growth.

Some of the factors which may play a role in the observed nutrient limitation patterns include:

- During Jan.-April the lake is either unstratified or just beginning to stratify. Mixing upwards of nutrients can occur with wind and storm events. This can increase NO_3 in the upper water column. Typically there is lower phytoplankton growth (primary production) early in period then increased algal growth later in period. Biomass is often dominated by diatoms.

- The period May-Sept. is typically a period when the lake stratification is prevalent. Less mixing typically occurs between the epilimnetic waters and deep hypolimnetic waters. Algal growth is high during much of period, depletion of NO_3 in the upper water column occurs. Tributary inputs peak early in period. Biomass often dominated by diatoms during this period too.

- During the period Oct.-Dec. thermal stratification breaks down. Water (and phytoplankton) which was below thermocline are mixed upwards, nutrient levels are still relatively low and algal growth is typically low during this period. Biomass often dominated by flagellates.

Control of nutrients to Lake Tahoe should not be made on the basis of these growth bioassays alone. Increased nutrient loading affects the growth of attached algae (periphyton) on hard surfaces in the nearshore. The observation that N+P additions almost always stimulate growth is strong evidence that nutrient load should be controlled as called for as part of the Lake Tahoe TMDL. While any future management action to specifically control N-loading will use this bioassay response data, these actions will require additional supportive information.

Summary Points for Bioassay Monitoring 2007-2010

1. **There was a significant growth response to the combination of N+P in nearly all bioassays (11 of 12 bioassays). This reinforces the fact that Tahoe phytoplankton are still N and P co-deficient and that nutrient reduction is important for the management of excessive algal growth.**

2. **Nitrogen limitation was prevalent during the summer to fall (into November) period during 2007- 2009 with 5 of 6 bioassays showing N stimulation. This was a change from summer to fall bioassays 2004-2007 when no summer N limitation was observed and either P or N+P co-limitation was prevalent.**

3. **P limitation remained prevalent during Jan.-April. NO_3-N availability from deep mixing is likely a potential contributing factor to this apparent P limitation.**

Table 3.a. Bioassay done using 2,5,8,11,14,17,20m lake water collected 9/27/07.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.158	0.007	3		
N(20)	0.226	0.019	3	143	*
P(2)	0.144	0.006	3	91	
P(10)	0.141	0.005	3	89	
N(20)P(2)	0.320	0.023	3	202	*
N(20)P(10)	0.449	0.028	3	284	*

Table 3.b. Bioassay done using 2,5,8,11,14,17,20m lake water collected 11/9/07.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.260	0.020	3		
N(20)	0.297	0.020	3	114	*
P(2)	0.271	0.005	3	104	
P(10)	0.282	0.024	3	108	
N(20)P(2)	0.392	0.016	3	150	*
N(20)P(10)	0.469	0.028	3	180	*

Table 3.c. Bioassay done using 2,5,8,11,14,17,20m lake water collected 1/30/08.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.278	0.015	3		
N(20)	0.284	0.006	3	102	
P(2)	0.342	0.016	3	123	*
P(10)	0.354	0.026	3	127	*
N(20)P(2)	0.346	0.023	3	124	*
N(20)P(10)	0.352	0.016	3	127	*

Table 3.d. Bioassay done using 2,5,8,11,14,17,20m lake water collected 4/24/08.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.312	0.027	3		
N(20)	0.309	0.010	3	99	
P(2)	0.323	0.012	3	104	
P(10)	0.316	0.016	3	102	
N(20)P(2)	0.309	0.008	3	99	
N(20)P(10)	0.318	0.023	3	102	

Table 3e. Bioassay done using 2,5,8,11,14,17,20m lake water collected 7/24/08.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.242	0.005	3	100	
N(20)	0.651	0.006	3	269	*
P(2)	0.263	0.009	3	109	
P(10)	0.253	0.008	3	105	
N(20)P(2)	0.709	0.028	3	293	*
N(20)P(10)	0.771	0.024	3	318	*

Table 3f. Bioassay done using 2,5,8,11,14,17,20m lake water collected 10/27/08.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.270	0.002	3	100	
N(20)	0.267	0.007	3	99	
P(2)	0.274	0.015	3	102	
P(10)	0.271	0.001	3	100	
N(20)P(2)	0.334	0.031	3	124	*
N(20)P(10)	0.460	0.039	3	171	*

Table 3g. Bioassay done using 2,5,8,11,14,17,20m lake water collected 1/30/09.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.433	0.008	3	100	
N(20)	0.423	0.006	3	98	
P(2)	0.606	0.015	3	140	*
P(10)	0.623	0.034	3	144	*
N(20)P(2)	0.665	0.012	3	154	*
N(20)P(10)	0.689	0.002	3	159	*

Table 3h. Bioassay done using 2,5,8,11,14,17,20m lake water collected 5/1/09.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. ($p \leq .05$) Response ="*"
Control	0.430	0.013	3	100	
N(20)	0.432	0.020	3	100	
P(2)	0.660	0.023	3	153	*
P(10)	0.712	0.042	3	166	*
N(20)P(2)	0.707	0.023	3	164	*
N(20)P(10)	0.782	0.026	3	182	*

Table 3i. Bioassay done using 2,5,8,11,14,17,20m lake water collected 8/17/09.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. (p≤.05) Response =“*”
Control	0.232	0.006	3	100	
N(20)	0.413	0.015	3	178	*
P(2)	0.243	0.014	3	105	
P(10)	0.252	0.046	3	109	
N(20)P(2)	0.659	0.021	3	285	*
N(20)P(10)	0.782	0.026	3	338	*

Table 3j. Bioassay done using 2,5,8,11,14,17,20m lake water collected 11/13/09.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. (p≤.05) Response =“*”
Control	0.177	0.010	3	100	
N(20)	0.219	0.010	3	124	*
P(2)	0.183	0.012	3	103	
P(10)	0.182	0.008	3	103	
N(20)P(2)	0.284	0.003	3	160	*
N(20)P(10)	0.367	0.030	3	207	*

Table 3k. Bioassay done using 2,5,8,11,14,17,20m lake water collected 1/28/10.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. (p≤.05) Response =“*”
Control	0.282	0.013	3	100	
N(20)	0.282	0.005	3	100	
P(2)	0.397	0.009	3	141	*
P(10)	0.405	0.030	3	144	*
N(20)P(2)	0.415	0.006	3	147	*
N(20)P(10)	0.424	0.024	3	150	*

Table 3l. Bioassay done using 2,5,8,11,14,17,20m lake water collected 4/15/10.

Treatment	Day 6 Mean Fluorescence	Std. Dev.	n	Day 6 Mean Fluorescence as % of Control	Statistically Signif. (p≤.05) Response =“*”
Control	0.405	0.008	3	100	
N(20)	0.406	0.011	3	100	
P(2)	0.613	0.012	3	152	*
P(10)	0.655	0.051	3	162	*
N(20)P(2)	0.665	0.017	3	164	*
N(20)P(10)	0.692	0.041	3	171	*

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. Treatment responses statistically significantly different from the control at the p≤.05 level are indicated with borders and shading.

(a) 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

(b) 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

(c) 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

(d) 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

(e) 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

(f) 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

(g) 2008 Bioassays

	1/30/08	4/24/08	7/24/08	10/27/08
Control	100	100	100	100
N20	102	99	269	99
P2	123	104	109	102
P10	127	102	105	100
N20P2	124	99	293	124
N20P10	127	102	318	171

(h) 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

(i) 2010 Bioassays

	1/28/10	4/15/10
Control	100	100
N20	100	100
P2	141	152
P10	144	162
N20P2	147	164
N20P10	150	171

Task 4. Enumeration and Identification of Phytoplankton

Phytoplankton populations are continually changing, with an underlying structure imposed by seasonality. Population dynamics such as blooms, crashes, and resource competition all form the basis of an investigative story which can be repetitive or surprisingly counter-intuitive to what we suspect we know. The challenge is to gain insight and perspective so that one can discern ecologically relevant and long-term changes amidst inter-annual variability.

Phytoplankton is viewed by some limnologists as the proverbial ‘canary’ in the coal mine. It is the built-in biological warning for systemic change. This is because these organisms are very sensitive to environmental changes, even those that are too subtle or too complicated for us to observe. Phytoplankton is the main primary producer in the aquatic food chain, the lowest rung of an increasingly complex food web. Understanding phytoplankton community dynamics is central to the functional understanding of lake processes.

This report summarizes the phytoplankton populations from July 2007- June 2010. A three-year time span is helpful to delineate seasonal rhythms and inter-annual variability (Fig. 2 & 3). Highest bio-volume and abundance of phytoplankton is found in the summer, and is lowest in the winter. Diatoms are the dominant group during most of the annual cycle. They are responsible for much of the variability throughout the year. Chlorophytes, chrysophytes, and cryptophytes are ever-present with more consistent bio-volume and abundance. Dinoflagellates are usually large cells and therefore contribute significantly to the total bio-volume even though the population abundance (in terms of cell number) is low. Cyanophytes are most abundant during the late summer and tend to have a more opportunistic niche within the community.

Cell abundance for all taxonomic groups combined (Fig 2) fluctuated from the relatively low numbers in the latter half of 2007 to the highest abundance ever seen during the summer of 2009. The fluctuation is caused by the variable diatom cell numbers during the spring-summer growth season. In 2008 and 2009, especially, the summer bloom of small centric diatoms, *Cyclotella glomerata* and *Cyclotella gordonensis,* are dramatic. The cell count for July 2009 exceeded 1,200,000 cells per liter. The other algal groups remained fairly stable throughout the three years, with few seasonal trends in over-all population numbers. It is notable that blue-green algae (cyanophytes) are present in significant numbers in the summer of 2007. The stable water column and low nutrient conditions are ideal for this group of algae. Blue-greens are seen also in the summer of 2008 and 2009 but with less impact to the overall community.

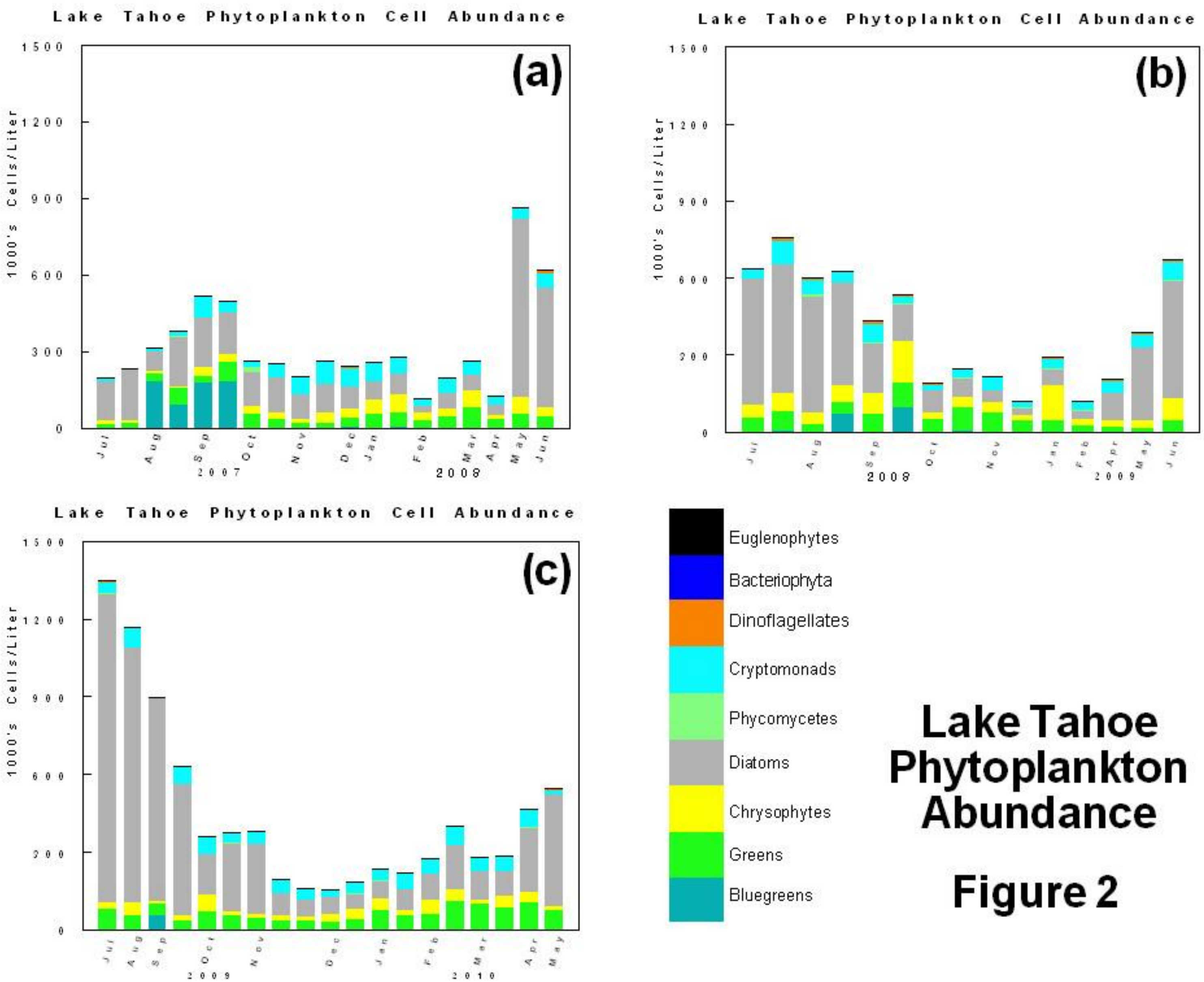
Bio-volume measurement in algal cells is a better parameter of community dynamics. Algal cell biomass (Fig 3) closely follows the abundance cyclic pattern seen for cell abundance. In Lake Tahoe, over the three-year period 2007-2009, the timing of peak cell bio-volume is variable. In March 2007 there is a seasonally early bloom of diatoms and cryptophytes. The atypical timing of this peak has an impact on diatom growth in the next few months. Summer diatom bio-volume is muted and is followed by a significant cyanophyte population in late summer. Cyanophytes, which can be a problem to water quality in many other lakes, are not typically abundant in Lake Tahoe. Indeed, this could be a concern if cyanophytes continued to appear in large numbers each summer. As the 2007 calendar year progressed, the total phytoplankton bio-volume remained low well into 2008. Dinoflagellates, being large cells, appear on the bio-volume graphs but barely show up in any significant numbers. The years following 2007 show a more typical seasonal pattern in the timing of the bio-volume peak. The summer diatom assemblage began to grow in May but did not reach its peak until July. In both 2008 and 2009 summers, total cell bio-volume is hovering near 200 mm^3/m^3. *Cyclotella glomerata and Cyclotella gordonensis* (~5 µm) are dominant throughout the summer and have a huge influence on the total bio-volume.

The abundance of *Cyclotella spp.* over the last decade shows increasing trends. In recent years, this taxon was found to contribute over 50% of the total diatom biomass. In Figure 4, not only is total cell abundance increasing over time but the proportion of increase due to *Cyclotella* spp. is also growing. This diatom genera is one of the main contributors to the overall increases in total cell abundance.

The environmental conditions for centric diatom dominance and specifically *Cyclotella spp.* may have something to do with the stability of the water column (Winder et. al., 2008) *Cyclotella* species are relatively small centric cells with a high surface to volume ratios which decrease sinking speed in the water column. Winder and co-authors suggested that intensified vertical stratification is the main driver of change in diatom size structure in Lake Tahoe. In a stable water column, cells need strategies to maintain buoyancy. During the summer, most of the *Cyclotella spp.* cells are located in the upper euphotic zone, generally 60m or less. They remain in this depth zone for months, finally sinking out of the range of physiological viability in late October.

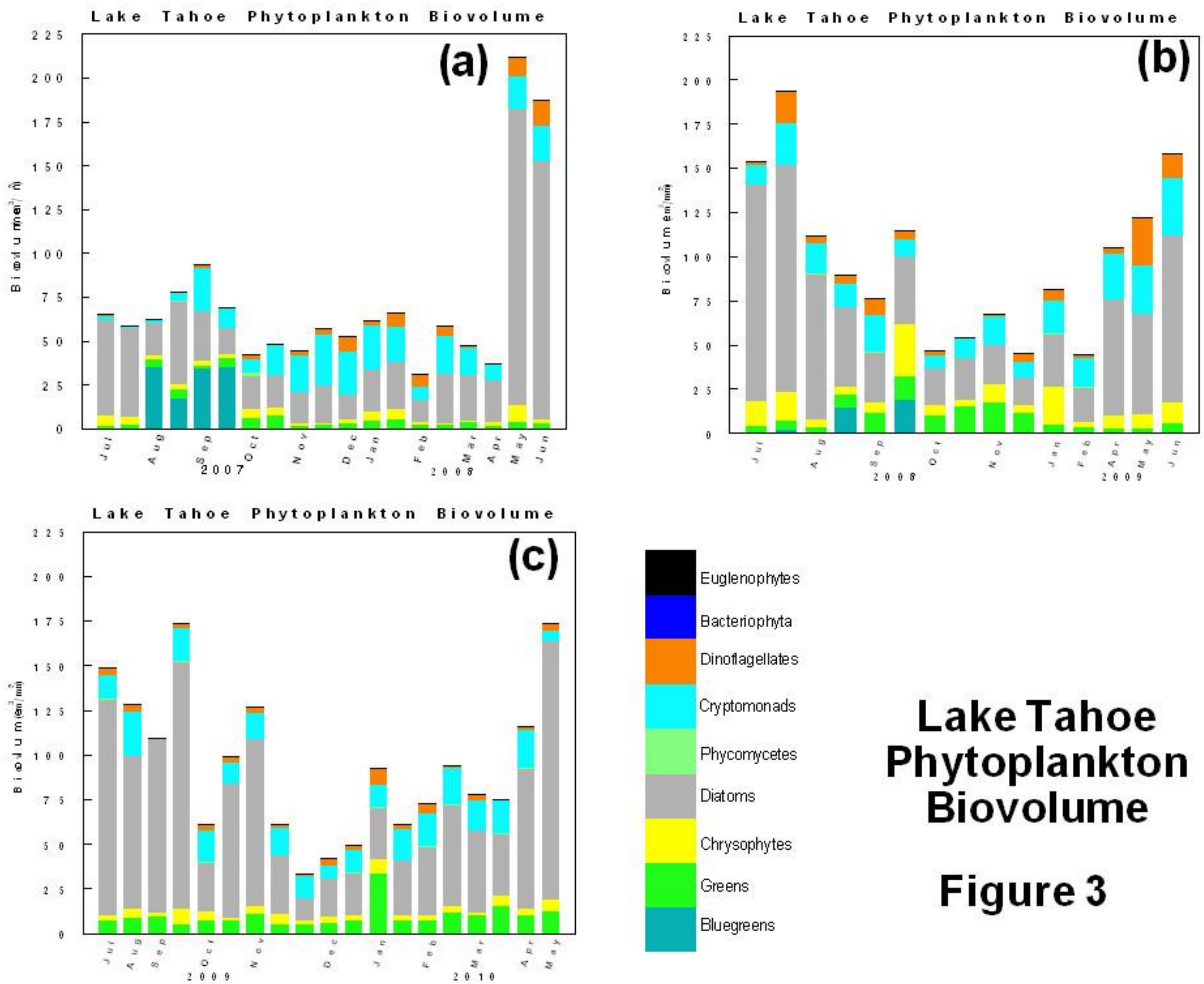
It is also possible that the structural form of the centric diatoms (radial symmetry) offers functional and/or physiological advantage. Pennate diatoms (bilateral symmetry) were favored in the 1980's and late 1990's (Winder et. al., 2008). In the last decade, a shift has taken place with centric diatoms often out-competing the pennates. Winder et. al. hypothesized that centrics were doing well because many were small in size and could therefore hold their position in the water column longer. The buoyancy advantage is certainly true but may be part of a larger story. Some of the centric diatoms are relatively large cells. *Cyclotella bodanica* (~ 28µm diameter) and *Aulacoseira italica* (chain forming cylinders of varying lengths not less than 15 µm) are two cell species which do not have are buoyancy advantages over the typical pennates found in Lake Tahoe. They are frequent and at times abundant cell forms. The appearance of *Cyclotella bodanica* and *Aulacoseira italica* in the diatom community, now, is even more remarkable because they have not been seen in any great numbers since the 1970's. This leads one to believe that the current 'environmental climate' in Lake Tahoe is advantageous for centric diatoms.

The long-term consequence of community change is not entirely predictable. As researchers and management agencies will continue to consider phytoplankton as both (1) an indicator of lake water quality and trophic status and (2) their role in aquatic food web and fish production, the long-term database for phytoplankton in Lake Tahoe is a very significant asset.



Lake Tahoe Phytoplankton Abundance

Figure 2



Lake Tahoe Phytoplankton Biovolume

Figure 3

Temporal Abundance of Cyclotella species

2000 to 2010

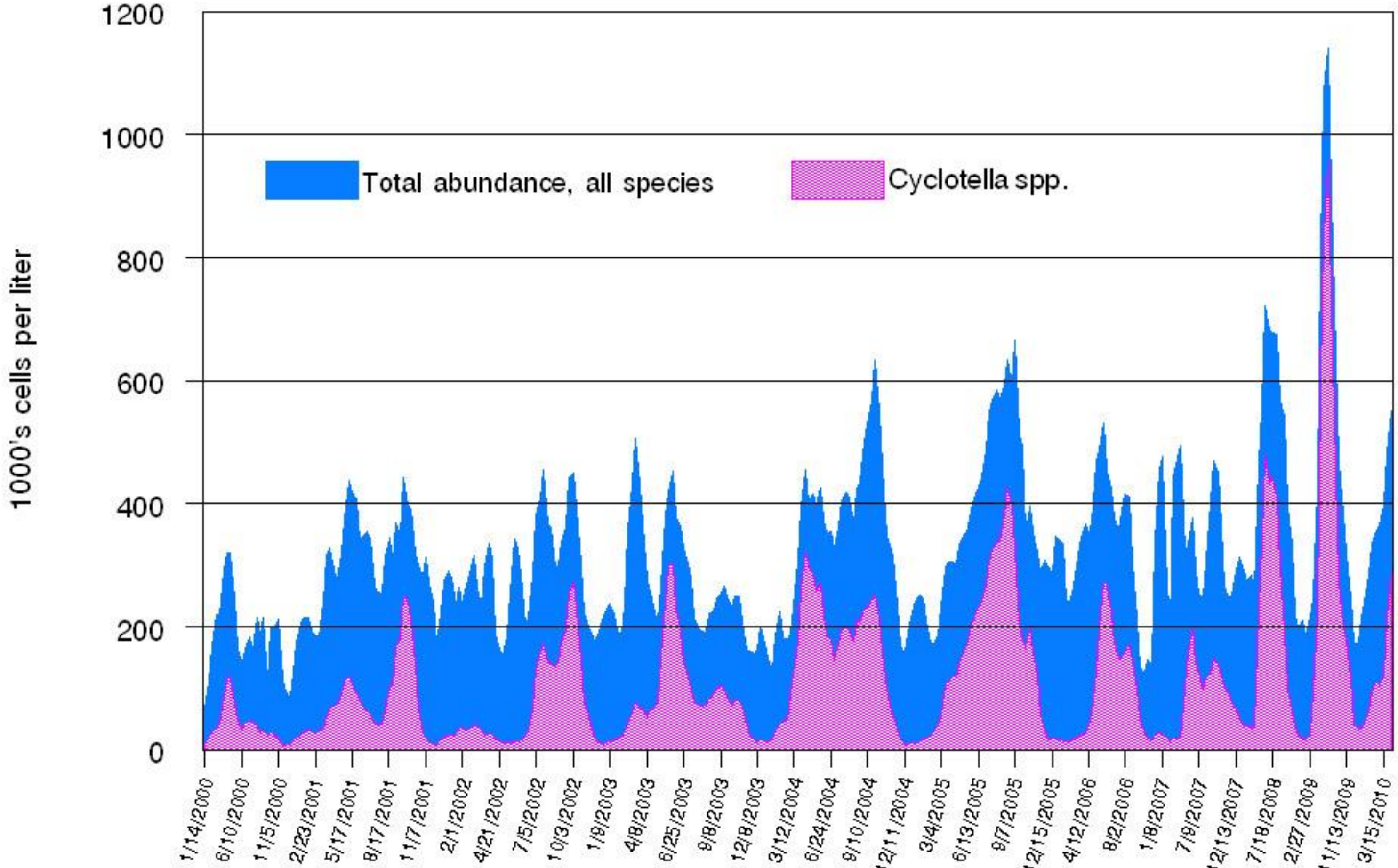


Figure 4

Task 4.b. Zooplankton Enumeration and Analysis

The zooplankton community of Lake Tahoe has been relatively consistent since the 1980s, dominated by the copepod species *Diaptomus tyrelli* and *Epischura nevadensis*, and the rotifers *Kellicottia spp*, *Keratella spp.* and *Polyarthra spp*. (Winder et al., 2008). Zooplankton are significant in the food web structure of the lake. The zooplankton community is composed of herbivorous members (which feed on phytoplankton), omnivorous members (which may feed on phytoplankton, other zooplankton, bacteria, and detritus), and predatory species (which feed on other zooplankton). Different life stages of some of the species can have different primary food sources. The zooplankton are a food source for fish and the invertebrate *Mysis relicta*.

During the period July 1, 2007 to June 30, 2008 eight surface to 150 m vertical tows for zooplankton were collected at the mid-lake station; nine surface to 150 m vertical tows were collected at TERC's Index station off of the west shore. Some difficulties were encountered with rough lake conditions on certain dates which reduced the total number of samples collected. Additional sampling was done however during several cruises to obtain information on zooplankton distribution at discreet depths in the water column.

Figures 5 and 6 present the results for the surface to 150 m zooplankton monitoring July 1, 2007 to June 30, 2008. Overall abundances for *Epischura*, *Diaptomus* and rotifers were relatively low over the year. At the Index station, peaks in rotifers were observed in July, 2007 and June 2008. *Epischura*, and nauplii (larval stages of *Epischura* and *Diaptomus*) peaked in August 2007. *Diaptomus* populations were low throughout most of the year. At the mid-lake station (for data available through February 2008), rotifers peaked in July 2007and again in January, 2008, *and Epischura* density was low with a slight peak in October 2007. *Diaptomus* numbers were very low throughout most of the year. Nauplii numbers were highest in July 2007. Typically, *Epischura* peaks in Fall and *Diaptomus* in early spring/summer. Rotifers are very variable but usually abundant from fall until late spring and decline during the summer.

Monitoring of zooplankton is important for understanding current food web structure and ecosystem interactions in Lake Tahoe. This data will be incorporated into the long-term dataset for zooplankton. The data will be used to better understand current as well as historical interactions between zooplankton, phytoplankton, invertebrates, fishery and other aspects of the lake ecosystem.

Samples collected from July 2008 through June 2010 were preserved and archived for future identification and enumeration.

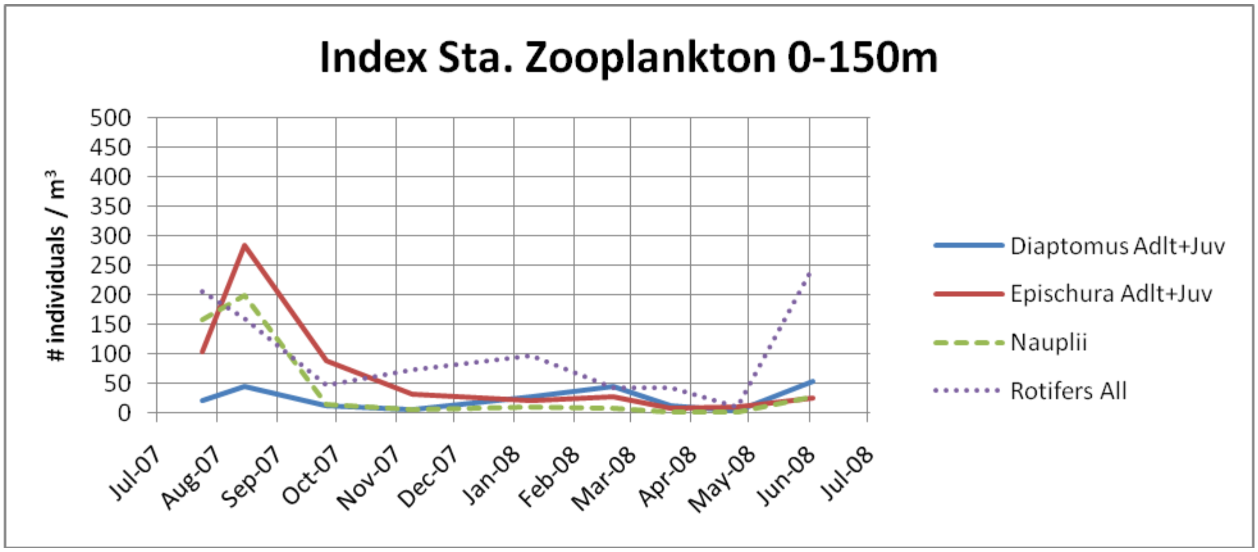


Figure 5. Zooplankton densities (individuals per cubic meter) at the Index station during July 1, 2007 to June 30, 2008.

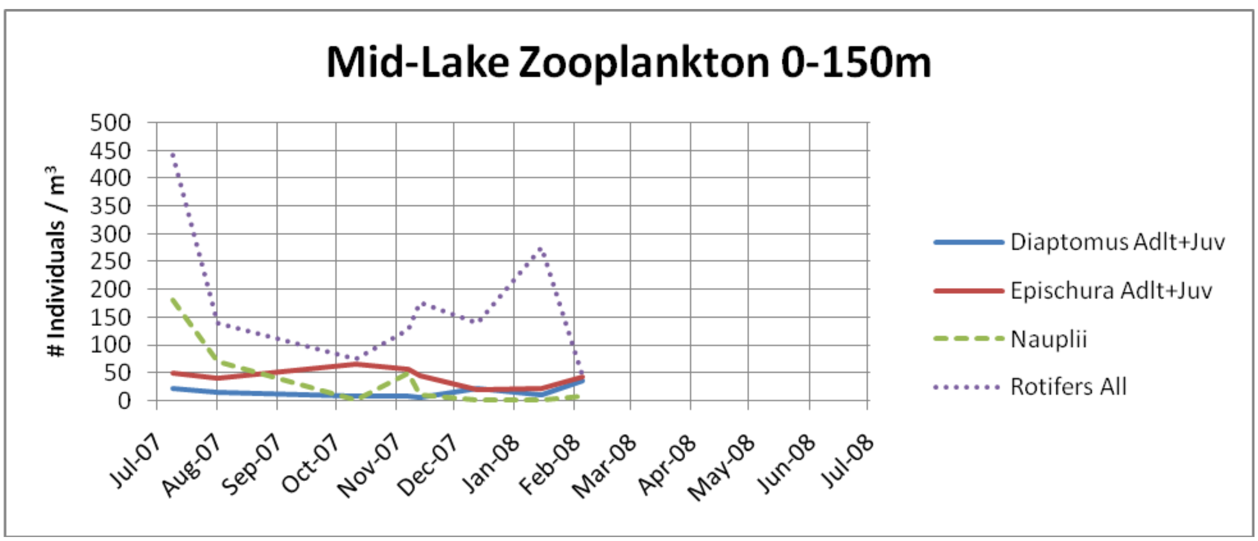


Figure 6. Zooplankton densities (individuals per cubic meter) at the Mid-lake station during July 1, 2007 through February, 2008.

Task 5. Atmospheric Deposition of Nitrogen and Phosphorus

Monitoring of atmospheric deposition is crucial to an understanding of 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. Estimates used in the Lake Tahoe TMDL for the contribution of atmospheric deposition of nutrients comes in large part from the LTIMP atmospheric deposition dataset. Those data indicated that 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 an additional lake buoy (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. It consists of a NovaLynx electrically-heated 8 inch diameter tipping bucket gage (TBG) located approximately 8 feet above the ground on a tower. The TBG was modified so that precipitation could also be caught for measurement. This station also 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 and a small basic rain gage for verification of precipitation amounts. 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 data summary, calculated loads and loading rates for Lower Ward Wet, Dry, Buoy TB1 Dry-bulk and Snow Tube and Buoy TB4 Dry-bulk is presented in Appendices 1-5.

During July 1, 2007-June 15, 2010, 371 samples were collected from the 3 primary stations (84 dry bucket and 107 wet bucket samples from the Ward Lake Level station, 71 dry-bulk samples from each of the lake buoy stations and 38 Mid-lake snow tube samples). Samples were analyzed for ammonium (NH_4-N), nitrate (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. The data is also added to a long-term atmospheric deposition data base.

General Patterns for Precipitation July 1, 2007- June, 2010

The period of study included one relatively dry (Water Year 2008) and two years with moderate precipitation amounts WY 2009 and WY 2010 (through June). Figure 7 below shows the distribution of precipitation amounts for samples collected at the Lower Ward Valley station during the 3-year period.

Each Water Year had certain distinguishing precipitation events or precipitation patterns. The contract period began with the last quarter (the summer) of WY 2007. The summer of 2007 was extremely dry (and frequently windy). The devastating Angora Fire which began during strong winds on June 24, 2007 was contained the first part of July. The dry summer of 2007 completed a very dry WY 2007 in which only 27.92 inches of precipitation occurred at the Lower Ward station.

WY 2008 (Oct. 1, 2007 to Sept. 30, 2008) was characterized by overall low precipitation (24.98 inches) which primarily occurred during winter and early spring. 16.76 inches of precipitation fell mostly as snow during Jan. to March 2008. A particularly strong rain and snow storm (memorable for the heavy snow and strong winds) occurred during the first week of January, 2008. Generally small storms occurred early in the WY, during Oct. – Dec. 2007 and later in the spring (April – June). Spring 2008 was noted to be unusually windy in Northern California (John Juskie of National Weather Service in Sacramento, Capital Public Radio, 2008) and also generally windy in the Tahoe basin. Summer 2008 was notable for a prolonged period of smoke in the basin resulting from an unprecedented number of wildfires in northern California to the west of Lake Tahoe. On June 21, 2008 a storm system moved across parts of California including areas of the Sierra west of the Lake Tahoe basin with significant lightning. Approximately 8000 lightning strikes resulted from this storm and started about 800 fires in California. The number of fires eventually grew significantly. This turned out to be the single largest wildfire "event" in California's history (since since record-keeping began in 1936) (Associated Press, 2008). Smoke from some of these fires began filling the Tahoe basin soon after they started and varying levels of smoke were present in the basin for more than three consecutive weeks, through mid- July. A significant ash fall event was noted along parts of the northwest portion of Lake Tahoe on July 9, 2008. Overall, summer into early fall (July 1 through September 30 2008) was very dry with minimal precipitation along the northwest shore.

WY 2009, was characterized by moderate amounts of precipitation which was extended over a greater portion of the year than the preceding year. A total of 37.34 inches of precipitation fell at the Lower Ward Station during this period with the majority of the precipitation occurring between October 2008 and mid-June 2009. Some of the more significant events included: a fall rain storm which dropped 3.77 inches of rain on Nov. 1-2, 2008; a rain/snow mix event March 2-4, 2009 which contributed 5.87 inches of precipitation; and a series of storms May 1-5, 2009 which dropped 4.96 inches of precipitation mostly as rain. Runoff from the storms in early May combined with the spring snowmelt and caused west shore stream flows to reach their peak for WY 2009. During the period July 1 to September 30, 2009 "typical" Tahoe basin summer-time weather prevailed with very limited precipitation, which often occurred as isolated thunderstorms.

WY 2010 was also characterized by moderate amounts of precipitation (37.50 inches as of mid-June when this report was being prepared). This water year began with a significant fall rain event Oct. 13-14 2009 in which 4.24. inches of precipitation occurred at the Lower Ward Valley station. This rainfall included moisture from remnants of

Typhoon Parma which merged with a strong low pressure system. Some of the other notable periods of storms during the water year included: Dec. 6-14 which included two storms each dropping 2 feet of snow occurred along with some very cold temperatures; the period Jan. 17-25 in which a series of wet snow and rain/snow mix storms pushed by a strong jet stream occurred; in late February two storms occurred dropping 2.93 inches of water as rain and snow; a wet storm occurred March 29-31 dropped 2.93 inches of precipitation as rain and snow at lake level. Several of the winter storms were observed to have very strong winds associated with them. Storms continued throughout the spring 2010 with periods of cool weather and snow alternating with periods of warmer weather. The spring runoff was slowed several times during cool weather periods and as a consequence peak stream flows were delayed to early June.

Patterns of N and P deposition for Individual Samples July 1, 2007- June, 2010

To better understand some of the patterns of N and P loading in atmospheric deposition, the amounts of DIN (NO_3-N + NH_4-N) and SRP associated with individual samples through time, were graphed (Figures 8-15). Loads of DIN and SRP (grams/hectare) in Wet deposition samples are shown in Figures 8 and 9 respectively. The pattern for Wet DIN and SRP was overall not very similar to the patterns for precipitation amount shown in Figure 7. A large proportion of the sample DIN and SRP loads fell within a consistent range (DIN loads usually less than or near 30 g/ha and SRP loads were usually low, less than or near 0.50 g/ha). Although many of the higher loads of DIN and SRP during this period did correspond to events or collection periods with moderate to high amounts of precipitation, this was not always the case. In some cases low precipitation amounts had moderate to high DIN and/or SRP loads (i.e. in Fig. 8, on 10/2/07 precipitation was relatively low, but DIN was moderately high).

Loading rates (grams/hectare/day) of DIN in Dry deposition samples for the Lower Ward station and in Dry-bulk deposition at buoys TB1, TB4 are shown in Figures 10,11,12 respectively. Loading rates for DIN in Dry deposition at the Lower Ward station were relatively consistent (usually around 3 g/ha/day or less) with occasional higher values. Levels of DIN in Dry-bulk deposition at the lake buoys showed a bit more fluctuation than the lower Ward site, but still many of the values were around 5 g/ha/day or less. High DIN values in Lower Ward Dry and TB1, TB4 Dry-bulk deposition did not typically correspond among all sites. This might be expected when comparing the Lower Ward data with the buoy station data, since the Dry collection period at the Lower Ward site is not always synchronized with the buoy bucket collection periods. A notable exception however, occurred in the period in early July 2008 when DIN load and loading rates were elevated moderately above typical loading at all three sites during the same period. This coincided with an unusual wildfire-related ash-fall event that occurred on July 9, 2008. (See section on atmospheric deposition during this ash fall event later in this report).

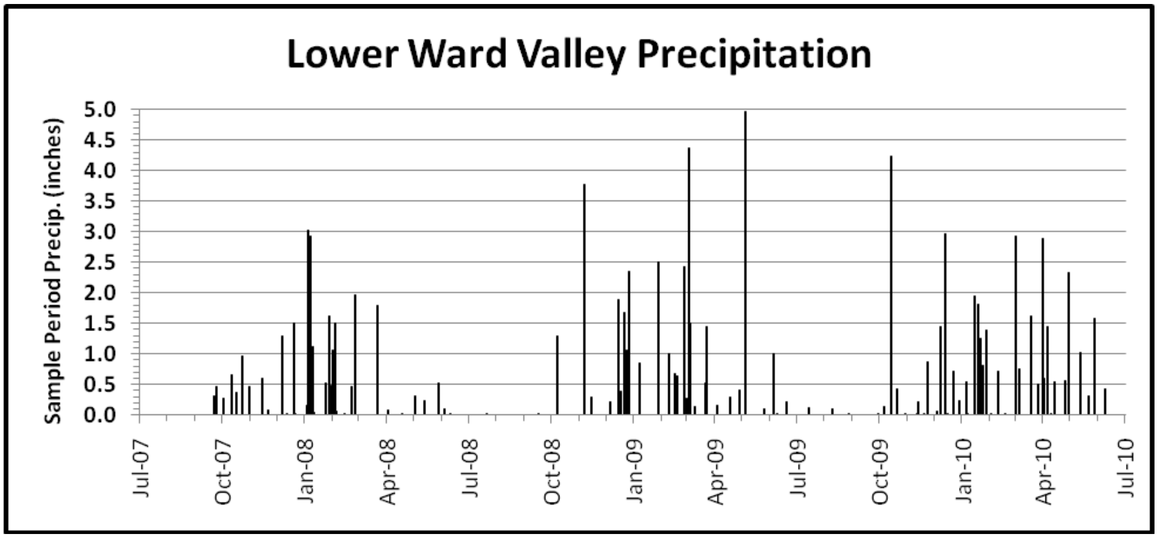


Figure 7. Precipitation amounts occurring at the Lower Ward Valley station. Each vertical bar represents total amount of precipitation during a period for a sample – in some cases samples include multiple events, (date under bars are collection dates).

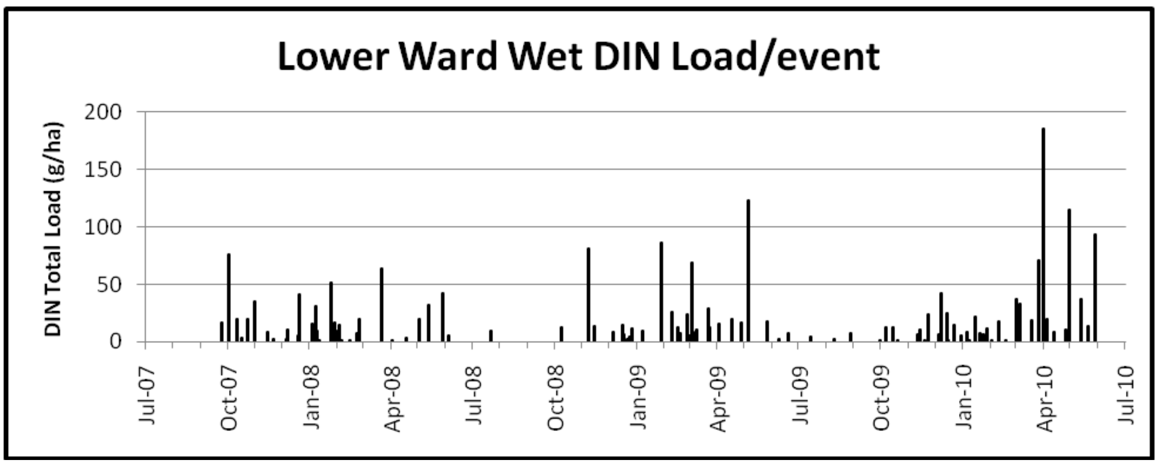


Figure 8. DIN (NO3-N + NH4-N) loads in Precip. (Wet) samples from Lower Ward Sta.

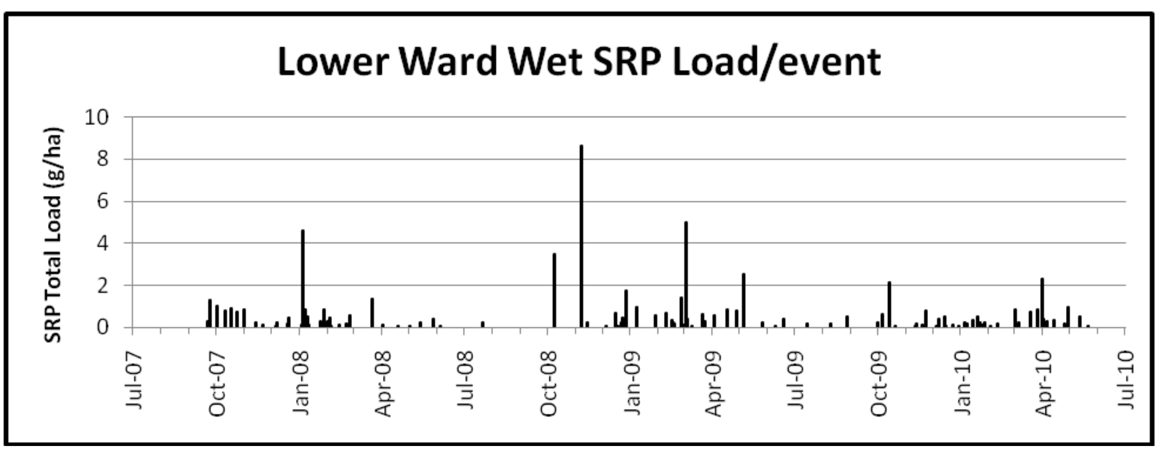


Figure 9. SRP loads in precipitation (Wet) samples from the Lower Ward Station.

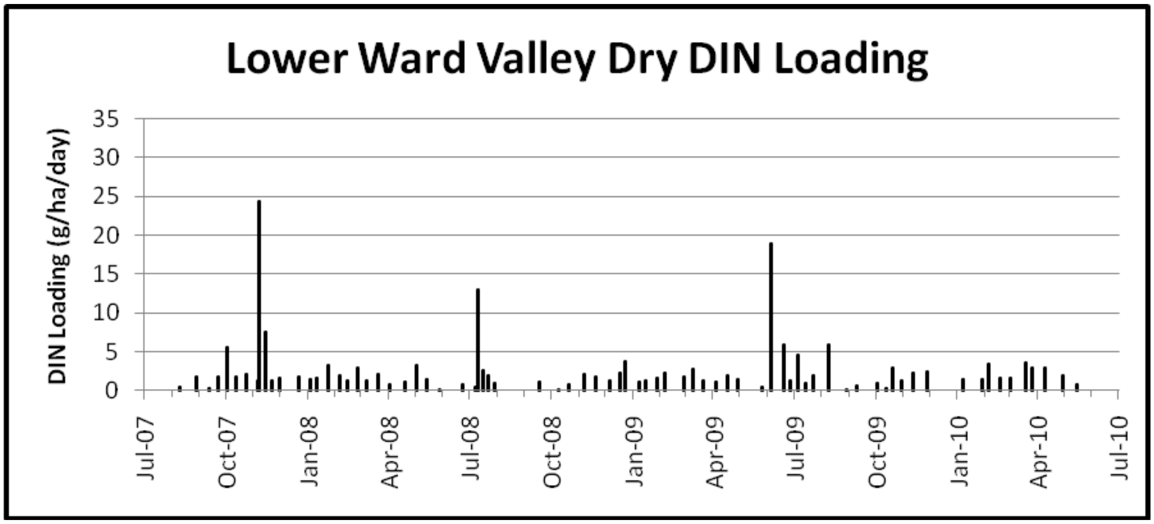


Figure 10. DIN (NO3-N+NH4-N) loading rate (g/ha/day) for Dry Dep. Samples at Lower Ward Sta.

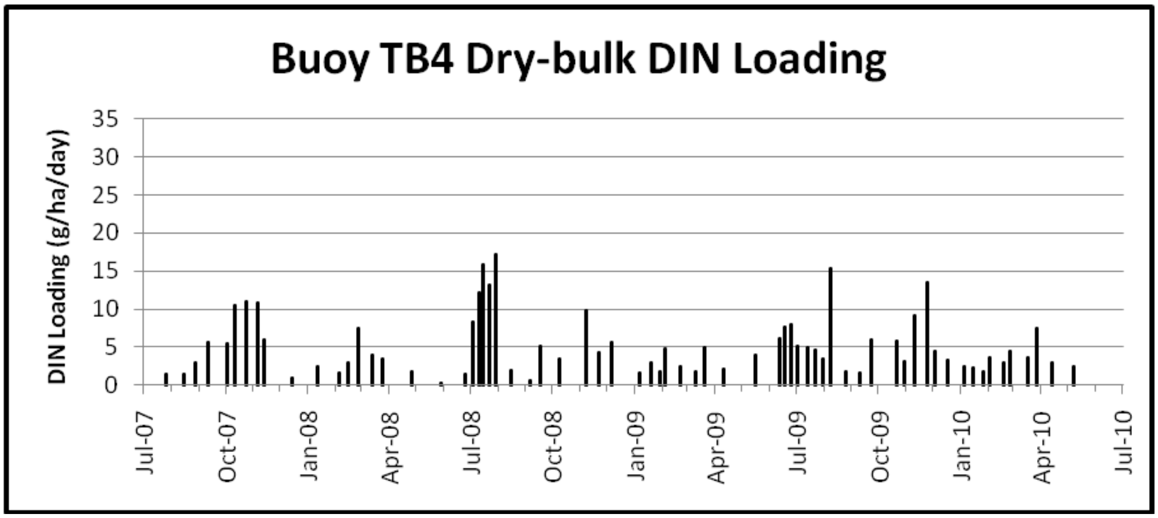


Figure 11. DIN loading rate (g/ha/day) for Dry Dep. Samples at Buoy TB4.

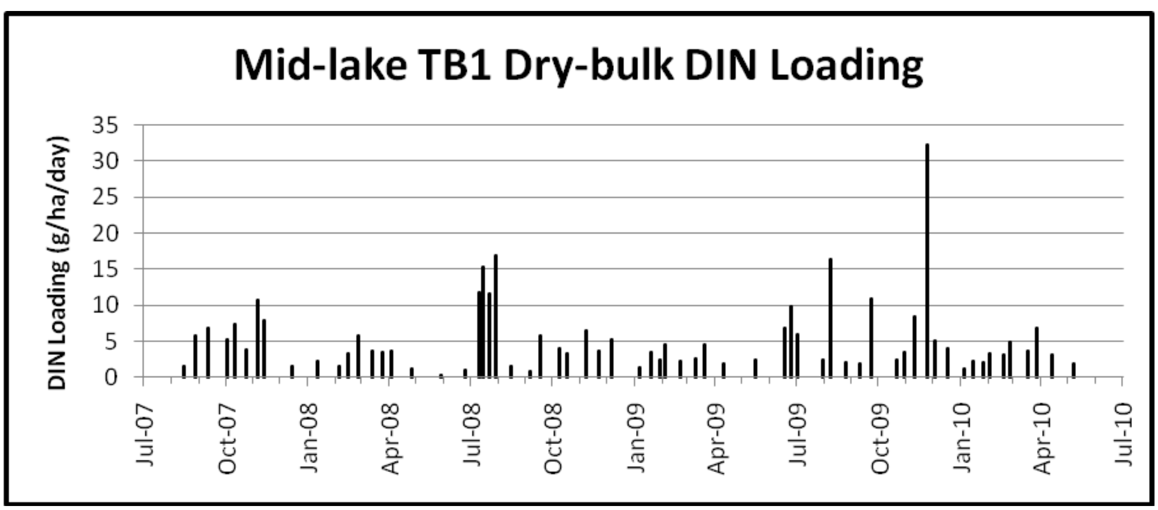


Figure 12. DIN loading rate (g/ha/day) for Dry Dep. Samples at Mid-lake Buoy TB1.

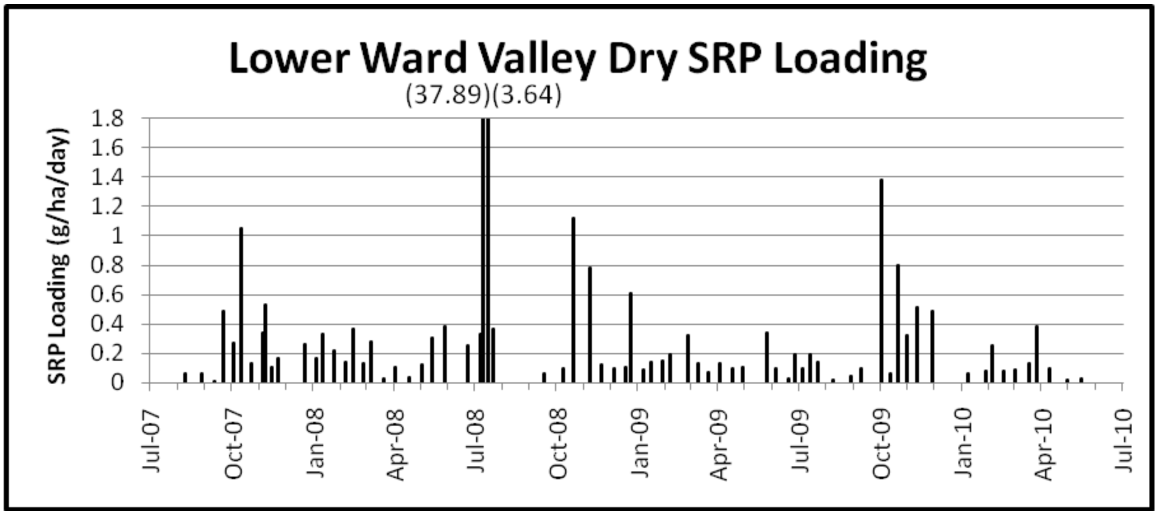


Figure 13. SRP loading rate (g/ha/day) for Dry Dep. Samples at Lower Ward Sta.

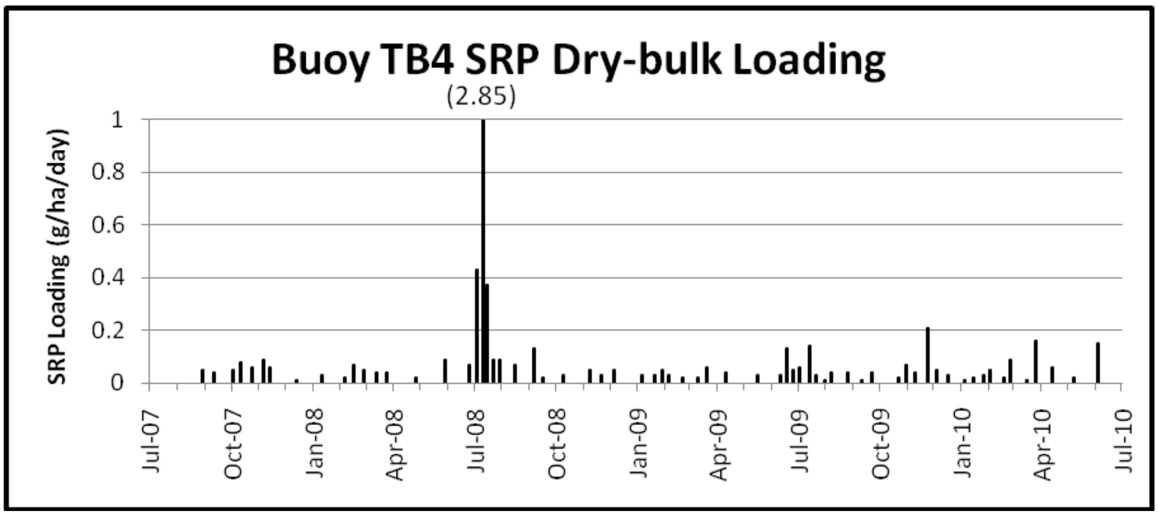


Figure 14. SRP loading rate (g/ha/day) for Dry Dep. Samples at Buoy TB4.

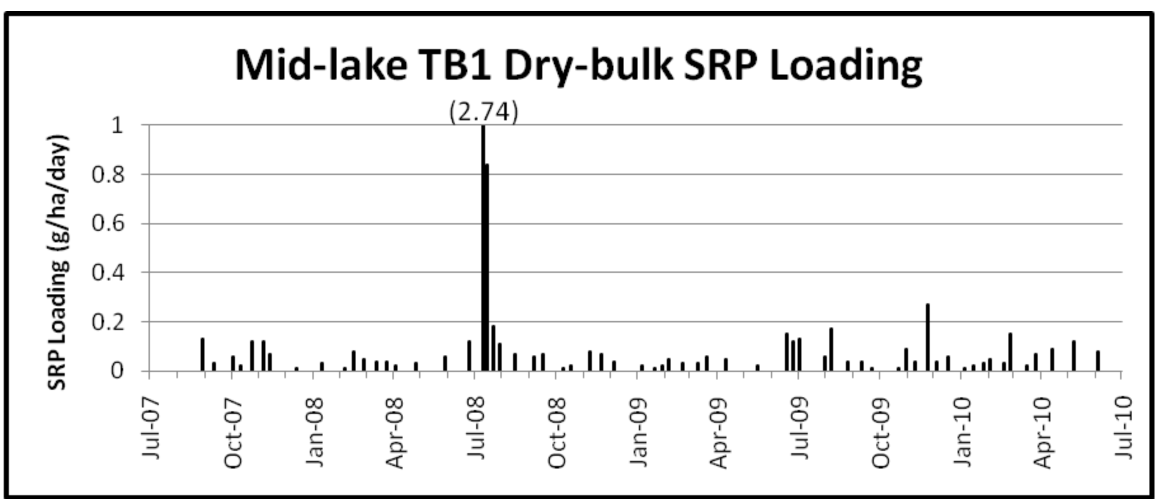


Figure 15. SRP loading rate (g/ha/day) for Dry Dep. Samples at Mid-lake Buoy TB1.

Loading rates (grams/hectare/day) of SRP in Dry deposition samples for the Lower Ward station and in Dry-bulk deposition at buoys TB1, TB4 are shown in Figures 13,14,15 respectively. SRP loading rates were generally slightly higher and showed more fluctuation at the Lower Ward Valley Station than for the buoy sites. Dry SRP deposition at the Lower ward site was often below 0.4 g/ha/day while Dry-bulk deposition of SRP at Buoys TB1 and TB4 was often less than 0.2 g/ha/day. The Lower Ward site is located at the base of the Ward watershed on land and likely more significantly impacted by terrestrial sources of P. The most apparent feature of the SRP loading data was the significant "spike" in SRP loading rates at all sites in early July, 2008. This again, coincided with the unusual ash-fall event observed on July 9, 2008 from fires to the west of the basin. Highest levels of SRP in ash fell at the Lower Ward Station (37.89 g/ha/day) with lesser amounts at Buoy TB4 (2.85 g/ha/day) and Buoy TB1 (2.74 g/ha/day). These levels were much above the typical SRP loading rates noted above and resulted in a pulse of in the northwestern part of the basin. It was significant enough to boost average annual loading of SRP such that WY 2008 was the highest among WY 2005-2009 for Dry loading at Lower Ward (WY 2008 = 0.66 g/ha/day with next highest in WY 2007 at 0.26 g/ha/day) and for Dry-bulk loading at buoy TB4 (WY 2008 = 0.12 g/ha/day and next highest in WY 2005 at 0.08 g/ha/day). At buoy TB1 the loading rate of 0.12 g/ha/day was near that observed in WY 2005 of 0.13 g/ha/day. (See section on atmospheric deposition during this ash fall event later in this report).

Annual Loading of Nitrogen and Phosphorus in Atmospheric Deposition

One of the most important products of the atmospheric deposition monitoring has been to provide estimates of annual N and P loading by Water Year from atmospheric deposition in the Ward Creek watershed and on the lake at the buoy sampling locations. Table 5 presents estimates for loading rates during WY 2007, 2008, and 2009 at the Lower Ward Valley, Mid-lake buoy TB-1 and buoy TB4 stations. Precipitation amounts at the Lower Ward Valley station are shown as well as loading rates from WY 2005 and 2006 for comparison.

Table 5. Comparisons of loading rates (grams/ hectare/ day) of N and P at the Upper and Lower Ward Valley and buoy stations TB-1 and TB-4 during Water Years 2005 through 2009. To determine dry deposition loading rate, the load for analyzed dry samples was divided by the total number of sampling days represented by analyzed samples. To determine a daily loading rate for Wet or Wet/Bulk precipitation samples, the annual total load for a nutrient was first extrapolated by dividing the load total for samples analyzed (some samples did not have data for all analyses) by the proportion of total precipitation analyzed (amount of precipitation analyzed for a nutrient/ total annual precipitation). This number was divided by # days in year to give the estimate of daily loading rate. Note this data was updated from previous reports to include all available chemistry data.

	Precip. (in)	**NO3-N g/ha/d**	**NH4-N g/ha/d**	**TKN g/ha/d**	**SRP g/ha/d**	**DP g/ha/d**	**TP g/ha/d**
Lower Ward (Wet) WY'05	49.40	1.92	1.89	3.95	0.10	0.21	0.36
Lower Ward (Wet) WY'06	65.99	1.59	1.56	2.83	0.06	0.24	0.42
Lower Ward (Wet) WY'07	27.92	0.71	0.79	2.16	0.08	0.12	0.20
Lower Ward (Wet) WY'08	24.98	0.75	0.73	1.93	0.05	0.13	0.25
Lower Ward (Wet) WY'09	37.34	1.11*	1.06*	2.90*	0.10*	0.14*	0.23*
Lower Ward (Dry) WY'05		0.84	1.39	12.73	0.23	0.64	1.16
Lower Ward (Dry) WY'06		0.89	1.00	11.94	0.17	0.51	1.31
Lower Ward (Dry) WY'07		0.74	1.01	12.55	0.26	0.44	1.03
Lower Ward (Dry) WY'08		0.98	1.01	12.23	0.66	0.88	2.10
Lower Ward (Dry) WY'09		1.13*	1.26*	11.73*	0.24*	0.39*	0.92*
Lower Ward (Wet+Dry) WY'05		2.76	3.28	16.68	0.33	0.85	1.52
Lower Ward (Wet+Dry) WY'06		2.48	2.57	14.78	0.23	0.75	1.73
Lower Ward (Wet+Dry) WY'07		1.45	1.80	14.71	0.34	0.56	1.23
Lower Ward (Wet+Dry) WY'08		1.73	1.74	14.16	0.71	1.01	2.35
Lower Ward (Wet+Dry) WY'09		2.24	2.32	14.63	0.34	0.53	1.15
TB-4 (Dry-Bulk) WY'05		3.26	3.30	5.54	0.08	0.16	0.29
TB-4 (Dry-Bulk) WY'06		1.81	2.10	3.51	0.05	0.14	0.24
TB-4 (Dry-Bulk) WY'07		2.18	1.61	3.93	0.04	0.09	0.24
TB-4 (Dry-Bulk) WY'08		1.66	2.43	4.29	0.12	0.19	0.35
TB-4 (Dry-Bulk) WY'09		1.92	2.48	4.49	0.04	0.06	0.14
Mid-lake TB-1 (Dry-Bulk) WY'05		3.23	3.03	5.96	0.13	0.22	0.36
Mid-lake TB-1 (Dry-Bulk) WY'06		2.05	1.88	4.06	0.09	0.21	0.45
Mid-lake TB-1 (Dry-Bulk) WY'07		2.19	1.63	3.14	0.06	0.13	0.27
Mid-lake TB-1 (Dry-Bulk) WY'08		1.78	1.87	3.93	0.12	0.19	0.35
Mid-lake TB-1 (Dry-Bulk) WY'09		1.90	2.03	3.61	0.05	0.07	0.16

Notes: "*" – The Wet/Dry sampler malfunctioned in Dec. 2008, resulting in the Dry bucket collecting a portion of the precipitation for several storms, the Wet bucket loading values shown do not account for Wet precipitation in the Dry bucket, the Dry bucket values include some Wet precip.

Annual N and P Loads in Wet Precipitation in Lower Ward Valley

Loading of nitrogen in Wet deposition at the Lower Ward Valley station was decreased in WY 2007 and 2008 compared with WY 2005 and 2006 for all N fractions. The decrease was most dramatic for the dissolved N-fractions. NO_3-N and NH_4-N loading rates in WY2007 and WY2008 were about one half the loading rates in WY 2005 and 2006. In WY 2009 the levels of DIN in Wet deposition at the Lower Ward Valley station were intermediate between WY 2005-2006 values and WY 2007-2008 values and TKN was within the 2005-2006 range. DIN has shown a weak association with annual WY precipitation amounts (Hackley et al, 2009) and it is likely lower precipitation in WY 07-09 compared with WY05-06 contributed in part to the lower loads.

Loading rates for phosphorus in Wet precipitation were lower for DP and TP fractions in WY 2007-WY2009. Loading of SRP in Wet has been variable the last five WY ranging from 0.05 g/ha/d in WY 2008 to 0.10 g/ha/d in WY 2005.

Figures 16 and 17 present the WY 1981- 2008 data for Dissolved Inorganic Nitrogen (DIN) and Soluble Reactive Phosphorus respectively in Wet deposition at the Lower Ward station. A couple of patterns are apparent for the WY 2007-2009 “Wet” DIN and SRP data. DIN average concentrations and total precipitation were low in WY 2007 and 2008 and overall DIN loads were very low in these two WY. Indeed, these low DIN loads (~500 g/ha) during WY 2007 and WY 2008 were the lowest since the record began in 1981. The DIN load increased in WY 2009 with increased precipitation, however it was still relatively low when compare with all data 1981-2009. SRP average concentrations were in the mid-range for values 1981-2009 in precipitation during WY 2007-2009. With relatively low precipitation, total loads of SRP were also low in WY 2007 and 2008. With increased precipitation in WY 2009 loads of SRP increased but were still relatively low when compared with the long-term data set.

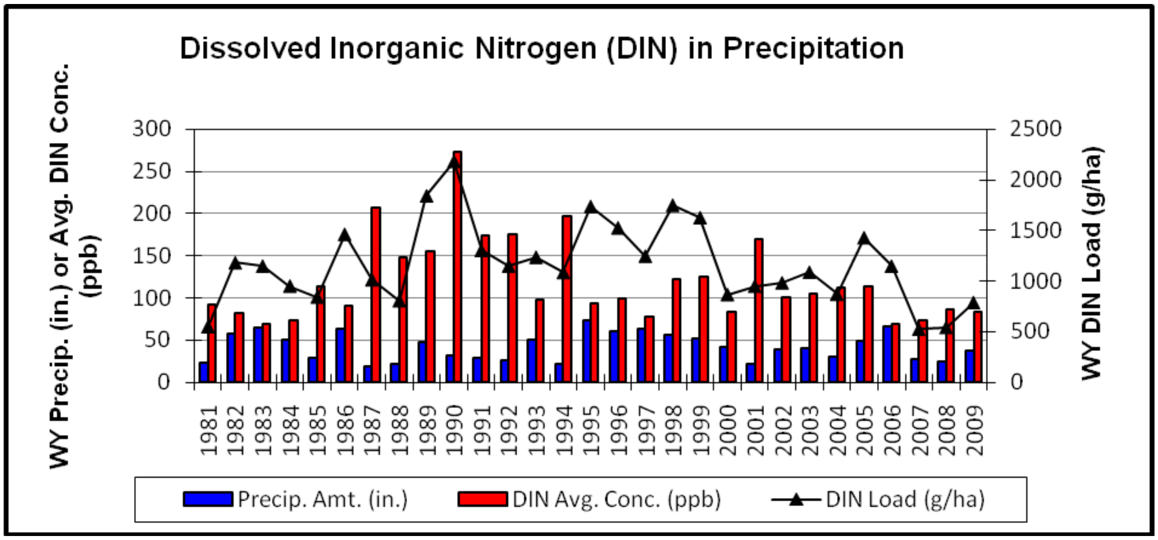


Figure 16. Summary plot of Water Year (WY) total precipitation (inches), average Dissolved Inorganic Nitrogen (DIN) concentration (ppb), and extrapolated annual DIN load (g/ha/yr) in Wet Deposition at the Ward Valley Lake Level station for WY 1981-2009. A Water Year begins Oct. 1 and ends Sept. 30 (i.e. WY 1981 ended Sept. 30, 1981).

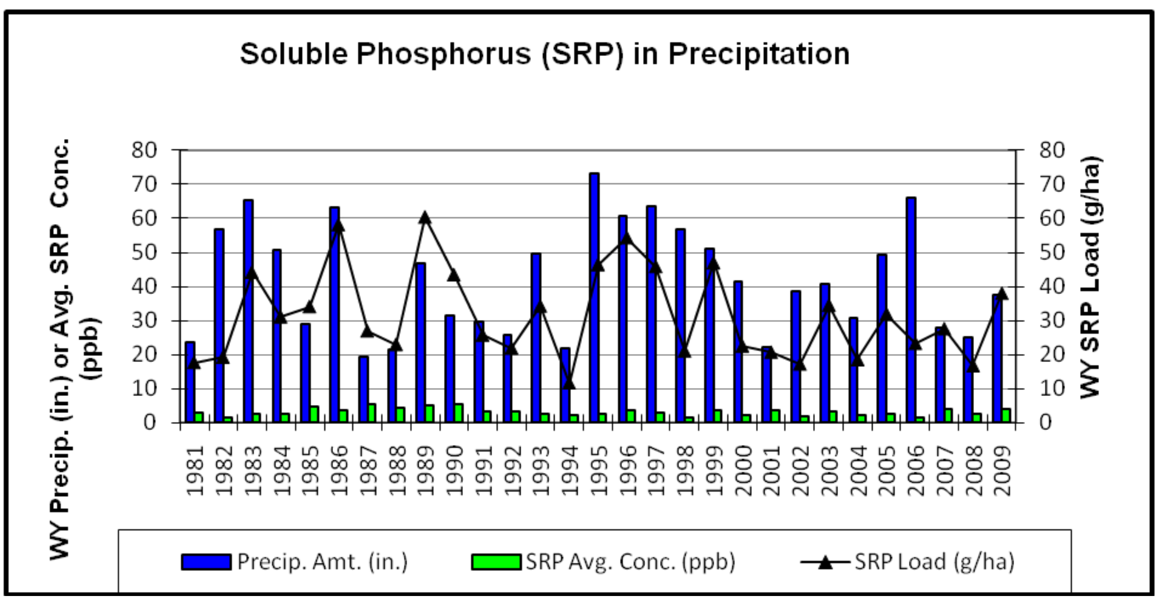


Figure 17. Summary plot of Water Year (WY) total precipitation (inches), average Soluble Reactive Phosphorus (SRP) concentration (ppb), and extrapolated annual SRP load (g/ha/yr) in Wet Deposition at the Ward Valley Lake Level station for WY 1981-2009.

Annual N and P Loads in Dry Deposition in Lower Ward Valley

Dry deposition loading of nitrogen at the Lower Ward station also showed patterns (Table 5). NH_4-N loading in dry deposition was very consistent ranging from 1.00-1.01 g/ha/d for WY 06- WY08. However NH_4-N loading was slightly higher in WY 2005 at 1.39 g/ha/d and in WY 09 at 1.26 g/ha/d. TKN loading in dry deposition was fairly similar in WY 2005-2009 ranging from 11.73 to 12.73 g/ha/d. Loading of NO_3-N was somewhat variable between years, ranging from 0.74 g/ha/d in WY 2007 to 1.13 g/ha/d in WY 2009. The increased loading of N during the ash deposition event was not significant enough to make a large difference in the annual N load in WY 2008.

As mentioned above, of particular interest, the Dry deposition data at the Lower Ward site, showed deposition of phosphorus in WY 2008 was elevated. Levels of SRP, DP and TP loading in Dry deposition were all significantly greater in WY 2008 compared with WY 2005-2007 and WY 2009 values. SRP loading ranged from 0.17-0.26 g/ha/d for WY 2005-2007 and 2009 but was 0.66 g/ha/d in WY 2008. DP loading ranged from 0.39-0.64 g/ha/d for WY 2005-2007 and 2009 and was 0.88 in WY 2008. TP ranged from 0.92-1.31 g/ha/d in WY 2005-2007 and 2009 and was 2.10 g/ha/d in WY2008. The elevated annual levels of Dry deposition of phosphorus at the Lower Ward station appears to have been the result of phosphorus contributions during the ash deposition event in July 2008.

Annual N and P Loads in Dry-bulk Deposition at Buoys TB1, TB4

The deposition loading rates obtained from the two buoys (TB1 and TB4) continue to give similar results for loading (Table 5). Dry-bulk N and P loading rates were very close to each other in WY 2009 at Buoys TB-1 and TB-4. Dry-bulk loading rates in WY 2009 for TB-1 and TB-4 respectively by nutrient were: NO_3-N (TB-1: 1.90 g/ha/d; TB-4: 1.92 g/ha/d); NH_4-N (2.03; 2.48); TKN (3.61, 4.49), SRP (0.05; 0.04); DP (0.07; 0.06); and TP (0.16; 0.14). It is nice to have data available from two sites on the lake which have shown fairly good replication of deposition loads.

Loading rates for NO_3-N and NH_4-N and TKN were relatively consistent during WY 2006-2009 (and close to the WY 2009 values given above). Levels were higher in WY 2005. The elevated DIN associated with the ash fall event in 2008 did not significantly boost the annual loading totals. At buoy TB-4 SRP, DP, and TP loading was highest in WY 2008 and equal at to or the lowest values, in WY 2009. At mid-lake buoy TB-1 SRP, DP and TP loading rates were the highest in WY 2005 and 2008 and lowest in WY 2009. The deposition of phosphorus during the ash deposition event in July 2008, contributed to elevated annual P deposition at buoy stations TB4 and TB1 in WY 2008.

Notes on Additional Atmospheric Deposition-related Studies 2007-2010

Analysis of Atmospheric Deposition Monitoring during the Heavy Smoke Period with emphasis on Ash Fall event July 9, 2008 (note much of this analysis was originally reported in the 2008 Annual Report (Hackley et al., 2008)).

Summer 2008 was particularly interesting, as Lake Tahoe experienced a prolonged period of smoke resulting from fires burning outside the Basin - to the west in California. On June 21, 2008 a storm system moved across parts of California including areas of the Sierra west of the Lake Tahoe basin with significant lightning. Approximately 8000 lightning strikes resulted from this storm and started about 800 fires in California. The number of fires eventually grew significantly. This turned out to be the single largest wildfire "event" in California's history (since since record-keeping began in 1936) (Associated Press, 2008). Smoke from some of these fires began filling the Tahoe basin soon after they started and varying levels of smoke were present in the basin for more than three consecutive weeks, through mid- July.

The presence of smoke for such a prolonged period is unusual for the basin. During past summers, significant smoke has occasionally filled the basin for periods of many days but rarely for periods of several weeks. During the recent Angora fire in 2007, a distinct plume of smoke covered parts of the basin for about 5 days with smoke (light smoke was observed after it was controlled). Goldman et al. (1990) noted smoke from large fires in Southern California in 1985 to impact visibility in the Tahoe basin beginning July 3, 1985 with the entire basin shrouded in smoke by July 11.

Smoke from wildfires can impact Lake Tahoe. Goldman et al (1990) found smoke in the Basin from the Southern California fires to have impacted solar radiation reaching the lake surface and also to have impacted algal primary production, likely as a consequence of nutrients contributed by dry fallout from the smoke. Observations by TERC during the Angora fire in 2007 documented increases in atmospheric deposition of N and P associated with the smoke from the fire and associated brief increases in algal growth in the South Shore area. While we are analyzing all the data from the summer of 2008, it is instructive to present some initial observations on one ash fall event which occurred during this period of heavy smoke.

During the period of heavy smoke an unusual ash fall event was observed on July 9 in the northwest portion of the basin. In the afternoon on July 9, 2008, pieces of ash including small pine needle ashes were carried by the air currents over the lake. Ash was deposited out on the lake at least as far as mid-lake buoy TB-1 (where light ash was observed in the Dry-bulk deposition bucket). Significant ash fell at TERC's Ward Valley precipitation station near the lake. Figure 18 shows a photo of charred remnants of pine needles and coarser ash on a screen situated over deionized water in the collection bucket. Finer particles of ash were found in that deionized water. In Tahoe City, a thin coating of ash was deposited on boats at the Tahoe City Marina and along the shoreline (some charred remains of possibly bay leaves were also observed floating in the lake). Very light ash fall was observed also at TERC in Incline Village, NV on this date. Anecdotal observations suggest that this ash fall event may have been localized to a region in the northwest portion of the lake. Heaviest ash may have been along the shore near Tahoe City (significant ash was observed at sites in Lower Ward Valley and in Tahoe City) with less ash deposited at mid-lake, and very little in Incline at TERC.

This ash was likely derived from the American River Complex fires over 35 miles to the west of the Tahoe basin. "Strong up-canyon afternoon winds" occurred at the fire on July 9 and were noted "to cause a significant run of the Westville fire to the east and north" (news story from KCRA.com, July 10, 2008). It is possible these air currents and topography played a role in carrying ash from this fire to the Tahoe basin. Deposition from wildfire smoke can have impacts quite a distance from the fire. In a summary of general wildfire impacts on the northernfirerockies.org website (Cilimburg and Short, 2005) it was indicated that although much of the ash and charred material in wildfires is usually deposited in nearby forests, during massive conflagrations, fire-generated convection currents may transport ash in towering smoke columns and deposit it hundreds of miles from its origin (McNabb and Cromack, 1990). Goldman et al. (1990) provided evidence for impacts of smoke from fires in Southern California, hundreds of miles away.

During the heavy smoke period, Dry and Dry-bulk deposition was collected about weekly from the Lower Ward Valley station and Buoys TB-1 and TB-4 near the middle portion of the lake. The N and P concentration, loads and loading data from this period is included with data in Appendix Tables 2, 4 and 5.

The data does appear to show an impact possibly associated with the ash deposition event July 9th, 2008. Phosphorus loading appears to have been quite high in samples collected during this ash fall event (see figures 13-15 in this report). SRP load and loading rates collected at the Lower Ward Valley site (collection period July 7th (17:55) – July 10th (13:10)) were extremely high (load =106.17 g/ha; loading rate = 37.89 g/ha/d). SRP loads and loading at Buoys TB-1 and TB-4 were also quite elevated relative to typical levels at these sites. SRP load and loading rate at Buoy TB-4 (collection period July 3rd (10:22) – July 10th (07:50)) were 19.62 g/ha and 2.85 g/ha/d respectively and at Buoy TB-1 (collection period collection period July 3rd (10:50) – July 10th (08:12)) were 18.87 g/ha and 2.74 g/ha/d, respectively. For the Lower Ward and the open-water buoys stations respectively, these daily deposition rates for phosphorus were approximately 60 and 25 times the daily average values respectively (see Table 5 for comparison). DP loads and loading were generally only slightly higher than SRP loading at these sites, indicating most of the dissolved fraction was SRP. Total phosphorus was also high for samples collected on this date. There did not appear to be a similar large spike in dissolved inorganic nitrogen (NO_3-N, NH_4-N) during this period, although a moderate increase was observed.

Preliminary analysis of the data also indicates that deposition loads for samples collected July 10 (which included the ash fall) comprised a significant portion of the total Wet + Dry deposition of SRP for WY 2008 (Figure 19). At Lower Ward, SRP in Dry deposition collected July 10 (106.17 g/ha) was 41% of total Wet + Dry SRP deposition for the year, at TB-1 deposition of 18.87 g/ha was 43% of the total Dry-bulk (Wet + Dry)

Figure 18. Ash deposited on “bug screen” over Dry Deposition bucket in Lower Ward Valley (note charred remnants of pine needles on the screen and surrounding equipment). Finer particles of ash accumulated in the deionized water underneath the bug screen. Photo taken on July 10, 2008 after significant ash fall event on July 9.

SRP load for the WY, at TB-4 deposition of 19.62 g/ha was 45% of the WY SRP total. Based on anecdotal evidence, this ash fall may not have impacted the whole lake. The value from the lake buoys of 44% therefore might be considered an upper limit estimate of percent of annual atmospheric SRP loading contributed to the whole lake during the ash fall event.

The portions of Total P in July 10 samples contributed with ash fall relative to the whole WY were somewhat less than for SRP (figure 20). At Lower Ward, TP in Dry deposition collected July 10 (153.49 g/ha) was 18% of total Wet + Dry TP deposition for the year, at TB-1 deposition of 34.21 g/ha was 27% of the total Dry-bulk TP load for the WY, at TB-4 deposition of 29.60 g/ha was 23% of the WY TP total. Again, since this ash deposition event may not have impacted the whole lake, the values from the lake buoys of 23-27% may be considered an upper limit for % annual atmospheric loading of TP contributed to the whole lake during the ash fall event. For comparison we estimated that 6-11 percent of the total annual P-loading from atmospheric deposition was contributed by the Angora fire in 2007 (data presented by TERC, 2008 at the 4th Biennial Lake Tahoe Science Symposium). Based on NASA remote imagining photos, the Basin was not completely filled in by smoke during the entire period of the Angora Fire. The relative ability of phosphorus to leach from the fine particles transported into the Basin in WY 2008 may have also contributed to these observations. We hope to gain further information on possible extent of the plume associated with the July 9th, 2008 ash fall event (including possibly NASA photos) which may help further refine our estimates.

Phosphorus as well as other relatively heat tolerant nutrients (potassium, magnesium and calcium) tend to be concentrated in ash (Cilimburg and Short, 2005). It is possible the high phosphorus in the samples collected July 10 was attributable to the ash. The July 9th ash fall event initially appears to have been localized over part of the northwest portion of the Tahoe basin. Deposition of P was highest on shore (as measured at the Lower Ward station and was much less, about 20% of the Lower Ward value at the mid-lake buoy). It would be desirable to have additional corroborative data on P deposition associated with the ash fall over the lake, and information on areal extent of the ash fall area. It is of particular interest because the SRP contributed with such deposition would have been a readily available form of phosphorus for algal growth.

The calculations presented above – and specifically related to the WY 2008 fire/smoke/ash event should be viewed as preliminary until these additional analyses are complete. They are included to keep the Basin's resource agencies up-to-date with our current ideas. These findings should not be used at this time to support policy decisions.

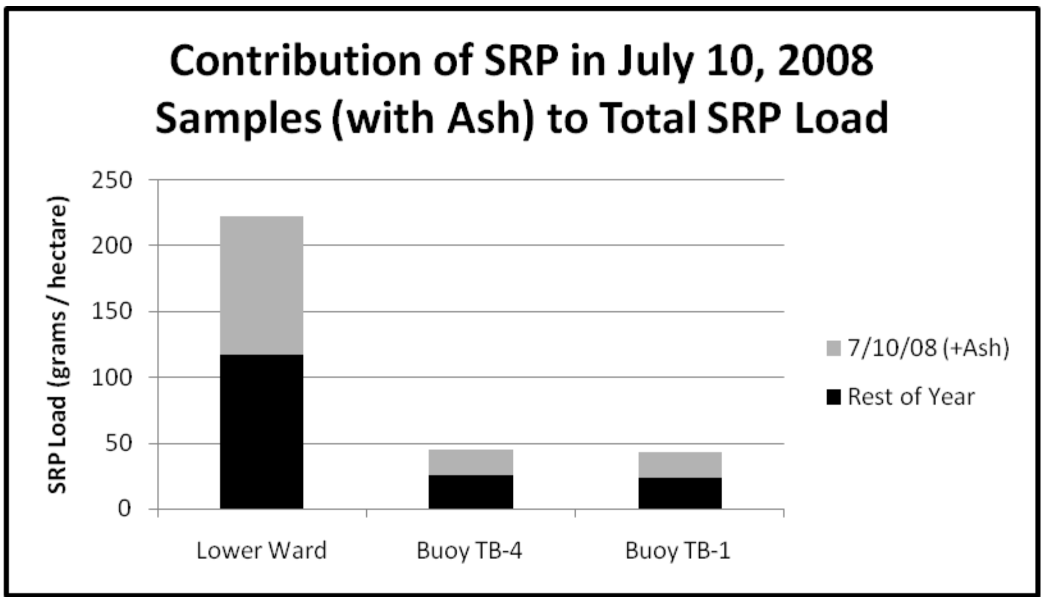


Figure 19. Estimate of contribution of dry deposition SRP collected including 7/9/08 ash fall deposition relative to total water year (Wet + Dry) SRP deposition at the Lower Ward, Buoy TB-4 and Buoy TB-1 stations (note Dry-bulk deposition collected at the buoys is combination of Wet + Dry deposition). The collection periods for buckets which caught the 7/9/08 ash fall were slightly different for the Lower Ward and two buoy stations: i.e. the Dry bucket at Lower Ward sat out for 3 days (7/7/08 17:55 – 7/10/08 13:10), the Dry-bulk bucket at Buoy TB-4 sat out for 7 days (7/3/08 10:22 – 7/10/08 07:50), and the Dry-bulk bucket at Buoy TB-1 also sat out for 7 days (7/3/08 10:50 – 7/10/08 08:12). Important note – these loading estimates are specific to each station and may not necessarily represent deposition to the whole lake area.

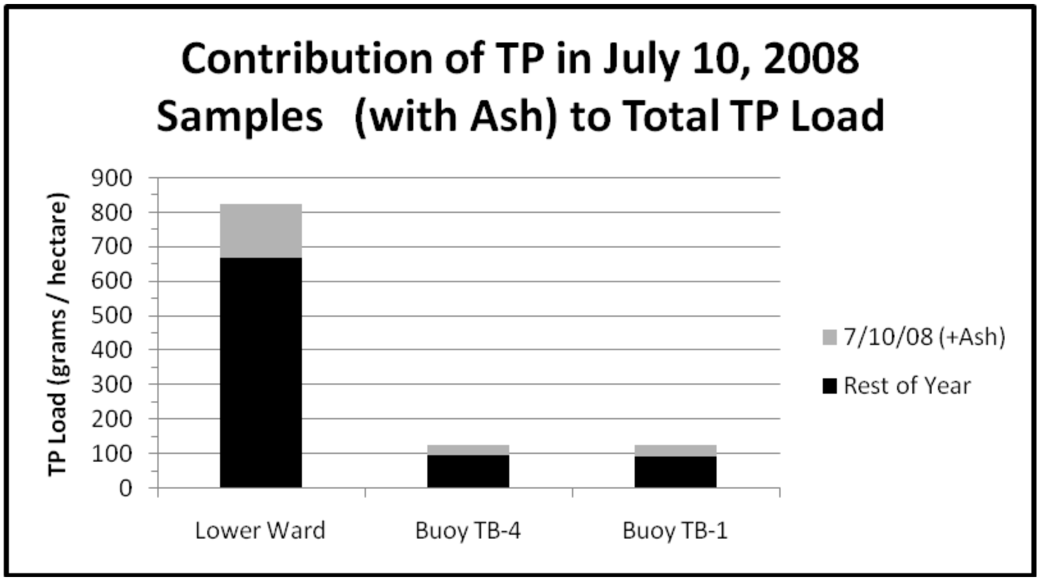


Figure 20. Estimate of contribution of dry deposition TP collected including 7/9/08 ash fall deposition relative to total water year (Wet + Dry) TP.

Results of inquiry into use of Dry-bulk buckets for collection of particulates for size analysis

As part of an assessment of whether the dry deposition buckets could be used for collection of particles for size analysis, a literature search was done. This search found many studies focusing on the use of water as a potential surrogate collection surface for atmospheric deposition studies (i.e. Lee and Lee, 2004; Golomb et al., 1997a,b; Shahin et al., 1999; Shahin et al, 2002; Cole et al., 1990; Yi et al., 1997). However no references were found on the use of water collection surfaces specifically for particle size studies. Factors affecting atmospheric particle deposition and behavior of particles once in the water are likely to be complex. Type and geometry of a dry deposition collector affects the amount of material collected (Noll, et al., 1988). Knowing the complexity of interactions among particles as well as complexity of processes influencing atmospheric deposition of particles, adequate study of use of water surfaces for collection of particles to estimate particle deposition was deemed well beyond the scope of a pilot study. Therefore we did not move forward with a pilot study of use of dry buckets for particle collection. It is beyond the scope of our deposition monitoring to develop methodology for measurement of particle deposition to the lake using bucket methodology.

Summary Points for Atmospheric Deposition Monitoring 2007-2010

1. **Precipitation amounts were relatively low in WY 2007 (27.92 in.) and 2008 (24.98 in.) at the TERC Lower Ward Valley station. Moderate levels of precipitation occurred in WY 2009 (37.34 in.) and WY 2010 (through mid-June 37.50 in. had fallen).**

2. **Atmospheric deposition continues to be a significant source of nitrogen and phosphorus loading for the lake.**

3. **DIN in wet precipitation at Lower Ward Valley was very low in WY 2007-2008. These low DIN loads (~500 g/ha) were the lowest since the record began in 1981. The DIN load increased in WY 2009 with increased precipitation, however it was still relatively low when compared with all data 1981-2009. Total loads of SRP were also low in WY 2007 and 2008. With increased precipitation in WY 2009 loads of SRP increased but were still relatively low when compared with the long-term data set.**

4. **DIN in Dry deposition at the Lower Ward station showed some fluctuation 2007-2009. NH_4-N loading in dry deposition at Lower Ward was consistent for WY 07- WY08 and slightly higher in WY 09. Loading of NO_3-N was somewhat variable between years. TKN loading in dry deposition was fairly consistent.**
5. **Levels of SRP, DP and TP loading in Dry deposition at the Lower Ward Valley station were all significantly greater in WY 2008 compared with WY 2007 and WY 2009 values. The elevated levels of dry deposition of phosphorus at the Lower Ward station appears to have been the result of phosphorus contributions during the ash deposition event in July 2008.**
6. **For Dry-bulk deposition to the lake at buoys TB1 and TB4 loading rates for NO_3-N and NH_4-N and TKN were relatively consistent during WY 2007-2009. N and P deposition at the on-lake buoy buckets has remained relatively consistent since WY 05 even though there is some interannual variability. At buoy TB-4 SRP, DP, and TP loading was highest in WY 2008 and low in WY 2009. At mid-lake buoy TB-1 SRP, DP and TP loading rates were the highest in WY 2008 and lowest in WY 2009. The deposition of phosphorus during the ash deposition event in July 2008, contributed to elevated annual P deposition at buoy stations TB4 and TB1 in WY 2008.**
7. **During summer 2008 a prolonged period (> 3 weeks) of smoke occurred in the basin associated with a large number of lightning started wildfires to the west of Lake Tahoe in Northern California. During this period of elevated smoke an unusual ash deposition event occurred July 9 in the northwest portion of the basin. A significant spike in SRP concentrations and loads was observed at the Lower Ward Valley site and on the buoys on the lake associated with this event. The impact of deposition of this ash was also observable as moderate spikes in DIN at all three sites. This was an particularly interesting event that we were able to monitor during the atmospheric deposition monitoring program. Calculations specifically related to the WY 2008 fire/smoke/ash event should be viewed as preliminary until these additional analyses are complete. They are included to keep the Basin's resource agencies up-to-date with our current ideas on this interesting event. These findings should <u>not</u> be used at this time to support policy decisions.**

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 lend 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 July 2007-June 2010 (Rubicon Pt., Sugar Pine Pt., Pineland, Tahoe City, Dollar Pt., Zephyr Pt., Deadman Pt., Sand Pt, 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 from July 2007- May 2010. The nine routine sampling sites were sampled five times per year during each of the three years. Three of the sampling circuits each year were made during the period of heavier growth in the spring. Additional samplings were made during Nov. to Dec. 2007, during Jan. or Feb. (all three years), and in late summer in 2008, 2009. Table 7 presents the results for biomass (chlorophyll *a*, AFDW) and field observations of visual score, average filament length, percent algal coverage and basic algal types at the nine routine periphyton sites for the period July 2007-May 2010. Figures 21(a-i) present summary graphs of periphyton chlorophyll a biomass from 2007-2010 in combination with data collected since 2000. Figure 22 presents the fluctuation in lake level since 2000.

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 2007-June 2010. 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; TBA is to be analyzed.

Site	Date	Depth (m)	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 Coverage (%)	Biomass Index	Algal Type
Rubicon Pt.	12/12/07	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	2/11/08	0.5	70.82	6.11	27.82	0.54	NA	3	0.5	90%	0.45	FG,SD,CY
	3/12/08	0.5	63.69	10.29	20.20	0.98	3	4	2.0	90%	1.8	SD,FG
	4/10/08	0.5	168.17*	NA*	113.79	18.94	4	4	3.0	90%	2.7	SD
	5/23/08	0.5	13.79	1.28	15.46	2.61	5	3	0.5	70%	0.35	SD
	8/13/08	0.5	10.13	2.92	11.98	5.73	1	1	<0.1	50%	<0.05	CY
	1/23/09	0.5	62.47	29.98	36.85	11.69	2	3	1.0	60%	0.6	CY,FG
	3/10/09	0.5	38.26	6.70	27.70	2.05	3	3	0.4	70%	0.28	FG,CY
	3/31/09	0.5	78.34	12.57	27.92	9.74(n=3)	2	3	0.8	10-90%	0.08-0.72	CY,FG,SD
	6/25/09	0.5	19.59	5.19	27.62	3.74	3.5	3.5	1.0	80%	0.8	FG,CY,SD
	9/22/09	0.5	30.61	3.02	36.27	5.00	3	3	0.4	80%	0.32	CY,FG
	1/4/10	0.5	17.11	6.54	17.73	7.22	3	3	0.5	90%	0.45	FG,CY
	2/25/10	0.5	45.40	10.56	28.54	7.94	NA	3	1.0	90%	0.9	FG,CY
	3/24/10	0.5	58.47	9.66(n=3)	43.10	4.42(n=3)	4	4	1.2	95%	1.14	FG,CY
	4/13/10	0.5	NA	NA	NA	NA	3	3	1.0	80%	0.8	SD,FG,CY
Sugar Pine Pt.	12/12/07	0.5	10.52	0.81	7.92	1.57	2	2	<0.1	30%	<0.03	FG,CY
	2/11/08	0.5	31.18	0.98	18.35	0.89	NA	2	0.4	80%	0.32	SD,CY
	3/12/08	0.5	17.44	0.75	8.59	1.41	NA	2	0.3	70%	0.21	SD,FG
	4/10/08	0.5	32.15	8.18	13.33	3.54	NA	2	0.5	60%	0.3	SD,FG
	5/23/08	0.5	13.77	1.50	8.38	2.41	2	2	0.6	90%	0.54	CY,SD,FG
	8/13/08	0.5	7.61	4.39	10.10	6.59	NA	1	<0.1	70%	<0.07	CY
	1/23/09	0.5	34.02	NA(n=1)	21.83	3.14	NA	2	0.1	80%	0.08	CY
	3/10/09	0.5	45.52	48.52	31.36	32.21	NA	2	0.2	80%	0.16	CY

Site	Date	Depth (m)	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 Coverage (%)	Biomass Index	Algal Type
Sugar Pine Pt.	3/31/09	0.5	39.97	0.80	39.41	2.85(n=3)	2	3	0.5	80%	0.4	CY,SD,FG
	6/25/09	0.5	5.16	3.91	9.00	6.03	NA	2	<0.1	70%	<0.07	CY,FG
	9/22/09	0.5	16.36	2.82	18.71	4.51	1.5	2	0.1	60%	0.06	CY
	1/4/10	0.5	24.36	6.71	26.94	2.38	2	3	0.2	90%	0.18	SD,CY
	2/25/10	0.5	27.38	0.59	22.36	1.01	2	2	0.15	80%	0.12	CY
	3/24/10	0.5	55.51	27.89	44.91	20.53	2	2	0.3	80%	0.24	CY
	4/13/10	0.5	NA	NA	NA	NA	NA	2	0.2	70%	0.14	SD,CY
Pineland	12/12/07	0.5	52.32	NA(n=1)	24.85	4.24	2	2	0.2	40%	0.08	SD,CY
	2/11/08	0.5	68.47	23.66	24.25	1.04	NA	3	0.8	100%	0.8	SD,FG
	3/12/08	0.5	75.47	10.22	44.29	11.71	NA	5	3.2	100%	3.2	SD
	4/10/08	0.5	119.68	47.18	57.91	15.69	4	4	2.2	90%	1.98	SD
	5/19/08	0.5	76.20	60.86	44.09	32.64	4	4	2.0	70%	1.4	SD
	8/13/08	0.5	9.87	0.53	8.69	0.84	2	2	0.1	60%	0.06	SD,CY
	1/23/09	0.5	55.49	15.68	41.00	4.93	2	3	0.8	70%	0.56	SD,CY
	3/13/09	0.5	91.01	36.32	69.85	8.90	3	4	1.3	90%	1.17	SD
	3/31/09	0.5	119.21	23.05	53.68	10.35(n=3)	4	5	3.0	70%	2.1	SD,FG,CY
	6/26/09	0.5	26.04	0.25	28.98	2.11	2	3	0.5	70%	0.35	CY,SD
	9/22/09	0.5	19.74	5.85	22.14	6.22	2	2	0.2	90%	0.18	CY
	1/4/10	0.5	55.95	13.01	49.92	9.82	2	3	0.5	80%	0.4	SD,FG,CY
	2/25/10	0.5	61.86	49.55	51.80	30.18	2	3	0.7	80%	0.56	SD
	3/24/10	0.5	78.63	2.29	65.49	1.03	3	4	2.3	90%	2.07	SD,CY
	4/16/10	0.5	TBA	TBA	75.02	11.17	3	5	3.5	90%	3.15	SD,FG
Tahoe City	12/12/07	0.5	26.15	5.39	12.61	1.45	2	2	0.3	50%	0.15	SD
	2/7/08	0.5	64.18	27.37	36.16	14.86	3	3	0.7	70%	0.49	SD
	3/12/08	0.5	72.71	13.76(n=3)	52.33	20.05(n=3)	2	4	2.8	70%	1.96	SD
	4/10/08	0.5	183.72	1.89	87.52	4.02	4	4	3.2	80%	2.56	SD
	5/19/08	0.5	21.78	7.97	21.02	11.08	3	3	1.7	40%	0.68	SD
	9/8/08	0.5	17.58	11.13	13.77	4.22	2	2	<0.1	90%	<0.09	SD

Site	Date	Depth (m)	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 Coverage (%)	Biomass Index	Algal Type
Tahoe City	1/27/09	0.5	26.83	0.31	NA	NA	2	2	0.3	90%	0.27	SD
	3/13/09	0.5	73.05	0.26	80.36	7.01	3	4	0.6	50%	0.3	SD
	4/7/09	0.5	39.98	2.38(n=3)	33.64	5.85(n=3)	4	4	1.2	50%	0.6	SD
	6/26/09	0.5	32.05	4.42	43.89	5.24	2	2	0.1	80%	0.08	SD
	9/22/09	0.5	8.43	2.80	15.38	1.52	2	2	0.1	50%	0.05	SD
	1/4/10	0.5	34.01	2.46	33.64	3.81	2	2	0.2	80%	0.16	SD
	2/25/10	0.5	105.00	60.13	163.90	139.48	3	4	2.0	80%	1.6	SD
	3/24/10	0.5	59.24	3.23	46.42	1.95	3	4	2.0	60%	1.2	SD
	4/26/10	0.5	TBA	TBA	68.48	49.13(n=3)	4	4	2.0	80%	1.6	SD
Dollar Pt.	11/27/07	0.5	21.27	5.02	12.41	2.36	2	2	0.1	80%	0.08	SD,CY
	2/11/08	0.5	43.14	8.11	19.51	3.35	NA	3	0.8	100%	0.8	SD,CY
	3/12/08	0.5	99.32	8.80	58.58	8.01	2	3	0.6	80%	0.48	SD
	4/10/08	0.5	156.52	23.91	134.25	3.92	4	4	2.5	90%	2.25	SD
	5/19/08	0.5	17.36	5.47	12.31	1.75	3	3	0.1	60%	0.06	SD
	9/8/08	0.5	5.64	0.81	3.81	0.41	5	2	0.3	70%	0.21	SD,CY
	1/27/09	0.5	10.30	2.63	NA	NA	2	2	0.1	80%	0.08	SD,CY
	3/13/09	0.5	31.14	8.23	20.04	2.65	2	2	0.2	40%	0.08	SD,CY,FG
	4/7/09	0.5	97.47	35.06(n=3)	49.12	12.23(n=3)	3	3	0.7	50%	0.35	SD,FG
	6/26/09	0.5	55.29	6.98	26.91	3.73	2	2	<0.1	80%	<0.08	CY
	9/22/09	0.5	15.83	8.87	14.66	6.01	1.5	1	<0.1	NA	NA	CY
	1/4/10	0.5	33.19	20.82	18.34	4.61	2	2	<0.1	60%	<0.06	SD,CY
	2/25/10	0.5	20.25	3.59	10.99	1.69	2	2	0.3	60%	0.18	FG,CY
	3/24/10	0.5	56.25	2.51	22.34	1.86	3	3	0.5	70%	0.35	FG,SD,CY
	4/26/10	0.5	TBA	TBA	19.31	6.23	3.5	3.5	0.8	80%	0.64	SD,FG,CY
Incline West	11/26/07	0.55	24.67	1.84	31.49	4.13	3	3	0.4	90%	0.36	FG,CY
	2/12/08	0.5	48.19	0.84	35.90	2.74	2	2	0.4	90%	0.36	SD,FG
	3/12/08	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/10/08	0.5	35.94	1.98	31.81	3.23	4	4	1.5	100%	1.5	SD,FG

Site	Date	Depth (m)	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 Coverage (%)	Biomass Index	Algal Type
Incline West	6/4/08	0.5	34.93	10.18	43.05	6.99	4	4	2.5	90%	2.25	SD,FG
	9/5/08	0.55	11.81	2.14	15.66	4.95	3	3	0.3	70%	0.21	CY,SD,FG
	1/23/09	0.5	18.83	4.97	28.34	13.07	3	3	0.3	80%	0.24	CY,FG
	3/10/09	0.5	40.19	8.34	38.52	4.98	3	3	0.4	80%	0.32	FG,SD,CY
	4/22/09	0.5	31.20	2.84(n=3)	47.21	3.92(n=3)	4	4	1.2	90%	1.08	FG,SD,CY
	6/25/09	0.5	53.66	18.28	67.01	22.62	3	3	0.7	90%	0.63	CY,SD,FG
	9/22/09	0.5	21.27	6.32	30.72	8.36	3	3	0.3	80%	0.24	FG,CY
	1/4/10	0.5	21.01	3.94	27.63	10.42	2	2	0.2	90%	0.18	CY
	2/25/10	0.5	36.20	3.70	50.27	3.87	3	3	0.5	80%	0.4	FG,CY
	3/26/10	0.5	26.30	4.16	41.22	0.14	3	3	0.7	80%	0.56	FG,CY
	5/13/10	0.5	TBA	TBA	28.60	2.29	3.5	3.5	0.7	70%	0.49	FG,CY
Sand Point	11/26/07	0.34	12.03	0.19	20.97	2.49	2	3	0.5	70%	0.35	FG,CY
	2/12/08	0.5	26.80	3.21	25.76	2.49	2	2	0.2	90%	0.18	CY
	3/12/08	0.5	29.70	0.79	29.69	1.03	3	3	0.3	90%	0.27	SD,FG,CY
	4/10/08	0.5	24.96	2.23	29.71	2.00	3	3	0.4	80%	0.32	SD,FG,CY
	6/5/08	0.5	20.24	7.45	24.47	10.04	3	3	0.5	50%	0.25	SD,FG,CY
	8/15/08	0.34	12.67	1.75	22.99	2.59	3	3	0.8	50%	0.4	FG,CY
	1/23/09	0.5	23.44	1.47	30.09	1.89	3	3	0.2	90%	0.18	CY
	3/10/09	0.5	21.83	4.63	27.25	2.24	3	3	0.3	80%	0.24	FG,CY
	4/10/09	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6/25/09	0.5	37.34	6.06	53.75	12.92	3.5	4	0.8	90%	0.72	FG,CY
	9/22/09	0.5	18.34	5.98	27.04	5.29	3	3	0.3	80%	0.24	FG,CY
	1/4/10	0.5	26.28	1.67	30.11	1.21	2	2	0.2	90%	0.18	FG,CY
	2/25/10	0.5	28.17	2.18	35.71	1.20	3	3	0.5	75%	0.375	FG,CY
	3/26/10	0.5	23.19	0.32	29.37	7.30	2	3	0.5	95%	0.475	FG,CY
	5/3/10	0.5	TBA	TBA	42.02	7.24	3	3	0.5	90%	0.45	FG,CY
Deadman Pt.	11/26/07	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2/12/08	0.5	20.56	1.10	15.40	0.25	2	2	0.2	90%	0.18	FG,CY

Site	Date	Depth (m)	Chlor. *a* (mg/m²)	Std Dev (mg/m²)	AFDW (g/m²)	Std Dev (g/m²)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Coverage (%)	Biomass Index	Algal Type
Deadman Pt.	3/12/08	0.5	22.58	0.12	15.44	1.64	3	3	0.2	80%	0.16	SD,FG,CY
	4/10/08	0.5	16.49	1.45	15.44	5.15	3	2	0.1	70%	0.07	FG,CY
	6/5/08	0.5	15.75	1.66	15.28	1.51	3	3	0.4	40%	0.16	FG,CY
	8/15/08	0.5	7.74	1.26	10.87	0.31	3	3	0.8	75%	0.6	FG,CY
	1/23/09	0.5	18.52	2.64	22.84	2.73	3	3	0.3	80%	0.24	CY,FG
	3/10/09	0.5	31.27	7.53	31.17	4.19	3	3	0.3	70%	0.21	CY,FG
	4/10/09	0.5	19.90	2.18(n=3)	30.85	3.67(n=3)	2	2	0.2	40%	0.08	CY,FG
	6/25/09	0.5	24.74	2.41	39.63	4.68	3.5	3.5	0.8	70%	0.56	FG,CY
	9/22/09	0.5	24.47	3.40	26.70	2.55	4	4	0.5	70%	0.35	FG,CY
	1/4/10	0.5	19.66	1.11	32.55	3.39	2	2	0.1	80%	0.08	CY
	2/25/10	0.5	27.22	1.69	28.65	2.58	3	3	0.5	80%	0.4	FG,CY
	3/26/10	0.5	TBA	TBA	36.69	0.23	2	3	0.3	90%	0.27	FG,CY
	5/3/10	0.5	TBA	TBA	45.32	10.94(n=3)	3	3	0.3	90%	0.27	FG,CY
Zephyr Point	11/26/07	0.5	20.49	3.58	18.00	2.07	3	3	0.1	80%	0.08	SD,CY
	2/12/08	0.5	44.39	3.15	25.72	0.42	2	2	0.3	60%	0.18	SD,CY
	3/12/08	0.5	37.20	5.73	22.06	10.01	2	3	0.5	80%	0.4	SD,FG
	4/10/08	0.5	46.96	2.23	23.82	0.49	3	3	1.5	60%	0.9	SD,FG
	6/2/08		76.45	16.43	31.91	4.87	3	3	1.2	90%	1.08	SD
	8/15/08	0.5	7.42	1.76	8.84	2.40	3	2	0.1	70%	0.07	CY,SD,FG
	1/23/09	0.5	24.88	3.07	22.51	1.82	2	2	0.2	70%	0.14	CY,FG
	3/10/09	0.5	6.04	2.47	7.20	2.40	2	2	0.2	70%	0.14	FG,CY
	4/10/09	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6/25/09	0.5	12.56	3.16	15.06	1.54	3.5	3.5	0.9	60%	0.54	FG,CY,SD
	9/22/09	0.5	12.67	4.06	16.47	4.88	4	3.5	0.3	65%	0.195	FG,CY
	1/4/10	0.5	21.81	0.21	18.53	8.99	2	2	0.1	60%	0.06	CY
	2/25/10	0.5	20.49	1.98	18.21	5.92	3	3	0.3	60%	0.18	FG,CY
	3/26/10	0.5	TBA	TBA	12.91	2.68	2	2	0.5	60%	0.3	SD,FG
	5/12/10	0.5	TBA	TBA	15.26	4.63	2	2.5	0.3	40%	0.12	FG,CY

Notes - * One Rubicon Pt. Chlorophyll a for 4/10/08 was anomalously high (319.36 mg/m²) and not included (n=1).

Patterns of Periphyton Biomass July 1, 2007 to June 30, 2008

During 2007 to 2010 the periphyton monitoring program focused on sampling several times during the spring growth in order to collect samples when peak biomass was occurring, with additional sampling spread out over the rest of the year. During 2007-2010, certain patterns for biomass were apparent at the routine sites. Comparing the data by water year, the following patterns were present.

Water Year 2008 Patterns of Periphyton Biomass

In WY 2008 (Oct. 1, 2007 – Sept. 30, 2008) very significant spring peaks in periphyton growth were measured at five sites. Four of the sites along the west and northwest shore had chlorophyll *a* levels well over 100 mg/m^2: Rubicon Pt. (Chl = 168.17 mg/m^2), Pineland (Chl = 119.68 mg/m^2), Tahoe City (Chl = 183.72 mg/m^2), Dollar Pt. (Chl = 156.52 mg/m^2). One site along the southeast shore (Zephyr Pt.) also had a significant spring peak (Chl = 76.45 mg/m^2), but later in the season (in June). The spring peaks for biomass at all these sites appeared to be largely the result of increased growth of the stalked diatom *Gomphoneis herculeana*.[1] It is possible the high biomass at many sites was supported by a rather stable lake level during the spring and a relatively long period (2 years) of prior submergence of the 0.5m substrate.

At the four remaining sites (Sugar Pine Pt., Incline West, Sand Pt. and Deadman Pt.), biomass peaks were much lower than the above. Of these sites, Incline West had the highest peak biomass, (in February, Chl = 48.19 mg/m^2). Both *Gomphoneis* and green filamentous algae appeared to contribute to the biomass peak there. At the three remaining sites, relatively small spring peaks were observed and predominant algal types appeared to be a mix of *Gomphoneis*, green filamentous and blue-green algae at the four sites.

Biomass at all sites was much reduced during late summer 2008. Chlorophyll *a* ranged from 5.64 mg/m^2 at Dollar Pt. to 17.58 mg/m^2 at Tahoe City in Aug. and Sept. 2008. Along the northeast and east shore, filamentous green algae and blue-green algae were present, with also some stalked diatoms. As the lake level lowered, the bright green filamentous algae associated with blue-green algae were quite apparent on the rocks in many areas. Along the west and southwest shore, blue-green algae were observed to contribute to biomass at all sites except Tahoe City, where primarily stalked diatoms were observed. Stalked diatoms along with blue-greens also contributed to biomass at Pineland and Dollar Pt.

Water Year 2009 Patterns of Periphyton Biomass

In WY 2009, distinct spring peaks in growth were again observed at Rubicon Pt. (Chl = 78.34 mg/m^2), Pineland (Chl = 119.21 mg/m^2), Tahoe City (Chl = 73.05 mg/m^2), Dollar Pt. (Chl = 97.47mg/m^2). However, peak biomass was much reduced compared to WY

[1] Note that this stalked diatom contains relatively less chl *a* per unit biomass (weight) because the stalks – which comprise most of the biomass – do not contain chlorophyll.

2008 at all sites except Pineland which was similar to the previous year. It is possible strong winds and significant wave activity associated with storms at the end of March caused some sloughing of algae and reduced biomass peaks, particularly at the Tahoe City site. At Incline West and Sand Pt. the magnitudes of peaks (which occurred in early summer) were slightly higher than in 2008. At Deadman Pt. peak biomass occurred in March. At Zephyr Pt. barely any fluctuation in biomass was observed. This is in contrast to the large peak in biomass observed in June 2008.

The predominant algae present at these sites during the peak was varied. A mix of filamentous green algae, stalked diatoms and blue-green algae appeared to be present at most of the sites from Incline West in the northeast portion of the lake to Rubicon Pt. along the southwest portion. At Tahoe City however, primarily stalked diatoms were observed. For sites along the east shore, primarily filamentous greens and blue-green algae were observed.

Measured biomass minimums for the year occurred in the summer at most sites. Exceptions were Deadman Pt. where minimum biomass occurred in January and Zephyr Pt. where the minimum occurred in March. Along the northeast and east shore during biomass minimums, primary algae observed were combination of filamentous green algae and blue-green algae. Along the west shore during minimums, blue-green algae were observed at all sites except Tahoe City. Stalked diatoms and filamentous greens were also observed at Rubicon Pt.

<u>Routine Monitoring Results July 1, 2009 to June 30, 2010</u>

Monitoring at the routine sites only included samples taken through early May, 2010. Not all chlorophyll *a* analyses were completed as of preparation of this report. Some observations can be made based on the available data however.

Growth was generally light at most sites in January 2010. Blue-green algae were present at many sites as a consequence of the lake level being very low. In late February, periphyton growth was increasing at some of the sites. By late March growth was significantly increased at several sites along the west shore. At Tahoe City the peak AFDW occurred in late February, chlorophyll *a* was 105 mg/m^2; at Dollar Pt. the peak AFDW occurred in March, chlorophyll *a* was 56.25 mg/m^2; at Incline West the AFDW peak occurred in February and chlorophyll *a* was 36.20 mg/m^2 ;at Zephyr Pt. the AFDW peak occurred in January when chlorophyll *a* was 21.81 mg/m2. Further analysis of the WY2010 data will be done once all chlorophyll *a* data is available.

Predominant algae observed in 2010 so far continue to be filamentous green algae and blue-green algae for sites from Incline West in the northeast portion of the lake to Zephyr Pt. along the east shore. Sites along the west shore have had a variety of algae present including stalked diatoms and or filamentous green algae, with blue greens noted at most sites except Tahoe City.

Patterns in Biomass 2000-2010

The data for periphyton biomass during 2000-2010 was presented (Figures 21 a-i) to provide information on patterns of growth over this recent ten year period. During this period lake level fluctuated significantly. Some initial observations on patterns 2000-2010 are presented here.

Biomass at the three sites in the northwest portion of the lake (Pineland, Tahoe City and Dollar Pt.) were typically high in the spring. The annual pattern of biomass shows significant fluctuations between low baseline biomass and significant peaks in biomass in the spring. The magnitude of these peaks has varied, but these stations have exceeded 100 mg/m^2 several times over the last ten years. The heavy growth at these sites is usually primarily associated with the growth of the stalked diatom *Gomphoneis herculeana*. This is a very heavy amount of growth and visually can be quite unaesthetic (long, globs of slimy periphyton coating the rocks.). The other sites do not show a similar pattern of regular large increases in biomass in the spring.

Biomass at sites along the east shore (Sand Pt., Deadman Pt. and Zephyr Pt.) has typically been low. These sites have shown much less fluctuation in biomass between baseline and peak growth annually. When biomass was significantly elevated at these sites, this typically occurred during periods when the lake level was very low. For instance, in late 2004 and early 2005 the lake surface elevation was very low, below the rim. During this period, the 0.5m sampling depth was well down into a zone where biomass was high and dominated by blue green algae.

Lake level fluctuation appears to play a role in levels of periphyton biomass observed in the eulittoral zone. 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. Consequences of lowered lake levels on biomass are particularly noticeable for Incline West, Sand Pt., Deadman Pt., Sugar Pine Pt. and Rubicon Pt. sites. During periods of low lake elevation, definite increases in baseline biomass were observed.

At Rubicon Pt. and Zephyr Pt. significant peaks in biomass were measured in 2008. The peaks in biomass observed at Rubicon Pt. in the southwest portion of the lake and Zephyr Pt. in the southeast portion during spring 2008 were unusual when compared with the last ten years. It is possible the high biomass at these and several other sites during 2008 were related to a rather stable lake level during the spring and a relatively long period (2 years) of prior submergence of the 0.5m substrate.

Very low baseline biomass was measured during the middle portion of 2005 and again in 2006. These were periods after the lake level had recently risen rapidly. As a result the sampling was done on rock which had recently been submerged (there had been little time for significant periphyton biomass to develop).

Overall long-term trends upward or downward in the biomass at the sites are not readily apparent based on the patterns in these ten-year charts. However, due to lake level fluctuation and associated impacts on biomass, discernment of trends through time is complex involving much more detailed statistical analysis. We are currently in the process of looking at the longer periphyton biomass record (back to the early 1980s) to evaluate trends and patterns for periphyton biomass.

One other pattern was observed during the 10 year period that was not readily apparent from viewing the charts, but should be mentioned here. Bright green filamentous green algae (typically *Zygnema* sp.) were often found associated with the blue-green algae near the surface under conditions of lowered lake levels, particularly along the east shore. This bright green filamentous algae growth can be quite striking. In low water years, this algae growth may be quite apparent to boaters, kayakers and others using the east shore. This is in contrast to high water years, when rocks along the east shore may have very little growth due to rocks being recently submerged.

Our understanding of factors affecting periphyton growth continues to grow. Several factors likely interact to affect periphyton biomass patterns observed including: nutrient inputs (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.

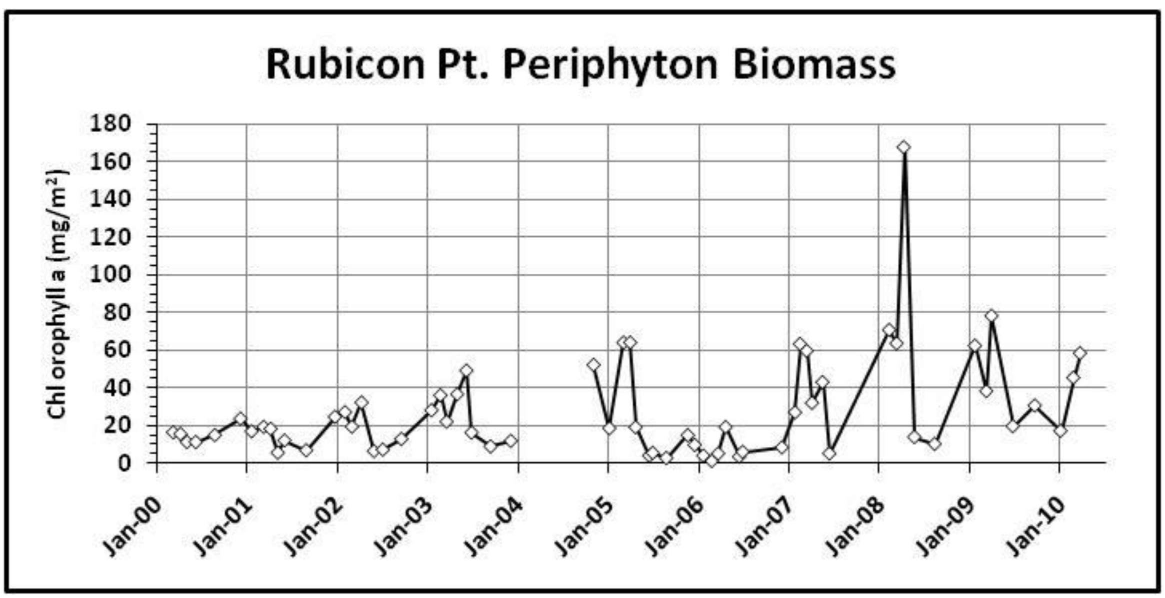


Figure 21 a. Rubicon Pt. periphyton biomass (chlorophyll *a*) 2000-2010.

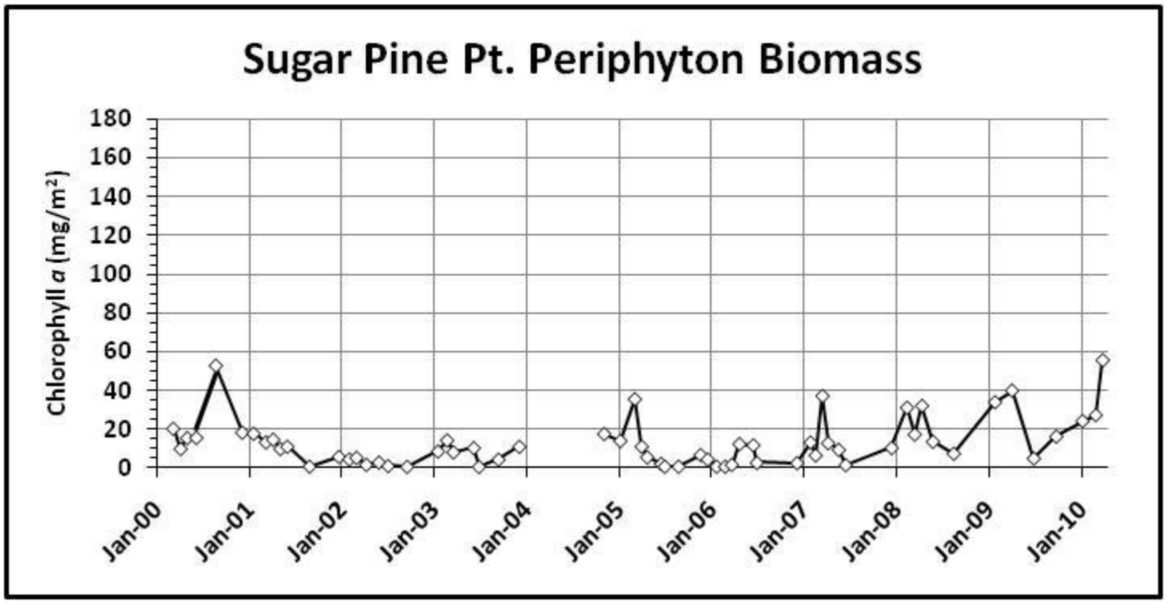


Figure 21 b. Sugar Pine Pt. periphyton biomass (chlorophyll *a*) 2000-2010.

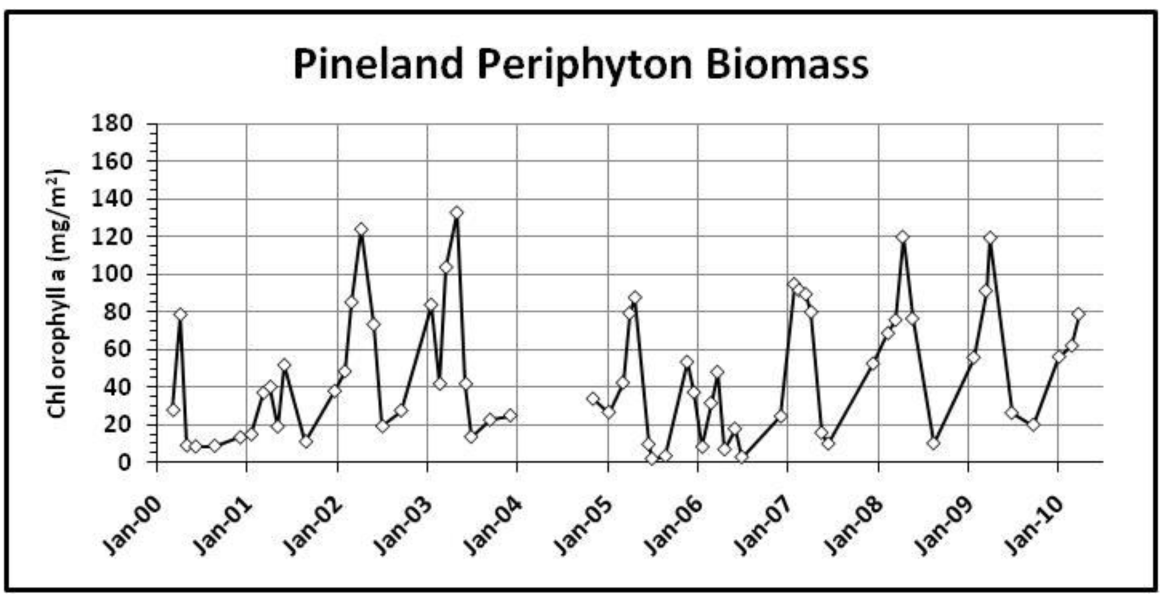


Figure 21 c. Pineland periphyton biomass (chlorophyll *a*) 2000-2010.

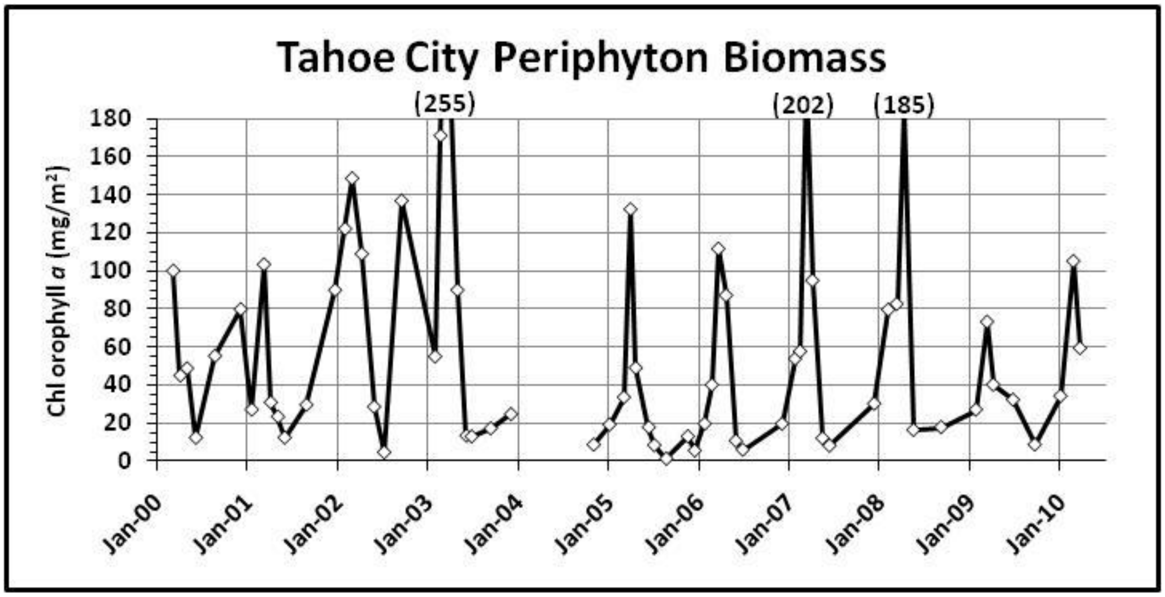


Figure 21 d. Tahoe City periphyton biomass (chlorophyll *a*) 2000-2010.

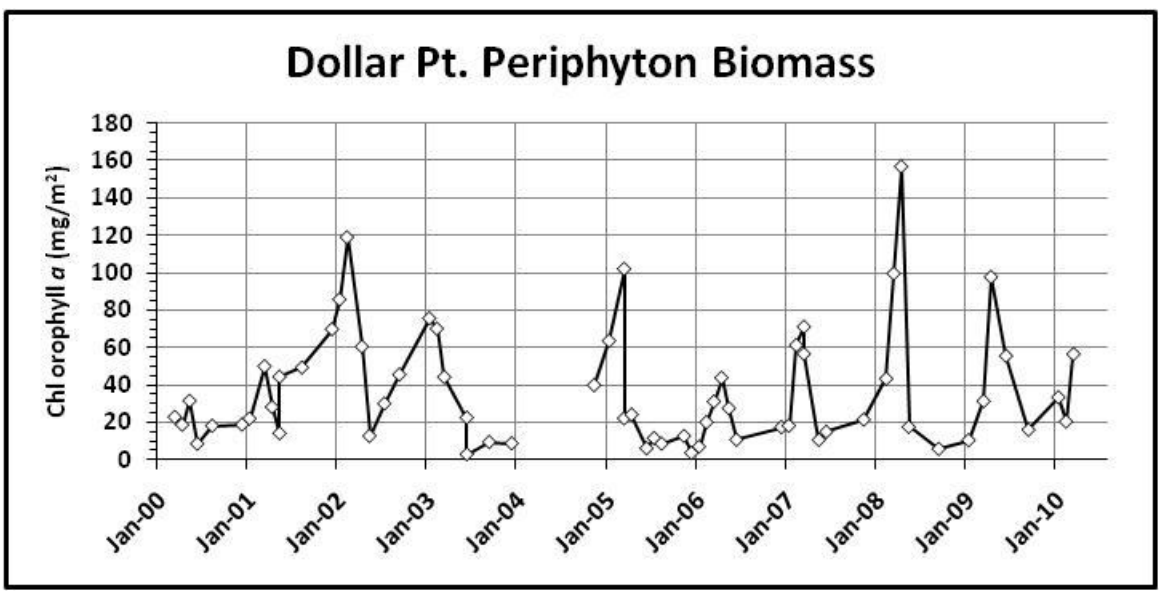


Figure 21 e. Dollar Pt. periphyton biomass (chlorophyll *a*) 2000-2010.

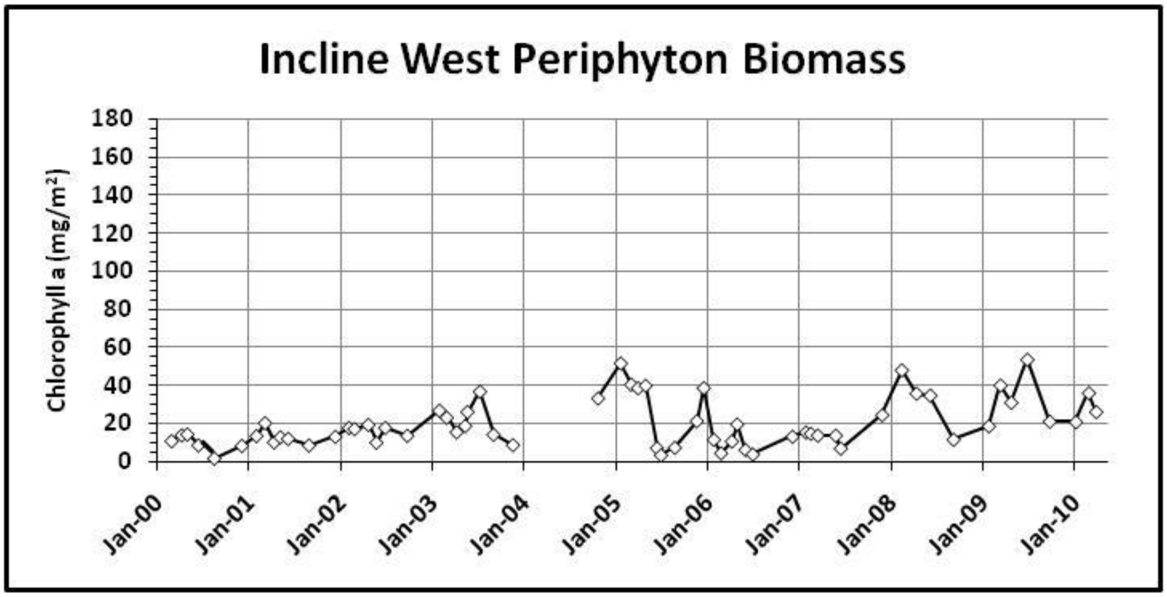


Figure 21 f. Incline West periphyton biomass (chlorophyll *a*) 2000-2010.

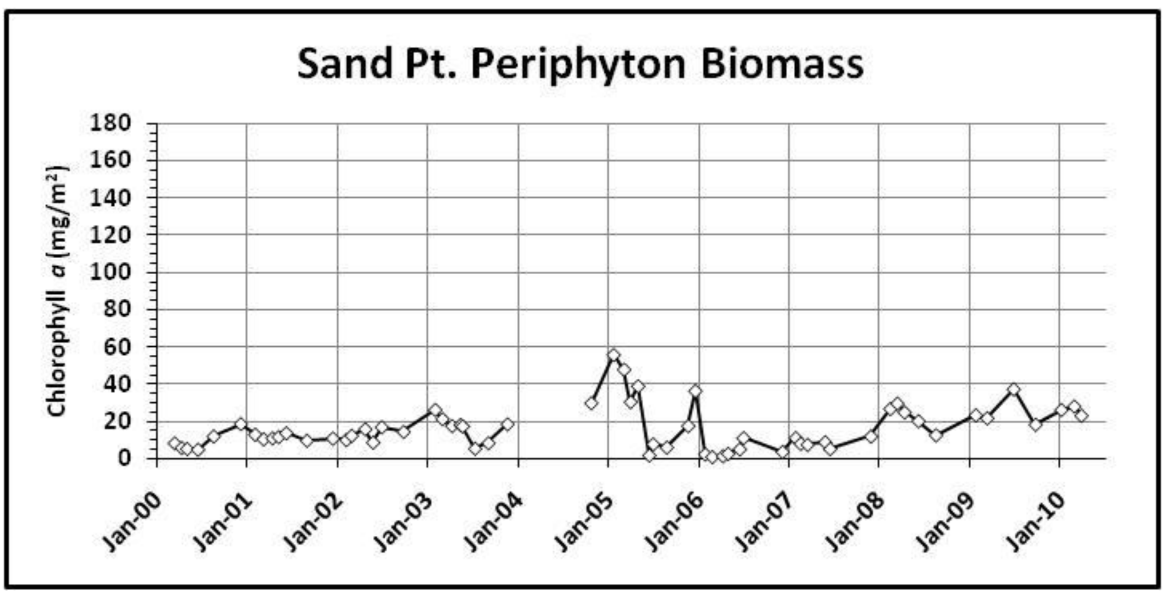


Figure 21 g. Sand Pt. periphyton biomass (chlorophyll *a*) 2000-2010.

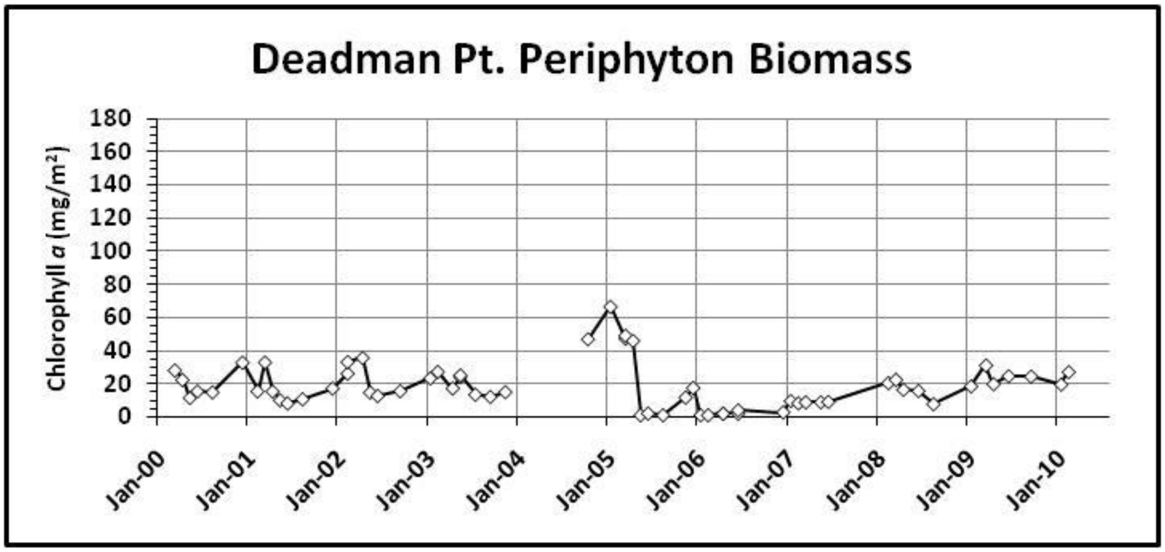


Figure 21 h. Deadman Pt. periphyton biomass (chlorophyll *a*) 2000-2010.

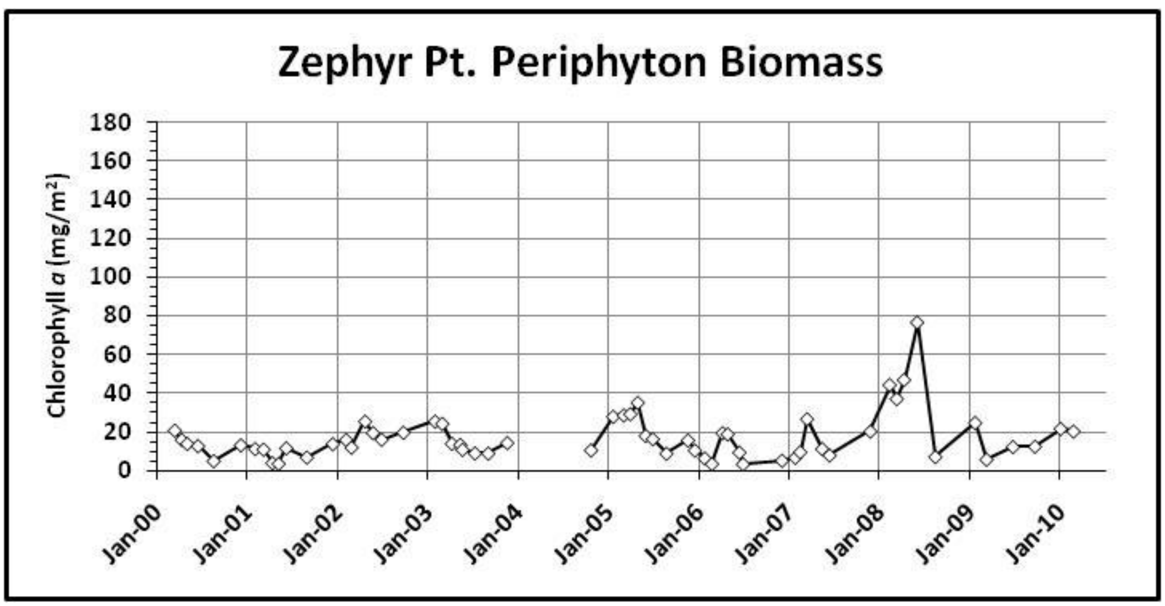


Figure 21 i. Zephyr Pt. periphyton biomass (chlorophyll *a*) 2000-2010.

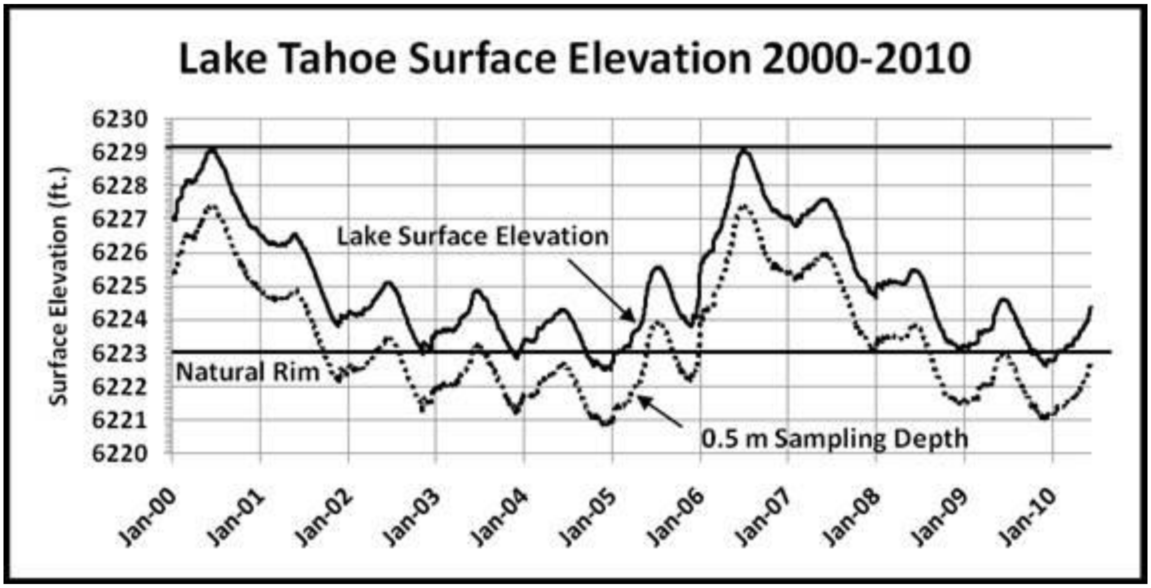


Figure 22. Fluctuation in Lake Tahoe surface elevation 1/1/00-6/13/10. Periphyton samples were collected during the period at a depth of 0.5m below the surface on natural rock substrata. The 0.5m sampling depth (shown as a dotted line) fluctuates with the lake surface elevation. The depth of the natural rim of Lake Tahoe is 6223 ft. The top 6.1 ft. of the lake above the rim are operated as a reservoir.

<u>Annual Maximum Biomass</u>

WY 2006-WY2009 maximum biomass values as estimated by chlorophyll *a* for all sites are shown in Figure 23. Similar to recent years, maximum annual biomass levels in WY 2009 were high in the northwest portion of the lake (Pineland, Tahoe City and Dollar Pt.). Peak biomass was also high at Rubicon Pt. in WY 2009. Annual maximum chlorophyll *a* values at Incline West, Sand Pt., Deadman Pt. and Sugar Pine Pt. in 2009 were lower and relatively close to levels observed in WY 2006-WY2008. At Zephyr Pt., the WY2009 annual maximum was similar to that observed in WY2006 and WY2007 but much less than the maximum in WY2008. As noted above peak biomasses observed in WY2008 were very high at Zephyr Pt., Rubicon Pt., Dollar Pt. and Tahoe City.

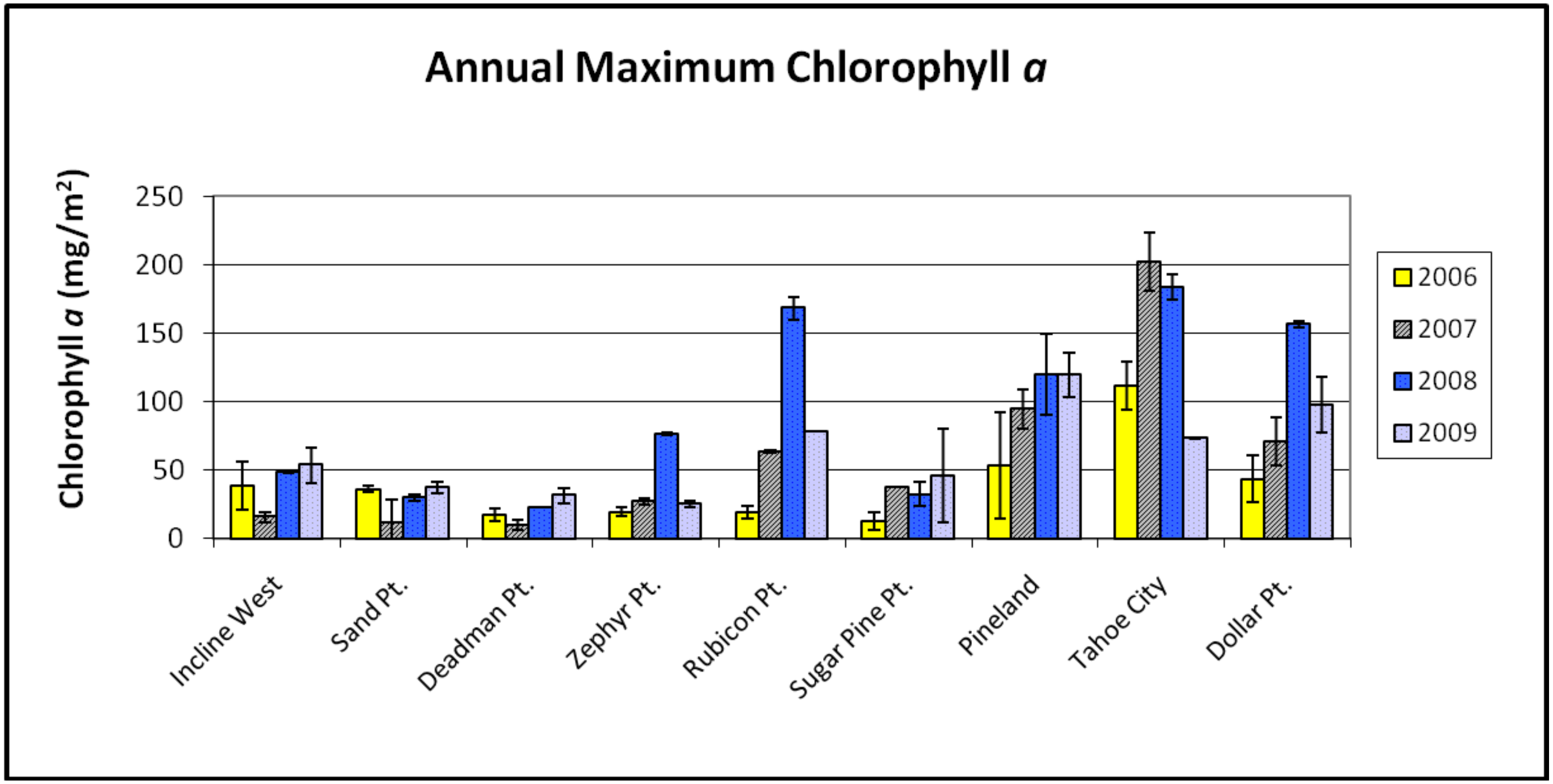


Figure 23. Annual maximum Chlorophyll *a* during Water Year 2009 compared with WY 2006-2008 at the nine routine periphyton monitoring sites at 0.5m. (*- Note, WY 2010 chlorophyll a data not yet complete).

Expanded Monitoring 2007-2010

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 samplings were done in the spring in which 30-40 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.

During spring 2008, 35 expanded sites were monitored visually while snorkeling. Measurements of filament length, % coverage, above and below water visual ranking, and observations on main algal types present were made. During 2009, 36 expanded sites were monitored visually as above. In addition biomass samples (chlorophyll *a* and AFDW were collected at 14 of the sites). Additional biomass monitoring was done at 3 sites along the South Shore (Tahoe Keys, Kiva Beach and So. Elks Pt. to better understand seasonal patterns in growth at these sites. During 2010, 36 expanded sites were monitored visually as above. In addition biomass samples (chlorophyll *a* and AFDW were collected at 7 of the sites. Monitoring was also done before and after a strong storm-related wind and wave event (April 27, 2010) at seven sites to check the impact of wave activity on biomass.

Biomass Index

At all expanded sites, a "biomass Index" was calculated for each date to approximate the level of biomass present. During 2007-2010 we did not collect biomass samples at all expanded monitoring sites due to time constraints. It was desirable to be able to estimate biomass rapidly in the field if possible based on measurable features of the algae growth. During this period we experimented with use of a "Biomass Index" to estimate levels of biomass present. The Biomass Index was calculated by multiplying the filament length times the % coverage of algae over the rock. Higher biomass should be associated with more material over the rock.

Data available for 2007-2010 from monitoring done at routine sites for Chlorophyll *a* and AFDW was used to assess the extent to which Biomass Index provides a good indication of biomass present.

First, data for Chlorophyll *a* and AFDW were compared to find the degree of association between these two commonly used estimates of biomass (Figure 24). A good association was found (R^2= 0.63). Chlorophyll *a* is used as an indicator of live algal biomass present, while Ash Free Dry Weight provides an indicator of all organic material present (includes algae, detritus and other organic material). Note there is a fair amount of scatter in the relationship (not all biomass present is necessarily chlorophyll containing, and in the case of biomass associated with the stalked diatom Gomphoneis, much of the material is stalk material which does not contain chlorophyll *a*).

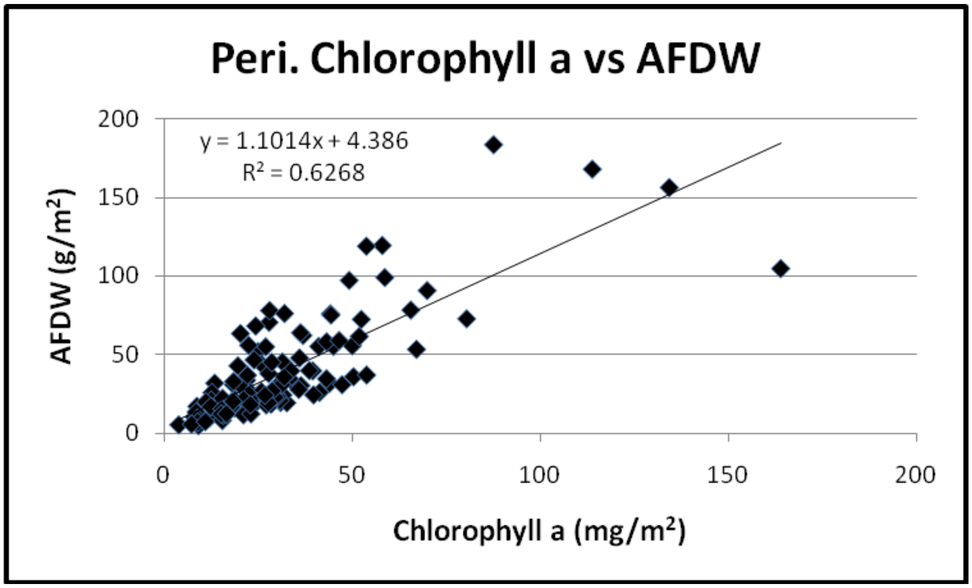


Figure 24. Degree of association between two measures of periphyton biomass chlorophyll a and Ash Free Dry Weight (AFDW) for 2007-2010 routine monitoring samples.

Next we looked at the extent to which calculated Biomass Index was associated with chlorophyll *a* (Figure 25). A fair association was found between chlorophyll a and Biomass Index during the period of the study (R^2= 0.56). There was more scatter than for the relationship between AFDW and chlorophyll, but it appeared Biomass Index roughly corresponds to chlorophyll *a* biomass.

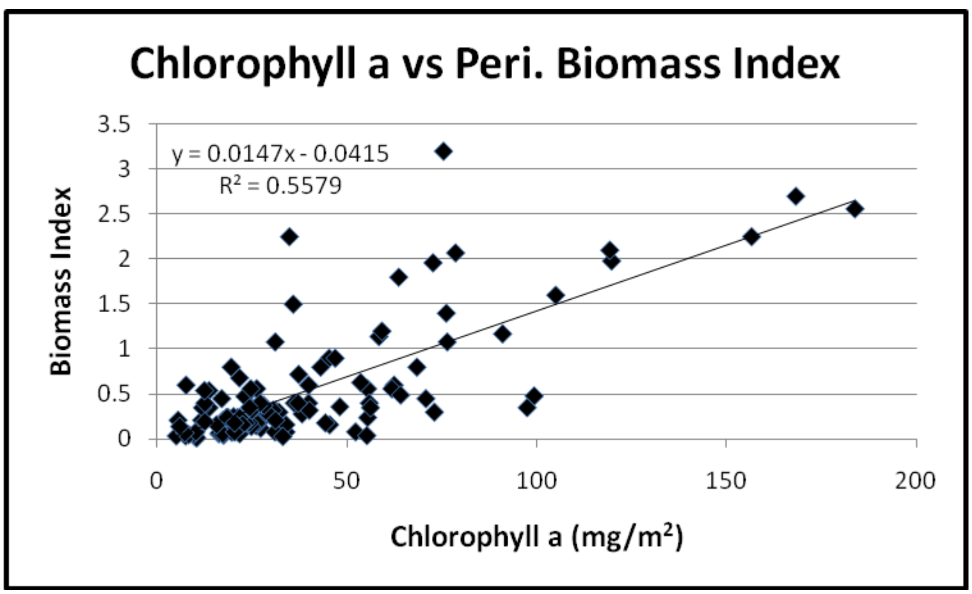


Figure 25. Degree of association between chlorophyll *a* and biomass index for 2007-2010 routine periphyton monitoring samples.

Finally we looked at degree to which Biomass Index corresponds to underwater visual ranking. In our field surveys we typically visually rank the level of growth on the rock (from 1 to 5 where 1 is clean rock and 5 is very heavy growth, worst appearing aesthetically). Visual ranking is ultimately a subjective measure which takes into account all visual aspects of the algae growth, filament length, coverage, color and relies on familiarity of the research divers with different levels of growth around the lake. The Biomass index incorporates measurable features of the growth. Periphyton Biomass Index also showed an association with the underwater visual rankings. Figure 26 shows the underwater visual rankings plotted against the Biomass Index. A fair association was found R^2= 0.60. This makes sense, since degree of coverage and filament length are considered when making the subjective ranking of growth.

It is interesting to note for this particular set of data, when Biomass Index was above a value of "1" it often (but not always) corresponded to higher visual rankings of 4 (which is heavy growth) or 5 (which is very heavy, worst appearing). So the biomass index appeared to have utility as a rough estimator of biomass, as well as a rough indicator of underwater ranking. In the maps of periphyton distribution that follow, since we did not have a complete chlorophyll data set for all sites, maps of distribution were based on Biomass Index.

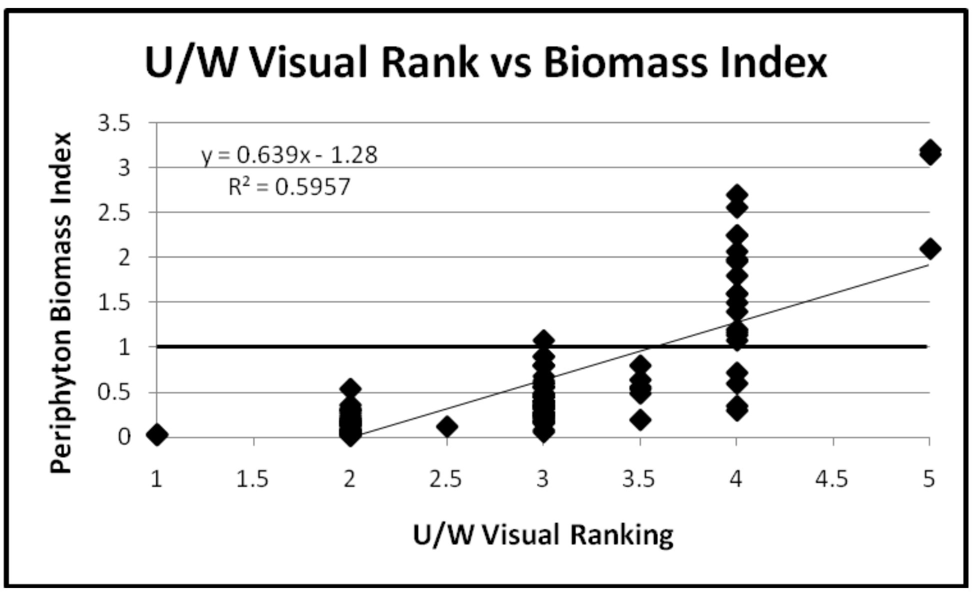


Figure 26. Degree of association between underwater visual ranking and periphyton biomass index for 2007-2010 routine periphyton samples. Note for biomass index values of 1 or greater, the underwater visual ranking was often indicated as a 4 or 5, with "4" indicating heavy growth and "5" very heavy growth, worst appearing conditions.

Table 8. Periphyton expanded monitoring locations.

SITE DESIGNATION	SITE NAME	LOCATION
	WEST SHORE	
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
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
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

2008 Synoptic Results

Results for the expanded monitoring done May 19 – June 5, 2008 are presented in Table 9 and depicted graphically in Figure 27. This synoptic monitoring was done somewhat after the peak growth at many sites along the west shore. At many sites along the west shore, the *Gomphoneis* was apparently in different states of sloughing from the rocks. In some areas however, very thick *Gomphoneis* was still growing near the surface (i.e. Rubicon Pt. near the surface, Gold Coast, South Meeks Pt., Ward Cr. Mouth, Pineland, Tahoe City Tributary, So. Dollar Pt.). These sites generally had higher visual scores (4 or 5) reflecting poor aesthetic appearance of algae nearshore and higher Biomass Index values (most were >1). A few sites had very little periphyton and sloughing of the algae may have already occurred at these (Blackwood Cr., Tahoma, North Sunnyside). It is important to note that due to the issue of variable timing of growth and subsequent die-off of periphyton at various locations around the lake, 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.

While *Gomphoneis* growth appeared to dominate the algal assemblage at many sites along the west shore, blue-green algae and some green filamentous algae were also noted as part of the algal assemblage. Blue-green algae were noted at sites from Cascade Cr. to Rubicon Pt., and at Sugar Pine Pt. Blue green algae may have been more prevalent then noted, potentially hidden under the overlying *Gomphoneis* growth. Green filamentous algae were noted in the algal assemblage at the E. Bay/ Rubicon area, Gold Coast, Rubicon Pt., Sugar Pine Pt, and So. Fleur Du Lac sites.

Along the northwest and north shores generally moderate levels of periphyton growth were observed. Visual scores and Biomass Index values were generally in the moderate range (visual score about 3; Biomass Index usually < 1). Much of the growth along this stretch was also attributable to *Gomphoneis*. Growth of *Gomphoneis* was particularly heavy at South Dollar, Brockway springs and Incline West, which all had underwater visual scores of 4 and Biomass Index values >1. Blue-green algae were noted at Agatam boat launch, Burnt Cedar Beach, North Stateline Pt.

Green filamentous algae were also noted to be part of the assemblage at several locations including North Stateline Pt., Brockway Springs and Incline West.

Along the east shore, levels of periphyton growth were light to moderate. Visual scores were generally 2's and 3's and Biomass Index values generally < 1. Exceptions were Chimney Beach, North Zephyr Cove and So. Side of Zephyr Pt. where although visual scores were 3's, the Biomass Index was elevated, near 1. At almost half the sites much of the growth was again due to *Gomphoneis*. However, at many sites blue-green algae and green filamentous algae also made a significant contribution to the algal assemblage: Such was the case for South Deadman Pt., and Skunk Harbor. At Deadman Pt. and Observation Pt. the whole assemblage appeared to be blue-green algae and green filamentous algae.

Growth of periphyton was low at the two south shore sites monitored. At the Tahoe Keys and Kiva sites algal growth apparently had already peaked. Visual scores were low 1-2 and Biomass Index less than 0.15. Only a small amount of *Gomphoneis* was observed.

Overall, growth of periphyton during late May and early June lake-wide was generally moderate, with some areas still having quite significant growth. There were some areas of noticeably higher growth than in recent years (i.e. Rubicon Pt., and Zephyr Pt). The stalked diatom *Gomphoneis* appeared to dominate the biomass in many areas around the lake. However, the *Gomphoneis* appeared to be in process of sloughing at many sites. Green filamentous algae and blue-green algae also were a significant part of the periphyton at some sites from the west, north and east regions of the lake. At some east shore sites the blue-green algae and filamentous green algae appeared to predominate in the algal assemblage.

<u>Algal Blooms in the Southeast Portion of the Lake During Summer 2008</u>

It should be noted that the summer of 2008 was also extremely interesting as a bloom of masses of bright green filamentous algae *Zygnema* occurred in Marla Bay just above the bottom. This algae was not strictly attached to rocks or other substrate as periphyton, nor strictly free-floating, but was found as large clumps or masses hovering just above the bottom. (Such algae which is neither strictly attached as periphyton nor strictly planktonic as phytoplankton is called metaphyton.) TERC was involved with much work related to this bloom. For more information specifically related to this bloom the reader is directed to Wittmann et al. (2008).

<u>Visual Observations of Green filamentous Algae Growth During Summer 2008</u>

During August 2008, bright green algal growth had been reported to be present along some areas of the east shore. Our inspection of the rocky shoreline at Sand Harbor showed some bright green filamentous algae growing near or just above the surface of the water on some areas of boulders impacted by waves. The bright green filamentous algae was an attached form of *Zygnema*. Typically, the level of periphyton growth is relatively low around much of the lake during the summer. So it was of interest to provide more documentation on the presence of green filamentous algae which was very noticeable on rocks in some areas of the lake.

To learn more about the overall distribution of the filamentous green algae in around the lake during August and September we did a very basic lake-wide visual survey for presence of bright green attached algae at or above the surface on rocks. Observations were made on presence or absence of bright green filamentous algae near or above the surface on rocks from boat or from shore. At several sites, samples of periphyton at the were also collected for species identification. We present here some initial observations from this work done late in the summer 2008.

The results of this survey showed that during August and September 2008, bright green attached algae were present to some degree on rocks at or just above waterline in many areas of the lake (Table 10). This bright green algae often covered only a portion of the exposed rock surfaces, yet still was visually quite noticeable. There was also significant blue-green algae at or above the surface in many areas due to a rapidly lowering lake level. This algae appeared as dark-colored organic material above the water line. The blue-greens and green filamentous algae were found together at many sites. It is interesting to note that green filamentous algae had been observed earlier in the year during the expanded monitoring in May and June submerged at many but not all sites where it was found later in the summer.

The filamentous algae and blue green algae was sampled at several sites for species identification during the late summer survey. The bright green algae was found to be the attached form of *Zygnema* at many of these sites. The blue green algae appeared to include *Dichothrix* and other species.

The survey also showed interesting presence of some other green filamentous algae in certain areas of the lake. Near Garwoods a darker green *Cladophora*-like filamentous algae was found growing over a thick covering of diatoms (*Cymbella*). At South Shore, off El Dorado Beach, some similar thick growth of a green *Cladophora*-like filamentous algae was also found on some rocks. Definitive identification of this *Cladophora*-like filamentous algae still must be made. In addition *Sprirogyra* was found on rocks near the Timber Cove pier. Significant algal metaphyton was found in the south east portion of the lake during this survey and during the bloom-related work (see Wittmann et al. 2008).

We are continuing to analyze the most recent periphyton data to understand patterns and significance of periphyton growth during summer 2008. The above observations were included to keep the Basin's resource agencies up-to-date with our recent observations of growth around the lake. Again, these findings should <u>not</u> be used at this time to support policy decisions.

Table 9. Summary of visual survey of relative levels of periphyton growth at 0.5m for expanded sites clockwise around the lake beginning in the SW corner at Cascade Cr.. Survey was performed by snorkeling, data collected included above water "Above" and below water "Below" visual score, avg. filament length and % algal coverage May 19 – June 5, 2008. Visual score is a subjective ranking of the aesthetic appearance of algal growth (where 1 is the least offensive and 5 is the most offensive). Biomass Index was a metric developed for rapid assessment of level of periphyton present based on % Area covered X Filament Length.

Site	Site Name	Date	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Coverage %	Biomass Index Fil L x % Cover	Algal Type
A	Cascade Creek	5/23/08	2	2	0.6	50%	0.30	SD,CY
B	S. of Eagle Point	5/23/08	2	3	1.2	80%	0.96	SD,CY
C	E.Bay/Rubicon	5/23/08	3	3	0.5	80%	0.40	FG,SD,CY
D	Gold Coast	5/23/08	3	4	1.5	70%	1.05	SD,FG
E	S. Meeks Point	5/23/08	4	4	2.2	40%	0.88	SD
G	Tahoma	5/23/08	1	2	0.4	70%	0.28	SD
H	S. Fleur Du Lac	5/19/08	3.5	3.5	1.5	70%	1.05	SD,FG
I	Blackwood Creek	5/23/08	1	1	0.0	5%	0.00	-
J	Ward Creek	5/23/08	4	5	6.0	50%	3.00	SD
K	N. Sunnyside	5/19/08	2	2	0.5	40%	0.20	SD
TCT	Tahoe City Tributary	5/19/08	4	4	1.8	60%	1.08	SD
M	TCPUD Boat Ramp	5/19/08	3	3	0.2	20%	0.04	SD
O	S. Dollar Creek	5/28/08	3	4	2.0	70%	1.4	SD
P	Cedar Flat	5/28/08	2	3	1.0	50%	0.50	SD
Q	Garwood's	5/28/08	2	2	0.5	60%	0.30	SD
R	Flick Point	5/28/08	2	3	1.2	70%	0.84	SD,FG
S	Stag Avenue	5/28/08	1	2	0.7	50%	0.35	SD
T	Agatam Boat Launch	6/4/08	2	2	<0.1	30%	0.03	SD,FG
E17	Kings Beach	6/4/08	3	3	0.2	50%	0.10	SD
E16	Brockway Springs	6/4/08	3	4	1.5	90%	1.35	SD,FG
E15	North Stateline Point	6/5/08	3	3	0.6	50%	0.30	FG,SD,CY
E13	Burnt Cedar Beach	6/5/08	3	3	0.5	50%	0.25	SD,CY
E11	Observation Point	6/5/08	3	3	0.5	40%	0.20	FG,CY

Site	Site Name	Date	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Coverage %	Biomass Index Fil L x % Cover	Algal Type
E10	Chimney Beach	6/2/08	3	4	1.2	90%	1.08	SD
E9	Skunk Harbor	6/5/08	3	3	0.4	50%	0.20	FG,SD,CY
E8	South Deadman Point	6/5/08	3	3	0.7	80%	0.56	SD,FG**,CY
E7	South Glenbrook Bay	6/5/08	2	2	0.6	80%	0.48	SD,FG**
E6	Cave Rock Ramp	6/2/08	2	3	0.5	50%	0.25	SD
E5	Logan Shoals	6/5/08	1	1	0.3	5%	0.02	SD,FG**
E4	North Zephyr Cove	6/5/08	3	3	1.5	60%	0.90	SD,FG**
E3	South Side of Zephyr Pt	6/5/08	3	3	1.4	70%	0.98	SD
E2	North Side of Elk Point	6/5/08	-	2	0.2	40%	0.08	SD
E1	South side of Elk Point	6/2/08	3	3	0.3	70%	0.21	SD
S1	Tahoe Keys Entrance	5/27/08	1	2	0.1	30%	0.03	SD
S2	Kiva Point	5/27/08	2	2	0.3	40%	0.12	SD

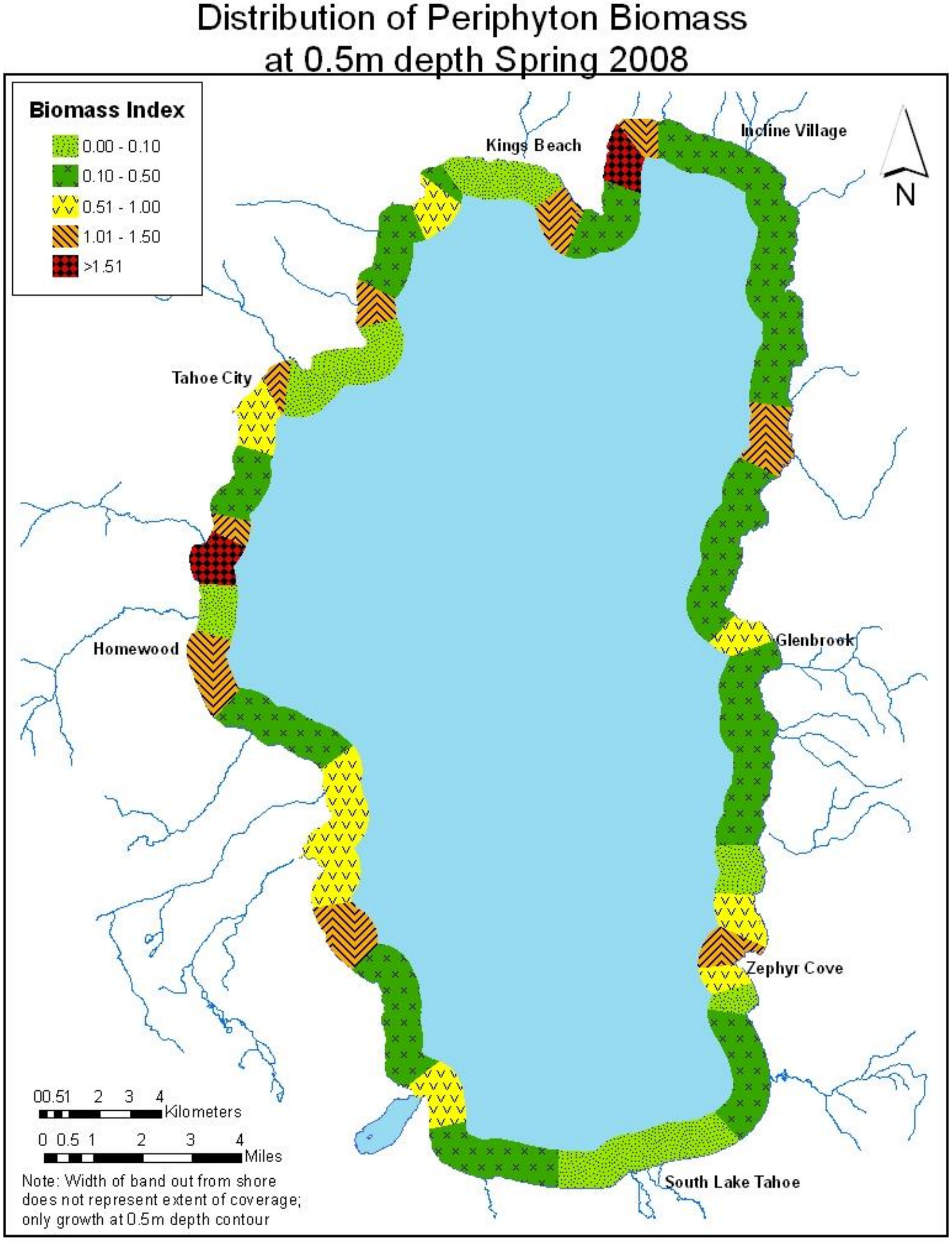


Figure 27. Extrapolated regional distribution of periphyton biomass measured as Biomass Index (Avg. Filament Length x % Area Covered with Algae) during May 19 – June 5, 2008.

Table 10. Visual survey of presence of bright green attached filamentous algae on rocks at the surface around the lake August-September 2008.

Site	Site Name	Date	Bright Green Attached Algae on rocks At Surface?
C	E.Bay/Rubicon	9/16/08	yes
	Rubicon Pt.	9/16/08	yes
E	S. Meeks Point	9/16/08	yes
	Sugar Pine Pt.	9/16/08	yes*
	Kaspian Campground	9/17/08	no
	Kaspian Pt.	9/17/08	yes*
	Pineland	9/16/08	yes*
TCT	Tahoe City Tributary	9/8/08	no**
M	TCPUD Boat Ramp	9/8/08	no
	Dollar Pt.	9/8/08	yes
Q	Garwood’s	9/5/08	no**
R	Flick Point	9/5/08	yes
S	Stag Avenue	9/5/08	yes
E17	Kings Beach	9/8/08	yes*
E16	Brockway Springs	9/5/08	yes
E15	North Stateline Point	9/5/08	yes
E14	Stillwater Cove	9/5/08	yes
	Incline West	9/5/08	yes
E13	Burnt Cedar Beach	9/5/08	yes
E12	Hidden Beach	9/5/08	yes
E11	Observation Point	9/5/08	yes
	Sand Harbor	8/14/08	yes
	Sand Point	8/15/08	yes
E9	Skunk Harbor	8/22/08	yes
	Deadman Point	8/15/08	yes
E8	South Deadman Point	8/22/08	yes
E7	South Glenbrook Bay	8/22/08	yes
E6	Cave Rock Ramp	8/22/08	yes
E5	Logan Shoals	8/22/08	yes
E4	North Zephyr Cove	8/22/08	yes
E1	Elk Pt	8/15/08	no
	Timber Cove Pier	10/1/08	no**
	El Dorado Beach	10/1/08	no**

*- very small amount of bright green algae on rocks at surface
** - other attached green filamentous algae present just below surface

2009 Expanded Monitoring Results

Results for the expanded monitoring done in 2009 are presented in Table 11 and presented graphically in Figure 28. The expanded monitoring was divided into two periods this year. The west and north shores were sampled 3/31/09 – 4/16/09, a period when significant growth was observed there at many sites. Since growth of periphyton appeared to peak later in the spring and early summer along the east shore, we sampled there from 6/11/09-6/18/09. Some sites along the east shore ultimately may have been sampled past the peak. Again, it is important to note that due to the issue of variable timing of growth and subsequent die-off of periphyton at various locations around the lake, 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.

Along much of the west and northwest shores growth was variable with areas of heavy growth (underwater visual scores of 4-5 and Biomass Indexes > 1) interspersed among stretches with low-to-moderate growth (Biomass Indexes < 1). From Cascade Creek to So. Meeks Bay, growth was generally light. Growth was relatively high at the Emerald Bay/ Rubicon site (visual score of 4, Biomass Index 1.2). From Tahoma to Agatam growth was variable (Biomass Index ranged from 0.21 to 4.0). Sites with very heavy periphyton growth (underwater visual scores of 5; Biomass Index >1) along the west and north portions of the lake included: a site near the mouth of Ward Cr. (Chlor. *a* was 211.26 mg/m^2), Tahoe City Tributary (Chlor. *a* was 118.54 mg/m^2), TCPUD boat ramp, and South Dollar Cr. These sites are in the northwest region of the lake where routine monitoring also indicates typically heavier spring growth. The algae at most of these sites appeared to be a mix of stalked diatoms and filamentous greens. At the Tahoe City Boat Ramp the assemblage appeared to be mostly stalked diatoms.

Along the stretch from Kings Beach to Burnt Cedar Beach in Incline Village, growth was moderate (visual scores of 3-4). Biomass index values were less than 1. Along the east shore from Observation Pt. to So. Elks Pt. generally moderate growth was observed in June (Biomass Index values were <1).

Growth of periphyton at three of the South Shore sites was monitored on four different dates during the period February to July 2009, this was more intensive than in the past. This monitoring was done to provide additional information for the SNPLMA Nearshore study and for our long-term monitoring. This monitoring provided valuable information on growth patterns and biomass peaks for periphyton in the South. At Kiva Beach, the highest biomass there was measured on March 20, 2009 and was very high (103.28 mg/m^2). Surprisingly large amounts of stalked diatoms were growing over the rocky substrate offshore of the sandy beach area at the Kiva site. Near the Tahoe Keys East Channel entrance, the peak biomass was measured on February 3, 2009 and found to be 83.79 mg/m^2. The algal assemblage was primarily filamentous green algae. Biomass at the So. Elks site was highest on the May 15, 2009 sampling and found to be 38.10 mg/m^2. The algal assemblage on that date was a mix of stalked diatoms and filamentous green algae.

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), water temperature for expanded periphyton monitoring sites during 2009. 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. "na" = not available or not collected; "nes" = not enough sample for analysis.

Site	Site Name	Date	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 Coverage %	Biomass Index	Algal Type	T ºC
A	Cascade Creek	3/31/2009	26.93	3.57	11.80	5.02(n=3)	2	2	1.0	70%	0.7	FG	6.0
B	S. of Eagle Point	3/31/2009					2	2	0.5	30%	0.15	SD,FG	
C	E.Bay/Rubicon	3/31/2009					4	4	2.0	60%	1.20	SD,FG	
D	Gold Coast	3/31/2009					2	2	1.2	50%	0.60	SD,FG	6.0
E	S. Meeks Point	3/31/2009	17.44	5.54	19.35	6.34(n=3)	2	2	0.8	70%	0.56	FG,CY	5.9
G	Tahoma	3/31/2009					3	3	0.5	60%	0.30	SD	
H	S. Fleur Du Lac	3/31/2009					3	4	1.2	80%	0.96	FG,SD	7.5
I	Blackwood Creek	3/31/2009					2	3	0.3	70%	0.21	SD,SD,FG	6.5
J	Ward Creek	3/31/2009	211.26	22.68	80.35	17.46(n=3)	4	5	3.5	90%	3.15	SD,FG	5.5
K	N. Sunnyside	3/31/2009					3	3	1.0	60%	0.60	FG,SD	6.0
L	Tavern Pt.	3/31/2009					3	3	0.7	60%	0.42	SD,FG	8.8
TCT	Tahoe City Trib.	4/16/2009	118.54	41.20(n=3)	86.99	6.69(n=3)	5	5	4.0	100%	4.00	SD	7.0
M	TCPUD Boat R.	4/7/2009					5	5	1.5	70%	1.05	SD,FG	
N	S. Dollar Pt.	4/7/2009					2	3	0.5	40%	0.20	SD	
O	S. Dollar Creek	4/7/2009					5	5	3.5	80%	2.80	SD,FG	7.5
P	Cedar Flat	4/7/2009					3	3	0.7	60%	0.42	SD,FG	
Q	Garwood's	4/7/2009	74.77	16.41(n=3)	49.27	12.36(n=3)	NA	4	1.7	50%	0.85	SD,CY	7.0
R	Flick Point	4/7/2009					2	3	0.5	70%	0.35	SD,FG	8.0
S	Stag Avenue	4/7/2009					2	3	0.5	70%	0.35	SD,FG	8.0
T	Agatam Boat L.	4/7/2009	52.12	6.55(n=3)	33.81	5.96(n=3)	2	3	0.75	60%	0.45	SD	8.0
E1	So. side of Elk Pt	5/15/2009	38.10	13.56	27.12	6.32	NA	4	1.0	100%	1.00	SD,FG	
E4	No. Zephyr Cove	6/18/2009					3	3	0.5	50%	0.25	FG,SD	
E5	Lincoln Park	6/18/2009	18.07	3.72	22.93	0.47	2	3	0.5	50%	0.25	FG,CY	
E6	Cave Rock Ramp	6/11/2009	21.46	5.45	29.57	4.16	3	4	0.5	80%	0.40	FG,SD,CY	14.0
E7	So.Glenbrook Bay	4/10/2009					2	2	0.5	60%	0.30	CY,FG	6.5
E8	So. Deadman Pt.	4/10/2009					2	2	0.3	20%	0.06	SD,FG	6.0

Site	Site Name	Date	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 Coverage %	Biomass Index	Algal Type	Temp ºC
E8	So. Deadman Pt.	6/18/2009					3	3	0.7	50%	0.35	FG,CY	
E9	Skunk Harbor	6/18/2009					3.5	3.5	0.7	90%	0.63	FG,CY	
E10	Chimney Beach	6/11/2009	10.34	0.26	10.94	0.90	3	3	0.5	70%	0.35	SD,FG,CY	13.5
E11	Observation Point	6/18/2009	31.06	6.28	35.18	7.61	NA	3	1.0	70%	0.70	CY,SD,FG	
E13	Burnt Cedar Bch	4/16/2009	8.45	1.09(n=3)	15.47	4.05(n=3)	3	3	0.2	70%	0.14	SD,FG,CY	
E14	Stillwater Cove	4/22/2009					3	4	0.6	60%	0.36	FG,CY	
E15	North Stateline Pt	4/22/2009					3	3	0.3	70%	0.21	FG,CY	
E16	Brockway Springs	4/22/2009					3	4	0.7	70%	0.49	SD,FG,CY	9.2
E17	Kings Beach R.	4/16/2009					3	3	1.5	50%	0.75	SD	7.5
S1	T. Keys Entrance	3/20/2009	6.49	2.17	1.57	0.50	2	2	0.4	50%	0.20	SD,FG	
S2	Kiva Point	3/20/2009	103.28	0.50	60.40	4.91	NA	4	1.5	90%	1.35	SD	
E1	So. Elk Pt	2/3/2009	8.48	(n=1)	6.15	3.14	1	1	0.2	10%	0.02	SD	5.5
E1	So. Elk Pt	3/20/2009	7.42	0.50	3.66	0.72	NA	3	0.2	65%	0.13	SD,CY	6.5
E1	So. Elk Pt	5/15/2009	38.10	13.56	27.12	6.32	NA	4	1.0	100%	1.00	SD,FG	9.8
E1	So. Elk Pt	7/2/2009	32.42	15.42	30.79	6.40	3	4	0.9	80%	0.72	SD,FG	18.0*
S1	T. Keys Entrance	2/3/2009	83.79	39.76	40.52	2.75	3	3	0.4	40%	0.16	FG	4.0
S1	T. Keys Entrance	3/20/2009	6.49	2.17	1.57	0.50	2	2	0.4	50%	0.20	SD,FG	8.0
S1	T. Keys Entrance	5/13/2009	5.32	3.66	4.38	1.87	NA	3	0.2	40%	0.08	SD	14.5
S1	T. Keys Entrance	6/30/2009	4.30	0.41	3.62	(n=1)	3	2	0.2	50%	0.10	SD,FG	20.0
S2	Kiva Point	2/3/2009	25.66	1.91	21.29	1.35	NA	3	0.4	80%	0.32	SD	5.5
S2	Kiva Point	3/20/2009	103.28	0.50	60.40	4.91	NA	4	1.5	90%	1.35	SD	8.5
S2	Kiva Point	5/13/2009	27.59	8.83(n=3)	19.80	5.99	NA	3.5	1.2	80%	0.96	SD	13.0
S2	Kiva Point	6/30/2009	1.92	0.54	4.37	5.26	NA	2	NA	30%	NA	SD	18.0

Note - *-Temperature on this date collected adjacent to pier leading to rocks at end of pier rather than at rocks at end of pier.

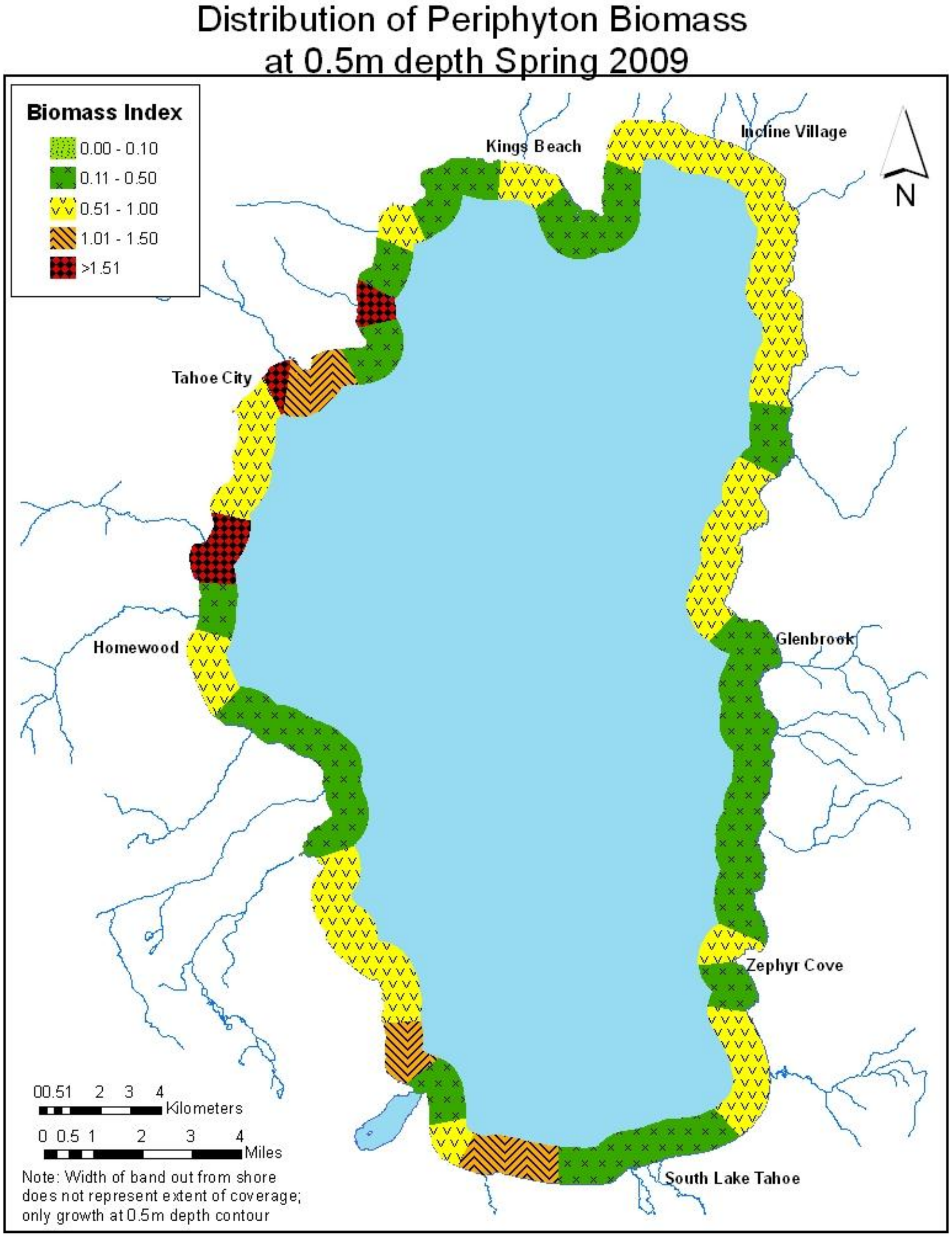


Figure 28. Extrapolated regional distribution of periphyton biomass measured as Biomass Index. The west and north shores were sampled 3/31/09 – 4/16/09, a period when significant growth was observed there at many sites. Since growth of periphyton appeared to peak later in the spring and early summer along the east shore, we sampled there from 6/11/09-6/18/09.

2010 Expanded Monitoring Results

Results for the expanded monitoring done in 2010 are presented in Table 12 and presented graphically in Figure 29. Monitoring was done from April 13 to May 12, 2010. Along much of the west and northwest shores growth was variable with areas of heavy growth (underwater visual scores of 4-5 and Biomass Indexes > 1) interspersed among stretches with low-to-moderate growth (Biomass Indexes < 1). There appeared to be more areas with heavy growth in 2010 compared with 2009. Sites with notably heavy biomass (visual score =5) included: Tahoma (Periphyton Biomass Index "PBI": 3); Ward Cr. mouth (PBI=4.95); and North Sunnyside (PBI=2.88), Tahoe City (PBI=4.95), Tahoe City Tributary (PBI=4.95) and South Dollar Creek (PBI=4.95). The heavy biomass at these sites appeared to be predominantly stalked diatoms (*Gomphoneis*), filamentous green algae were also mixed in at the North Sunnyside site. Algae present at the other sites in the west and northwest were mixed with either stalked diatoms predominating, or combinations of filamentous greens and blue greens, stalked diatoms and filamentous greens, stalked diatoms and blue greens and combinations of all three.

From Kings Beach around the east shore to South Lake Tahoe growth was low to moderate. Visual scores were in the moderate range for many sites (3) and Biomass Index values were less than 0.50. Algae types similar to the west shore consisted of various mixes of predominant types. For monitoring in 2010, we were only able include measurements through early May in the Synoptic. It is possible, growth peaked at some locations (i.e. particularly along the east shore) later in the spring or early summer.

During the middle of the expanded monitoring, on April 27, 2010 a spring storm with very strong winds (S/ SW gusts exceeding 60 mph) and high waves occurred. Past experience has indicated strong wave activity may result in removal of some biomass from rock surfaces. Since this storm occurred during the middle of our synoptic sampling it was desirable to learn more of the impacts of this event on the biomass. Monitoring was done on April 26 at seven sites from Tahoe City to Kings Beach and again on April 29 at the same sites after the storm. The information collected is included in Table 12. The wave activity did appear to cause some reduction of biomass (based on declines in biomass index). The most significant impacts appeared to be at the two sites in the Tahoe City area. Changes in Biomass Index included: Tahoe City (before storm PBI=1.60; after storm PBI=0.85); Tahoe City Tributary (before 2.7; after 1.25); Dollar Pt. (before 0.64; after 0.42); Garwoods (before 0.60; after 0.30); Stag (before 0.60; after 0.20); Agatam (before 0.12; after 0.09); Kings Beach (before 0.30; after 0.49). Moderate amounts of sloughed periphyton were observed along the bottom and along portions of lake shore at the Tahoe City site. So some decrease in periphyton may have occurred at some of the synoptic sites sampled after April 27 as a result of this storm event.

Several of the sites with very high biomass in 2010 have been frequently observed to have high biomass in past years. Spring synoptic monitoring was done in 2003 and then from 2005-2010 at the expanded sites. Sites which frequently have had underwater visual scores of 5 (worst appearing/ heaviest growth) have included Tahoe City Tributary (4 of 6 years), Ward Cr. mouth (4 of 7 years) and So. Dollar Cr. (3 of 7 years).

When chlorophyll a has been measured during these heavy years, the chlorophyll has always been above 100 mg/m^2. These three sites are tributary discharge sites in the northwest portion of the lake in the northwest region of the lake which has been shown in routine monitoring to have typically high levels of biomass at Pineland, Tahoe City and Dollar Pt. Nutrients in the stream discharge likely are contributing to growth at these sites. The Tahoe City Tributary also appears to receive urban inputs. Other factors may also be contributing to growth in these areas as well. (i.e. groundwater inputs, lake mixing/upwelling/ currents and substrate availability).

Table 12. 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 all expanded periphyton monitoring sites during 2010. 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. "na" = not available or not collected; "nes" = not enough sample for analysis. Notes: 1- These were sites revisited after a significant South-Southwest wind (max. gust 61 mph) and wave event on 4/27/10 to check for the impacts of this event on biomass along the northwest shore.

Site	SITE NAME	Date	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 Coverage (%)	Biomass Index	Algal Type	Temp ºC
A	Cascade Creek	4/13/2010					3	3	1	70%	0.70	SD,FG	5.5
B	S. of Eagle Point	4/13/2010					2	3	0.8	60%	0.48	SD,FG	5.4
C	E.Bay/Rubicon	4/13/2010					3	3	1.1	75%	0.83	SD,FG,CY	5.5
D	Gold Coast	4/13/2010	TBA		39.24	2.50	NA	2	0.7	30%	0.21	FG,CY	6.0
E	S. Meeks Point	4/13/2010					3	3	1.5	70%	1.05	FG,CY	5.8
F	No. Meeks Bay	4/13/2010					2	2	0.5	60%	0.30	FG,SD,CY	5.9
G	Tahoma	4/16/2010					NA	5	3	100%	3.00	SD	5.7
H	S. Fleur Du Lac	4/16/2010					2	3	1.3	80%	1.04	FG,SD,CY	5.6
I	Blackwood Creek	4/16/2010					1	2	0.2	40%	0.08	SD	5.5
J	Ward Creek	4/16/2010	TBA		51.97	18.97	NA	5	5.5	90%	4.95	SD	5.6
K	N. Sunnyside	4/16/2010					3	5	3.2	90%	2.88	SD,FG	6.0
	Tavern Pt.	4/16/2010					2	2	0.5	60%	0.30	SD,FG	
	Tahoe City	4/26/2010					4	4	2.0	80%	1.60	SD	10.0
	Tahoe City[1]	4/29/2010					3	4	1.7	50%	0.85	SD	7.0
TCT	Tahoe City Tributary	4/26/2010	TBA		78.11	13.15	5	5	3	90%	2.70	SD	
TCT[1]	Tahoe City Tributary	4/29/2010					5	5	2.5	50%	1.25	SD	7.0
M	TCPUD Boat Ramp	4/26/2010					4	4	2	70%	1.40	SD	
	Dollar Point	4/26/2010					3.5	3.5	0.8	80%	0.64	SD,FG,CY	9.0
	Dollar Point[1]	4/29/2010					NA	3	0.6	70%	0.42	SD,CY	7.0
O	S. Dollar Creek	5/3/2010	TBA		135.42	99.28	3	4	2.5	80%	2.00	SD	
P	Cedar Flat	5/3/2010					2	3	0.3	70%	0.21	SD,FG,CY	
Q	Garwood's	4/26/2010					3	3	1	60%	0.60	SD,FG	

Site	SITE NAME	Date	Chl a (mg/m²)	Std Dev (mg/m²)	AFDW (g/m²)	Std Dev (mg/m²)	Above Visual Score	Below Visual Score	Fil. Length (cm)	Algal Coverage (%)	Biomass Index	Algal Type	Temp ºC
Q[1]	Garwood's	4/29/2010					2	3	0.5	60%	0.30	SD,CY	7.0
R	Flick Point	5/3/2010					1	2	0.2	40%	0.08	SD,FG,CY	9.0
S	Stag Avenue	4/26/2010					NA	3	1	60%	0.60	SD,FG	
S[1]	Stag Avenue	4/29/2010					3	3	0.4	50%	0.20	SD,CY	9.0
T	Agatam Boat Launch	4/26/2010	TBA		30.84	1.34	NA	2.5	0.3	40%	0.12	SD	11.0
T[1]	Agatam Boat Launch	4/29/2010					3	2.5	0.3	30%	0.09	SD	9.0
E17	Kings Beach Ramp	4/26/2010					NA	3	0.5	60%	0.30	SD	10.5
E17[1]	Kings Beach Ramp	4/29/2010					NA	3	0.7	70%	0.49	SD	7.0
E16	Brockway Springs	5/3/2010					2	3	1	30%	0.30	SD,CY	9.0
E15	North Stateline Point	5/3/2010					3	3	0.3	70%	0.21	FG,CY	
	Stillwater Cove	5/3/2010					3	3	0.6	70%	0.42	FG,CY	7.4
E13	Burnt Cedar Beach	5/3/2010					2	2.5	0.2	60%	0.12	SD,CY,FG	7.5
	Hidden Beach	5/3/2010					3	3	0.2	80%	0.16	CY	7.0
E10	Chimney Beach	5/3/2010					3	3	0.4	70%	0.28	CY,FG,SD	6.5
E9	Skunk Harbor	5/3/2010					3	3	NA	90%	NA	FG,CY	7.0
E8	South Deadman Point	5/3/2010					3	3	0.3	70%	0.21	FG,SD,CY	7.0
E6	Cave Rock Ramp	5/12/2010					3.5	3.5	0.5	60%	0.30	FG,CY	
MB	Marla Bay	5/12/2010					2	3	0.7	60%	0.42	SD	
E1	South side of Elk Point	5/12/2010	TBA		12.72	1.82	NA	3.5	0.5	80%	0.40	SD,FG	8.0
S1	Tahoe Keys Entrance	5/12/2010					2.5	3	0.2	60%	0.12	SD,FG	14.0
S2	Kiva Point	4/13/2010			105.68	20.97	2	4	1.2	90%	1.08	SD	5.5

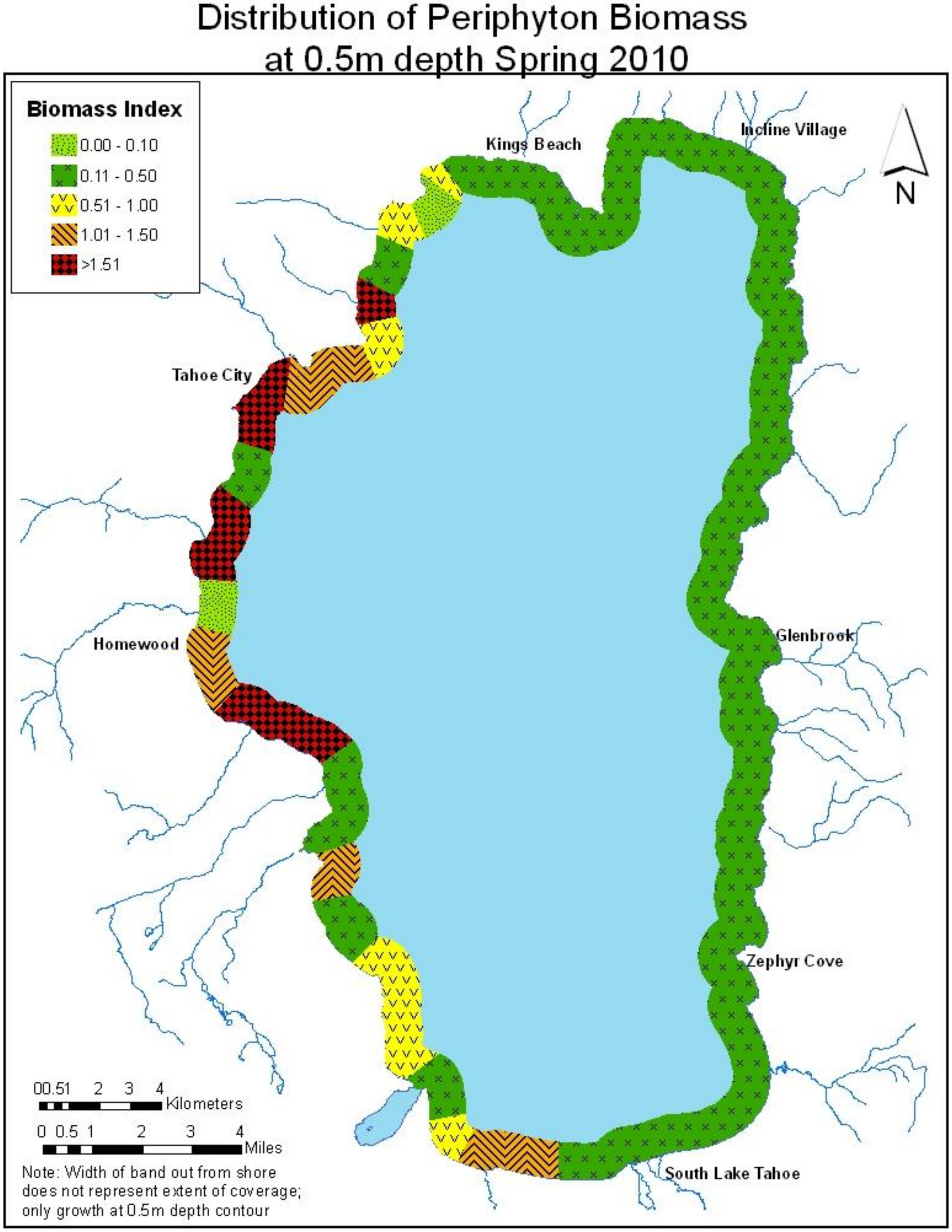


Figure 29. Extrapolated regional distribution of periphyton biomass measured as Biomass Index during April 13 – May 12, 2010.

Summary Points for Periphyton Monitoring

1. **Peak periphyton biomass has been consistently high in the urbanized northwest portion of the lake. Biomass along the east shore is typically low. The observed patterns are likely a combination of several interacting factors: nutrient inputs (e.g. surface runoff, enhanced inputs from urban/disturbed areas, groundwater, lake mixing/upwelling/ currents), lake level, substrate availability and perhaps even wind and wave action as they act to dislodge biomass from their bottom substrates.**

2. **Lake level fluctuation appears to play a role in amount of periphyton biomass observed in the shallow eulittoral zone (0.5m deep). During years when lake surface elevation is very low, biomass associated with the stable deeper blue-green algal communities is located close 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. Consequences of lowered lake levels on biomass are particularly noticeable for Incline West, Sand Pt., Deadman Pt., Sugar Pine Pt. and Rubicon Pt. sites. During periods of low lake elevation, noticeable increases in baseline biomass were observed at these sites.**

3. **In WY 2008 (Oct. 1, 2007 – Sept. 30, 2008) very significant peaks in periphyton growth were measured at five sites. Four of the sites along the west and northwest shore had chlorophyll levels well over 100 mg/m^2: Rubicon Pt. (Chl = 168.2 mg/m^2), Pineland (Chl = 119.7 mg/m^2), Tahoe City (Chl = 183.7 mg/m^2), Dollar Pt. (Chl = 156.5 mg/m^2). One site along the southeast shore (Zephyr Pt.) also had a significant spring peak (Chl = 76.5 mg/m^2), but later in the season (in June). The spring peaks for biomass at all these sites appeared to be largely the result of increased growth of the stalked diatom *Gomphoneis herculeana*.**

4. **In WY 2009, distinct spring peaks in growth were again observed at Rubicon Pt. (Chl = 78.3 mg/m^2), Pineland (Chl = 119.2 mg/m^2), Tahoe City (Chl = 73.1 mg/m^2), Dollar Pt. (Chl = 97.47mg/m^2). However, peak biomass was much reduced compared to WY 2008 at all sites except Pineland which was similar to the previous year.**

5. **Bright green filamentous green algae (typically *Zygnema* sp.) were often found associated with blue-green algae near the surface under conditions of lowered lake levels, particularly along the east shore. The bright green filamentous algae growth can be quite striking. In low water years, this algae growth is apparent to boaters, kayakers and others using the east shore. This is in contrast to high water years, when rocks along the east shore may**

have relatively little algae growth near the surface, due to the rocks recently being submerged.

6. **Spring synoptic sampling has been useful for providing more information on spatial variation in biomass lake-wide during the important spring growth period. It is important to note that due to the issue of variable timing of growth and subsequent die-off of periphyton at various locations around the lake, 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.**

7. **Three of the spring synoptic monitoring sites had high biomass in several of the years monitored. Sites which frequently have had underwater visual scores of 5 (worst appearing/ heaviest growth) have included Tahoe City Tributary (4 of 6 years), Ward Cr. mouth (4 of 7 years) and So. Dollar Cr. (3 of 7 years). When chlorophyll a has been measured during these heavy years, the chlorophyll has always been above 100 mg/m^2. These sites are tributary mouths in the northwest portion of the lake which has been shown in routine monitoring to have typically high levels of biomass at Pineland, Tahoe City and Dollar Pt. Nutrients in the stream discharge likely are contributing to growth at these sites. The Tahoe City Tributary also appears to receive urban inputs. Other factors may also be contributing to growth in these areas as well. (i.e. groundwater inputs, lake mixing/upwelling/ currents and substrate availability).**

8. **While the concentration of fine sediment particles appears to be very important in affecting lake visibility (Secchi depth), these particles have virtually no impact on periphyton growth. This biomass accumulation is very dependent on nutrient availability.**

Task 7. Water Quality Conditions Following the 2007 Angora Wildfire

Work in Task 7 was added to the Lake Tahoe Water Quality Investigations work for 2007-2010 to address many of the questions surrounding the impacts of the Angora Fire on water quality. The final results of the two-year monitoring program are presented in a separate report: Reuter et al (2010), "Water Quality Conditions Following the 2007 Angora Wildfire in the Lake Tahoe Basin. The reader is referred to that report for complete presentation of data and findings. The following presents a brief background on the Angora Fire, the goals of the water quality post-fire monitoring program (Task 7) and the main conclusions, from Reuter et al (2010).

Background

The Angora Fire ignited on June 24, 2007 and was contained by July 2nd. Nearly 3,100 acres were burned in El Dorado County, California in the Upper Truckee River watershed – located in the southwest portion of the Lake Tahoe Basin. The Upper Truckee watershed delivers on the order of 20-25 percent of total surface water drainage into Lake Tahoe, and approximately nine percent of this watershed was burned.

According to the USDA-Forest Service *Burned-Area Report* (BAER Report; July 11, 2007) the burned area included 2,736 acres of US Forest Service land, 163 acres owned by the State of California and 144 acres of private property. A total of 242 homes and 67 commercial structures were lost; however, rebuilding has been significant over the past two years. Figure 30 comes directly from the BAER Report and shows the erosion hazard for land within the burned area expressed as high, moderate and low erosion potential.

The BAER Report further stated that there were 5.0 miles of perennial streams and 22.0 miles of ephemeral streams at risk in the affected area. The hazard rating for soil erosion within the burned area ranged from low to high. The BAER Report further estimated that erosion potential was 10-35 tons/acre, and emphasized the likely threats to water quality in Angora Creek and potential threats downstream in the Upper Truckee River and Lake Tahoe.

The scientific research community and water resource agencies in the Tahoe basin largely concurred that there were real threats to water quality and worked collaboratively to develop a post-fire water quality monitoring program.

As expected, questions related to the social and environmental ramifications of the fire were raised immediately. Even before the fire was officially contained state, federal and local government agencies were busy addressing these and other issues. Related to the environment, topics of concern included, but were not limited to, the best approaches for treating and mitigating the burned landscape through design and project implementation; the environmental concerns regarding water quality, upland soils and erosion control effectiveness, stream geomorphology and biological resources; designing an environmental monitoring program to assess changes or damages due to restoration efforts; and securing a funding package to meet all of these, and other needs.

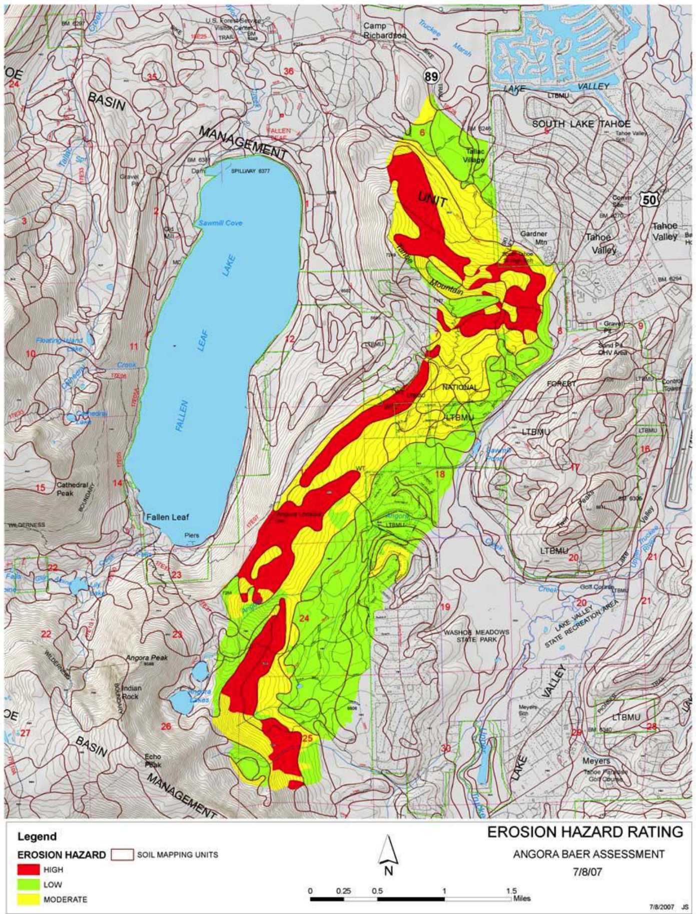


Figure 30. Erosion hazard for land within the burned area (from BAER Report, 2007).

The response of the science community was also immediate. Within 24 hours of the fire's ignition, researchers at the University of California, Davis Tahoe Environmental Research Center (TERC) were collecting data on air quality, atmospheric deposition and lake water quality. Before the fire was fully contained, researchers from the Desert Research Institute (DRI) and UC Davis -TERC collaboratively began to inspect Angora Creek and its environs for signs of water quality impairment. Researchers embarked on a rapid response strategy for water quality sampling in Angora Creek, with instrumented monitoring stations activated and sampling just three days after the declared containment (July 5th).

Work in Task 7 was added to the Lake Tahoe Water Quality Investigations work for 2007-2010 to address many of the questions surrounding the impacts of the Angora Fire on water quality.

Purpose of the Study

The Angora Creek monitoring design was intended to address the following:

- Water quality impacts to Angora Creek within the burned watershed
- Comparison to post-fire conditions
- Influence of urban runoff on downstream water quality

- Effect of passage through the Washoe Meadows (natural grass) ecosystem on downstream water quality
- Time needed for burned area to return to pre-fire conditions, vis-à-vis, pollutant loading on water quality conditions
- Change in pollutant loading characteristics to Lake Tahoe, via the Upper Truckee River

Conclusions

Wildfires have been shown to have major effects on forest ecosystem processes (Johnson, 2001; Zhong, 2006) and can negatively affect water quality by altering watershed hydrology and increasing sediment and nutrient delivery to surface waters (Biggio and Cannon, 2001; DeBano et al., 1979; Helvey et al., 1985). The magnitude of these effects is influenced by a suite of factors including fire severity, precipitation patterns, climate, topography, soil type, vegetation, and land use (Bradstock et al., 2010; Johnson, 2001), making predictions of watershed response complex and challenging. Wildfire is a natural and regular phenomenon in Sierra Nevada mountain ecosystems, but like much of the western United States, the Sierra Nevada has experienced a century of fire suppression and fuels accumulation resulting in increased potential for catastrophic wildfire events (Keeley et al., 1999; Fried et al., 2004; Westerling et al., 2006). In the aftermath of wildfire, a well-designed and intensive monitoring program established in the context of local site characteristics can elucidate watershed conditions, ecosystem recovery, and mitigation or restoration effectiveness. Monitoring programs can be directed at evaluating a variety of ecological parameters such as soil characteristics (Martin et al., 2009), erosion patterns (Carroll et al., 2007), vegetation succession (Clemente et al., 2009; Williams et al., 2006), and faunal recovery (Dunham et al., 2003; Williams et al., 2006). Stream water monitoring is an especially effective tool for monitoring watershed ecosystem recovery, as streams integrate conditions throughout the watershed, link terrestrial and aquatic processes, and reflect biogeochemical and hydrological responses over both space and time (Likens et al., 1970).

In the first two years following the Angora Fire, stream NO_3^- -N increased 2- to 10-fold over pre-fire concentrations but declined by approximately 38% the second year relative to year one. TN increased 6 to 9 fold over pre-fire concentrations but decreased 76% the second year to within the range, yet still higher than pre-fire conditions. No pre-fire concentrations were available for comparison of NH_4^+-N concentrations, however mean concentrations declined at all sites the second year except for Site 4, which saw an increase in NH_4^+-N concentrations. This could be due to increased discharge and subsequent flushing of leached NH_4^+-N, which has been shown to increase in ash and soils following fire in the Tahoe Basin (Murphy et al., 2006) as well as increased contribution of NH_4^+-N enriched subsurface water in the wet meadow area. Two years following the Angora Fire, N parameters may be showing trends towards reducing concentrations relative to the first year after the fire (WY08); however, TN in WY09 was still twice its pre-fire levels and nitrate was 5-10 time above pre-fire levels.

The time needed to see to a recovery to pre-fire conditions can vary greatly. Increased NO_3—N is often observed the first few years following wildfire and subsequently declines as forest succession proceeds (Ranalli, 2004). Elevated levels of NO_3—N and TN have been observed to increase 7.5 and 4.1 fold, respectively, over unburned reference streams in the Alberta Rocky Mountains (Bladon et al., 2008). These elevated values were still apparent in snowmelt and precipitation events, but background levels had declined after 3 years. Post-fire concentrations of NO_3^-N were also elevated following the Hayman Fire in Colorado, but returned to background levels the following year (Hall and Lombardozzi 2008). Similarly, Mast and Clow (2008) studied changes in stream chemistry for four years following a large wildfire in Glacier National Park. Stream-water nitrate concentrations showed the greatest effect demonstrating a 10-fold increase in the first year after the fire. A steady downward progression towards baseline conditions was seen in each of the four years monitored, but pre-fire levels were not reached after year four. In that study there was little evidence that the fire affected suspended sediment levels in the burned drainage. The authors suggested that in subalpine streams the relatively slow release of rate of water may not result in accelerated erosion. In 1988 a wildfire burned over 50 percent of the Jones Creek watershed near Yellowstone Park (Wyoming). Gerla and Galloway (1998) reported that it took approximately two years (until 1991) to see a spike in nitrate as a result of the fire. They related this to a slow leaching of N in the soils. Nitrate began to decline in both 1992 and 1993, but was still only ~50 percent reduced after the two years. Large differences in ammonium concentrations between the burned and unburned watershed was not seen. Total-P levels were very high in the first summer following the fire and declined dramatically by year two. Minshall et al. (1997) examined environmental, chemical and biological responses of 20 streams in Yellowstone National Park over five years following extensive wildfires in 1988. They found an influence of wildfire on in-stream nitrate concentrations – similar results were not seen for ortho-P. Baylay et al. (1992) found that wildfire in the boreal forests in Ontario, Canada caused significant losses of both N and P from the burned watershed. In general N loss partially recovered 5-6 years after the fire, while there was a recovery to pre-fire P conditions in 2-3 years post fire.

On a much shorter time scale, Hauer and Spencer (1991) found a 5-60 fold increase in N and P in stream water within the first two days of the fire as a result of ash deposition directly to the stream (source of P) and diffusion of smoke gases into the stream water (source of N). This effect was not seen within several days to weeks after the fire. Our monitoring program began shortly after the Angora Fire was contained and we did not see this phemonenon.

The Gondola Fire occurred in South Lake Tahoe in the summer of 2002, and after 3-4 years levels of NO_3^-N, NH_4^+-N and SRP in streamflow had declined but still had not reached baseline (pers. comm. Kip Allander, USGS, Carson City, NV and Wally Miller, University of Nevada, Reno). While SRP concentrations increased only slightly from pre-fire levels, TP increased less than 1-fold the first year, and 3-fold in the second year above pre-fire levels. According to W. Miller, post-fire erosion was substantial, but seemed to be largely limited to one major storm event three weeks after the fire. In Tahoe soils, strong correlations have not been determined between increases in soil water or stream water concentrations of SRP and TP following fire (Stephens, 2004). However, fire has been shown to increase erosion of sediments and ash, which mobilize particulate P into stream water.

The Angora Fire provided a unique opportunity to thoroughly monitor the effects of a severe wildfire on water quality across burned undeveloped forest and developed "urban" montane landscapes. Biogeochemical cycling in the eastern Sierra Nevada Mountains is characterized by high degrees of spatial and temporal variability, with the most significant temporal variations being attributed to seasonal snowmelt and periodic fire events (Johnson et al., 2009). Our post-fire stream monitoring efforts were successful at capturing the variability in characteristics of water quality in Angora Creek over space and time. An important component to watershed response and ecosystem recovery following the Angora Fire was the timing, magnitude, and form of precipitation during the first two years of forest succession. Given the relatively small overall size of the Angora Creek watershed, the high-angle slopes, and the extent burned at high severity, a major rainfall event would have been predicted to elicit a large watershed response (Debano et al., 1998). The hydrograph of Angora Creek exhibited similar responses to other disturbance-related watershed monitoring studies, including earlier and increased rates of snowmelt in the burned watershed in comparison to local unburned streams and rapid discharge response in association with storm events (Likens et al., 1970). The absence of large rainfall events the first year after the Angora Fire was likely one major reason why watershed response and erosion events were not considerably worse. For example, the Gondola Fire at Lake Tahoe in 2002 was followed by a large precipitation event, resulting in erosion that was estimated to remove 1.4 cm of soil (not including ash and charcoal) from the burned area (Murphy et al., 2006). The Gondola Fire was neither as severe nor as large as the Angora Fire, but resulted in much greater watershed response as a consequence of the timing and magnitude of precipitation.

There was no evidence of massive sediment or nutrient inputs from the burned urban area into Angora Creek. However, there is some indication of urban runoff contributing to slightly elevated concentrations in the lower Angora Creek site, compared to the upper Angora Creek site. The Angora Meadow restoration areas appear to provide stormwater treatment to runoff from the surrounding catchment, resulting in lower concentrations of most constituents in urban runoff discharged to Angora Creek. Although electrical conductivity remained elevated, and may be a useful conservative tracer of urban input.

Overall, Angora urban runoff and Angora Creek conditions after the fire were generally much better than observed at other urban sites around the Tahoe Basin. Nitrate was the one constituent monitored that show high concentrations in the upper burned urban area relative to other urban sites around the Tahoe Basin. It is important to note that absence of significant water quality effects on urban runoff or in Angora Creek are different from observations after the Gondola Fire. This difference is likely due to post-fire thunderstorm conditions immediately following the Gondola Fire. Fortunately, there were no larger precipitation events after the Angora Fire until several months later, allowing time for large-scale emergency restoration and mitigation efforts to be completed by the USFS LTBMU and El Dorado County.

Another important component to watershed response following the Angora Fire is the variety of landscapes (i.e. subalpine forest, urban, wet meadow) and their relative positions within the Angora Creek watershed and the burned area. Coats et al. (2008) examined how landscape factors influence nutrient and sediment concentrations and flux from watersheds in Lake Tahoe and found that impervious surfaces and residential density played roles in decreasing water quality, whereas well-developed soils increased water quality. An interesting result from our study is that despite the greater area of severely burned watershed above Site 2 (see Fig. 31), the smaller, urbanized sub-watershed above Site 3 most negatively influenced water quality. The urban area contained a large amount of impervious surfaces relative to the other areas, as well as storm drains that routed surface runoff into collection areas and ditches that ultimately flowed into Angora Creek (Figure 32). In comparison with the watershed above Site 2, Site 3 contributed higher stream discharge, nutrient concentrations, and nutrient yields. This area served as a sink for NO_3^--N the first year, and largely exported NH_4^+-N and organic N. In both years this area was a source of P, which is consistent with previous studies in the Tahoe Basin that suggest surface soil erosion from developed areas contribute relatively greater P-enriched suspended sediment concentrations than less-developed larger watersheds (Coats et al. 2008). These effects increased the second year following fire, when higher precipitation likely decreased residence time and increased flushing from the urban zone to Angora Creek.

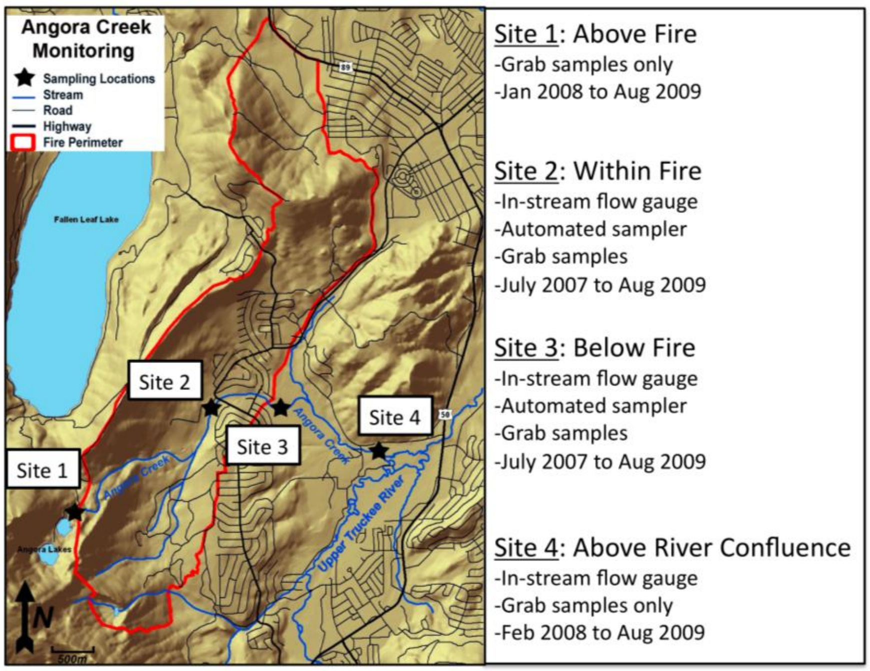


Figure 31. Sampling sites along Angora Creek. Site 1 was sampled by UC Davis-LAWR. Sites 2 and 3 correspond to AU and AU, respectively and were sampled by DRI/UC Davis-TERC and UC Davis-LAWR. Site a corresponds to AC and was sampled by the USGS and UC Davis-LAWR. The red line denotes the boundary of the burn area.

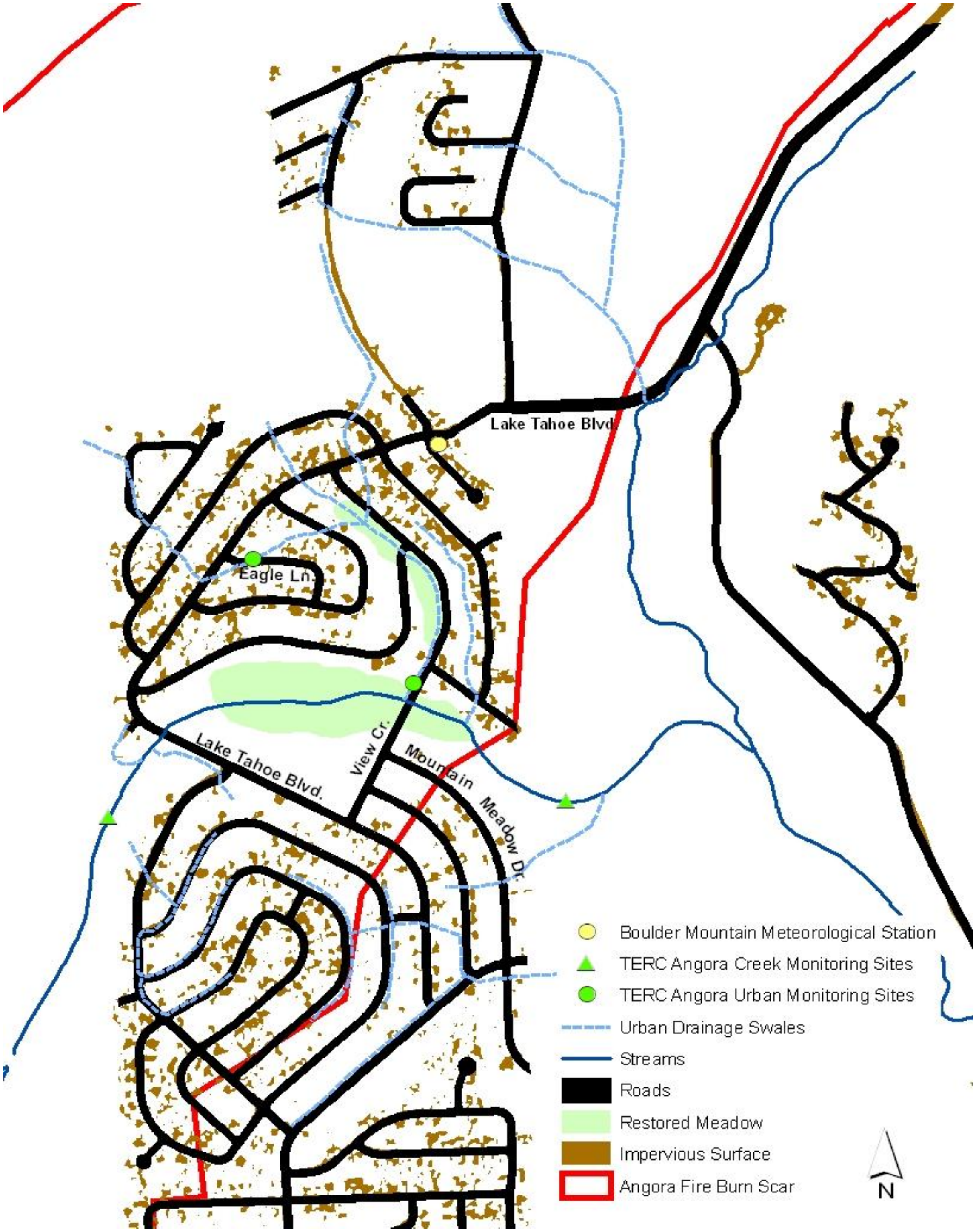


Figure 32. Angora Wildfire Monitoring Project area showing monitoring site locations within an urban area and along Angora Creek upstream and downstream of the urban area, urban drainage swales, restored meadows, and pre-fire impervious surfaces.

The burned watershed area as a whole contributed the majority of nutrient concentrations and nutrient loading to Angora Creek, however the unburned lower watershed (above Site 4) largely ameliorated these upstream effects. In this study, the location of the wet meadow effectively reduced downstream transport of sediment and nutrients, highlighting the importance of these areas in processing materials and preserving water quality. The meadow area was even more effective at buffering upstream when total precipitation and discharge were greater the second year.

The Angora Fire had the potential to be a large threat to water quality in the Lake Tahoe Basin. In the first two years following fire, changes in water quality were similar to the effects seen in streams draining wildfires elsewhere (see review by Ranalli 2004), and most concentrations may be trending towards recovery; although this will largely depend on variability in precipitation patterns and it is likely that some year-to-year variability could still be observed. Despite the fact that loading from the Angora Fire was not as significant as it might have been, this should not be taken as an indication that wildfires will not affect erosion and nutrient/sediment loading should wildfire occur in the future. A number of factors contributed to the reduced affect seen after the Angora Fire. These included (1) low precipitation and lack of severe storms, (2) re-growth of new vegetation, (3) the Washoe Meadows with its grassland vegetation and minimal slope acted as a buffer prior to flow and material being able to reach the Upper Truckee River, and (4) the USFS-LTBMU embarked on a watershed restoration program to help stabilize the steep slopes within the burn area. Our monitoring program was not designed to separate out the specific contribution of each factor on its own.

This study presents the unique perspective on how the timing and magnitude of the hydrograph, as well as landscape type and position can variably affect post-fire stream chemistry. Managing the future of water resources in the Lake Tahoe Basin should take into account wildfire interactions within undeveloped versus urbanized forests, as well as the importance of wet meadows in designing sustainable communities that can reintegrate fire as a natural process in their landscapes.

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Appendix Table 1.a. Precipitation amounts, N and P concentrations in wet deposition at the Ward Valley Lake Level Station 7/1/07-5/28/10.

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	9/21/2007 14:00	0.31	RS	WET	0.31	NA	298.16	238.50	3.85	15.31	25.52	
2	9/24/2007 17:10	0.46	R	WET	0.46	71.05	76.04	266.74	10.84	10.79	36.13	
3	10/2/2007 10:45	0.28	RS	WET	0.28	397.55	673.44	706.53	14.54	23.74	36.68	
4	10/11/07 10:20	0.65	S	WET	0.65	61.39	57.73	79.30	4.85	8.94	18.50	
5	10/17/07 15:25	0.37	RS	WET	0.37	16.81	23.89	99.33	9.61	C	19.45	9
6	10/23/07 10:45	0.97	R	WET	0.97	47.35	33.87	62.42	2.98	5.87	9.26	10
7	10/31/07 10:30	0.47	R	WET	0.46+	282.30	10.57	554.06	7.11	9.57	12.35	11
8	11/14/07 14:10	0.61	R	WET	0.61	32.31	21.94	39.60	1.60	4.02	6.49	12
9	11/21/07 09:55	0.08	R	WET	0.08	31.54	5.00	10.40	1.62	5.19	18.17	13
10	12/6/07 11:20	0.25	R	WET	0.25	16.61	22.17	NA	1.39	6.11	16.63	
11	12/7/07 17:50	1.30	S	WET	1.30	17.07	14.26	78.81	0.69	2.47	4.27	14
	12/12/07 14:50	Trace		WET	Trace	NA	NA	NA	NA	NA	NA	15
12	12/19/07 09:50	0.66		WET	0.66	15.32	19.17	112.20	0.93	3.09	6.87	16
13	12/20/07 11:15	1.51	S	WET	1.51	50.85	55.47	54.04	1.16	15.40	32.03	17
	12/21/07 11:15	Trace	S	WET	Trace	NA	NA	NA	NA	NA	NA	18
14	1/3/08 11:00	0.16	S	WET	0.16	106.42	118.19	NA	3.01	7.32	11.59	
15	1/4/08 16:20	3.02	RS	WET	3.02	10.94	9.62	110.32	6.02	C	14.64	
16	1/7/08 10:30(a)	See "b"	S	WET	1.08	32.83	12.29	38.36	0.69	3.40	5.80	34
17	1/7/08 10:30(b)	2.92	S	WET	1.40	19.70	22.50	91.82	1.16	13.55	17.39	35
18	1/9/08 11:10	1.12	S	WET	1.12	26.06	7.46	37.95	1.81	5.80	6.87	
19	1/11/08 10:10	0.04	R	WET	0.04	4.44	7.67	176.03	1.82	3.96	5.19	36
20	1/24/08 10:00	0.53		WET	0.53	167.70	211.22	251.55	2.26	6.10	12.32	
21	1/28/08 11:00	1.62	S	WET	1.62	23.32	17.76	63.11	2.04	0.91	8.63	37
22	1/30/08 10:30	0.49	S	WET	0.49	41.50	34.38	97.94	1.81	4.88	11.40	
23	2/1/08 10:40	1.06	S	WET	1.06	15.99	20.58	62.35	1.13	1.83	12.94	

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
24	2/3/08 15:00	1.51+	S	WET	1.21	13.81	24.56	55.65	1.13	4.88	6.78	38
25	2/5/08 10:00	0.07	S	WET	0.07	7.27	14.51	50.79	0.68	4.27	5.85	39
26	2/14/08 17:25	T	RS	WET	.0025	2.87	1.73	35.10	1.81	5.55	7.39	40
27	2/22/08 10:30	0.46	S	WET	0.46	29.25	31.05	39.93	1.58	6.78	9.24	
28	2/25/08 18:30	1.96	S	WET	1.96	20.07	20.37	46.78	1.13	5.85	7.81	41
29	3/21/08 13:40	1.80	RS	WET	1.80	70.11	68.41	123.67	2.95	7.35	9.49	
30	4/2/08 10:15	0.08	S	WET	0.08	15.50	7.11	43.14	1.84	4.66	6.21	48
31	4/18/08 09:40	0.02		WET	0.02	27.18	20.05	108.74	0.90	3.43	4.21	49
32	5/2/08 10:00	0.31		WET	0.31	169.03	86.90	381.33	0.90	6.45	19.35	
33	5/13/08 15:10	0.23	R	WET	0.23	34.78	506.26	609.66	3.61	8.15	44.53	
34	5/28/08 11:45	0.52	RH	WET	0.52	155.39	167.31	268.84	2.93	NA	16.36	
35	6/4/08 10:10	0.11	R	WET	0.11	53.93	11.30	95.72	1.13	12.06	59.37	50
	6/11/08 15:05	T		WET	T	NA	NA	NA	NA	NA	NA	
36	7/21/08 12:15	0.01	R	WET	0.01	45.77	75.51	72.49	3.17	6.42	8.85	63
	9/17/08 10:15	T	R	WET	T	NA	NA	NA	NA	NA	NA	71
37	10/8/2008 11:40	1.29	R	WET	1.29	28.52	11.13	58.92	10.56	10.23	14.88	85
38	11/7/2008 10:45	3.77	R+S	WET	3.77	37.98	46.71	97.92	8.99	10.97	11.89	
39	11/14/2008 10:00	0.29	R	WET	0.29	93.53	98.3	450.47	3.15	4.27	4.88	
40	12/5/2008 9:30	0.21	R+S	WET	0.21	113.69	41.15	86.94	0.9	1.54	2.47	
41	12/15/2008 17:30	1.88e	S	WET	0.43+	72.4	63.36	246.78	6.08	23.85	66.58	86
42	12/17/2008 10:30	0.39	S	WET	0.39	36.45	28.55	46.12	0.9	2.48	9.6	
43	12/21/2008 12:00	1.67e	R+S	WET	0.37+	14.08	8.63	73.04	2.25	3.72	13.94	87
44	12/23/2008 14:50	1.07e	S	WET	0.6+	17.81	11.64	30.03	2.93	4.96	5.26	88
45	12/26/2008 12:30	2.35	S	WET	2.35	10.45	8.42	41.57	2.95	4.34	6.81	89
46	1/7/2009 17:15	0.86	S	WET	0.86	30	13.08	64.38	4.31	5.9	10.84	
47	1/28/2009 10:05	2.51	R+S	WET	2.51	118.4	16.86	8.93	0.9	2.17	2.77	
48	2/9/2009 17:15	1.01	S	WET	1.01	40.26	61.38	112.21	2.71	4.35	8.04	98
49	2/15/2009 12:15	0.68	S	WET	0.68	34.37	39.5	98.08	2.03	3.41	4.97	
50	2/16/2009 14:30	0.64	S	WET	0.64	14.3	13.36	NA	1.58	3.1	3.41	

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
51	2/18/2009 13:15	0.64	S	WET	0.64	19.61	25.75	170.85	0.9	2.79	3.1	
52	2/26/2009 10:30	2.42	R+S	WET	2.42	22.73	16.51	71.75	2.26	4.25	5.16	
53	2/28/2009 13:15	0.28	R	WET	0.28	29.33	47.34	72.5	1.35	3.04	5.16	
54	3/3/2009 14:20	4.37	R+S+G	WET	4.37	21.81	40.53	119.67	4.51	3.64	10.32	99
55	3/4/2009 13:30	1.5	S	WET	1.39	10.45	14.57	82.07	1.13	1.72	1.87	100
56	3/9/2009 17:10	0.15	S	WET	0.15	129.07	141.04	477.23	2.26	3.11	6.22	
57	3/21/2009 14:00	0.52		WET	0.52	93.51	127.44	150.51	4.51	4.35	11.18	
58	3/23/2009 12:00	1.45	S	WET	0.66	41.31	34.72	80.31	1.8	2.17	6.21	101
59	4/3/2009 15:40	0.16	S+G	WET	0.16	78.99	121.24	161.16	7.23	9.01	21.73	111
60	4/17/2009 18:25	0.29	S	WET	0.29	133.71	139.05	263.53	11.25	17.01	21.96	
61	4/28/2009 10:00	0.41	S	WET	0.41	112.56	45.01	121.87	7.4	8.98	15.79	
62	5/5/2009 16:45	4.96	R	WET	4.96	40.41	57.46	149.44	2.02	3.08	3.12	
63	5/26/2009 12:00	0.1	R	WET	0.1	246.3	442.62	NA	9.2	38.79	146.55	112
64	6/5/2009 13:20	1.0e	R+H	WET	1.0e	NA	NA	NA	NA	NA	NA	113
65	6/9/2009 11:30	0.02	R	WET	0.02	30.19	37.64	179.98	0.45	0.94	3.1	114
66	6/19/2009 12:25	0.21	R	WET	0.21	21.19	123.78	428.73	7.21	10.87	17.69	
67	7/14/2009 9:50	0.12	R	WET	0.12	107.44	39.77	274.34	5.61	8.14	10.37	121
68	8/9/2009 11:30	0.11	R	WET	0.11	10.99	18.81	586.26	2.47	4.92	23.05	122
69	8/28/2009 12:20	0.01	R	WET	0.01	49.36	45.77	60.94	6.27	1.83	1.53	123
70	9/30/2009 16:40	T		WET	0.001	5.67	12.95	34.35	2.65	2.5	5.63	124
71	10/6/09 09:45	0.15	S	WET	0.15	150.16	181.85	312.59	16.77	25.53	60.78	140
72	10/14/09 17:40	4.24	R	WET	4.24	10.69	0.88	170.55	1.99	6.08	7.36	141
73	10/20/09 11:10	0.42	R+S	WET	0.04	45.63	43.39	201.56	0.88	3.1	3.08	142
	10/30/09 11:30	T		WET	0.00	NA	NA	NA	NA	NA	NA	143
74	11/11/09 11:00	0.02		WET	0.02	4.56	77.25	17.79	0.9	2.77	2.46	144
75	11/13/09 13:00	0.21	S	WET	0.21	109.96	79.94	163.51	2.93	3.39	5.23	
76	11/19/09 17:00	0.03	S	WET	0.03	9.52	9.16	89.1	1.74	2.77	4.0	145
77	11/23/09 10:20	0.87	R+S	WET	0.87	48.64	59.76	178.2	3.54	4.62	12.93	146
78	12/4/09 10:30	0.07	S	WET	0.07	40.42	44.19	65.81	1.14	2.79	4.65	147

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
79	12/7/09 17:15	1.44	S	WET	1.44	52.78	63.78	77.08	1.13	1.24	3.5	148
80	12/13/09 16:00	2.97	S	WET	2.97	22.09	11.36	46.49	0.68	1.55	1.64	149
81	12/15/09 11:15	0.03	S	WET	0.03	4.5	7.86	48.79	0.23	0.41	0.1	150
82	12/22/09 11:15	0.71	R+S	WET	0.71	44.71	35.77	NA	0.68	1.33	1.95	151
83	12/29/09 18:15	0.24	S	WET	0.24	60.32	20.59	73.94	1.35	2.46	8.93	152
84	1/5/10 16:50	0.54	R+S	WET	0.54	53.05	10.54	169.64	1.58	3.7	6.47	
85	1/7/10 12:00	0.01	R+S	WET	0.01	5.73	3.32	63.13	2.03	2.46	1.85	164
86	1/14/10 12:00	1.94	R+S	WET	1.94	34.33	10.07	121.14	0.68	2.51	2.77	
87	1/19/10 11:10	1.81	S	WET	1.81	7.14	10.07	NA	1.13	1.26	3.07	165
88	1/21/10 10:30	1.26	S	WET	1.26	12.47	8.84	126.32	0.68	2.15	4.61	166
89	1/24/10 13:30	0.81	R+S	WET	0.76	22.02	11.71	46.49	0.68	4.3	3.69	167
90	1/27/10 10:30	1.39	R+S	WET	1.39	20.85	10.93	37.28	0.68	3.07	3.64	
91	2/2/10 10:30	0.03	S	WET	0.03	8.37	11.51	111.81	0.68	2.42	3.94	
92	2/10/10 10:20	0.71	S	WET	0.71	55.41	40.61	NA	0.9	3.08	4.0	
93	2/17/10 09:10	0.01		WET	0.01	4.91	7.34	NA	0	2.51	3.45	168
94	3/1/10 17:30	2.93	R+S	WET	2.93	30.26	18.97	NA	1.13	2.79	3.1	
95	3/5/10 14:50	0.75	R+S	WET	0.75	65.56	110.23	NA	1.13	2.79	6.53	
96	3/18/10 10:20	1.63	R+S	WET	1.63	23.42	20.77	NA	1.81	3.67	5.2	
97	3/26/10 11:50	0.51	S	WET	0.51	195.52	349.94	NA	6.56	8.45	39.11	
98	3/31/10 11:50	2.89	R+S	WET	2.89	70.91	182.05	NA	3.17	5.05	93.52	169
99	4/2/10 16:30	0.61	R+S	WET	0.61	49.99	44.72	NA	2.72	3.47	11.26	
100	4/5/10 11:30	1.45	S	WET	1.24	26.54	34.63	NA	0.91	3.79	7.51	170
101	4/9/10 17:30	0.02e	R+S	WET	0.02e	NA	NA	NA	NA	NA	NA	171
102	4/13/10 13:00	0.54	S	WET	0.54	30.02	33.25	NA	2.72	5.04	5.67	
103	4/25/10 11:00	0.57	S	WET	0.57	39.05	36.51	NA	1.14	4.72	5.35	
104	4/29/10 17:30	2.34	S	WET	2.34	66.69	126.19	NA	1.58	7.11	NA	
105	5/12/10 11:00	1.03	S	WET	1.03	73.18	67.06	NA	2.03	NA	NA	
106	5/21/10 13:00	0.31	S	WET	0.31	71.56	99.47	NA	1.14	NA	NA	
107	5/28/10 16:05	1.58	S	WET	1.58	66.45	166.47	NA	NA	NA	NA	

Appendix Table 1.b. Precipitation loads of N and P in wet deposition at the Ward Valley Lake Level Station 7/1/07-5/28/10.

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	9/21/2007 14:00	0.31	RS	WET	0.31	NA	23.48	18.78	0.31	1.21	2.01	
2	9/24/2007 17:10	0.46	R	WET	0.46	8.30	8.88	31.17	1.27	1.26	4.22	
3	10/2/2007 10:45	0.28	RS	WET	0.28	28.27	47.90	50.25	1.03	1.69	2.61	
4	10/11/07 10:20	0.65	S	WET	0.65	10.14	9.53	13.09	0.80	1.48	3.05	
5	10/17/07 15:25	0.37	RS	WET	0.37	1.58	2.25	9.34	0.90	C	1.83	9
6	10/23/07 10:45	0.97	R	WET	0.97	11.67	8.34	15.38	0.73	1.45	2.28	10
7	10/31/07 10:30	0.47	R	WET	0.46+	33.70	1.26	66.14	0.85	1.14	1.47	11
8	11/14/07 14:10	0.61	R	WET	0.61	5.01	3.40	6.14	0.25	0.62	1.01	12
9	11/21/07 09:55	0.08	R	WET	0.08	2.46	0.39	0.81	0.13	0.40	1.42	13
10	12/6/07 11:20	0.25	R	WET	0.25	1.05	1.41	NA	0.09	0.39	1.06	
11	12/7/07 17:50	1.30	S	WET	1.30	5.64	4.71	26.02	0.23	0.82	1.41	14
	12/12/07 14:50	Trace		WET	Trace	NA	NA	NA	NA	NA	NA	15
12	12/19/07 09:50	0.66		WET	0.66	2.57	3.21	18.81	0.16	0.52	1.15	16
13	12/20/07 11:15	1.51	S	WET	1.51	19.50	21.27	20.73	0.44	5.91	12.28	17
	12/21/07 11:15	Trace	S	WET	Trace	NA	NA	NA	NA	NA	NA	18
14	1/3/08 11:00	0.16	S	WET	0.16	4.32	4.80	NA	0.12	0.30	0.47	
15	1/4/08 16:20	3.02	RS	WET	3.02	8.39	7.38	84.62	4.62	C	11.23	
16	1/7/08 10:30(a)	See “b”	S	WET	1.08							34
17	1/7/08 10:30(b)	2.92	S	WET	1.40	14.61	16.69	68.10	0.86	10.05	12.90	35
18	1/9/08 11:10	1.12	S	WET	1.12	7.41	2.12	10.80	0.51	1.65	1.95	
19	1/11/08 10:10	0.04	R	WET	0.04	0.35	0.60	13.72	0.14	0.31	0.40	36
20	1/24/08 10:00	0.53		WET	0.53	22.58	28.43	33.86	0.30	0.82	1.66	
21	1/28/08 11:00	1.62	S	WET	1.62	9.60	7.31	25.97	0.84	0.37	3.55	37
22	1/30/08 10:30	0.49	S	WET	0.49	5.17	4.28	12.19	0.23	0.61	1.42	
23	2/1/08 10:40	1.06	S	WET	1.06	4.31	5.54	16.79	0.30	0.49	3.48	

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
24	2/3/08 15:00	1.51+	S	WET	1.21	5.30	9.42	21.34	0.43	1.87	2.60	38
25	2/5/08 10:00	0.07	S	WET	0.07	0.57	1.13	3.96	0.05	0.33	0.46	39
26	2/14/08 17:25	T	RS	WET	.0025	0.23	0.14	2.76	0.14	0.44	0.58	40
27	2/22/08 10:30	0.46	S	WET	0.46	3.42	3.63	4.67	0.18	0.79	1.08	
28	2/25/08 18:30	1.96	S	WET	1.96	9.99	10.14	23.29	0.56	2.91	3.89	41
29	3/21/08 13:40	1.80	RS	WET	1.80	32.05	31.28	56.54	1.35	3.36	4.34	
30	4/2/08 10:15	0.08	S	WET	0.08	1.21	0.55	3.36	0.14	0.36	0.48	48
31	4/18/08 09:40	0.02		WET	0.02	2.12	1.56	8.48	0.07	0.27	0.33	49
32	5/2/08 10:00	0.31		WET	0.31	13.31	6.84	30.03	0.07	0.51	1.52	
33	5/13/08 15:10	0.23	R	WET	0.23	2.03	29.58	35.62	0.21	0.48	2.60	
34	5/28/08 11:45	0.52	RH	WET	0.52	20.52	22.10	35.51	0.39	NA	2.16	
35	6/4/08 10:10	0.11	R	WET	0.11	4.20	0.88	7.46	0.09	0.94	4.63	50
	6/11/08 15:05	T		WET	T	NA	NA	NA	NA	NA	NA	
36	7/21/08 12:15	0.01	R	WET	0.01	3.57	5.89	5.65	0.25	0.50	0.69	63
	9/17/08 10:15	T	R	WET	T	NA	NA	NA	NA	NA	NA	71
37	10/8/2008 11:40	1.29	R	WET	1.29	9.34	3.65	19.31	3.46	3.35	4.88	85
38	11/7/2008 10:45	3.77	R+S	WET	3.77	36.37	44.73	93.77	8.61	10.50	11.39	
39	11/14/2008 10:00	0.29	R	WET	0.29	6.89	7.24	33.18	0.23	0.31	0.36	
40	12/5/2008 9:30	0.21	R+S	WET	0.21	6.06	2.19	4.64	0.05	0.08	0.13	
41	12/15/2008 17:30	1.88e	S	WET	0.43+	7.91	6.92	26.95	0.66	2.60	7.27	86
42	12/17/2008 10:30	0.39	S	WET	0.39	3.61	2.83	4.57	0.09	0.25	0.95	
43	12/21/2008 12:00	1.67e	R+S	WET	0.37+	1.32	0.81	6.86	0.21	0.35	1.31	87
44	12/23/2008 14:50	1.07e	S	WET	0.6+	2.71	1.77	4.58	0.45	0.76	0.80	88
45	12/26/2008 12:30	2.35	S	WET	2.35	6.24	5.03	24.81	1.76	2.59	4.06	89
46	1/7/2009 17:15	0.86	S	WET	0.86	6.55	2.86	14.06	0.94	1.29	2.37	
47	1/28/2009 10:05	2.51	R+S	WET	2.51	75.48	10.75	5.69	0.57	1.38	1.77	
48	2/9/2009 17:15	1.01	S	WET	1.01	10.33	15.75	28.79	0.70	1.12	2.06	98
49	2/15/2009 12:15	0.68	S	WET	0.68	5.94	6.82	16.94	0.35	0.59	0.86	
50	2/16/2009 14:30	0.64	S	WET	0.64	2.32	2.17	NA	0.26	0.50	0.55	

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
51	2/18/2009 13:15	0.64	S	WET	0.64	3.19	4.19	27.77	0.15	0.45	0.50	
52	2/26/2009 10:30	2.42	R+S	WET	2.42	13.97	10.15	44.10	1.39	2.61	3.17	
53	2/28/2009 13:15	0.28	R	WET	0.28	2.09	3.37	5.16	0.10	0.22	0.37	
54	3/3/2009 14:20	4.37	R+S+G	WET	4.37	24.21	44.99	132.83	5.01	4.04	11.45	99
55	3/4/2009 13:30	1.5	S	WET	1.39	3.69	5.14	28.98	0.40	0.61	0.66	100
56	3/9/2009 17:10	0.15	S	WET	0.15	4.92	5.37	18.18	0.09	0.12	0.24	
57	3/21/2009 14:00	0.52		WET	0.52	12.35	16.83	19.88	0.60	0.57	1.48	
58	3/23/2009 12:00	1.45	S	WET	0.66	6.93	5.82	13.46	0.30	0.36	1.04	101
59	4/3/2009 15:40	0.16	S+G	WET	0.16	6.16	9.45	12.56	0.56	0.70	1.69	111
60	4/17/2009 18:25	0.29	S	WET	0.29	9.85	10.24	19.41	0.83	1.25	1.62	
61	4/28/2009 10:00	0.41	S	WET	0.41	11.72	4.69	12.69	0.77	0.94	1.64	
62	5/5/2009 16:45	4.96	R	WET	4.96	50.91	72.39	188.27	2.54	3.88	3.93	
63	5/26/2009 12:00	0.1	R	WET	0.1	6.26	11.24	NA	0.23	0.99	3.72	112
64	6/5/2009 13:20	1.0e	R+H	WET	1.0e	NA	NA	NA	NA	NA	NA	113
65	6/9/2009 11:30	0.02	R	WET	0.02	1.20	1.50	7.16	0.02	0.04	0.12	114
66	6/19/2009 12:25	0.21	R	WET	0.21	1.13	6.60	22.87	0.38	0.58	0.94	
67	7/14/2009 9:50	0.12	R	WET	0.12	3.27	1.21	8.36	0.17	0.25	0.32	121
68	8/9/2009 11:30	0.11	R	WET	0.11	0.86	1.47	45.71	0.19	0.38	1.80	122
69	8/28/2009 12:20	0.01	R	WET	0.01	3.85	3.57	NA	0.49	0.14	0.12	123
70	9/30/2009 16:40	T		WET	0.001	0.44	1.01	NA	0.21	NA	NA	124
71	10/6/09 09:45	0.15	S	WET	0.15	5.72	6.93	11.91	0.64	0.97	2.32	140
72	10/14/09 17:40	4.24	R	WET	4.24	11.51	0.95	183.68	2.14	6.55	7.93	141
73	10/20/09 11:10	0.42	R+S	WET	0.04	0.46	0.44	2.05	0.01	0.03	0.03	142
	10/30/09 11:30	T		WET	0.00	NA	NA	NA	NA	NA	NA	143
74	11/11/09 11:00	0.02		WET	0.02	0.36	6.02	1.39	0.07	0.22	0.19	144
75	11/13/09 13:00	0.21	S	WET	0.21	5.87	4.26	8.72	0.16	0.18	0.28	
76	11/19/09 17:00	0.03	S	WET	0.03	0.74	0.71	6.95	0.14	0.22	0.31	145
77	11/23/09 10:20	0.87	R+S	WET	0.87	10.75	13.21	39.38	0.78	1.02	2.86	146
78	12/4/09 10:30	0.07	S	WET	0.07	3.18	3.48	5.18	0.09	0.22	0.37	147

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
79	12/7/09 17:15	1.44	S	WET	1.44	19.30	23.33	28.19	0.41	0.45	1.28	148
80	12/13/09 16:00	2.97	S	WET	2.97	16.66	8.57	35.07	0.51	1.17	1.24	149
81	12/15/09 11:15	0.03	S	WET	0.03	0.35	0.61	3.80	0.02	0.03	0.01	150
82	12/22/09 11:15	0.71	R+S	WET	0.71	8.06	6.45	NA	0.12	0.24	0.35	151
83	12/29/09 18:15	0.24	S	WET	0.24	3.68	1.26	4.51	0.08	0.15	0.54	152
84	1/5/10 16:50	0.54	R+S	WET	0.54	7.28	1.45	23.27	0.22	0.51	0.89	
85	1/7/10 12:00	0.01	R+S	WET	0.01	0.45	0.26	4.92	0.16	0.19	0.14	164
86	1/14/10 12:00	1.94	R+S	WET	1.94	16.92	4.96	59.69	0.34	1.24	1.36	
87	1/19/10 11:10	1.81	S	WET	1.81	3.28	4.63	NA	0.52	0.58	1.41	165
88	1/21/10 10:30	1.26	S	WET	1.26	3.99	2.83	40.43	0.22	0.69	1.48	166
89	1/24/10 13:30	0.81	R+S	WET	0.76	4.53	2.41	9.56	0.14	0.88	0.76	167
90	1/27/10 10:30	1.39	R+S	WET	1.39	7.36	3.86	13.16	0.24	1.08	1.29	
91	2/2/10 10:30	0.03	S	WET	0.03	0.65	0.90	8.72	0.05	0.19	0.31	
92	2/10/10 10:20	0.71	S	WET	0.71	9.99	7.32	NA	0.16	0.56	0.72	
93	2/17/10 09:10	0.01		WET	0.01	0.38	0.57	NA	0.00	0.20	0.27	168
94	3/1/10 17:30	2.93	R+S	WET	2.93	22.52	14.12	NA	0.84	2.08	2.31	
95	3/5/10 14:50	0.75	R+S	WET	0.75	12.49	21.00	NA	0.22	0.53	1.24	
96	3/18/10 10:20	1.63	R+S	WET	1.63	9.70	8.60	NA	0.75	1.52	2.15	
97	3/26/10 11:50	0.51	S	WET	0.51	25.33	45.33	NA	0.85	1.09	5.07	
98	3/31/10 11:50	2.89	R+S	WET	2.89	52.05	133.64	NA	2.33	3.71	68.65	169
99	4/2/10 16:30	0.61	R+S	WET	0.61	7.75	6.93	NA	0.42	0.54	1.74	
100	4/5/10 11:30	1.45	S	WET	1.24	8.36	10.91	NA	0.29	1.19	2.37	170
101	4/9/10 17:30	0.02e	R+S	WET	0.02e	NA	NA	NA	NA	NA	NA	171
102	4/13/10 13:00	0.54	S	WET	0.54	4.12	4.56	NA	0.37	0.69	0.78	
103	4/25/10 11:00	0.57	S	WET	0.57	5.65	5.29	NA	0.17	0.68	0.77	
104	4/29/10 17:30	2.34	S	WET	2.34	39.64	75.00	NA	0.94	4.23	NA	
105	5/12/10 11:00	1.03	S	WET	1.03	19.15	17.54	NA	0.53	NA	NA	
106	5/21/10 13:00	0.31	S	WET	0.31	5.63	7.83	NA	0.09	NA	NA	
107	5/28/10 16:05	1.58	S	WET	1.58	26.67	66.81	NA	NA	NA	NA	

Appendix Table 2.a. N and P concentrations in dry deposition at the Ward Valley Lake Level Station 7/1/07-5/15/10.

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	6/28/2007 13:59	7/13/2007 17:20	1.203	DF	DRY	C	C	C	C	C	C	1
2	7/13/2007 17:20	8/9/2007 10:15	0.5	DF	DRY	63.41	53.33	NA	15.65	16.16	NA	2
3	8/9/2007 10:15	8/20/2007 15:30	1.86	DF	DRY	C	C	C	C	C	C	3
4	8/20/2007 15:30	8/28/2007 10:00	2.707	DF	DRY	8.90	17.21	177.35	0.91	C	8.93	
5	8/28/2007 10:00	9/11/2007 10:10	2.191	DF	DRY	10.78	0.63	278.04	0.45	11.66	13.40	
6	9/11/2007 10:10	9/21/2007 14:00	2.85	DF	DRY	25.16	7.55	140.80	8.83	10.21	14.35	
7	9/21/2007 14:00	10/2/2007 15:45	3.288	DF	DRY	45.54	50.93	303.70	4.61	9.56	19.11	
8	10/2/2007 15:45	10/11/07 10:20	3.426	DF	DRY	18.42	4.72	235.71	13.61	20.81	29.60	
9	10/11/07 10:20	10/23/07 10:45	3.748	DF	DRY	27.43	6.14	299.55	2.07	5.87	8.95	19
10	10/23/07 10:45	11/5/07 09:00	3.620	DF	DRY	19.47	2.81	155.44	6.20	8.96	9.58	20
11	11/5/07 09:00	11/7/07 17:10	3.878	DF	DRY	15.48	59.23	102.30	1.61	3.71	4.95	21
12	11/7/07 17:10	11/14/07 14:10	3.394	DF	DRY	15.74	61.37	NA	1.14	4.33	4.95	22
13	11/14/07 14:10	11/21/07 09:55	3.532	DF	DRY	2.94	10.29	NA	1.62	5.49	16.01	23
14	11/21/07 09:55	11/30/07 14:15	2.786	DF	DRY	5.57	23.30	491.31	C	6.18	7.93	
15	11/30/07 14:15	12/12/07 14:50	NA	DF	DRY	8.61	15.84	115.60	2.32	5.49	13.73	24
16	12/12/07 14:50	12/21/07 11:15	3.558	DF	DRY	17.51	5.41	76.32	3.24	8.01	10.68	25
17	12/21/07 11:15	1/3/08 11:00	3.642	DF	DRY	7.75	18.06	51.94	3.01	7.70	18.31	
18	1/3/08 11:00	1/11/08 10:10	3.483	DF	DRY	12.25	7.05	230.31	3.86	6.10	13.73	
19	1/11/08 10:10	1/24/08 10:00	4.069	DF	DRY	25.21	27.94	62.35	3.62	3.66	23.41	42
20	1/24/08 10:00	2/5/08 10:00	4.590	DF	DRY	13.08	12.00	57.85	1.81	4.94	9.58	43
21	2/5/08 10:00	2/14/08 17:25	2.947	DF	DRY	11.28	11.16	60.99	5.88	8.32	32.04	
22	2/14/08 17:25	2/25/08 18:30	3.106	DF	DRY	22.56	30.63	76.86	2.26	7.39	24.49	44
23	2/25/08 18:30	3/6/08 17:20	2.567	DF	DRY	19.15	7.97	115.73	5.53	6.79	20.70	
24	3/6/08 17:20	3/19/08 17:15	1.935	DF	DRY	37.94	37.36	149.00	0.91	4.29	28.47	
25	3/19/08 17:15	4/2/08 10:15	1.751	DF	DRY	22.72	7.81	102.51	4.37	6.83	25.78	
26	4/2/08 10:15	4/18/08 09:40	2.133	DF	DRY	28.91	17.52	204.15	1.58	6.54	20.57	
27	4/18/08 09:40	5/2/08 10:00	2.200	DF	DRY	54.36	52.09	437.86	3.84	7.37	25.19	

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
28	5/2/08 10:00	5/13/08 15:10	2.278	DF	DRY	16.09	20.50	NA	7.66	11.07	151.21	
29	5/13/08 15:10	5/28/08 11:45	2.030	DF	DRY	3.46	4.78	NA	14.20	5.20	181.17	
30	5/28/08 11:45	6/11/08 15:05	1.615	DF	DRY	C	C	C	C	C	C	51
31	6/11/08 15:05	6/23/08 13:35	2.164	DF	DRY	12.93	9.04	NA	7.0	34.01	67.71	52
32	6/23/2008 13:35	7/7/2008 17:55	1.852	DF	DRY	14.04	2.41	1003.98	12.64	43.6	124.16	64
33	7/7/2008 17:55	7/10/2008 13:10	3.462	DF	DRY	26.23	27.2	209.37	155.39	157.54	224.65	65
34	7/10/2008 13:10	7/15/2008 13:20	3.236	DF	DRY	15.08	5.95	492.37	28.55	32.73	58.43	66
35	7/15/2008 13:20	7/21/2008 12:15	3.055	DF	DRY	13.68	5.22	161.42	3.62	7.65	13.42	67
36	7/21/2008 12:15	7/29/2008 10:10	2.613	DF	DRY	9.2	5.23	162.14	NA	12.24	23.49	68
37	7/29/2008 10:10	8/20/2008 20:15	0.73	DF	DRY	C	C	C	C	C	C	69
38	8/20/2008 20:15	9/5/2008 17:45	1.655	DF	DRY	C	C	C	C	C	C	70
39	9/5/2008 17:45	9/17/2008 10:15	2.627	DF	DRY	15.97	9.54	268.75	1.35	3.4	11.14	72
40	9/17/2008 10:15	10/8/2008 11:40	2.637	DF	DRY	3.69	5.14	531.3	3.93	6.47	10.54	90
41	10/8/2008 11:40	10/20/2008 17:10	3.487	DF	DRY	3.31	10.95	194.07	19.99	25.57	26.48	91
42	10/20/2008 17:10	11/7/2008 10:45	3.5	DF	DRY	22.26	30.73	319.07	20.01	15.54	22.4	
43	11/7/2008 10:45	11/20/2008 10:45	3.807	DF	DRY	8.83	21.47	293.41	2.04	4.88	6.71	
44	11/20/2008 10:45	12/5/2008 9:30	2.917	DF	DRY	13.36	22.06	NA	2.71	4.95	6.49	92
45	12/5/2008 9:30	12/17/2008 10:30	4.206	DF+S	DRY	16.48	16.67	61.33	1.58	3.69	6.16	93
46	12/17/2008 10:30	12/23/2008 14:50	4.974	DF+S	DRY	11.54	12.62	70.59	3.83	6.35	8.36	94
47	12/23/2008 14:50	1/7/2009 17:15	2.939	DF	DRY	9.38	20.33	56.85	2.27	3.42	15.48	102
48	1/7/2009 17:15	1/15/2009 10:30	3.975	DF	DRY	4.86	8.81	32.58	1.36	3.42	12.72	103
49	1/15/2009 10:30	1/28/2009 10:05	3.105	DF	DRY	17.17	19.29	54.42	3.16	2.48	13.3	104
50	1/28/2009 10:05	2/5/2009 10:45	3.486	DF	DRY	8.5	17.68	74.96	2.25	13.35	13	105
51	2/5/2009 10:45	2/26/2009 10:30	3.901	DF	DRY	25.66	23.92	91.7	8.59	10.93	18.38	105
52	2/26/2009 10:30	3/9/2009 17:10	3.081	DF	DRY	20.51	31.57	81.68	2.49	4.35	11.2	
53	3/9/2009 17:10	3/20/2009 17:45	2.385	DF	DRY	16.49	14.5	59.76	1.58	1.86	10.55	
54	3/20/2009 17:45	4/3/2009 15:40	2.173	DF	DRY	21.17	17.28	101.45	4.07	9.01	23.28	
55	4/3/2009 15:40	4/17/2009 18:25	1.76	DF	DRY	42.94	40.16	144.35	4.05	8.04	21.65	

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	Conc. NO_3-N (µg/l)	NH_4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
56	4/17/2009 18:25	4/28/2009 10:00	2.088	DF	DRY	26.77	10.89	314.4	2.92	9.29	24.15	115
57	4/28/2009 10:00	5/26/2009 12:00	2.048	DF	DRY	13.49	15.83	1098.96	23.34	29.6	112.52	113
58	5/26/2009 12:00	6/5/2009 13:20	3.907	DF	DRY	76.72	169.78	561.03	1.34	8.87	15.6	
59	6/5/2009 13:20	6/19/2009 12:25	2.743	DF	DRY	140.82	12.69	268.77	0.68	2.44	6.52	
60	6/19/2009 12:25	6/26/2009 12:30	3.048	DF	DRY	3.47	11.97	296.67	2.18	5.28	21.44	
61	6/26/2009 12:30	7/5/2009 11:00	2.705	DF	DRY	6.13	69.89	588.72	1.73	8.7	46.3	
62	7/5/2009 11:00	7/14/2009 9:50	2.552	DF	DRY	6.78	10.95	167.09	3.37	10.64	21.6	121
63	7/14/2009 9:50	7/22/2009 10:00	2.357	DF	DRY	7.68	25.14	543.47	2.37	3.05	14.33	125
64	7/22/2009 10:00	8/9/2009 11:30	2.798	DF	DRY	135.81	58.2	137.62	0.67	1.54	5.84	
65	8/9/2009 11:30	8/28/2009 12:20	1.47	DF	DRY	10.66	2.92	1337.72	3.14	7.03	117.02	126
66	8/28/2009 12:20	9/9/2009 13:30	2.325	DF	DRY	10.66	6.98	313.1	2.7	4.91	11.35	
67	9/9/2009 13:30	9/22/2009 15:10		DF	DRY	C	C	C	C	C	C	127
68	9/22/2009 15:10	10/2/2009 10:45	3.013	DF	DRY	7.4	7.99	362.25	22.73	28.26	34.78	128
69	10/2/2009 10:45	10/12/09 15:45	2.830	DF	DRY	5.84	1.3	300	1.1	6.38	26.16	153
70	10/12/09 15:45	10/20/09 11:10	4.300	DF+RS	DRY	13.32	13.84	457.91	7.37	8.67	8.93	154
71	10/20/09 11:10	10/30/09 11:30	3.568	DF+R?S?	DRY	15.67	2.54	136.85	4.48	5.23	8.0	155
72	10/30/09 11:30	11/11/09 11:00	3.287	DF	DRY	19.95	23.08	233.65	9.41	9.54	9.54	
73	11/11/09 11:00	11/28/09 11:30	3.571	DF	DRY	19.42	39.14	324.17	11.89	13.85	20.63	156
74	11/28/09 11:30	12/15/09 11:15	NA	DF	DRY	NA	NA	NA	NA	NA	NA	157
75	12/15/09 11:15	1/7/10 12:00	3.539	DF	DRY	30.64	19.91	63.13	2.03	3.08	26.8	158
76	1/7/10 12:00	1/28/10 10:00	4.460+	DF	DRY	19.87	15.87	141.72	1.81	4.61	11.82	172
77	1/28/10 10:00	2/4/10 13:55	3.039	DF	DRY	21.11	19.25	NA	2.94	4.61	9.84	
78	2/4/10 13:55	2/17/10 09:10	3.018	DF	DRY	16.78	17.2	NA	1.81	4.7	11.28	
79	2/17/10 09:10	3/1/10 17:30	2.382	DF	DRY	28.32	16.61	NA	2.49	4.03	12.45	
80	3/1/10 17:30	3/18/10 10:20	3.456	DF	DRY	35.13	55.6	NA	3.16	5.51	21.42	
81	3/18/10 10:20	3/26/10 11:50	3.243	DF	DRY	15.02	22.3	NA	4.75	5.63	NA	
82	3/26/10 11:50	4/9/10 17:30	2.419	DF	DRY	37.2	51.37	NA	2.94	6.88	17.2	
83	4/9/10 17:30	4/29/10 17:30	1.528	DF	DRY	61.98	74.56	NA	1.13	8.97	31.55	
84	4/29/10 17:30	5/15/10 17:00	1.416	DF	DRY	28.92	15.29	NA	1.81	NA	NA	

Appendix Table 2.b. N and P loads in dry deposition at the Ward Valley Lake Level Station 7/1/07-5/15/10.

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/28/2007 13:59	7/13/2007 17:20	1.203	DF	DRY	C	C	C	C	C	C	1
2	7/13/2007 17:20	8/9/2007 10:15	0.5	DF	DRY	6.26	5.26	NA	1.54	1.59	NA	2
3	8/9/2007 10:15	8/20/2007 15:30	1.86	DF	DRY	C	C	C	C	C	C	3
4	8/20/2007 15:30	8/28/2007 10:00	2.707	DF	DRY	4.75	9.19	94.75	0.49	C	4.77	
5	8/28/2007 10:00	9/11/2007 10:10	2.191	DF	DRY	4.66	0.27	120.22	0.19	5.04	5.79	
6	9/11/2007 10:10	9/21/2007 14:00	2.85	DF	DRY	14.15	4.25	79.19	4.97	5.74	8.07	
7	9/21/2007 14:00	10/2/2007 15:45	3.288	DF	DRY	29.55	33.05	197.07	2.99	6.20	12.40	
8	10/2/2007 15:45	10/11/2007 10:20	3.426	DF	DRY	12.45	3.19	159.37	9.20	14.07	20.01	
9	10/11/2007 10:20	10/23/2007 10:45	3.748	DF	DRY	20.29	4.54	221.57	1.53	4.34	6.62	19
10	10/23/2007 10:45	11/5/2007 9:00	3.62	DF	DRY	13.91	2.01	111.05	4.43	6.40	6.84	20
11	11/5/2007 9:00	11/7/2007 17:10	3.878	DF	DRY	11.85	45.33	78.29	1.23	2.84	3.79	21
12	11/7/2007 17:10	11/14/2007 14:10	3.394	DF	DRY	10.54	41.11	NA	0.76	2.90	3.32	22
13	11/14/2007 14:10	11/21/2007 9:55	3.532	DF	DRY	2.05	7.17	NA	1.13	3.83	11.16	23
14	11/21/2007 9:55	11/30/2007 14:15	2.786	DF	DRY	3.06	12.81	270.13	C	3.40	4.36	
15	11/30/2007 14:15	12/12/2007 14:50	NA	DF	DRY	NA	NA	NA	NA	NA	NA	24
16	12/12/2007 14:50	12/21/2007 11:15	3.558	DF	DRY	12.30	3.80	53.59	2.28	5.62	7.50	25
17	12/21/2007 11:15	1/3/2008 11:00	3.642	DF	DRY	5.57	12.98	37.33	2.16	5.53	13.16	
18	1/3/2008 11:00	1/11/2008 10:10	3.483	DF	DRY	8.42	4.85	158.31	2.65	4.19	9.44	
19	1/11/2008 10:10	1/24/2008 10:00	4.069	DF	DRY	20.24	22.44	50.07	2.91	2.94	18.80	42
20	1/24/2008 10:00	2/5/2008 10:00	4.59	DF	DRY	11.85	10.87	52.40	1.64	4.47	8.68	43
21	2/5/2008 10:00	2/14/2008 17:25	2.947	DF	DRY	6.56	6.49	35.47	3.42	4.84	18.63	
22	2/14/2008 17:25	2/25/2008 18:30	3.106	DF	DRY	13.83	18.78	47.11	1.39	4.53	15.01	44
23	2/25/2008 18:30	3/6/2008 17:20	2.567	DF	DRY	9.70	4.04	58.63	2.80	3.44	10.49	
24	3/6/2008 17:20	3/19/2008 17:15	1.935	DF	DRY	14.49	14.27	56.90	0.35	1.64	10.87	
25	3/19/2008 17:15	4/2/2008 10:15	1.751	DF	DRY	7.85	2.70	35.42	1.51	2.36	8.91	
26	4/2/2008 10:15	4/18/2008 9:40	2.133	DF	DRY	12.17	7.38	85.94	0.67	2.75	8.66	
27	4/18/2008 9:40	5/2/2008 10:00	2.2	DF	DRY	23.60	22.62	190.11	1.67	3.20	10.94	

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
28	5/2/2008 10:00	5/13/2008 15:10	2.278	DF	DRY	7.23	9.22	NA	3.44	4.98	67.98	
29	5/13/2008 15:10	5/28/2008 11:45	2.03	DF	DRY	1.39	1.91	NA	5.69	2.08	72.58	
30	5/28/2008 11:45	6/11/2008 15:05	1.615	DF	DRY	C	C	C	C	C	C	51
31	6/11/2008 15:05	6/23/2008 13:35	2.164	DF	DRY	5.52	3.86	NA	2.99	14.52	28.92	52
32	6/23/2008 13:35	7/7/2008 17:55	1.852	DF	DRY	5.13	0.88	366.95	4.62	15.94	45.38	64
33	7/7/2008 17:55	7/10/2008 13:10	3.462	DF	DRY	17.92	18.58	143.05	106.17	107.64	153.49	65
34	7/10/2008 13:10	7/15/2008 13:20	3.236	DF	DRY	9.63	3.80	314.44	18.23	20.90	37.32	66
35	7/15/2008 13:20	7/21/2008 12:15	3.055	DF	DRY	8.25	3.15	97.32	2.18	4.61	8.09	67
36	7/21/2008 12:15	7/29/2008 10:10	2.613	DF	DRY	4.74	2.70	83.61	NA	6.31	12.11	68
37	7/29/2008 10:10	8/20/2008 20:15	0.73	DF	DRY	C	C	C	C	C	C	69
38	8/20/2008 20:15	9/5/2008 17:45	1.655	DF	DRY	C	C	C	C	C	C	70
39	9/5/2008 17:45	9/17/2008 10:15	2.627	DF	DRY	8.28	4.95	139.33	0.70	1.76	5.78	72
40	9/17/2008 10:15	10/8/2008 11:40	2.637	DF	DRY	1.92	2.67	276.50	2.05	3.37	5.49	90
41	10/8/2008 11:40	10/20/2008 17:10	3.487	DF	DRY	2.28	7.54	133.55	13.76	17.60	18.22	91
42	10/20/2008 17:10	11/7/2008 10:45	3.5	DF	DRY	15.38	21.23	220.39	13.82	10.73	15.47	
43	11/7/2008 10:45	11/20/2008 10:45	3.807	DF	DRY	6.63	16.13	220.45	1.53	3.67	5.04	
44	11/20/2008 10:45	12/5/2008 9:30	2.917	DF	DRY	7.69	12.70	NA	1.56	2.85	3.74	92
45	12/5/2008 9:30	12/17/2008 10:30	4.206	DF+S	DRY	13.68	13.84	50.91	1.31	3.06	5.11	93
46	12/17/2008 10:30	12/23/2008 14:50	4.974	DF+S	DRY	11.33	12.39	69.29	3.76	6.23	8.21	94
47	12/23/2008 14:50	1/7/2009 17:15	2.939	DF	DRY	5.44	11.79	32.97	1.32	1.98	8.98	102
48	1/7/2009 17:15	1/15/2009 10:30	3.975	DF	DRY	3.81	6.91	25.56	1.07	2.68	9.98	103
49	1/15/2009 10:30	1/28/2009 10:05	3.105	DF	DRY	10.52	11.82	33.35	1.94	1.52	8.15	104
50	1/28/2009 10:05	2/5/2009 10:45	3.486	DF	DRY	5.85	12.16	51.57	1.55	9.18	8.94	105
51	2/5/2009 10:45	2/26/2009 10:30	3.901	DF	DRY	19.75	18.42	70.60	6.61	8.41	14.15	105
52	2/26/2009 10:30	3/9/2009 17:10	3.081	DF	DRY	12.47	19.20	49.67	1.51	2.64	6.81	
53	3/9/2009 17:10	3/20/2009 17:45	2.385	DF	DRY	7.76	6.82	28.13	0.74	0.88	4.97	
54	3/20/2009 17:45	4/3/2009 15:40	2.173	DF	DRY	9.08	7.41	43.51	1.75	3.86	9.98	
55	4/3/2009 15:40	4/17/2009 18:25	1.76	DF	DRY	14.91	13.95	50.14	1.41	2.79	7.52	
56	4/17/2009 18:25	4/28/2009 10:00	2.088	DF	DRY	11.03	4.49	129.56	1.20	3.83	9.95	115

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
57	4/28/2009 10:00	5/26/2009 12:00	2.048	DF	DRY	5.45	6.40	444.18	9.43	11.96	45.48	113
58	5/26/2009 12:00	6/5/2009 13:20	3.907	DF	DRY	59.16	130.91	432.59	1.03	6.84	12.03	
59	6/5/2009 13:20	6/19/2009 12:25	2.743	DF	DRY	76.23	6.87	145.50	0.37	1.32	3.53	
60	6/19/2009 12:25	6/26/2009 12:30	3.048	DF	DRY	2.09	7.20	178.46	1.31	3.18	12.90	
61	6/26/2009 12:30	7/5/2009 11:00	2.705	DF	DRY	3.27	37.31	314.28	0.92	4.64	24.72	
62	7/5/2009 11:00	7/14/2009 9:50	2.552	DF	DRY	3.41	5.51	84.15	1.70	5.36	10.88	121
63	7/14/2009 9:50	7/22/2009 10:00	2.357	DF	DRY	3.57	11.69	252.80	1.10	1.42	6.67	125
64	7/22/2009 10:00	8/9/2009 11:30	2.798	DF	DRY	74.99	32.14	75.99	0.37	0.85	3.22	
65	8/9/2009 11:30	8/28/2009 12:20	1.47	DF	DRY	3.09	0.85	388.08	0.91	2.04	33.95	126
66	8/28/2009 12:20	9/9/2009 13:30	2.325	DF	DRY	4.89	3.20	143.66	1.24	2.25	5.21	
67	9/9/2009 13:30	9/22/2009 15:10		DF	DRY	C	C	C	C	C	C	127
68	9/22/2009 15:10	10/2/2009 10:45	3.013	DF	DRY	4.40	4.75	215.40	13.52	16.80	20.68	128
69	10/2/2009 10:45	10/12/2009 15:45	2.83	DF	DRY	3.26	0.73	167.55	0.61	3.56	14.61	153
70	10/12/2009 15:45	10/20/2009 11:10	4.3	DF+RS	DRY	11.30	11.74	388.59	6.25	7.36	7.58	154
71	10/20/2009 11:10	10/30/2009 11:30	3.568	DF+R?S?	DRY	11.03	1.79	96.36	3.15	3.68	5.63	155
72	10/30/2009 11:30	11/11/2009 11:00	3.287	DF	DRY	12.94	14.97	151.57	6.10	6.19	6.19	
73	11/11/2009 11:00	11/28/2009 11:30	3.571	DF	DRY	13.69	27.58	228.46	8.38	9.76	14.54	156
74	11/28/2009 11:30	12/15/2009 11:15	NA	DF	DRY	NA	NA	NA	NA	NA	NA	157
75	12/15/2009 11:15	1/7/2010 12:00	3.539	DF	DRY	21.40	13.91	44.09	1.42	2.15	18.72	158
76	1/7/2010 12:00	1/28/2010 10:00	4.46+	DF	DRY	17.49	13.97	124.74	1.59	4.06	10.40	172
77	1/28/2010 10:00	2/4/2010 13:55	3.039	DF	DRY	12.66	11.55	NA	1.76	2.76	5.90	
78	2/4/2010 13:55	2/17/2010 9:10	3.018	DF	DRY	9.99	10.24	NA	1.08	2.80	6.72	
79	2/17/2010 9:10	3/1/2010 17:30	2.382	DF	DRY	13.31	7.81	NA	1.17	1.89	5.85	
80	3/1/2010 17:30	3/18/2010 10:20	3.456	DF	DRY	23.96	37.92	NA	2.16	3.76	14.61	
81	3/18/2010 10:20	3/26/2010 11:50	3.243	DF	DRY	9.61	14.27	NA	3.04	3.60	NA	
82	3/26/2010 11:50	4/9/2010 17:30	2.419	DF	DRY	17.76	24.52	NA	1.40	3.28	8.21	
83	4/9/2010 17:30	4/29/2010 17:30	1.528	DF	DRY	18.69	22.48	NA	0.34	2.70	9.51	
84	4/29/2010 17:30	5/15/2010 17:00	1.416	DF	DRY	8.08	4.27	NA	0.51	NA	NA	

Appendix Table 2.c. N and P loading per day in dry deposition at the Ward Valley Lake Level Station 7/1/07-5/15/10.

	Ward Valley Dry	Lake Level				(Load/day)						
Samp.	Start	Collection	Vol.	Precip.	Collector	NO3-N	NH4-N	TKN	SRP	DP	TP	
No.	Date-Time	Date-Time	Liters	Form	Type	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	Notes
1	6/28/2007 13:59	7/13/2007 17:20	1.203	DF	DRY	C	C	C	C	C	C	1
2	7/13/2007 17:20	8/9/2007 10:15	0.5	DF	DRY	0.23	0.20	NA	0.06	0.06	NA	2
3	8/9/2007 10:15	8/20/2007 15:30	1.86	DF	DRY	C	C	C	C	C	C	3
4	8/20/2007 15:30	8/28/2007 10:00	2.707	DF	DRY	0.61	1.18	12.19	0.06	C	0.61	
5	8/28/2007 10:00	9/11/2007 10:10	2.191	DF	DRY	0.33	0.02	8.58	0.01	0.36	0.41	
6	9/11/2007 10:10	9/21/2007 14:00	2.85	DF	DRY	1.39	0.42	7.79	0.49	0.57	0.79	
7	9/21/2007 14:00	10/2/2007 15:45	3.288	DF	DRY	2.67	2.98	17.80	0.27	0.56	1.12	
8	10/2/2007 15:45	10/11/2007 10:20	3.426	DF	DRY	1.42	0.36	18.16	1.05	1.60	2.28	
9	10/11/2007 10:20	10/23/2007 10:45	3.748	DF	DRY	1.69	0.38	18.44	0.13	0.36	0.55	19
10	10/23/2007 10:45	11/5/2007 9:00	3.62	DF	DRY	1.08	0.16	8.59	0.34	0.50	0.53	20
11	11/5/2007 9:00	11/7/2007 17:10	3.878	DF	DRY	5.06	19.37	33.45	0.53	1.21	1.62	21
12	11/7/2007 17:10	11/14/2007 14:10	3.394	DF	DRY	1.53	5.98	NA	0.11	0.42	0.48	22
13	11/14/2007 14:10	11/21/2007 9:55	3.532	DF	DRY	0.30	1.05	NA	0.17	0.56	1.64	23
14	11/21/2007 9:55	11/30/2007 14:15	2.786	DF	DRY	0.33	1.40	29.42	C	0.37	0.47	
15	11/30/2007 14:15	12/12/2007 14:50	NA	DF	DRY	NA	NA	NA	NA	NA	NA	24
16	12/12/2007 14:50	12/21/2007 11:15	3.558	DF	DRY	1.39	0.43	6.05	0.26	0.64	0.85	25
17	12/21/2007 11:15	1/3/2008 11:00	3.642	DF	DRY	0.43	1.00	2.87	0.17	0.43	1.01	
18	1/3/2008 11:00	1/11/2008 10:10	3.483	DF	DRY	1.06	0.61	19.88	0.33	0.53	1.18	
19	1/11/2008 10:10	1/24/2008 10:00	4.069	DF	DRY	1.56	1.73	3.85	0.22	0.23	1.45	42
20	1/24/2008 10:00	2/5/2008 10:00	4.59	DF	DRY	0.99	0.91	4.37	0.14	0.37	0.72	43
21	2/5/2008 10:00	2/14/2008 17:25	2.947	DF	DRY	0.70	0.70	3.81	0.37	0.52	2.00	
22	2/14/2008 17:25	2/25/2008 18:30	3.106	DF	DRY	1.25	1.70	4.27	0.13	0.41	1.36	44
23	2/25/2008 18:30	3/6/2008 17:20	2.567	DF	DRY	0.97	0.41	5.89	0.28	0.35	1.05	
24	3/6/2008 17:20	3/19/2008 17:15	1.935	DF	DRY	1.11	1.10	4.38	0.03	0.13	0.84	
25	3/19/2008 17:15	4/2/2008 10:15	1.751	DF	DRY	0.57	0.20	2.58	0.11	0.17	0.65	
26	4/2/2008 10:15	4/18/2008 9:40	2.133	DF	DRY	0.76	0.46	5.38	0.04	0.17	0.54	
27	4/18/2008 9:40	5/2/2008 10:00	2.2	DF	DRY	1.68	1.61	13.57	0.12	0.23	0.78	

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load/day) NO3-N (g/ha/d)	NH4-N (g/ha/d)	TKN (g/ha/d)	SRP (g/ha/d)	DP (g/ha/d)	TP (g/ha/d)	Notes
28	5/2/2008 10:00	5/13/2008 15:10	2.278	DF	DRY	0.64	0.82	NA	0.31	0.44	6.06	
29	5/13/2008 15:10	5/28/2008 11:45	2.03	DF	DRY	0.09	0.13	NA	0.38	0.14	4.89	
30	5/28/2008 11:45	6/11/2008 15:05	1.615	DF	DRY	C	C	C	C	C	C	51
31	6/11/2008 15:05	6/23/2008 13:35	2.164	DF	DRY	0.46	0.32	C	0.25	1.22	2.42	52
32	6/23/2008 13:35	7/7/2008 17:55	1.852	DF	DRY	0.36	0.06	25.88	0.33	1.12	3.20	64
33	7/7/2008 17:55	7/10/2008 13:10	3.462	DF	DRY	6.40	6.63	51.05	37.89	38.41	54.78	65
34	7/10/2008 13:10	7/15/2008 13:20	3.236	DF	DRY	1.92	0.76	62.80	3.64	4.17	7.45	66
35	7/15/2008 13:20	7/21/2008 12:15	3.055	DF	DRY	1.39	0.53	16.34	0.37	0.77	1.36	67
36	7/21/2008 12:15	7/29/2008 10:10	2.613	DF	DRY	0.60	0.34	10.57	NA	0.80	1.53	68
37	7/29/2008 10:10	8/20/2008 20:15	0.73	DF	DRY	C	C	C	C	C	C	69
38	8/20/2008 20:15	9/5/2008 17:45	1.655	DF	DRY	C	C	C	C	C	C	70
39	9/5/2008 17:45	9/17/2008 10:15	2.627	DF	DRY	0.71	0.42	11.92	0.06	0.15	0.49	72
40	9/17/2008 10:15	10/8/2008 11:40	2.637	DF	DRY	0.09	0.13	13.13	0.10	0.16	0.26	90
41	10/8/2008 11:40	10/20/2008 17:10	3.487	DF	DRY	0.19	0.62	10.92	1.12	1.44	1.49	91
42	10/20/2008 17:10	11/7/2008 10:45	3.5	DF	DRY	0.87	1.20	12.43	0.78	0.61	0.87	
43	11/7/2008 10:45	11/20/2008 10:45	3.807	DF	DRY	0.51	1.24	16.96	0.12	0.28	0.39	
44	11/20/2008 10:45	12/5/2008 9:30	2.917	DF	DRY	0.51	0.85	NA	0.10	0.19	0.25	92
45	12/5/2008 9:30	12/17/2008 10:30	4.206	DF+S	DRY	1.14	1.15	4.23	0.11	0.25	0.42	93
46	12/17/2008 10:30	12/23/2008 14:50	4.974	DF+S	DRY	1.83	2.00	11.21	0.61	1.01	1.33	94
47	12/23/2008 14:50	1/7/2009 17:15	2.939	DF	DRY	0.36	0.78	2.18	0.09	0.13	0.59	102
48	1/7/2009 17:15	1/15/2009 10:30	3.975	DF	DRY	0.49	0.90	3.31	0.14	0.35	1.29	103
49	1/15/2009 10:30	1/28/2009 10:05	3.105	DF	DRY	0.81	0.91	2.57	0.15	0.12	0.63	104
50	1/28/2009 10:05	2/5/2009 10:45	3.486	DF	DRY	0.73	1.52	6.42	0.19	1.14	1.11	105
51	2/5/2009 10:45	2/26/2009 10:30	3.901	DF	DRY	0.94	0.88	3.36	0.32	0.40	0.67	105
52	2/26/2009 10:30	3/9/2009 17:10	3.081	DF	DRY	1.11	1.70	4.40	0.13	0.23	0.60	
53	3/9/2009 17:10	3/20/2009 17:45	2.385	DF	DRY	0.70	0.62	2.55	0.07	0.08	0.45	
54	3/20/2009 17:45	4/3/2009 15:40	2.173	DF	DRY	0.65	0.53	3.13	0.13	0.28	0.72	
55	4/3/2009 15:40	4/17/2009 18:25	1.76	DF	DRY	1.06	0.99	3.55	0.10	0.20	0.53	
56	4/17/2009 18:25	4/28/2009 10:00	2.088	DF	DRY	1.04	0.42	12.17	0.11	0.36	0.93	115

Samp. No.	Ward Valley Dry Start Date-Time	Lake Level Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load/day) NO3-N (g/ha/d)	NH4-N (g/ha/d)	TKN (g/ha/d)	SRP (g/ha/d)	DP (g/ha/d)	TP (g/ha/d)	Notes
57	4/28/2009 10:00	5/26/2009 12:00	2.048	DF	DRY	0.19	0.23	15.82	0.34	0.43	1.62	113
58	5/26/2009 12:00	6/5/2009 13:20	3.907	DF	DRY	5.88	13.02	43.02	0.10	0.68	1.20	
59	6/5/2009 13:20	6/19/2009 12:25	2.743	DF	DRY	5.46	0.49	10.42	0.03	0.09	0.25	
60	6/19/2009 12:25	6/26/2009 12:30	3.048	DF	DRY	0.30	1.03	25.48	0.19	0.45	1.84	
61	6/26/2009 12:30	7/5/2009 11:00	2.705	DF	DRY	0.37	4.17	35.16	0.10	0.52	2.77	
62	7/5/2009 11:00	7/14/2009 9:50	2.552	DF	DRY	0.38	0.62	9.40	0.19	0.60	1.22	121
63	7/14/2009 9:50	7/22/2009 10:00	2.357	DF	DRY	0.45	1.46	31.57	0.14	0.18	0.83	125
64	7/22/2009 10:00	8/9/2009 11:30	2.798	DF	DRY	4.15	1.78	4.21	0.02	0.05	0.18	
65	8/9/2009 11:30	8/28/2009 12:20	1.47	DF	DRY	0.16	0.04	20.39	0.05	0.11	1.78	126
66	8/28/2009 12:20	9/9/2009 13:30	2.325	DF	DRY	0.41	0.27	11.92	0.10	0.19	0.43	
67	9/9/2009 13:30	9/22/2009 15:10		DF	DRY	C	C	C	C	C	C	127
68	9/22/2009 15:10	10/2/2009 10:45	3.013	DF	DRY	0.45	0.48	21.94	1.38	1.71	2.11	128
69	10/2/2009 10:45	10/12/2009 15:45	2.83	DF	DRY	0.32	0.07	16.41	0.06	0.35	1.43	153
70	10/12/2009 15:45	10/20/2009 11:10	4.3	DF+RS	DRY	1.45	1.50	49.76	0.80	0.94	0.97	154
71	10/20/2009 11:10	10/30/2009 11:30	3.568	DF+R?S?	DRY	1.10	0.18	9.62	0.32	0.37	0.56	155
72	10/30/2009 11:30	11/11/2009 11:00	3.287	DF	DRY	1.08	1.25	12.65	0.51	0.52	0.52	
73	11/11/2009 11:00	11/28/2009 11:30	3.571	DF	DRY	0.80	1.62	13.42	0.49	0.57	0.85	156
74	11/28/2009 11:30	12/15/2009 11:15	NA	DF	DRY	NA	NA	NA	NA	NA	NA	157
75	12/15/2009 11:15	1/7/2010 12:00	3.539	DF	DRY	0.93	0.60	1.91	0.06	0.09	0.81	158
76	1/7/2010 12:00	1/28/2010 10:00	4.46	+DF	DRY	0.84	0.67	5.96	0.08	0.19	0.50	172
77	1/28/2010 10:00	2/4/2010 13:55	3.039	DF	DRY	1.77	1.61	NA	0.25	0.39	0.82	
78	2/4/2010 13:55	2/17/2010 9:10	3.018	DF	DRY	0.78	0.80	NA	0.08	0.22	0.52	
79	2/17/2010 9:10	3/1/2010 17:30	2.382	DF	DRY	1.08	0.63	NA	0.09	0.15	0.47	
80	3/1/2010 17:30	3/18/2010 10:20	3.456	DF	DRY	1.43	2.27	NA	0.13	0.23	0.87	
81	3/18/2010 10:20	3/26/2010 11:50	3.243	DF	DRY	1.19	1.77	NA	0.38	0.45	NA	
82	3/26/2010 11:50	4/9/2010 17:30	2.419	DF	DRY	1.25	1.72	NA	0.10	0.23	0.58	
83	4/9/2010 17:30	4/29/2010 17:30	1.528	DF	DRY	0.93	1.12	NA	0.02	0.14	0.48	
84	4/29/2010 17:30	5/15/2010 17:00	1.416	DF	DRY	0.51	0.27	NA	0.03	NA	NA	

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 7/1/07-6/3/10.

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
	6/27/2007 8:15	7/26/2007 10:18	0.01	DF	ST	NA	NA	NA	NA	NA	NA	4
	7/26/2007 10:18	8/15/2007 9:32	0	DF	ST	NA	NA	NA	NA	NA	NA	
	8/15/2007 9:32	8/28/2007 14:57	0	DF	ST	NA	NA	NA	NA	NA	NA	
	8/28/2007 14:57	9/11/2007 8:42	0.01	DF	ST	NA	NA	NA	NA	NA	NA	5
1	9/11/2007 8:42	10/2/2007 14:15	0.21	R+S+DF	ST	848.85	333.50	945.74	25.15	37.30	105.43	6
2	10/2/2007 14:15	10/11/07 14:40	0.29	S+DF	ST	929.20	380.00	1088.32	42.22	62.67	117.72	
3	10/11/07 14:40	10/23/07 12:35	0.10	R+S+DF	ST	64.60	58.28	117.45	5.05	10.19	11.73	26
4	10/23/07 12:35	11/5/07 09:42	0.13	R+DF	ST	173.45	159.23	311.59	25.47	36.74	38.59	27
5	11/5/07 09:42	11/13/07 14:05	0.38	R+DF	ST	363.37	205.12	3438.44	19.46	25.32	40.14	
6	11/13/07 14:05	12/13/07 12:36	0.61+	R+S+DF	ST	18.52	157.70	328.44	12.05	29.57	31.42	28
	12/13/07 12:36	1/11/08 11:40	NA	R+S+DF		NA	NA	NA	NA	NA	NA	45
7	1/11/08 11:40	2/5/08 14:47	0.64+	R+S+DF	ST	144.60	94.93	283.66	3.39	7.01	15.10	46
	2/5/08 14:47	2/15/08 13:58	T	R+S+DF	ST	NA	NA	NA	NA	NA	NA	
8	2/15/08 13:58	2/26/08 11:26	0.46	S+DF	ST	302.05	230.05	401.18	4.52	10.78	11.33	
	2/26/08 11:26	3/12/08 10:00	0	DF	ST	NA	NA	NA	NA	NA	NA	
9	3/12/08 10:00	3/24/08 09:38	0.20	S+DF	ST	69.67	212.37	349.38	4.53	7.65	12.86	47
10	3/24/08 09:38	4/3/08 11:27	0.01	S+DF	ST	43.84	38.95	1479.65	2.49	4.67	4.99	54
	4/3/08 11:27	4/26/08 12:15	0	DF	ST	NA	NA	NA	NA	NA	NA	
11	4/26/08 12:15	5/29/08 14:14	0.40	R+DF	ST	88.94	424.31	1276.09	32.67	68.03	170.50	
	5/29/08 14:14	6/25/08 10:20	0	DF	ST	NA	NA	NA	NA	NA	NA	
	6/25/2008 10:20	7/3/2008 10:50	0	DF	ST	NA	NA	NA	NA	NA	NA	
	7/3/2008 10:50	7/10/2008 8:12	0	DF	ST	NA	NA	NA	NA	NA	NA	73
	7/10/2008 8:12	7/15/2008 10:25	0	DF	ST	NA	NA	NA	NA	NA	NA	
	7/15/2008 10:25	7/29/2008 9:28	0	DF	ST	NA	NA	NA	NA	NA	NA	
	7/29/2008 9:28	8/15/2008 9:50	0	DF	ST	NA	NA	NA	NA	NA	NA	74
	8/15/2008 9:50	9/16/2008 10:00	0	DF	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 (µg/l)	NH4-N (µg/l)	TKN (µg/l)	SRP (µg/l)	DP (µg/l)	TP (µg/l)	Notes
12	9/16/2008 10:00	10/8/2008 10:40	0.46	R	ST	C	C	C	C	C	C	84
	10/8/2008 10:40	10/17/2008 10:30	0		ST	NA	NA	NA	NA	NA	NA	
13	10/17/2008 10:30	11/7/2008 9:45	1.05	R+S	ST	337.35	164.29	371.86	28.78	35.66	52.73	
14	11/7/2008 9:45	11/21/2008 10:22	0.12	R	ST	358.79	178.52	NA	6.11	11.28	NA	
15	11/21/2008 10:22	12/5/2008 8:31	0.12	R+S	ST	163.29	105.08	192.41	3.95	6.18	6.8	95
16	12/5/2008 8:31	1/6/2009 10:47	0.99	R+S	ST	264.67	88.19	296.53	9.75	13.63	24.16	97
	1/6/2009 10:47	1/19/2009 9:45	0		ST	NA	NA	NA	NA	NA	NA	
17	1/19/2009 9:45	1/28/2009 9:50	1.01	R+S	ST	170.73	113.89	154.47	5.42	4.66	7.74	
	1/28/2009 9:50	2/4/2009 15:47	0		ST	NA	NA	NA	NA	NA	NA	
18	2/4/2009 15:47	2/20/2009 8:15	0.12	S	ST	52.05	39.81	623.83	2.26	3.37	6.71	106
19	2/20/2009 8:15	3/10/2009 9:48	1.48	R+S	ST	95.47	90.15	229.93	3.62	4.04	5.91	
	3/10/2009 9:48	3/20/2009 10:55	T		ST	NA	NA	NA	NA	NA	NA	
20	3/20/2009 10:55	4/10/2009 9:50	0.36	S	ST	111.2	248.16	618.48	7.88	18.49	47.23	
21	4/10/2009 9:50	5/15/2009 14:10	NA		ST	256.85	230.45	406	9.65	14.66	25.97	116
	5/15/2009 14:10	6/11/2009 9:12	0.42	R+H?	ST	C	C	C	C	C	C	117
	6/11/2009 9:12	6/18/2009 10:55	T		ST	NA	NA	NA	NA	NA	NA	118
	6/18/2009 10:55	6/25/2009 9:45	0		ST	NA	NA	NA	NA	NA	NA	
	6/25/2009 9:45	7/2/2009 10:05	0		ST	NA	NA	NA	NA	NA	NA	
22	7/2/2009 10:05	7/13/2009 9:50	0.08	R	ST	C	C	C	C	C	C	129
	7/13/2009 9:50	7/21/2009 9:55	0		ST	NA	NA	NA	NA	NA	NA	
	7/21/2009 9:55	7/30/2009 7:25	0		ST	NA	NA	NA	NA	NA	NA	
	7/30/2009 7:25	8/7/2009 8:35	T		ST	NA	NA	NA	NA	NA	NA	
	8/7/2009 8:35	8/25/2009 9:10	T		ST	NA	NA	NA	NA	NA	NA	
23	8/25/2009 9:10	9/22/2009 9:26	0.01	R	ST	34.39	33.45	114.86	15.11	19.08	17.82	130
24	9/22/2009 9:26	10/21/09 11:56	0.12+	R+S	ST	205.81	159.86	NA	8.95	20.62	NA	159
	10/21/09 11:56	10/30/09 14:01	T		ST	NA	NA	NA	NA	NA	NA	
	10/30/09 14:01	11/10/09 08:15	0		ST	NA	NA	NA	NA	NA	NA	
25	11/10/09 08:15	11/24/09 08:20	0.25	R+S	ST	534.2	252.36	576.3	20.46	21.67	45.26	160
26	11/24/09 08:20	12/3/09 11:27	0.01	S	ST	144.08	100.89	185.33	2.96	5.59	8.69	161

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
27	12/3/09 11:27	12/17/09 15:17	0.85	S	ST	190.95	183.17	401.52	18.08	18.67	36.93	
28	12/17/09 15:17	1/4/10 09:15	0.15	R+S	ST	121.71	45.51	135.1	2.48	4.93	5.24	162
29	1/4/10 09:15	1/14/10 11:57	0.62	R+S	ST	269.99	129.27	428.19	7.67	9.74	15.07	
30	1/14/10 11:57	1/26/10 13:28	0.53	R+S	ST	204.23	112.29	459.33	9.48	12.61	11.52	
31	1/26/10 13:28	2/2/10 08:43	T	T	ST	NA	NA	NA	NA	NA	NA	
32	2/2/10 08:43	2/17/10 16:18	0.24	S	ST	133.86	89.86	NA	2.94	4.7	5.33	173
33	2/17/10 16:18	2/25/10 09:40	0.55		ST	135.58	70.29	NA	3.85	4.97	6.53	
34	2/25/10 09:40	3/16/10 08:36	1.24	R+S	ST	106.93	62.53	NA	1.81	3.98	5.81	
35	3/16/10 08:36	3/26/10 09:05	NA	S	ST	NA	NA	NA	NA	NA	NA	
36	3/26/10 09:05	4/13/10 09:30	0.54	R+S	ST	313	77.64	NA	4.77	10.39	25.82	
37	4/13/10 09:30	5/7/10 13:26	0.64	R+S	ST	328.35	251.91	NA	9.47	NA	NA	
38	5/7/10 13:26	6/3/10 09:37	0.48	S	ST	NA	550.29	NA	NA	NA	NA	

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 7/1/07-6/3/10.

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
	6/27/2007 8:15	7/26/2007 10:18	0.01	DF	ST	C	C	C	C	C	C	4
	7/26/2007 10:18	8/15/2007 9:32	0	DF	ST	NA	NA	NA	NA	NA	NA	
	8/15/2007 9:32	8/28/2007 14:57	0	DF	ST	NA	NA	NA	NA	NA	NA	
	8/28/2007 14:57	9/11/2007 8:42	0.01	DF	ST	C	C	C	C	C	C	5
1	9/11/2007 8:42	10/2/2007 14:15	0.21	R+S+DF	ST	130.83	51.40	145.76	3.88	5.75	16.25	6
2	10/2/2007 14:15	10/11/07 14:40	0.29	S+DF	ST	68.44	27.99	80.17	3.11	4.62	8.67	
3	10/11/07 14:40	10/23/07 12:35	0.10	R+S+DF	ST	9.96	8.98	18.10	0.78	1.57	1.81	26
4	10/23/07 12:35	11/5/07 09:42	0.13	R+DF	ST	26.73	24.54	48.02	3.93	5.66	5.95	27
5	11/5/07 09:42	11/13/07 14:05	0.38	R+DF	ST	35.07	19.80	331.88	1.88	2.44	3.87	
6	11/13/07 14:05	12/13/07 12:36	0.61+	R+S+DF	ST	2.87	24.43	50.89	1.87	4.58	4.87	28
	12/13/07 12:36	1/11/08 11:40	NA	R+S+DF		NA	NA	NA	NA	NA	NA	45
7	1/11/08 11:40	2/5/08 14:47	0.64+	R+S+DF	ST	23.51	15.43	46.11	0.55	1.14	2.45	46
	2/5/08 14:47	2/15/08 13:58	T	R+S+DF	ST	NA	NA	NA	NA	NA	NA	
8	2/15/08 13:58	2/26/08 11:26	0.46	S+DF	ST	35.29	26.88	46.87	0.53	1.26	1.32	
	2/26/08 11:26	3/12/08 10:00	0	DF	ST	NA	NA	NA	NA	NA	NA	
9	3/12/08 10:00	3/24/08 09:38	0.20	S+DF	ST	10.74	32.73	53.85	0.70	1.18	1.98	47
10	3/24/08 09:38	4/3/08 11:27	0.01	S+DF	ST	6.76	6.00	228.05	0.38	0.72	0.77	54
	4/3/08 11:27	4/26/08 12:15	0	DF	ST	NA	NA	NA	NA	NA	NA	
11	4/26/08 12:15	5/29/08 14:14	0.40	R+DF	ST	9.04	43.11	129.65	3.32	6.91	17.32	
	5/29/08 14:14	6/25/08 10:20	0	DF	ST	NA	NA	NA	NA	NA	NA	
	6/25/2008 10:20	7/3/2008 10:50	0	DF	ST	NA	NA	NA	NA	NA	NA	
	7/3/2008 10:50	7/10/2008 8:12	0	DF	ST	NA	NA	NA	NA	NA	NA	73
	7/10/2008 8:12	7/15/2008 10:25	0	DF	ST	NA	NA	NA	NA	NA	NA	
	7/15/2008 10:25	7/29/2008 9:28	0	DF	ST	NA	NA	NA	NA	NA	NA	
	7/29/2008 9:28	8/15/2008 9:50	0	DF	ST	NA	NA	NA	NA	NA	NA	74
	8/15/2008 9:50	9/16/2008 10:00	0	DF	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	(Load) NO_3-N (g/ha)	NH_4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
12	9/16/2008 10:00	10/8/2008 10:40	0.46	R	ST	C	C	C	C	C	C	84
	10/8/2008 10:40	10/17/2008 10:30	0		ST	NA	NA	NA	NA	NA	NA	
13	10/17/2008 10:30	11/7/2008 9:45	1.05	R+S	ST	89.97	43.82	99.18	7.68	9.51	14.06	
14	11/7/2008 9:45	11/21/2008 10:22	0.12	R	ST	10.94	5.44	NA	0.19	0.34	NA	
15	11/21/2008 10:22	12/5/2008 8:31	0.12	R+S	ST	25.17	16.20	29.66	0.61	0.95	1.05	95
16	12/5/2008 8:31	1/6/2009 10:47	0.99	R+S	ST	66.55	22.18	74.57	2.45	3.43	6.08	97
	1/6/2009 10:47	1/19/2009 9:45	0		ST	NA	NA	NA	NA	NA	NA	
17	1/19/2009 9:45	1/28/2009 9:50	1.01	R+S	ST	43.80	29.22	39.63	1.39	1.20	1.99	
	1/28/2009 9:50	2/4/2009 15:47	0		ST	NA	NA	NA	NA	NA	NA	
18	2/4/2009 15:47	2/20/2009 8:15	0.12	S	ST	8.02	6.14	96.15	0.35	0.52	1.03	106
19	2/20/2009 8:15	3/10/2009 9:48	1.48	R+S	ST	35.89	33.89	86.44	1.36	1.52	2.22	
	3/10/2009 9:48	3/20/2009 10:55	T		ST	NA	NA	NA	NA	NA	NA	
20	3/20/2009 10:55	4/10/2009 9:50	0.36	S	ST	10.17	22.69	56.55	0.72	1.69	4.32	
	4/10/2009 9:50	5/15/2009 14:10	NA		ST	NA	NA	NA	NA	NA	NA	116
	5/15/2009 14:10	6/11/2009 9:12	0.42	R+H?	ST	C	C	C	C	C	C	117
	6/11/2009 9:12	6/18/2009 10:55	T		ST	NA	NA	NA	NA	NA	NA	118
	6/18/2009 10:55	6/25/2009 9:45	0		ST	NA	NA	NA	NA	NA	NA	
	6/25/2009 9:45	7/2/2009 10:05	0		ST	NA	NA	NA	NA	NA	NA	
21	7/2/2009 10:05	7/13/2009 9:50	0.08	R	ST	19.90	11.03	34.24	1.84	3.15	5.28	
	7/13/2009 9:50	7/21/2009 9:55	0		ST	NA	NA	NA	NA	NA	NA	
	7/21/2009 9:55	7/30/2009 7:25	0		ST	NA	NA	NA	NA	NA	NA	
	7/30/2009 7:25	8/7/2009 8:35	T		ST	NA	NA	NA	NA	NA	NA	
	8/7/2009 8:35	8/25/2009 9:10	0		ST	NA	NA	NA	NA	NA	NA	
22	8/25/2009 9:10	9/22/2009 9:26	0.01	R	ST	5.35	5.21	17.88	2.35	2.97	2.77	130
24	9/22/2009 9:26	10/21/09 11:56	0.12+	R+S	ST	6.27	4.87	NA	0.27	0.63	NA	159
	10/21/09 11:56	10/30/09 14:01	T		ST	NA	NA	NA	NA	NA	NA	
	10/30/09 14:01	11/10/09 08:15	0		ST	NA	NA	NA	NA	NA	NA	
25	11/10/09 08:15	11/24/09 08:20	0.25	R+S	ST	82.33	38.90	88.82	3.15	3.34	6.98	160
26	11/24/09 08:20	12/3/09 11:27	0.01	S	ST	22.21	15.55	28.56	0.46	0.86	1.34	161

No.	Mid-lake (TB-1) Start Date-Time	Snow Tube Collection Date-Time	Precip. (in.)	Precip. Form	Collector Type	(Load) NO_3-N (g/ha)	NH_4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
27	12/3/09 11:27	12/17/09 15:17	0.85	S	ST	41.23	39.55	86.69	3.90	4.03	7.97	
28	12/17/09 15:17	1/4/10 09:15	0.15	R+S	ST	18.76	7.01	20.82	0.38	0.76	0.81	162
29	1/4/10 09:15	1/14/10 11:57	0.62	R+S	ST	42.52	20.36	67.43	1.21	1.53	2.37	
30	1/14/10 11:57	1/26/10 13:28	0.53	R+S	ST	27.49	15.12	61.84	1.28	1.70	1.55	
31	1/26/10 13:28	2/2/10 08:43	T	T	ST	NA	NA	NA	NA	NA	NA	
32	2/2/10 08:43	2/17/10 16:18	0.24	S	ST	20.63	13.85	NA	0.45	0.72	0.82	173
33	2/17/10 16:18	2/25/10 09:40	0.55		ST	18.94	9.82	NA	0.54	0.69	0.91	
34	2/25/10 09:40	3/16/10 08:36	1.24	R+S	ST	33.68	19.69	NA	0.57	1.25	1.83	
35	3/16/10 08:36	3/26/10 09:05	NA	S	ST	NA	NA	NA	NA	NA	NA	
36	3/26/10 09:05	4/13/10 09:30	0.54	R+S	ST	42.93	10.65	NA	0.65	1.43	3.54	
37	4/13/10 09:30	5/7/10 13:26	0.64	R+S	ST	53.38	40.95	NA	1.54	NA	NA	
38	5/7/10 13:26	6/3/10 09:37	0.48	S	ST	NA	67.09	NA	NA	NA	NA	

Appendix Table 4.a. N and P concentrations in dry-bulk deposition (buoy bucket) at Mid-lake Buoy (TB-1) Station 7/1/07-6/3/10.

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	6/28/2007 7:35	7/26/2007 10:18	0.500	DF	DRY-BULK	C	C	C	C	C	C	83
2	7/26/2007 10:18	7/27/2007 9:57	3.283	DF	DRY-BULK	NA	NA	28.61	NA	NA	4.47	
3	7/27/2007 9:57	8/15/2007 9:32	0.500	DF	DRY-BULK	236.18	65.08	317.63	14.60	24.55	68.26	7
4	8/15/2007 9:32	8/28/2007 14:57	0.500	DF	DRY-BULK	255.86	533.36	1031.87	17.92	33.87	81.66	7
5	8/28/2007 14:57	9/11/2007 8:42	0.500	DF	DRY-BULK	533.12	419.96	759.01	4.54	19.27	24.72	7
6	9/11/2007 8:42	10/2/2007 14:15	0.500	DF	DRY-BULK	789.58	348.04	680.79	13.38	21.89	56.41	7
7	10/2/2007 14:15	10/11/07 14:40	0.500	DF+S	DRY-BULK	226.55	275.72	399.08	1.15	7.41	10.28	29
8	10/11/07 14:40	10/23/07 12:35	0.772	DF+R	DRY-BULK	289.38	13.90	696.63	6.65	12.66	16.67	
9	10/23/07 12:35	11/5/07 09:42	1.564	DF+R	DRY-BULK	197.35	253.53	344.81	4.82	11.11	25.01	30
10	11/5/07 09:42	11/13/07 14:05	2.678	DF+R	DRY-BULK	43.18	79.60	51.80	1.14	5.85	4.27	
11	11/13/07 14:05	12/13/07 12:36	0.722	DF+R+S	DRY-BULK	288.96	25.82	416.89	2.78	6.71	21.96	
12	12/13/07 12:36	1/11/08 11:40	0.646	DF+R+S	DRY-BULK	331.91	186.90	338.79	7.71	6.40	18.91	
13	1/11/08 11:40	2/5/08 14:47	0.600	DF+S	DRY-BULK	197.27	139.12	180.50	1.81	5.49	12.01	
14	2/5/08 14:47	2/15/08 13:58	1.680	DF+R+S	DRY-BULK	61.94	41.11	73.91	2.26	7.39	8.93	
15	2/15/08 13:58	2/26/08 11:26	3.260	DF+S	DRY-BULK	49.51	49.90	70.38	0.90	5.90	6.52	
16	2/26/08 11:26	3/12/08 10:00	0.320	DF	DRY-BULK	405.01	453.32	464.33	8.35	8.26	10.71	
17	3/12/08 10:00	3/24/08 09:38	0.745	DF+R+S	DRY-BULK	149.37	136.83	178.49	2.95	6.43	7.96	
18	3/24/08 09:38	4/3/08 11:27	0.765	DF+S	DRY-BULK	134.38	110.19	338.64	1.58	4.67	9.97	
19	4/3/08 11:27	4/26/08 12:15	0.500	DF+R	DRY-BULK	165.01	119.41	310.47	7.00	11.07	35.53	55
20	4/26/08 12:15	5/29/08 14:14	0.595	DF+R	DRY-BULK	70.08	38.21	NA	15.85	49.35	126.47	56
21	5/29/08 14:14	6/25/08 10:20	0.500	DF	DRY-BULK	199.11	95.67	NA	33.41	45.76	69.82	57
22	6/25/2008 10:20	7/3/2008 10:50	1.205	DF	DRY-BULK	C	C	C	C	C	C	58
23	7/3/2008 10:50	7/10/2008 8:12	0.939	DF	DRY-BULK	158.48	277.85	NA	101.81	110.39	184.6	75
24	7/10/2008 8:12	7/15/2008 10:25	2.04	DF	DRY-BULK	64.62	130.54	270.85	10.57	11.93	19.43	76
25	7/15/2008 10:25	7/22/2008 7:38	0.822	DF+R?	DRY-BULK	147.29	347.93	328.84	7.46	10.71	13.12	77
26	7/22/2008 7:38	7/29/2008 9:28	0.676	DF	DRY-BULK	268.32	634.22	510.96	6.07	10.4	20.44	78
27	7/29/2008 9:28	8/15/2008 9:50	0.5	DF	DRY-BULK	169.41	101.17	420.73	11.46	24.77	56.97	79
28	8/15/2008 9:50	9/5/2008 13:50	0.5	DF	DRY-BULK	38.75	149.34	463.32	12.61	25.39	89.32	79

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
29	9/5/2008 13:50	9/16/2008 10:00	0.69	DF	DRY-BULK	227.35	231.76	323.08	5.41	8.66	38.99	
30	9/16/2008 10:00	10/8/2008 10:40	0.535	DF+R	DRY-BULK	488.38	354.86	1434.63	2.7	7.13	28.22	80
31	10/8/2008 10:40	10/17/2008 10:30	0.695	DF	DRY-BULK	129.5	85.18	179.1	1.35	5.48	8.52	
32	10/17/2008 10:30	11/7/2008 9:45	1.33	DF+R+S	DRY-BULK	227.69	294.37	419.94	6.07	6.4	8.23	
33	11/7/2008 9:45	11/21/2008 10:22	1.515	DF+R	DRY-BULK	94.97	82.47	290.14	3.17	2.74	4.88	
34	11/21/2008 10:22	12/5/2008 8:31	1.268	DF+R+S	DRY-BULK	152.81	136.37	164.9	2.03	4.02	2.78	
35	12/5/2008 8:31	1/6/2009 10:47	0.6	DF +R+S	DRY-BULK	247.03	123.62	387	6.57	9.29	31.9	97
36	1/6/2009 10:47	1/19/2009 9:45	1.381	DF	DRY-BULK	102.1	64.46	113.65	0.68	1.55	2.17	107
37	1/19/2009 9:45	1/28/2009 9:50	2.348	DF +R+S	DRY-BULK	35.59	12.2	172.99	0.45	2.17	1.86	
38	1/28/2009 9:50	2/4/2009 15:47	2.875	DF	DRY-BULK	33.47	24.63	40.72	0.68	2.02	2.17	
39	2/4/2009 15:47	2/20/2009 8:15	1.27	DF+S	DRY-BULK	72.58	65.83	163	1.92	3.37	7.32	
40	2/20/2009 8:15	3/10/2009 9:48	1.463	DF +R+S	DRY-BULK	75.77	87.01	197.4	2.03	2.49	4.04	108
41	3/10/2009 9:48	3/20/2009 10:55	1.77		DRY-BULK	59.13	72.13	211.86	1.8	2.17	5.59	
42	3/20/2009 10:55	4/10/2009 9:50	0.5	DF+S	DRY-BULK	71.99	340.3	445.6	10.35	11.15	12.98	109
43	4/10/2009 9:50	5/15/2009 14:10	0.5	DF+S	DRY-BULK	425.56	446.48	420.29	7.18	11.91	41.85	119
44	5/15/2009 14:10	6/11/2009 9:12	0.5	DF+R+H?	DRY-BULK	C	C	C	C	C	C	120
45	6/11/2009 9:12	6/18/2009 10:55	1.469	DF+T	DRY-BULK	81.94	85.4	102.59	3.6	4.04	7.45	
46	6/18/2009 10:55	6/25/2009 9:45	0.775	DF	DRY-BULK	141.91	303.03	408.5	5.32	6.53	21.44	
47	6/25/2009 9:45	7/2/2009 10:05	1.072	DF	DRY-BULK	103.11	95.3	164.51	4.2	6.21	15.85	
48	7/2/2009 10:05	7/13/09 09:50	0.500	DF+R	DRY-BULK	C	C	C	C	C	C	131A
49	7/13/09 09:50	7/21/2009 9:55	0.622	DF	DRY-BULK	C	C	C	C	C	C	132
50	7/21/2009 9:55	7/30/2009 7:25	0.51	DF	DRY-BULK	172.96	46.49	476.05	5.62	18.6	50.91	133
51	7/30/2009 7:25	8/7/2009 8:35	0.5	DF	DRY-BULK	527.18	806.01	1283.83	13.94	24.9	41.5	134
52	8/7/2009 8:35	8/25/2009 9:10	0.5	DF+T	DRY-BULK	241.28	127.8	462.35	7.62	10.69	47.66	135
53	8/25/2009 9:10	9/10/2009 9:30	0.5	DF	DRY-BULK	200.21	110.99	312.12	6.74	11.04	25.15	135
54	9/10/2009 9:30	9/22/2009 9:26	0.5	DF	DRY-BULK	469.38	861.72	72.45	1.13	5.31	11.25	136
55	9/22/2009 9:26	10/21/09 11:56	0.378	DF+R+S	DRY-BULK	689.89	257.72	732.91	4.48	17.54	45.86	163
56	10/21/09 11:56	10/30/09 14:01	1.444	DF+T	DRY-BULK	67.64	44.63	58.51	2.91	4.62	6.77	
57	10/30/09 14:01	11/10/09 08:15	1.302	DF	DRY-BULK	128.26	228.02	220.22	1.79	4.65	8.98	

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
58	11/10/09 08:15	11/24/09 08:20	1.320	DF+S+R	DRY-BULK	583.79	1147.6	1524.03	14.37	17.24	25.55	
59	11/24/09 08:20	12/3/09 11:27	1.088	DF+S	DRY-BULK	115.63	101.32	368.19	1.59	3.41	5.59	
60	12/3/09 11:27	12/17/09 15:17	2.383	DF+S	DRY-BULK	61.91	61.06	205.66	1.81	1.64	4.62	
61	12/17/09 15:17	1/4/10 09:15	1.478	DF+R+S	DRY-BULK	44.0	35.26	227.16	0.45	2.16	3.7	
62	1/4/10 09:15	1/14/10 11:57	2.500	DF+R+S	DRY-BULK	39.73	5.5	NA	0.45	2.2	4.3	
63	1/14/10 11:57	1/26/10 13:28	2.328	DF+R+S	DRY-BULK	36.82	17.93	36.82	0.68	2.46	3.94	
64	1/26/10 13:28	2/2/10 08:43	2.498	DF+T	DRY-BULK	29.88	16.56	112.73	0.68	3.03	3.33	
65	2/2/10 08:43	2/17/10 16:18	1.511	DF+S	DRY-BULK	102.19	57.46	NA	1.36	5.01	8.77	174
66	2/19/10 11:32	2/25/10 09:40	2.810	DF	DRY-BULK	34.72	17.04	NA	1.58	2.79	6.53	
67	2/25/10 09:40	3/16/10 08:36	1.121	DF+R+S	DRY-BULK	163.7	151.23	NA	1.81	4.59	15.3	
68	3/16/10 08:36	3/26/10 09:05	1.200	DF+S	DRY-BULK	93.98	197.15	NA	2.94	4.07	7.2	
69	3/26/10 09:05	4/13/10 09:30	0.500	DF+R+S	DRY-BULK	467.05	112.19	NA	15.89	19.52	37.78	175
70	4/13/10 09:30	5/7/10 13:26	0.500	DF+R+S	DRY-BULK	440.25	34.7	NA	29.98	38.67	64.96	176
71	5/7/10 13:26	6/3/10 09:37	0.500	DF+S	DRY-BULK	NA	275.85	NA	20.77	NA	NA	177

Appendix Table 4.b. N and P loads in dry-bulk deposition (buoy bucket) at the Mid-lake Buoy (TB-1) Station 7/1/07-6/3/10.

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/28/2007 7:35	7/26/2007 10:18	0.500	DF	DRY-BULK	C	C	C	C	C	C	7
2	7/26/2007 10:18	7/27/2007 9:57	3.283	DF	DRY-BULK	NA	NA	18.54	NA	NA	2.90	
3	7/27/2007 9:57	8/15/2007 9:32	0.500	DF	DRY-BULK	23.31	6.42	31.34	NA	2.42	6.74	7
4	8/15/2007 9:32	8/28/2007 14:57	0.500	DF	DRY-BULK	25.25	52.63	101.82	1.77	3.34	8.06	7
5	8/28/2007 14:57	9/11/2007 8:42	0.500	DF	DRY-BULK	52.61	41.44	74.90	0.45	1.90	2.44	7
6	9/11/2007 8:42	10/2/2007 14:15	0.500	DF	DRY-BULK	77.91	34.34	67.18	1.32	2.16	5.57	7
7	10/2/2007 14:15	10/11/07 14:40	0.500	DF+S	DRY-BULK	30.40	37.00	53.56	0.15	0.99	1.38	29
8	10/11/07 14:40	10/23/07 12:35	0.772	DF+R	DRY-BULK	44.09	2.12	106.14	1.38	1.93	2.54	
9	10/23/07 12:35	11/5/07 09:42	1.564	DF+R	DRY-BULK	60.91	78.25	106.43	1.49	3.43	7.72	30
10	11/5/07 09:42	11/13/07 14:05	2.678	DF+R	DRY-BULK	22.82	42.07	27.38	0.60	3.09	2.26	
11	11/13/07 14:05	12/13/07 12:36	0.722	DF+R+S	DRY-BULK	41.17	3.68	59.40	0.40	0.96	3.13	
12	12/13/07 12:36	1/11/08 11:40	0.646	DF+R+S	DRY-BULK	42.32	23.83	43.19	0.98	0.82	2.41	
13	1/11/08 11:40	2/5/08 14:47	0.600	DF+S	DRY-BULK	23.36	16.47	21.37	0.21	0.65	1.42	
14	2/5/08 14:47	2/15/08 13:58	1.680	DF+R+S	DRY-BULK	20.54	13.63	24.51	0.75	2.45	2.96	
15	2/15/08 13:58	2/26/08 11:26	3.260	DF+S	DRY-BULK	31.85	32.10	45.28	0.58	3.80	4.19	
16	2/26/08 11:26	3/12/08 10:00	0.320	DF	DRY-BULK	25.58	28.63	29.32	0.53	0.52	0.68	
17	3/12/08 10:00	3/24/08 09:38	0.745	DF+R+S	DRY-BULK	21.96	20.12	26.24	0.43	0.95	1.17	
18	3/24/08 09:38	4/3/08 11:27	0.765	DF+S	DRY-BULK	20.29	16.64	51.13	0.24	0.71	1.51	
19	4/3/08 11:27	4/26/08 12:15	0.500	DF+R	DRY-BULK	16.28	11.78	30.64	0.69	1.09	3.51	55
20	4/26/08 12:15	5/29/08 14:14	0.595	DF+R	DRY-BULK	8.23	4.49	NA	1.86	5.79	14.85	56
21	5/29/08 14:14	6/25/08 10:20	0.500	DF	DRY-BULK	19.65	9.44	NA	3.30	4.52	6.89	57
22	6/25/2008 10:20	7/3/2008 10:50	1.205	DF	DRY-BULK	C	C	C	C	C	C	58
23	7/3/2008 10:50	7/10/2008 8:12	0.939	DF	DRY-BULK	29.37	51.49	NA	18.87	20.46	34.21	75
24	7/10/2008 8:12	7/15/2008 10:25	2.04	DF	DRY-BULK	26.02	52.56	109.04	4.26	4.80	7.82	76
25	7/15/2008 10:25	7/22/2008 7:38	0.822	DF+R?	DRY-BULK	23.89	56.44	53.35	1.21	1.74	2.13	77
26	7/22/2008 7:38	7/29/2008 9:28	0.676	DF	DRY-BULK	35.80	84.61	68.17	0.81	1.39	2.73	78
27	7/29/2008 9:28	8/15/2008 9:50	0.5	DF	DRY-BULK	16.72	9.98	41.52	1.13	2.44	5.62	79
28	8/15/2008 9:50	9/5/2008 13:50	0.5	DF	DRY-BULK	3.82	14.74	45.72	1.24	2.51	8.81	79

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
29	9/5/2008 13:50	9/16/2008 10:00	0.69	DF	DRY-BULK	30.96	31.56	43.99	0.74	1.18	5.31	
30	9/16/2008 10:00	10/8/2008 10:40	0.535	DF+R	DRY-BULK	51.56	37.47	151.47	0.29	0.75	2.98	80
31	10/8/2008 10:40	10/17/2008 10:30	0.695	DF	DRY-BULK	17.76	11.68	24.57	0.19	0.75	1.17	
32	10/17/2008 10:30	11/7/2008 9:45	1.33	DF+R+S	DRY-BULK	59.76	77.27	110.23	1.59	1.68	2.16	
33	11/7/2008 9:45	11/21/2008 10:22	1.515	DF+R	DRY-BULK	28.40	24.66	86.75	0.95	0.82	1.46	
34	11/21/2008 10:22	12/5/2008 8:31	1.268	DF+R+S	DRY-BULK	38.24	34.13	41.27	0.51	1.01	0.70	
35	12/5/2008 8:31	1/6/2009 10:47	0.6	DF +R+S	DRY-BULK	29.25	14.64	45.83	0.78	1.10	3.78	97
36	1/6/2009 10:47	1/19/2009 9:45	1.381	DF	DRY-BULK	27.83	17.57	30.97	0.19	0.42	0.59	107
37	1/19/2009 9:45	1/28/2009 9:50	2.348	DF +R+S	DRY-BULK	16.49	5.65	80.16	0.21	1.01	0.86	
38	1/28/2009 9:50	2/4/2009 15:47	2.875	DF	DRY-BULK	18.99	13.97	23.10	0.39	1.15	1.23	
39	2/4/2009 15:47	2/20/2009 8:15	1.27	DF+S	DRY-BULK	18.19	16.50	40.85	0.48	0.84	1.68	
40	2/20/2009 8:15	3/10/2009 9:48	1.463	DF +R+S	DRY-BULK	21.88	25.12	56.99	0.59	0.72	1.17	108
41	3/10/2009 9:48	3/20/2009 10:55	1.77		DRY-BULK	20.65	25.20	74.01	0.63	0.76	1.95	
42	3/20/2009 10:55	4/10/2009 9:50	0.5	DF+S	DRY-BULK	7.10	33.58	43.97	1.02	1.10	1.28	109
43	4/10/2009 9:50	5/15/2009 14:10	0.5	DF+S	DRY-BULK	41.99	44.06	41.47	0.71	1.18	4.13	119
44	5/15/2009 14:10	6/11/2009 9:12	0.5	DF+R+H?	DRY-BULK	C	C	C	C	C	C	120
45	6/11/2009 9:12	6/18/2009 10:55	1.469	DF+T	DRY-BULK	23.76	24.76	29.74	1.04	1.17	2.16	
46	6/18/2009 10:55	6/25/2009 9:45	0.775	DF	DRY-BULK	21.70	46.35	62.48	0.81	1.00	3.28	
47	6/25/2009 9:45	7/2/2009 10:05	1.072	DF	DRY-BULK	21.81	20.16	34.80	0.89	1.31	3.35	
48	7/2/2009 10:05	7/13/09 09:50	0.500	DF+R	DRY-BULK	C	C	C	C	C	C	131
49	7/13/09 09:50	7/21/2009 9:55	0.622	DF	DRY-BULK	C	C	C	C	C	C	132
50	7/21/2009 9:55	7/30/2009 7:25	0.51	DF	DRY-BULK	17.41	4.68	47.91	0.57	1.87	5.12	133
51	7/30/2009 7:25	8/7/2009 8:35	0.5	DF	DRY-BULK	52.02	79.53	126.68	1.38	2.46	4.10	134
52	8/7/2009 8:35	8/25/2009 9:10	0.5	DF+T	DRY-BULK	23.81	12.61	45.62	0.75	1.05	4.70	135
53	8/25/2009 9:10	9/10/2009 9:30	0.5	DF	DRY-BULK	19.76	10.95	NA	0.67	1.09	2.48	135
54	9/10/2009 9:30	9/22/2009 9:26	0.5	DF	DRY-BULK	46.32	85.01	NA	0.11	0.52	1.11	136
55	9/22/2009 9:26	10/21/09 11:56	0.378	DF+R+S	DRY-BULK	51.47	19.23	54.67	0.33	1.31	3.42	
56	10/21/09 11:56	10/30/09 14:01	1.444	DF+T	DRY-BULK	19.28	12.72	16.67	0.83	1.32	1.93	
57	10/30/09 14:01	11/10/09 08:15	1.302	DF	DRY-BULK	32.96	58.59	56.59	0.46	1.19	2.31	

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
58	11/10/09 08:15	11/24/09 08:20	1.320	DF+S+R	DRY-BULK	152.08	298.96	397.02	3.74	4.49	6.66	
59	11/24/09 08:20	12/3/09 11:27	1.088	DF+S	DRY-BULK	24.83	21.76	79.06	0.34	0.73	1.20	
60	12/3/09 11:27	12/17/09 15:17	2.383	DF+S	DRY-BULK	29.12	28.72	96.72	0.85	0.77	2.17	
61	12/17/09 15:17	1/4/10 09:15	1.478	DF+R+S	DRY-BULK	12.83	10.28	66.26	0.13	0.63	1.08	
62	1/4/10 09:15	1/14/10 11:57	2.500	DF+R+S	DRY-BULK	19.60	2.71	NA	0.22	1.09	2.12	
63	1/14/10 11:57	1/26/10 13:28	2.328	DF+R+S	DRY-BULK	16.92	8.24	16.92	0.31	1.13	1.81	
64	1/26/10 13:28	2/2/10 08:43	2.498	DF+T	DRY-BULK	14.73	8.16	55.57	0.34	1.49	1.64	
65	2/2/10 08:43	2/17/10 16:18	1.511	DF+S	DRY-BULK	30.47	17.13	NA	0.41	1.49	2.62	174
66	2/19/10 11:32	2/25/10 09:40	2.810	DF	DRY-BULK	19.25	9.45	NA	0.88	1.55	3.62	
67	2/25/10 09:40	3/16/10 08:36	1.121	DF+R+S	DRY-BULK	36.22	33.46	NA	0.40	1.02	3.38	
68	3/16/10 08:36	3/26/10 09:05	1.200	DF+S	DRY-BULK	22.26	46.69	NA	0.70	0.96	1.71	
69	3/26/10 09:05	4/13/10 09:30	0.500	DF+R+S	DRY-BULK	46.09	11.07	NA	1.57	1.93	3.73	175
70	4/13/10 09:30	5/7/10 13:26	0.500	DF+R+S	DRY-BULK	43.44	3.42	NA	2.96	3.82	6.41	176
71	5/7/10 13:26	6/3/10 09:37	0.500	DF+S	DRY-BULK	NA	27.22	NA	2.05	NA	NA	177

Appendix Table 4.c. N and P loading per day in dry-bulk deposition (buoy bucket) at Mid-lake Buoy (TB-1) Station 7/1/07-6/3/10.

Samp. No.	Mid-lake (TB-1) Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	NO3-N (g/ha/d)	NH4-N (g/ha/d)	TKN (g/ha/d)	SRP (g/ha/d)	DP (g/ha/d)	TP (g/ha/d)	Notes
						(Load/day)						
1	6/28/2007 7:35	7/26/2007 10:18	0.500	DF	DRY-BULK	C	C	C	C	C	C	7
2	7/26/2007 10:18	7/27/2007 9:57	3.283	DF	DRY-BULK	NA	NA	18.81	NA	NA	2.94	
3	7/27/2007 9:57	8/15/2007 9:32	0.500	DF	DRY-BULK	1.23	0.34	1.65	NA	0.13	0.35	7
4	8/15/2007 9:32	8/28/2007 14:57	0.500	DF	DRY-BULK	1.91	3.98	7.70	0.13	0.25	0.61	7
5	8/28/2007 14:57	9/11/2007 8:42	0.500	DF	DRY-BULK	3.83	3.02	5.45	0.03	0.14	0.18	7
6	9/11/2007 8:42	10/2/2007 14:15	0.500	DF	DRY-BULK	3.67	1.62	3.16	0.06	0.10	0.26	7
7	10/2/2007 14:15	10/11/07 14:40	0.500	DF+S	DRY-BULK	3.37	4.10	5.94	0.02	0.11	0.15	29
8	10/11/07 14:40	10/23/07 12:35	0.772	DF+R	DRY-BULK	3.70	0.18	8.91	0.12	0.16	0.21	
9	10/23/07 12:35	11/5/07 09:42	1.564	DF+R	DRY-BULK	4.73	6.08	8.26	0.12	0.27	0.60	30
10	11/5/07 09:42	11/13/07 14:05	2.678	DF+R	DRY-BULK	2.79	5.14	3.35	0.07	0.38	0.28	
11	11/13/07 14:05	12/13/07 12:36	0.722	DF+R+S	DRY-BULK	1.38	0.12	1.98	0.01	0.03	0.10	
12	12/13/07 12:36	1/11/08 11:40	0.646	DF+R+S	DRY-BULK	1.46	0.82	1.49	0.03	0.03	0.08	
13	1/11/08 11:40	2/5/08 14:47	0.600	DF+S	DRY-BULK	0.93	0.66	0.85	0.01	0.03	0.06	
14	2/5/08 14:47	2/15/08 13:58	1.680	DF+R+S	DRY-BULK	2.06	1.37	2.46	0.08	0.25	0.30	
15	2/15/08 13:58	2/26/08 11:26	3.260	DF+S	DRY-BULK	2.92	2.95	4.16	0.05	0.35	0.39	
16	2/26/08 11:26	3/12/08 10:00	0.320	DF	DRY-BULK	1.71	1.92	1.96	0.04	0.03	0.05	
17	3/12/08 10:00	3/24/08 09:38	0.745	DF+R+S	DRY-BULK	1.83	1.68	2.19	0.04	0.08	0.10	
18	3/24/08 09:38	4/3/08 11:27	0.765	DF+S	DRY-BULK	2.01	1.65	5.07	0.02	0.07	0.15	
19	4/3/08 11:27	4/26/08 12:15	0.500	DF+R	DRY-BULK	0.71	0.51	1.33	0.03	0.05	0.15	55
20	4/26/08 12:15	5/29/08 14:14	0.595	DF+R	DRY-BULK	0.25	0.14	NA	0.06	0.18	0.45	56
21	5/29/08 14:14	6/25/08 10:20	0.500	DF	DRY-BULK	0.73	0.35	NA	0.12	0.17	0.26	57
22	6/25/2008 10:20	7/3/2008 10:50	1.205	DF	DRY-BULK	C	C	C	C	C	C	58
23	7/3/2008 10:50	7/10/2008 8:12	0.939	DF	DRY-BULK	4.26	7.47	NA	2.74	2.97	4.96	75
24	7/10/2008 8:12	7/15/2008 10:25	2.04	DF	DRY-BULK	5.11	10.32	21.41	0.84	0.94	1.54	76
25	7/15/2008 10:25	7/22/2008 7:38	0.822	DF+R?	DRY-BULK	3.47	8.20	7.75	0.18	0.25	0.31	77
26	7/22/2008 7:38	7/29/2008 9:28	0.676	DF	DRY-BULK	5.06	11.96	9.63	0.11	0.20	0.39	78
27	7/29/2008 9:28	8/15/2008 9:50	0.5	DF	DRY-BULK	0.98	0.59	2.44	0.07	0.14	0.33	79
28	8/15/2008 9:50	9/5/2008 13:50	0.5	DF	DRY-BULK	0.18	0.70	2.16	0.06	0.12	0.42	79

	Mid-lake (TB-1)	Dry-Bulk				(Load/day)						
Samp.	Start	Collection	Vol.	Precip.	Collector	NO3-N	NH4-N	TKN	SRP	DP	TP	
No.	Date-Time	Date-Time	Liters	Form	Type	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	Notes
29	9/5/2008 13:50	9/16/2008 10:00	0.69	DF	DRY-BULK	2.86	2.91	4.06	0.07	0.11	0.49	
30	9/16/2008 10:00	10/8/2008 10:40	0.535	DF+R	DRY-BULK	2.34	1.70	6.88	0.01	0.03	0.14	80
31	10/8/2008 10:40	10/17/2008 10:30	0.695	DF	DRY-BULK	1.98	1.30	2.73	0.02	0.08	0.13	
32	10/17/2008 10:30	11/7/2008 9:45	1.33	DF+R+S	DRY-BULK	2.85	3.68	5.26	0.08	0.08	0.10	
33	11/7/2008 9:45	11/21/2008 10:22	1.515	DF+R	DRY-BULK	2.02	1.76	6.18	0.07	0.06	0.10	
34	11/21/2008 10:22	12/5/2008 8:31	1.268	DF+R+S	DRY-BULK	2.75	2.45	2.96	0.04	0.07	0.05	
35	12/5/2008 8:31	1/6/2009 10:47	0.6	DF +R+S	DRY-BULK	0.91	0.46	1.43	0.02	0.03	0.12	97
36	1/6/2009 10:47	1/19/2009 9:45	1.381	DF	DRY-BULK	2.15	1.36	2.39	0.01	0.03	0.05	107
37	1/19/2009 9:45	1/28/2009 9:50	2.348	DF +R+S	DRY-BULK	1.83	0.63	8.90	0.02	0.11	0.10	
38	1/28/2009 9:50	2/4/2009 15:47	2.875	DF	DRY-BULK	2.62	1.93	3.19	0.05	0.16	0.17	
39	2/4/2009 15:47	2/20/2009 8:15	1.27	DF+S	DRY-BULK	1.16	1.05	2.60	0.03	0.05	0.11	
40	2/20/2009 8:15	3/10/2009 9:48	1.463	DF +R+S	DRY-BULK	1.21	1.39	3.16	0.03	0.04	0.06	108
41	3/10/2009 9:48	3/20/2009 10:55	1.77		DRY-BULK	2.06	2.51	7.37	0.06	0.08	0.19	
42	3/20/2009 10:55	4/10/2009 9:50	0.5	DF+S	DRY-BULK	0.34	1.60	2.10	0.05	0.05	0.06	109
43	4/10/2009 9:50	5/15/2009 14:10	0.5	DF+S	DRY-BULK	1.19	1.25	1.18	0.02	0.03	0.12	119
44	5/15/2009 14:10	6/11/2009 9:12	0.5	DF+R+H?	DRY-BULK	C	C	C	C	C	C	120
45	6/11/2009 9:12	6/18/2009 10:55	1.469	DF+T	DRY-BULK	3.36	3.50	4.21	0.15	0.17	0.31	
46	6/18/2009 10:55	6/25/2009 9:45	0.775	DF	DRY-BULK	3.12	6.67	8.99	0.12	0.14	0.47	
47	6/25/2009 9:45	7/2/2009 10:05	1.072	DF	DRY-BULK	3.11	2.87	4.96	0.13	0.19	0.48	
48	7/2/2009 10:05	7/13/09 09:50	0.500	DF+R	DRY-BULK	C	C	C	C	C	C	131
49	7/13/09 09:50	7/21/2009 9:55	0.622	DF	DRY-BULK	C	C	C	C	C	C	132
50	7/21/2009 9:55	7/30/2009 7:25	0.51	DF	DRY-BULK	1.96	0.53	5.39	0.06	0.21	0.58	133
51	7/30/2009 7:25	8/7/2009 8:35	0.5	DF	DRY-BULK	6.46	9.88	15.74	0.17	0.31	0.51	134
52	8/7/2009 8:35	8/25/2009 9:10	0.5	DF+T	DRY-BULK	1.32	0.70	2.53	0.04	0.06	0.26	135
53	8/25/2009 9:10	9/10/2009 9:30	0.5	DF	DRY-BULK	1.23	0.68	NA	0.04	0.07	0.15	135
54	9/10/2009 9:30	9/22/2009 9:26	0.5	DF	DRY-BULK	3.86	7.09	NA	0.01	0.04	0.09	136
55	9/22/2009 9:26	10/21/09 11:56	0.378	DF+R+S	DRY-BULK	1.77	0.66	1.88	0.01	0.04	0.12	
56	10/21/09 11:56	10/30/09 14:01	1.444	DF+T	DRY-BULK	2.12	1.40	1.83	0.09	0.14	0.21	
57	10/30/09 14:01	11/10/09 08:15	1.302	DF	DRY-BULK	3.06	5.45	5.26	0.04	0.11	0.21	

	Mid-lake (TB-1)	Dry-Bulk					(Load/day)					
Samp.	Start	Collection	Vol.	Precip.	Collector	NO3-N	NH4-N	TKN	SRP	DP	TP	
No.	Date-Time	Date-Time	Liters	Form	Type	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	
58	11/10/09 08:15	11/24/09 08:20	1.320	DF+S+R	DRY-BULK	10.86	21.35	28.35	0.27	0.32	0.48	
59	11/24/09 08:20	12/3/09 11:27	1.088	DF+S	DRY-BULK	2.72	2.38	8.66	0.04	0.08	0.13	
60	12/3/09 11:27	12/17/09 15:17	2.383	DF+S	DRY-BULK	2.06	2.03	6.83	0.06	0.05	0.15	
61	12/17/09 15:17	1/4/10 09:15	1.478	DF+R+S	DRY-BULK	0.72	0.58	3.73	0.01	0.04	0.06	
62	1/4/10 09:15	1/14/10 11:57	2.500	DF+R+S	DRY-BULK	1.94	0.27	NA	0.02	0.11	0.21	
63	1/14/10 11:57	1/26/10 13:28	2.328	DF+R+S	DRY-BULK	1.40	0.68	1.40	0.03	0.09	0.15	
64	1/26/10 13:28	2/2/10 08:43	2.498	DF+T	DRY-BULK	2.17	1.20	8.17	0.05	0.22	0.24	
65	2/2/10 08:43	2/17/10 16:18	1.511	DF+S	DRY-BULK	1.99	1.12	NA	0.03	0.10	0.17	174
66	2/19/10 11:32	2/25/10 09:40	2.810	DF	DRY-BULK	3.25	1.60	NA	0.15	0.26	0.61	
67	2/25/10 09:40	3/16/10 08:36	1.121	DF+R+S	DRY-BULK	1.91	1.77	NA	0.02	0.05	0.18	
68	3/16/10 08:36	3/26/10 09:05	1.200	DF+S	DRY-BULK	2.22	4.66	NA	0.07	0.10	0.17	
69	3/26/10 09:05	4/13/10 09:30	0.500	DF+R+S	DRY-BULK	2.56	0.61	NA	0.09	0.11	0.21	175
70	4/13/10 09:30	5/7/10 13:26	0.500	DF+R+S	DRY-BULK	1.80	0.14	NA	0.12	0.16	0.27	176
71	5/7/10 13:26	6/3/10 09:37	0.500	DF+S	DRY-BULK	NA	1.01	NA	0.08	NA	NA	177

Table 5.a. N and P concentrations in dry-bulk deposition (buoy bucket) at the Northwest Buoy (TB-4) Station 7/1/07-6/3/10.

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	6/28/2007 6:46	7/26/2007 9:37	0.500	DF	DRY-BULK	295.23	122.83	416.37	28.07	23.92	105.26	7
2	7/26/2007 9:37	7/27/2007 9:20	2.885	DF	DRY-BULK	NA	NA	22.01	NA	NA	3.51	
3	7/27/2007 9:20	8/15/2007 9:02	0.500	DF	DRY-BULK	211.36	76.63	186.03	NA	13.05	33.81	7
4	8/15/2007 9:02	8/28/2007 15:40	0.500	DF	DRY-BULK	236.18	169.56	635.75	6.58	17.71	40.51	7
5	8/28/2007 15:40	9/11/2007 8:20	0.500	DF	DRY-BULK	440.70	338.06	721.37	5.90	17.40	30.30	7
6	9/11/2007 8:20	10/2/2007 13:45	0.500	DF	DRY-BULK	785.14	411.57	710.50	11.31	17.57	61.96	7
7	10/2/2007 13:45	10/11/07 13:13	0.528	DF+S	DRY-BULK	354.87	550.84	581.78	7.00	14.82	21.18	31
8	10/11/07 13:13	10/23/07 12:00	0.658	DF+R	DRY-BULK	299.12	720.58	787.72	5.74	10.19	12.97	
9	10/23/07 12:00	11/5/07 09:04	1.792	DF+R	DRY-BULK	146.02	246.87	359.35	3.21	10.50	11.42	32
10	11/5/07 09:04	11/13/07 14:45	2.235	DF+R	DRY-BULK	41.55	71.02	62.10	1.14	4.02	4.33	
11	11/13/07 14:45	12/13/07 13:20	0.616	DF+R+S	DRY-BULK	11.62	223.43	327.08	2.78	5.56	10.07	
12	12/13/07 13:20	1/11/08 10:33	0.818	DF+R+S	DRY-BULK	277.09	170.49	322.17	5.90	7.39	17.08	
13	1/11/08 10:33	2/5/08 15:32	1.028	DF+S	DRY-BULK	108.67	87.18	104.00	2.49	7.62	15.10	
14	2/5/08 15:32	2/15/08 14:41	1.673	DF+R+S	DRY-BULK	57.54	30.34	60.99	2.26	6.47	8.01	
15	2/15/08 14:41	2/26/08 10:52	3.320	DF+S	DRY-BULK	49.70	73.57	78.38	0.90	6.16	8.88	
16	2/26/08 10:52	3/12/08 09:44	0.444	DF	DRY-BULK	340.94	346.44	376.02	7.44	7.35	13.17	
17	3/12/08 09:44	3/24/08 10:02	1.031	DF+R+S	DRY-BULK	116.65	91.30	127.45	2.27	6.43	11.33	
18	3/24/08 10:02	4/3/07 11:09	0.511	DF+S	DRY-BULK	178.41	151.22	739.82	1.36	3.74	12.15	
19	4/3/07 11:09	4/26/08 11:57	0.500	DF+R	DRY-BULK	201	206.82	752.95	5.20	8.10	35.21	59
20	4/26/08 11:57	5/29/08 14:55	0.500	DF+R	DRY-BULK	60.04	35.60	1193.03	31.77	37.01	174.79	60
21	5/29/08 14:55	6/25/08 09:40	0.500	DF	DRY-BULK	197.27	194.93	449.26	18.06	30.30	45.23	61
22	6/25/2008 9:40	7/3/2008 10:22	0.962	DF	DRY-BULK	122.28	228.41	660.90	18.28	31.54	NA	61
23	7/3/2008 10:22	7/10/2008 7:50	0.91	DF	DRY-BULK	144.07	326	325.11	109.26	118.74	164.81	81
24	7/10/2008 7:50	7/15/2008 10:55	1.837	DF	DRY-BULK	72.77	151.1	205.8	5.17	7.65	29.45	
25	7/15/2008 10:55	7/22/2008 7:20	0.615	DF	DRY-BULK	317.78	423.81	522.95	4.98	7.04	13.27	
26	7/22/2008 7:20	7/29/2008 8:50	0.545	DF	DRY-BULK	278.12	850.82	1084.4	6.07	10.71	38.39	78
27	7/29/2008 8:50	8/15/2008 9:50	0.5	DF	DRY-BULK	152.2	195.75	203.66	11.88	43.03	22.6	

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
28	8/15/2008 9:50	9/5/2008 13:25	0.5	DF	DRY-BULK	46.26	92.52	1223.57	28.03	42.83	149.28	
29	9/5/2008 13:25	9/16/2008 9:35	0.248	DF	DRY-BULK	568.38	590.87	1209.22	4.28	9.59	80.45	
30	9/16/2008 9:35	10/8/2008 10:15	0.5	DF+R	DRY-BULK	453.21	342.86	557.58	7.19	10.85	22.02	82
31	10/8/2008 10:15	10/17/2008 10:12	0.965	DF	DRY-BULK	C	C	C	C	C	C	96
32	10/17/2008 10:12	11/7/2008 9:25	1.46	DF+R+S	DRY-BULK	154.18	567.42	672.34	3.94	6.4	6.71	
33	11/7/2008 9:25	11/21/2008 10:10	0.925	DF+R	DRY-BULK	155.41	174.27	325.77	2.38	3.35	4.88	
34	11/21/2008 10:10	12/5/2008 8:12	1.36	DF+R+S	DRY-BULK	157.18	138.46	211.83	2.37	4.33	4.95	
35	12/5/2008 8:12	1/6/2009 10:27	0.371	DF +R+S	DRY-BULK	447.72	291.05	546.46	11.11	14.25	34.38	97
36	1/6/2009 10:27	1/19/2009 9:26	1.085	DF	DRY-BULK	113.34	71.55	107.81	1.59	1.71	9.01	107
37	1/19/2009 9:26	1/28/2009 9:33	2.156	DF +R+S	DRY-BULK	25.29	12.41	21.45	1.02	2.48	2.48	
38	1/28/2009 9:33	2/4/2009 13:04	2.409	DF	DRY-BULK	38	35.79	36.87	0.45	1.86	2.33	
39	2/4/2009 13:04	2/20/2009 7:59	1.158	DF+S	DRY-BULK	83.94	89.34	91.44	1.58	3.39	NA	
40	2/20/2009 7:59	3/10/2009 9:33	1.01	DF +R+S	DRY-BULK	73.6	97.23	161.99	1.8	2.49	5.91	
41	3/10/2009 9:33	3/20/2009 10:55	1.483		DRY-BULK	75.62	94.44	388.01	2.03	3.11	3.73	
42	3/20/2009 10:55	4/10/2009 9:50	0.505	DF+S	DRY-BULK	74.27	372.76	548.32	8.78	8.7	22.16	110
43	4/10/2009 9:50	5/15/2009 14:33	0.5	DF+S	DRY-BULK	552.57	853.7	933.61	9.65	11	48.57	119
44	5/15/2009 14:33	6/11/2009 9:00	0.5	DF+R+H?	DRY-BULK	991.9	681.01	1864.93	7.43	17.69	36.62	120
45	6/11/2009 9:00	6/18/2009 10:30	1.26	DF+R	DRY-BULK	110.63	108.85	459.53	3.83	4.04	7.45	137
46	6/18/2009 10:30	6/25/2009 9:25	0.575	DF	DRY-BULK	148.04	346.89	491.86	3.3	6.21	16.78	
47	6/25/2009 9:25	7/2/2009 9:45	1.362	DF	DRY-BULK	81.67	53.21	128.47	1.5	2.49	11.19	
48	7/2/2009 9:45	7/13/2009 9:25	0.5	DF+R	DRY-BULK	243.19	313.47	561	15.94	21.91	46.32	135
49	7/13/2009 9:25	7/21/2009 9:30	0.696	DF	DRY-BULK	159.01	116.74	216.98	1.47	5.61	12.8	
50	7/21/2009 9:30	7/30/2009 7:10	0.5	DF	DRY-BULK	189.84	125.7	522.92	1.12	4.57	16.16	138
51	7/30/2009 7:10	8/7/2009 8:20	0.5	DF	DRY-BULK	296.77	955.32	1151.59	3.15	6.46	12.6	139
52	8/7/2009 8:20	8/25/2009 8:50	0.5	DF	DRY-BULK	217.98	112.71	317.73	6.5	8.86	19.86	135
53	8/25/2009 8:50	9/10/2009 9:10	0.5	DF	DRY-BULK	174.34	88.99	278.11	2.25	6.13	19.93	135
54	9/10/2009 9:10	9/22/2009 9:11	0.5	DF	DRY-BULK	329.85	401.7	860.94	4.28	9.38	14.59	135
55	9/22/2009 9:11	10/21/09 11:37	1.025	DF+R+S	DRY-BULK	320.61	511.22	578.69	2.24	8	22.47	
56	10/21/09 11:37	10/30/09 14:46	1.061	DF+T	DRY-BULK	70.18	69.71	81.12	3.13	4.31	7.08	

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
57	10/30/09 14:46	11/10/09 07:55	1.280	DF	DRY-BULK	107.36	281.71	311.19	1.79	3.41	4.96	
58	11/10/09 07:55	11/24/09 08:04	1.280	DF+S+R	DRY-BULK	287.1	464.42	794.31	11.44	13.85	27.4	164
59	11/24/09 08:04	12/3/09 11:08	1.335	DF+S	DRY-BULK	99.54	54.76	217.71	1.82	3.41	9.62	
60	12/3/09 11:08	12/17/09 14:58	2.089	DF+S	DRY-BULK	62.11	51.21	362.33	1.13	1.95	4.12	
61	12/17/09 14:58	1/4/10 09:35	1.766	DF+R+S	DRY-BULK	90.49	33.2	153.46	0.68	3.08	7.7	
62	1/4/10 09:35	1/14/10 11:40	2.363	DF+R+S	DRY-BULK	42.81	8.64	141.45	0.45	1.57	1.84	
63	1/14/10 11:40	1/26/10 13:10	2.944	DF+R+S	DRY-BULK	27.08	9.74	127.88	0.68	3.07	5.15	
64	1/26/10 13:10	2/2/10 08:25	2.335	DF+T	DRY-BULK	34.46	20.30	117.34	0.68	1.82	5.46	
65	2/2/10 08:25	2/17/10 12:28	1.480	DF+S	DRY-BULK	95.42	56.16	NA	1.13	3.13	3.76	
66	2/19/10 11:45	2/25/10 09:10	3.051	DF	DRY-BULK	23.86	20.05	NA	0.9	6.26	2.14	
67	2/25/10 09:10	3/16/10 08:17	0.905	DF+R+S	DRY-BULK	177.7	215.49	NA	1.35	4.59	7.04	
68	3/16/10 08:17	3/26/10 08:40	1.178	DF+S	DRY-BULK	100.85	219.47	NA	7.01	3.75	3.75	
69	3/26/10 08:40	4/13/10 09:10	0.513	DF+R+S	DRY-BULK	385.61	131.91	NA	11.13	13.22	48.49	
70	4/13/10 09:10	5/7/10 14:00	0.500	DF+R+S	DRY-BULK	499.39	107.02	NA	6.09	20.73	30.93	176
71	5/7/10 14:00	6/3/10 09:18	0.500	DF+S	DRY-BULK	NA	475.66	NA	40.62	NA	NA	176

Appendix Table 5.b. N and P loads in dry-bulk deposition (buoy bucket) at the Northwest Buoy (TB-4) Station 7/1/07-6/3/10.

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
1	6/28/2007 6:46	7/26/2007 9:37	0.500	DF	DRY-BULK	29.13	12.12	41.09	2.77	2.36	10.39	7
2	7/26/2007 9:37	7/27/2007 9:20	2.885	DF	DRY-BULK	NA	NA	12.53	NA	NA	2.00	
3	7/27/2007 9:20	8/15/2007 9:02	0.500	DF	DRY-BULK	20.86	7.56	18.36	NA	1.29	3.34	7
4	8/15/2007 9:02	8/28/2007 15:40	0.500	DF	DRY-BULK	23.31	16.73	62.73	0.65	1.75	4.00	7
5	8/28/2007 15:40	9/11/2007 8:20	0.500	DF	DRY-BULK	43.49	33.36	71.18	0.58	1.72	2.99	7
6	9/11/2007 8:20	10/2/2007 13:45	0.500	DF	DRY-BULK	77.47	40.61	70.11	1.12	1.73	6.11	7
7	10/2/2007 13:45	10/11/07 13:13	0.528	DF+S	DRY-BULK	57.40	57.40	60.62	0.73	1.54	2.21	31
8	10/11/07 13:13	10/23/07 12:00	0.658	DF+R	DRY-BULK	93.57	93.57	102.29	0.75	1.32	1.68	
9	10/23/07 12:00	11/5/07 09:04	1.792	DF+R	DRY-BULK	87.31	87.31	127.09	1.14	3.71	4.04	32
10	11/5/07 09:04	11/13/07 14:45	2.235	DF+R	DRY-BULK	31.33	31.33	27.39	0.50	1.77	1.91	
11	11/13/07 14:45	12/13/07 13:20	0.616	DF+R+S	DRY-BULK	27.16	27.16	39.76	0.34	0.68	1.22	
12	12/13/07 13:20	1/11/08 10:33	0.818	DF+R+S	DRY-BULK	27.52	27.52	52.01	0.95	1.19	2.76	
13	1/11/08 10:33	2/5/08 15:32	1.028	DF+S	DRY-BULK	17.69	17.69	21.10	0.51	1.55	3.06	
14	2/5/08 15:32	2/15/08 14:41	1.673	DF+R+S	DRY-BULK	10.02	10.02	20.14	0.75	2.14	2.64	
15	2/15/08 14:41	2/26/08 10:52	3.320	DF+S	DRY-BULK	48.20	48.20	51.36	0.59	4.04	5.82	
16	2/26/08 10:52	3/12/08 09:44	0.444	DF	DRY-BULK	30.36	30.36	32.95	0.65	0.64	1.15	
17	3/12/08 09:44	3/24/08 10:02	1.031	DF+R+S	DRY-BULK	18.58	18.58	25.93	0.46	1.31	2.31	
18	3/24/08 10:02	4/3/07 11:09	0.511	DF+S	DRY-BULK	15.25	15.25	74.61	0.14	0.38	1.23	
19	4/3/07 11:09	4/26/08 11:57	0.500	DF+R	DRY-BULK	20.41	20.41	74.30	0.51	0.80	3.47	59
20	4/26/08 11:57	5/29/08 14:55	0.500	DF+R	DRY-BULK	3.51	3.51	117.72	3.13	3.65	17.25	60
21	5/29/08 14:55	6/25/08 09:40	0.500	DF	DRY-BULK	19.23	19.23	44.33	1.78	2.99	4.46	61
22	6/25/2008 9:40	7/3/2008 10:22	0.962	DF	DRY-BULK	23.22	43.36	125.47	3.47	5.99	NA	62
23	7/3/2008 10:22	7/10/2008 7:50	0.91	DF	DRY-BULK	25.87	58.55	58.39	19.62	21.32	29.60	81
24	7/10/2008 7:50	7/15/2008 10:55	1.837	DF	DRY-BULK	26.38	54.78	74.61	1.87	2.77	10.68	
25	7/15/2008 10:55	7/22/2008 7:20	0.615	DF	DRY-BULK	38.57	51.44	63.47	0.60	0.85	1.61	
26	7/22/2008 7:20	7/29/2008 8:50	0.545	DF	DRY-BULK	29.91	91.51	116.64	0.65	1.15	4.13	78
27	7/29/2008 8:50	8/15/2008 9:50	0.5	DF	DRY-BULK	15.02	19.32	20.10	1.17	4.25	2.23	

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
28	8/15/2008 9:50	9/5/2008 13:25	0.5	DF	DRY-BULK	4.56	9.13	120.74	2.77	4.23	14.73	
29	9/5/2008 13:25	9/16/2008 9:35	0.248	DF	DRY-BULK	27.82	28.92	59.18	0.21	0.47	3.94	
30	9/16/2008 9:35	10/8/2008 10:15	0.5	DF+R	DRY-BULK	44.72	33.83	55.02	0.71	1.07	2.17	82
31	10/8/2008 10:15	10/17/2008 10:12	0.965	DF	DRY-BULK	C	C	C	C	C	C	96
32	10/17/2008 10:12	11/7/2008 9:25	1.46	DF+R+S	DRY-BULK	44.42	163.49	193.72	1.14	1.84	1.93	
33	11/7/2008 9:25	11/21/2008 10:10	0.925	DF+R	DRY-BULK	28.37	31.81	59.47	0.43	0.61	0.89	
34	11/21/2008 10:10	12/5/2008 8:12	1.36	DF+R+S	DRY-BULK	42.19	37.16	56.86	0.64	1.16	1.33	
35	12/5/2008 8:12	1/6/2009 10:27	0.371	DF +R+S	DRY-BULK	32.78	21.31	40.01	0.81	1.04	2.52	97
36	1/6/2009 10:27	1/19/2009 9:26	1.085	DF	DRY-BULK	24.27	15.32	23.09	0.34	0.37	1.93	107
37	1/19/2009 9:26	1/28/2009 9:33	2.156	DF +R+S	DRY-BULK	10.76	5.28	9.13	0.43	1.06	1.06	
38	1/28/2009 9:33	2/4/2009 13:04	2.409	DF	DRY-BULK	18.07	17.02	17.53	0.21	0.88	1.11	
39	2/4/2009 13:04	2/20/2009 7:59	1.158	DF+S	DRY-BULK	19.18	20.42	20.90	0.36	0.77	NA	
40	2/20/2009 7:59	3/10/2009 9:33	1.01	DF +R+S	DRY-BULK	14.67	19.38	32.29	0.36	0.50	1.18	
41	3/10/2009 9:33	3/20/2009 10:55	1.483		DRY-BULK	22.13	27.64	113.56	0.59	0.91	1.09	
42	3/20/2009 10:55	4/10/2009 9:50	0.505	DF+S	DRY-BULK	7.40	37.15	54.65	0.88	0.87	2.21	110
43	4/10/2009 9:50	5/15/2009 14:33	0.5	DF+S	DRY-BULK	54.53	84.24	92.13	0.95	1.09	4.79	119
44	5/15/2009 14:33	6/11/2009 9:00	0.5	DF+R+H?	DRY-BULK	97.88	67.20	184.02	0.73	1.75	3.61	120
45	6/11/2009 9:00	6/18/2009 10:30	1.26	DF+R	DRY-BULK	27.51	27.07	114.27	0.95	1.00	1.85	137
46	6/18/2009 10:30	6/25/2009 9:25	0.575	DF	DRY-BULK	16.80	39.36	55.82	0.37	0.70	1.90	
47	6/25/2009 9:25	7/2/2009 9:45	1.362	DF	DRY-BULK	21.95	14.30	34.53	0.40	0.67	3.01	
48	7/2/2009 9:45	7/13/2009 9:25	0.5	DF+R	DRY-BULK	24.00	30.93	55.36	1.57	2.16	4.57	135
49	7/13/2009 9:25	7/21/2009 9:30	0.696	DF	DRY-BULK	21.84	16.04	29.80	0.20	0.77	1.76	
50	7/21/2009 9:30	7/30/2009 7:10	0.5	DF	DRY-BULK	18.73	12.40	51.60	0.11	0.45	1.59	138
51	7/30/2009 7:10	8/7/2009 8:20	0.5	DF	DRY-BULK	29.28	94.27	113.63	0.31	0.64	1.24	139
52	8/7/2009 8:20	8/25/2009 8:50	0.5	DF	DRY-BULK	21.51	11.12	31.35	0.64	0.87	NA	135
53	8/25/2009 8:50	9/10/2009 9:10	0.5	DF	DRY-BULK	17.20	8.78	27.44	0.22	0.60	NA	135
54	9/10/2009 9:10	9/22/2009 9:11	0.5	DF	DRY-BULK	32.55	39.64	84.95	0.42	0.93	1.44	135
55	9/22/2009 9:11	10/21/09 11:37	1.025	DF+R+S	DRY-BULK	64.86	103.41	117.06	0.45	1.62	4.55	
56	10/21/09 11:37	10/30/09 14:46	1.061	DF+T	DRY-BULK	14.70	14.60	16.99	0.66	0.90	1.48	

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load) NO3-N (g/ha)	NH4-N (g/ha)	TKN (g/ha)	SRP (g/ha)	DP (g/ha)	TP (g/ha)	Notes
57	10/30/09 14:46	11/10/09 07:55	1.280	DF	DRY-BULK	27.12	71.16	78.61	0.45	0.86	1.25	
58	11/10/09 07:55	11/24/09 08:04	1.280	DF+S+R	DRY-BULK	72.52	117.32	200.65	2.89	3.50	6.92	164
59	11/24/09 08:04	12/3/09 11:08	1.335	DF+S	DRY-BULK	26.23	14.43	57.36	0.48	0.90	2.53	
60	12/3/09 11:08	12/17/09 14:58	2.089	DF+S	DRY-BULK	25.61	21.11	149.38	0.47	0.80	1.70	
61	12/17/09 14:58	1/4/10 09:35	1.766	DF+R+S	DRY-BULK	31.54	11.57	53.48	0.24	1.07	2.68	
62	1/4/10 09:35	1/14/10 11:40	2.363	DF+R+S	DRY-BULK	19.96	4.03	65.96	0.21	0.73	0.86	
63	1/14/10 11:40	1/26/10 13:10	2.944	DF+R+S	DRY-BULK	15.73	5.66	74.30	0.40	1.78	2.99	
64	1/26/10 13:10	2/2/10 08:25	2.335	DF+T	DRY-BULK	15.88	9.35	54.07	0.31	0.84	2.52	
65	2/2/10 08:25	2/17/10 12:28	1.480	DF+S	DRY-BULK	27.87	16.40	NA	0.33	0.91	1.10	
66	2/19/10 11:45	2/25/10 09:10	3.051	DF	DRY-BULK	14.37	12.07	NA	0.54	3.77	1.29	
67	2/25/10 09:10	3/16/10 08:17	0.905	DF+R+S	DRY-BULK	31.74	38.49	NA	0.24	0.82	1.26	
68	3/16/10 08:17	3/26/10 08:40	1.178	DF+S	DRY-BULK	23.45	51.02	NA	1.63	0.87	0.87	
69	3/26/10 08:40	4/13/10 09:10	0.513	DF+R+S	DRY-BULK	39.04	13.35	NA	1.13	1.34	4.91	
70	4/13/10 09:10	5/7/10 14:00	0.500	DF+R+S	DRY-BULK	49.28	10.56	NA	0.60	2.05	3.05	176
71	5/7/10 14:00	6/3/10 09:18	0.500	DF+S	DRY-BULK	NA	46.94	NA	4.01	NA	NA	176

Appendix Table 5.c. N and P load per day in dry-bulk deposition (buoy bucket) at the Northwest Buoy (TB-4) Sta. 7/1/07-6/3/10.

	Buoy TB-4	Dry-Bulk				(Load/day)						
Samp.	Start	Collection	Vol.	Precip.	Collector	NO3-N	NH4-N	TKN	SRP	DP	TP	
No.	Date-Time	Date-Time	Liters	Form	Type	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	(g/ha/d)	Notes
1	6/28/2007 6:46	7/26/2007 9:37	0.500	DF	DRY-BULK	1.04	0.43	1.46	NA	0.08	0.37	7
2	7/26/2007 9:37	7/27/2007 9:20	2.885	DF	DRY-BULK	NA	NA	12.68	NA	NA	2.02	
3	7/27/2007 9:20	8/15/2007 9:02	0.500	DF	DRY-BULK	1.10	0.40	0.97	NA	0.07	0.18	7
4	8/15/2007 9:02	8/28/2007 15:40	0.500	DF	DRY-BULK	1.76	1.26	4.73	0.05	0.13	0.30	7
5	8/28/2007 15:40	9/11/2007 8:20	0.500	DF	DRY-BULK	3.18	2.44	5.20	0.04	0.13	0.22	7
6	9/11/2007 8:20	10/2/2007 13:45	0.500	DF	DRY-BULK	3.65	1.91	3.30	0.05	0.08	0.29	7
7	10/2/2007 13:45	10/11/07 13:13	0.528	DF+S	DRY-BULK	4.12	6.39	6.75	0.08	0.17	0.25	31
8	10/11/07 13:13	10/23/07 12:00	0.658	DF+R	DRY-BULK	3.25	7.83	8.56	0.06	0.11	0.14	
9	10/23/07 12:00	11/5/07 09:04	1.792	DF+R	DRY-BULK	4.01	6.78	9.87	0.09	0.29	0.31	32
10	11/5/07 09:04	11/13/07 14:45	2.235	DF+R	DRY-BULK	2.23	3.80	3.33	0.06	0.22	0.23	
11	11/13/07 14:45	12/13/07 13:20	0.616	DF+R+S	DRY-BULK	0.05	0.91	1.33	0.01	0.02	0.04	
12	12/13/07 13:20	1/11/08 10:33	0.818	DF+R+S	DRY-BULK	1.55	0.95	1.80	0.03	0.04	0.10	
13	1/11/08 10:33	2/5/08 15:32	1.028	DF+S	DRY-BULK	0.87	0.70	0.84	0.02	0.06	0.12	
14	2/5/08 15:32	2/15/08 14:41	1.673	DF+R+S	DRY-BULK	1.91	1.01	2.02	0.07	0.21	0.27	
15	2/15/08 14:41	2/26/08 10:52	3.320	DF+S	DRY-BULK	3.00	4.45	4.74	0.05	0.37	0.54	
16	2/26/08 10:52	3/12/08 09:44	0.444	DF	DRY-BULK	2.00	2.03	2.20	0.04	0.04	0.08	
17	3/12/08 09:44	3/24/08 10:02	1.031	DF+R+S	DRY-BULK	1.98	1.55	2.16	0.04	0.11	0.19	
18	3/24/08 10:02	4/3/07 11:09	0.511	DF+S	DRY-BULK	1.79	1.52	7.43	0.01	0.04	0.12	
19	4/3/07 11:09	4/26/08 11:57	0.500	DF+R	DRY-BULK	0.86	0.89	3.23	0.02	0.03	0.15	59
20	4/26/08 11:57	5/29/08 14:55	0.500	DF+R	DRY-BULK	0.18	0.11	3.55	0.09	0.11	0.52	60
21	5/29/08 14:55	6/25/08 09:40	0.500	DF	DRY-BULK	0.73	0.72	1.66	0.07	0.11	0.17	61
22	6/25/2008 9:40	7/3/2008 10:22	0.962	DF	DRY-BULK	2.89	5.40	15.63	0.43	0.75	NA	62
23	7/3/2008 10:22	7/10/2008 7:50	0.91	DF	DRY-BULK	3.75	8.49	8.47	2.85	3.09	4.29	81
24	7/10/2008 7:50	7/15/2008 10:55	1.837	DF	DRY-BULK	5.14	10.68	14.55	0.37	0.54	2.08	
25	7/15/2008 10:55	7/22/2008 7:20	0.615	DF	DRY-BULK	5.63	7.51	9.26	0.09	0.12	0.24	
26	7/22/2008 7:20	7/29/2008 8:50	0.545	DF	DRY-BULK	4.24	12.96	16.51	0.09	0.16	0.58	78
27	7/29/2008 8:50	8/15/2008 9:50	0.5	DF	DRY-BULK	0.88	1.13	1.18	0.07	0.25	0.13	

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load/day) NO3-N (g/ha/d)	NH4-N (g/ha/d)	TKN (g/ha/d)	SRP (g/ha/d)	DP (g/ha/d)	TP (g/ha/d)	Notes
28	8/15/2008 9:50	9/5/2008 13:25	0.5	DF	DRY-BULK	0.22	0.43	5.71	0.13	0.20	0.70	
29	9/5/2008 13:25	9/16/2008 9:35	0.248	DF	DRY-BULK	2.57	2.67	5.46	0.02	0.04	0.36	
30	9/16/2008 9:35	10/8/2008 10:15	0.5	DF+R	DRY-BULK	2.03	1.54	2.50	0.03	0.05	0.10	82
31	10/8/2008 10:15	10/17/2008 10:12	0.965	DF	DRY-BULK	C	C	C	C	C	C	96
32	10/17/2008 10:12	11/7/2008 9:25	1.46	DF+R+S	DRY-BULK	2.12	7.80	9.24	0.05	0.09	0.09	
33	11/7/2008 9:25	11/21/2008 10:10	0.925	DF+R	DRY-BULK	2.02	2.27	4.24	0.03	0.04	0.06	
34	11/21/2008 10:10	12/5/2008 8:12	1.36	DF+R+S	DRY-BULK	3.03	2.67	4.08	0.05	0.08	0.10	
35	12/5/2008 8:12	1/6/2009 10:27	0.371	DF +R+S	DRY-BULK	1.02	0.66	1.25	0.03	0.03	0.08	97
36	1/6/2009 10:27	1/19/2009 9:26	1.085	DF	DRY-BULK	1.87	1.18	1.78	0.03	0.03	0.15	107
37	1/19/2009 9:26	1/28/2009 9:33	2.156	DF +R+S	DRY-BULK	1.19	0.59	1.01	0.05	0.12	0.12	
38	1/28/2009 9:33	2/4/2009 13:04	2.409	DF	DRY-BULK	2.53	2.38	2.45	0.03	0.12	0.16	
39	2/4/2009 13:04	2/20/2009 7:59	1.158	DF+S	DRY-BULK	1.22	1.29	NA	0.02	0.05	NA	
40	2/20/2009 7:59	3/10/2009 9:33	1.01	DF +R+S	DRY-BULK	0.81	1.07	1.79	0.02	0.03	0.07	
41	3/10/2009 9:33	3/20/2009 10:55	1.483		DRY-BULK	2.20	2.75	11.29	0.06	0.09	0.11	
42	3/20/2009 10:55	4/10/2009 9:50	0.505	DF+S	DRY-BULK	0.35	1.77	2.61	0.04	0.04	0.11	110
43	4/10/2009 9:50	5/15/2009 14:33	0.5	DF+S	DRY-BULK	1.55	2.39	2.62	0.03	0.03	0.14	119
44	5/15/2009 14:33	6/11/2009 9:00	0.5	DF+R+H?	DRY-BULK	3.66	2.51	6.87	0.03	0.07	0.13	120
45	6/11/2009 9:00	6/18/2009 10:30	1.26	DF+R	DRY-BULK	3.90	3.83	16.18	0.13	0.14	0.26	137
46	6/18/2009 10:30	6/25/2009 9:25	0.575	DF	DRY-BULK	2.42	5.66	8.03	0.05	0.10	0.27	
47	6/25/2009 9:25	7/2/2009 9:45	1.362	DF	DRY-BULK	3.13	2.04	4.92	0.06	0.10	0.43	
48	7/2/2009 9:45	7/13/2009 9:25	0.5	DF+R	DRY-BULK	2.18	2.82	5.04	0.14	0.20	0.42	135
49	7/13/2009 9:25	7/21/2009 9:30	0.696	DF	DRY-BULK	2.73	2.00	3.72	0.03	0.10	0.22	
50	7/21/2009 9:30	7/30/2009 7:10	0.5	DF	DRY-BULK	2.10	1.39	5.80	0.01	0.05	0.18	138
51	7/30/2009 7:10	8/7/2009 8:20	0.5	DF	DRY-BULK	3.64	11.71	14.12	0.04	0.08	0.15	139
52	8/7/2009 8:20	8/25/2009 8:50	0.5	DF	DRY-BULK	1.19	0.62	1.74	0.04	0.05	NA	135
53	8/25/2009 8:50	9/10/2009 9:10	0.5	DF	DRY-BULK	1.07	0.55	1.71	0.01	0.04	NA	135
54	9/10/2009 9:10	9/22/2009 9:11	0.5	DF	DRY-BULK	2.71	3.30	7.08	0.04	0.08	0.12	135
55	9/22/2009 9:11	10/21/09 11:37	1.025	DF+R+S	DRY-BULK	2.23	3.55	4.02	0.02	0.06	0.16	
56	10/21/09 11:37	10/30/09 14:46	1.061	DF+T	DRY-BULK	1.61	1.60	1.86	0.07	0.10	0.16	

Samp. No.	Buoy TB-4 Start Date-Time	Dry-Bulk Collection Date-Time	Vol. Liters	Precip. Form	Collector Type	(Load/day) NO3-N (g/ha/d)	NH4-N (g/ha/d)	TKN (g/ha/d)	SRP (g/ha/d)	DP (g/ha/d)	TP (g/ha/d)	Notes
57	10/30/09 14:46	11/10/09 07:55	1.280	DF	DRY-BULK	2.53	6.64	7.34	0.04	0.08	0.12	
58	11/10/09 07:55	11/24/09 08:04	1.280	DF+S+R	DRY-BULK	5.18	8.38	14.33	0.21	0.25	0.49	164
59	11/24/09 08:04	12/3/09 11:08	1.335	DF+S	DRY-BULK	2.87	1.58	6.28	0.05	0.10	0.28	
60	12/3/09 11:08	12/17/09 14:58	2.089	DF+S	DRY-BULK	1.81	1.49	10.55	0.03	0.06	0.12	
61	12/17/09 14:58	1/4/10 09:35	1.766	DF+R+S	DRY-BULK	1.77	0.65	3.01	0.01	0.06	0.15	
62	1/4/10 09:35	1/14/10 11:40	2.363	DF+R+S	DRY-BULK	1.98	0.40	6.54	0.02	0.07	0.09	
63	1/14/10 11:40	1/26/10 13:10	2.944	DF+R+S	DRY-BULK	1.30	0.47	6.16	0.03	0.15	0.25	
64	1/26/10 13:10	2/2/10 08:25	2.335	DF+T	DRY-BULK	2.33	1.38	7.95	0.05	0.12	0.37	
65	2/2/10 08:25	2/17/10 12:28	1.480	DF+S	DRY-BULK	1.84	1.08	NA	0.02	0.06	0.07	
66	2/19/10 11:45	2/25/10 09:10	3.051	DF	DRY-BULK	2.44	2.05	NA	0.09	0.64	0.22	
67	2/25/10 09:10	3/16/10 08:17	0.905	DF+R+S	DRY-BULK	1.67	2.03	NA	0.01	0.04	0.07	
68	3/16/10 08:17	3/26/10 08:40	1.178	DF+S	DRY-BULK	2.34	5.09	NA	0.16	0.09	0.09	
69	3/26/10 08:40	4/13/10 09:10	0.513	DF+R+S	DRY-BULK	2.17	0.74	NA	0.06	0.07	0.27	
70	4/13/10 09:10	5/7/10 14:00	0.500	DF+R+S	DRY-BULK	2.04	0.44	NA	0.02	0.08	0.13	176
71	5/7/10 14:00	6/3/10 09:18	0.500	DF+S	DRY-BULK	NA	1.75	NA	0.15	NA	NA	176

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.
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
(1) Small dead moth in sample, possible contamination; (2) bucket had gone dry, added 0.5 liters deionized water to process; (3) looked like screen and bucket had bird droppings on it, likely contamination; (4) 2 spiders in ST sample likely contamination; (5) likely contamination, discarded; (6) added 330ml deionized water to 170ml of sample to process; (7) bucket dry, added 500ml deionized water to process; (8) ST sat out for long period, likely partial sample evaporation; (9) 2 aspen leaves in sample; (10) major fires in So. Calif. from Santa Ana winds, no smoke in basin, 1 aspen leaf in sample; (11) rain from thunderstorms, filter has dark gray color, ash from So. Calif. fires?; (12) Aerochem Metrics sampler replaced, had been malfunctioning; (13) brought wet bkt volume to 500ml for processing; (14) Aerochem Metrics lid may have knocked some snow from bucket when closed; (15) small amt of precip was discarded; (16) some ice on bkt rim, Aerochem Metrics lid may not have sealed completely; (17) snow 3 inches above bkt rim, compacted with lid; (18) 3 ml of precip (trace) added to 12/20/07 sample and processed; (19) major fires in So. Calif. from Santa Ana winds, no smoke in basin, 1 aspen leaf in sample; (20) 3 aspen leaves in dry sample; (21) replaced

Aerochem Metrics sampler, had been malfunctioning, placed out dry bkt with heater for first time this season; (22) 200 ml of dry sample had spilled; (23) small amt of ice on surface of dry bkt; (24) dry bkt vol not available; (25) dry bkt partially frozen; (26) 61ml of sample + 439 ml deionized water to process; (27) 110 ml sample + 390ml deionized water to process, filter brownish-gray; (28) pin-hole leak in ST volume underestimated; (29) 204ml of sample, took 150ml of this and added to 350ml deionized water; (30) many plastic flakes, filter has slight gray color; (31) portion of sample spilled and caught enroute from boat; (32) slight dark color on filter; (33) filtered 150 ml ST sample and filter was grayish; (34) snow accumulated 1.5 ft. above bucket rim, "a" bucket = snow accumulated in original Aerochem Metrics wet bucket to rim, plus some compacted down with another bucket "b"; (35) "b" bucket, snow overlying bucket "a"; (36) 68 ml of sample, added 432ml of deionized water to process; (37) snow accumulated 4-5 inches above bucket rim, compacted down; (38) not all precip collected in wet bucket, Aerochem Metrics lid had shifted and knocked part of overlying snow off bucket, approximately 2 feet of dry snow from storm, TBG didn't collect all snow; (39) 113 ml sample + 387 ml deionized water, dry bucket caught portion of storm; (40) 4ml of sample + 501 ml deionized water; (41) snow compacted down into bucket during storm, approximately 2 feet total snow and wet snow from storm; (42) thin layer of ice in dry bucket, had added 1 liter additional of deionized water during period, sample filter very dirty; (43) dry bucket frozen with 1 inch of snow on surface; (44) small amt (20-30ml) spilled in transit and water contacted outer bag; (45) ST had pin-hole leak, no sample; (46) ST had pin-hole leak, partial sample; (47) ST had 168ml sample + 332 ml deionized water; (48) 132 ml sample + 368 ml deionized water; (49) 30ml sample + 470ml deionized water; (50) 178 ml sample + 322 ml deionized water; (51) dead bug and much pollen in sample, possible contamination; (52) much pollen some dark debris in dry bucket; (53) much pollen in sample, intermittent periods of smoke from fires in CAwhich were caused by lightning storms 6/21/08, some very smokey days; (54) 6 ml sample + 494ml deionized water; (55) bucket dry, added 500ml deionized water; (56) thunderstorms with rain this period; (57) bucket dry, added 500ml deionized water, moderate to heavy smoke when collected from CA fires; (58) many small black bugs and white plastic flakes; (59) bucket dry, added 500ml deionized water; (60) 45 ml sample + 455ml deionized water, filter dark-brown-green, National Weather Service noted dust from Nevada desert blown south over Lake Tahoe this period; (61) bucket dry, added 500ml deionized water to process, moderate-to-heavy smoke when collected; (62) much smoke past week from CA fires, often variable during the day; (63) 10 ml of precip + 490 ml of deionized water to process; (64) very heavy ash on screen in bucket and in sample, pieces of small charred pine needles, some suds upon mixing, significant ash fall event along at least northwest portion of the basin from American River Complex fire to the west, charred bay leaves actually found near Tahoe City marina; (65) some ash in sample, probably residual from surrounding surfaces; (66) not as much smoke this pd.; (67) some smoke during pd., one day of heavy smoke from fire near Yosemite, filter has some organic wind-blown debris, filtered first through non-precombusted GF/C filter then through precombusted GF/F filter; (68) dead moth in sample, possible contamination; (69) small dead bee in sample, possible contamination, very difficult to filter; (70) windy previous day associated with thunderstorms:; (71) trace of precip associated with thunderstorms and wind previous day, no precip in bucket, left out; (72) some aspen leaves in dry bucket; (73) obvious ash in ST sample; (74) ST dry, left out; (75) obvious ash in dry-bulk bucket from ash fall event 7/9/08, 6-7 small midge flys in dry-bulk sample too; (76) no obvious ash, much pollen in sample; (77) small amount of precip and pollen this period; (78) periods of smoke during period, one day of heavy smoke from fire near Yosemite entrance; (79) bucket dry, added 500ml deionized water; (80) 85ml of sample +450ml deionized water, small spider in sample, possible contamination; (81) obvious ash in sample, more than bucket at TB-1; (82) 10ml of precip + 490 ml deionized water to process; (83) bucket dry, added 500ml deionized water to process, much particulate debris in sample, likely bird feces; (84) small dead spider in ST sample, possible contamination; (85) many aspen leaves in dry bucket, possible contamination; (86) Aerochem Metrics Wet/Dry sampler malfunctioned, dry bucket caught at 10-12" of snow, most of this was removed from over dry bucket and dry bucket left out since lacking replacement, used estimate of precipitation during period as SNOTEL Ward #3 precip 12/15 + Ward #3 precip. 12/17) /1.5) - WLL precip. 12/17; (87) Aerochem Metrics Wet/Dry sampler malfunctioned again, Dry bucket caught much of snow, estimate precip amount as Ward #3/1.5; (88) Aerochem Metrics Wet/Dry sampler malfunctioned again – replaced the complete sampler with newer Aerochem sampler on loan from CARB, estimated precip as SNOTEL Ward #3/1.5; (89) Aerochem Metrics lid stuck over dry-side after storm, snow about 1.5 ft above wet bucket rim, collected in second cleaned bucket and combined samples for processing; (90) 1 aspen leaf in sample; many aspen leaves on dry bucket screen, a few leaves in water, possible contamination; (92) Aerochem Metrics sampler malfunctioned during the storm, dry side caught a portion of wet precip., approx 10-12 inches of snow over dry bucket on 12/15/08 was swept off bucket and not collected; (93) Aerochem Metrics sampler malfunctioned again, collected much Wet precip this period, – replaced the complete sampler with newer Aerochem sampler on loan from CARB; (94) Aerochem Metrics lid frozen over dry side portion of the period, i.e. until 12/26/08, 1230; (95) 100ml of sample + 400ml deionized water added to process; (96) medium-sized dead spider in sample, likely contamination; (97) rough conditions when sampled; (98) snow accumulated about 5 inches above Wet bucket rim, Aerochem lid frozen over Dry-side so some dry deposition in Wet bucket; (99) snow 2-3 inches above bucket rim, compacted; (100) snow 1 foot above bucket rim, compacted down, Aerochem lid stuck over Dry-side, so some dry deposition in Wet bucket; (101) snow 4-5 inches above bucket rim, compacted; (102) placed out wet bucket with 500ml deionized water during this period as field blank, bird feces on Aerochem sensor caused lid to cover Dry side for portion of period and expose wet field blank, combined the field blank water (500ml) with Dry-side (3475ml) for analysis as Dry sample; (103) small amount sample spilled; (104) filter dirty with road dust; (105) lid stuck over dry-side a portion of collection period, Wet caught some Dry deposition, dry side water frozen portion of the period, heater not plugged in; (106) 96ml precip + 404ml deionized water; (107) sample sat for 8 days chilled before processing; (108) small rip in bucket bag during transport, possible contamination from particles on bag falling into sample, sample knocked over during processing, volume likely slightly off; (109) 250ml Dry-Bulk sample + 250 ml of deionized water to process; (110) 150ml sample + 355ml deionized water; (111) 255ml sample + 245ml deionized water; (112) precipitation associated with thunderstorm previous night; (113) Aerochem sampler unplugged this period due to heater malfunction, heavy precipitation likely hail and rain associated with intense thunderstorm on 6/2/09 and possibly on other days, Dry bucket caught all wet and dry deposition this period; (114) 39ml of sample + 216ml of deionized water added for processing; (115) Dry bucket out for unusually long period, Aerochem sensor overheating this period; (116) leak in ST bag corner, many bugs in sample, volume not measured; (117) bird feces in sample, sample contaminated; (118) trace of precip from isolated thunderstorms; (119) dry-bulk bucket sat for very long period on buoy, dry, added 500ml deionized water to process; (120) precipitation from thunderstorms during period, bucket dry, added 500ml deionized water; (121) trees cut down near station possibly producing debris during pd.; (121) trees cut down near station during pd., opened canopy and possibly produced debris; (122) 185ml sample + 315ml DIW to process; (123) 23ml sample + 477ml DIW to process; (124) 2ml sample + 498ml DIW to process; (125) dead fly in sample, possible contamination; (126) much orange-yellow debris in dry bucket from either construction activity or tree cutting on property; (127) dead bee and many aspen leaves in sample, probable contamination, not processed; (128) significant new construction on land near station, trees to south of site removed, backhoe excavating, workers trying to control dust using hose spray; (129) pieces of unknown organic debris in ST sample, possible contamination; (130) 5ml sample + 500ml DIW to process; (131) probable contamination; (132) many small black bugs in sample; (133) possible contaminant on bucket rim; (134) 262ml sample + 238ml DIW; (135) bucket dry added 500ml DIW to process; (136) 80ml sample + 420ml DIW; (137) small amt of sample spilled in transit, estimate 125 ml, accounted for in final volume; (138) 162ml sample + 338 ml DIW to process; (139) 235ml sample + 265ml DIW; (140) excavation for new house adjacent to weather station ongoing, workers trying to control dust with spray hose, atmospheric deposition filter very dirty; (141) strong wet storm, moisture from typhoon Parma merged with strong low pressure system, strong winds also with it; (142) power off to station during portion of the storm, dry bucket caught much precipitation, 60ml sample + 440ml deionized water; (143) power off to station, dry bucket caught small amount of precipitation; (144) 25ml of sample + 475 ml deionized water; (145) 37ml precipitation + 463ml deionized water; (146) very strong winds with start of this storm; (147) 114 ml sample + 391ml deionized water; (148) approximately 2 ft. of snow, used second bucket to core and collect top snow; (149) snow approximately 1 ft. above rim, blocking movement of A.M. lid back over wet bucket; (150) 45ml of sample + 455ml deionized water; (151) Aerochem Metrics lid frozen over dry bucket when arrived, released; (153) 2 aspen leaves in sample; (154) power off to station during portion of period, dry bucket caught most of the precipitation, many aspen leaves in sample; (155) power out to station, dry collected all precipitation, small amount; (156) dry bucket water frozen with small amt. of snow on screen, placed out bucket with heater; (157) estimated date bucket changed, heater was broken, sample contaminated and discarded, no sample, date of collection not shown in field book, this most likely data/time; (158) many wind-blown particulates in dry bucket; (159) hole in ST, part of sample leaked; (160) 205ml sample + 295ml deionized water to process; (161) 12ml sample + 488ml deionized water to process; (162) 120ml sample + 380ml deionized water; (163) significant rain and winds this period; (164) very windy during period, filter very dirty with brown silt, 205ml sample + 295 ml deionized water; (164) 14ml precip. + 486ml deionized water; (165) snow accumulated 6-8 inches above rim, compacted down with lid, first in series of El Nino storms, pushed by strong jet stream; (166) approx. 10 inches snow above rim, cored down with one bucket to top of lower bucket, then removed both, melted and combined water, windy storm; (167) Aerochem Metrics lid stuck over wet bucket at end of storm, some snow in dry bucket; (168) 23ml sample + 477ml deionized water; (169) snow 5 inches above bucket rim; (170) snow to bucket rim; (171) wet bucket spilled, estimate 40ml in sample; (172) had added 1 liter additional deionized water on 1/24/10, dry bucket also caught some wet precip when Aerochem Metrics lid stuck over wet bucket during portion of period; (173) 198ml precip +302ml deionized water; (174) NASA working on buoy 2/17 – 2/19, bucket removed during this period; (175) 280ml sample + 220ml deionized water; (176) bucket dry, added 500ml deionized water to process; (177) trace of precip in dry bucket, added 500ml deionized water to process;