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Reed Lake Water Quality Monitoring Project January - June 2011 Final Report

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1 Introduction

1.1 Background

Reed Lake is located east of Highway 20 near Alger (WA) on the border of Whatcom and Skagit Counties. At the western tip of Reed Lake a concrete dam controls water flow into Cain Lake. Both lakes are surrounded by communities that have grown rapidly in the last few decades. Development extends to the shoreline around the entire perimeter of Reed Lake, with several boat launches and private docks. Residents around both lakes rely on individual septic systems for wastewater treatment. Recreation on the lake includes boating, swimming, and fishing for annually stocked rainbow trout (*Oncorhynchus mykiss*). Residents have expressed concern about the deterioration of recreation conditions due to aquatic plant growth hindering boat passage and sediment deposition under docks and swimming areas.

The Reed and Cain Lake basins most likely formed in low depressions in the alluvium deposited as a result of the Pleistocene glaciation. The elongated shape of both lakes is typical of many northern lakes formed by glacial scour including Lake Whatcom. The bedrock above the Reed Lake drainage consists of sandstone, shale and conglomerate of the Chuckanut Formation, and Darrington Phyllite. In some locations bedrock is overlain by glacial drift. Unstable soils have produced a history of debris flows.

Water input into Reed Lake is from a combination of precipitation, surface water runoff, tributaries, and groundwater seepage. The Cain Lake/Reed Lake watershed occupies approximately 8.5 km^2 of second growth mostly comprised of western red cedar, fir, and mixed hardwoods such as alder and maple. Three unnamed streams converge to create a composite fan on the western shore of Reed Lake. The three creeks drain a combined area of 620 acres on the southeastern face of Lookout Mountain. Nearshore reaches of the creeks are channelized with a small ($<$10 ft.) buffer consisting of a combination of native riparian vegetation and invasive Himalayan blackberries.

1.2 Previous Lake Improvement Projects

Several strategies have been implemented to improve water quality in Reed Lake. In 2008 the Glenhaven Lakes Committee released 50 grass carp (*Ctenopharyngodon idella*) to control the spread of aquatic plants. These imported fish have not been seen since the spring of 2010 and did not appear to make a significant impact on plant populations. Volunteers annually harvest and remove aquatic plants around the outflow. This method for plant control has been labor intensive, with only short-term benefits.

In April 2011 the Glenhaven Lakes Committee arranged for a presentation on landscaping with native shoreline vegetation. Immediate feedback to the presentation was positive, but it is unclear to what extent this will translate into action by lakeside residents. Current lake activities are described on the committee's website (glenhavenlakes.wordpress.com), which includes descriptions of past activities and a calendar of current and upcoming events.

1.3 Project Goals

Reed Lake has been monitored annually by the Institute for Watershed Studies (IWS) as part of their Small Lakes Monitoring Project, a public service project that generates water quality data for more than 50 local lakes. Although these data have been collected since 2006, they have not been used to provide lake management information for Reed Lake. To supplement the existing data, IWS was contracted by the Glenhaven Lakes Committee to collect six months of additional data and prepare a report that summarizes the water quality results and describes lake management methods that may be helpful for maintaining or improving the water quality in Reed Lake.

To help frame the discussion of lake management options, two public meetings were held with members of the Glenhaven Lakes Committee and other Reed Lake residents. The first meeting was held on December 9, 2010 to obtain comments from lake shore residents listing core concerns. These comments are summarized in Appendix A (page 26). The second meeting (June 9, 2011) included a short presentation by Maggie Taylor, IWS student intern, describing the preliminary results of her water quality analyses.

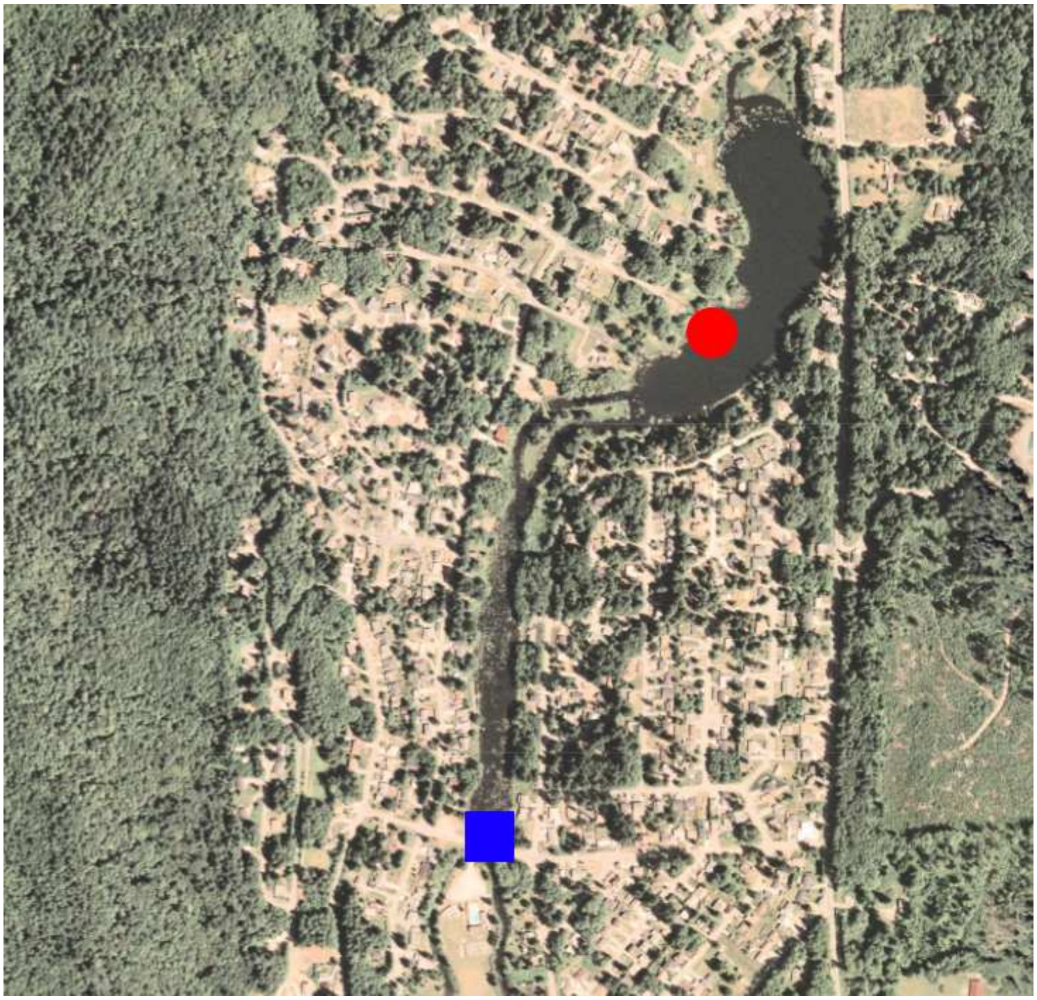
2 Sampling Procedures

The Reed Lake sampling site was selected to achieve a representative lake sample that was accessible from the shoreline (Figure 1, page 4). An empty lot at the end of Cedar Lane provided easy lake access at a location about midway between the north and south ends of the lake. Conditions at the site were fairly typical for Reed Lake, with a grassy bank, some nearshore aquatic plant growth, and a channelized tributary located about 10 meters from the sampling location. Water samples were collected 0.5 meters below the lake surface and approximately 1 meter away from the shoreline.[1]

The lake was sampled monthly from January through June 2011. Temperature and dissolved oxygen were measured using a YSI Model 550A dissolved oxygen meter, which was calibrated before each sampling trip. Water samples for turbidity, pH, conductivity, alkalinity, nitrogen (total, nitrate/nitrite, ammonium), and phosphorus (total and soluble) were collected in an acid washed bottle, transported on ice, and returned to the lab for processing. Additional water samples were collected in an opaque bottle to determine chlorophyll concentrations.

All laboratory analyses were conducted at IWS following the analytical methods listed in Table 1 (page 5). All of the water quality data are included in Appendix B (page 30) and posted online at the IWS web site (www.wwu.edu/iws) under Lake Studies/Small Lakes Project. To ensure quality control, ten percent of the water samples were collected in duplicate to estimate variation between samples collected at the same location, depth, and time (field duplicates); ten percent of all laboratory samples were measured in duplicate to estimate analytical variation for samples from the same bottle (lab duplicates). Laboratory blanks, matrix spikes, and laboratory control/check samples were included with all analytical runs to estimate background noise and recovery of known concentrations of each analyte. The laboratory at IWS is accredited by the Quality Assurance Section of the Department of Ecology. For additional information, contact Dr. Robin Matthews, IWS Director or Ms. Joan Vandersypen, IWS Laboratory Supervisor.

[1] The 2006–2010 IWS samples were also collected near the shoreline at approximately 0.5 meter depths, but the site was located at the bridge near the lake outlet (Figure 1, page 4).



Adapted with permission from base map provided by C. Llewellyn, 2010.

Figure 1: Reed Lake sampling sites (● = 2011 monitoring site; ■ = 2006–2010 IWS small lakes monitoring site).

Analyte	Abbr.	Method Reference (APHA 2005)	Detection Limit/ Sensitivity
Alkalinity	Alk	SM2320, titration	±0.5 mg $CaCO_3$/L
Chlorophyll - lab	Chl	SM10200 H, acetone extraction	±0.1 μg/L
Conductivity - field/lab	Cond	SM2510, lab or field meter	±0.1 units
Dissolved oxygen - field	DO	SM4500-O G.,membrane electrode (field meter)	±0.1 mg/L
Dissolved oxygen - lab	DO	SM4500-O C., Winkler, azide	±0.1 mg/L
Nitrogen - ammonium	NH_3	SM4500-NH3 H., flow inject, phenate	10 μg NH_3-N/L
Nitrogen - nitrate/nitrite	NO_3	SM4500-NO3 I., flow inject, Cd reduction	10 μg NO_3-N/L
Nitrogen - total	TN	SM4500-NO3 I., flow inject, persulfate digest	10 μg N/L
pH - field/lab	pH	SM4500-H, electometric lab or field meter	±0.1 units
Phosphorus - soluble	SRP	SM4500-P G., flow inject	3 μg PO_4-P/L
Phosphorus - total	TP	SM4500-P G., flow inject, persulfate digest	5 μg P/L
Temperature - field	Temp	SM2550 thermistor (field meter)	±0.1 °C
Turbidity	Turb	SM2130, nephelometric	±0.2 NTU

Table 1: Analytical methods used for the Reed Lake monitoring project.

3 Results and Discussion

All of the 2011 water quality data are included in Appendix B (page 30) and posted on the IWS web site (www.wwu.edu/iws). In addition, all of the 2006–2011 Reed Lake data are plotted with descriptive captions in (Figures 2–14 (pages 7–19). Each caption provides a short summary and interpretation of the specific water quality test. The 2006–2010 samples were collected at a different location in the lake, down-gradient from a narrow, shallow arm of the lake (Figure 1, page 4). Although the 2006–2010 samples were collected from a similar depth and off-shore distance (0.5 meters below the surface; 1 meter away from the shoreline), the results may not be entirely comparable to the 2011 data.

When appropriate, we included reference lines on the figures to illustrate how Reed Lake water quality compares with surface water quality standards for Washington State.[2] Following the annotated figures and water quality discussion, there is a short description of lake management options that might be appropriate for Reed Lake (Section 4, beginning on page 20).

[2] Not all water quality measurements have relevant surface water quality standards.

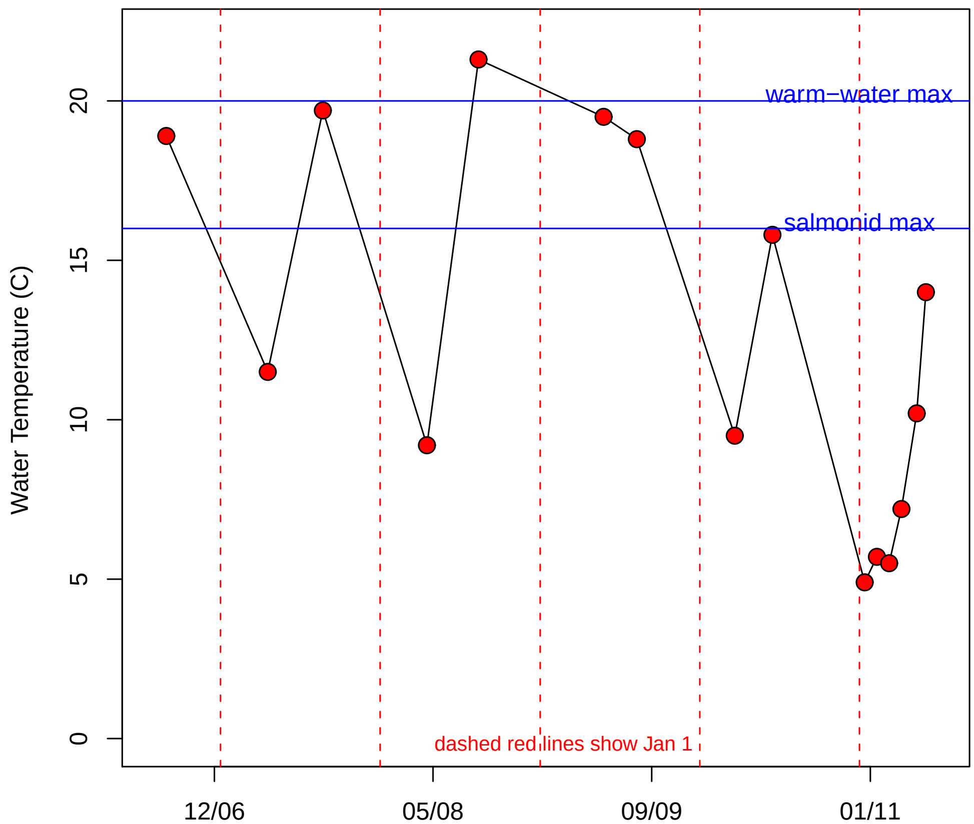


Figure 2: Reed Lake water temperature results, August 2006 - June 2011. Seasonal warming and cooling was evident, with warmer temperatures during the summer and cooler temperatures during the spring. The summer water temperatures exceeded the maximum level required for providing summer salmonid habitat, but were generally below the maximum temperature needed to sustain indigenous warm-water fishes (horizontal blue lines; WAC–173–201A–200). Water temperatures might be cooler away from the shoreline, but since the lake is very shallow, the nearshore temperatures are probably fairly similar to temperatures in most of the lake.

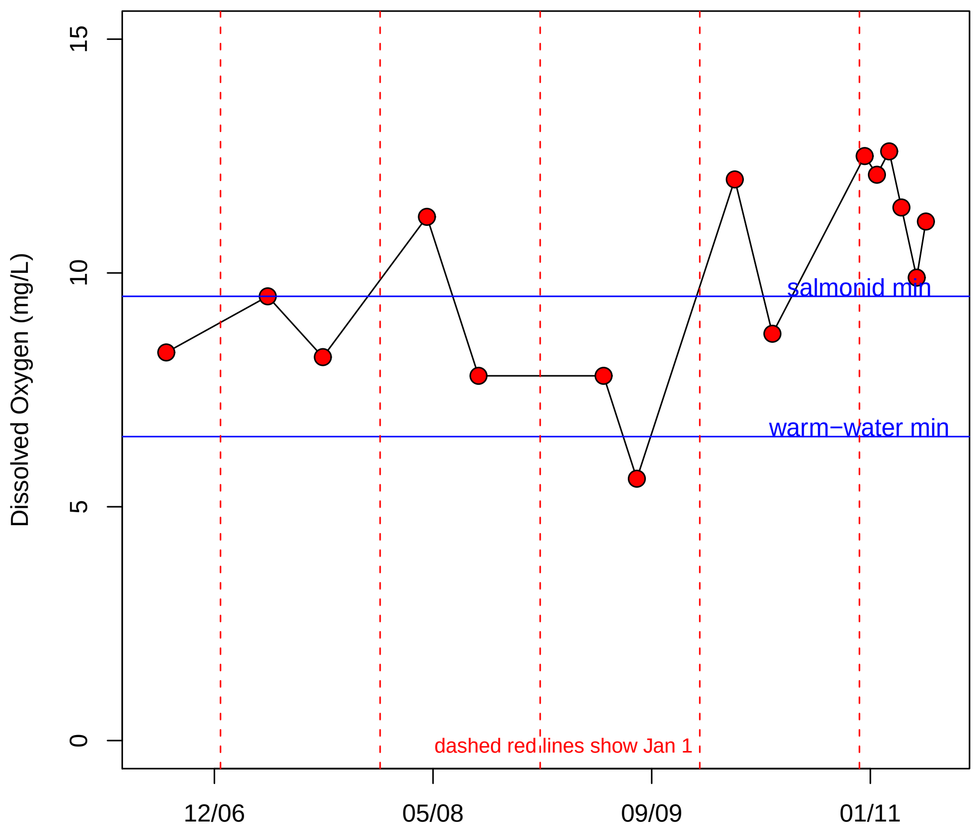


Figure 3: Reed Lake dissolved oxygen results, August 2006 - June 2011. The oxygen concentrations were usually above 5 mg/L, with higher levels during the spring (cold water holds more oxygen than warm water) compared to the summer, when warm water temperatures and high rates of organic matter decomposition work together to produce lower oxygen levels in the water column. The summer dissolved oxygen concentrations were usually too low to provide good summer habitat for salmonids, but were generally above the minimum levels required by indigenous warm-water fishes (horizontal blue lines; WAC–173–201A–200).

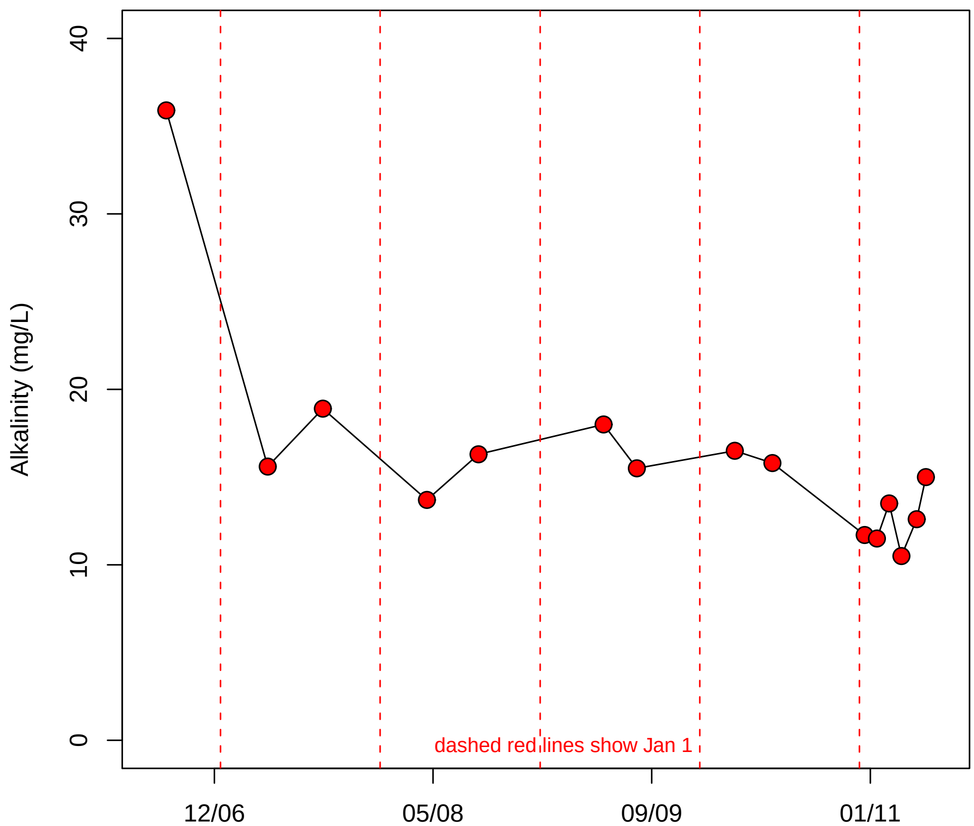


Figure 4: Reed Lake alkalinity results, August 2006 - June 2011. Alkalinity, pH, and specific conductance (conductivity) are related in surface waters. Alkalinity measures the *buffering capacity* or how resistant water is to pH changes. The alkalinity levels in Reed Lake were low ($\leq$20 mg/L), indicating that the water is poorly buffered against pH changes. This is typical for lakes in our region. Alkalinity may fluctuate seasonally, especially during algal blooms. During photosynthesis, algae remove dissolved CO_2 from the water, which can temporarily raise pH and lower alkalinity levels. This may have caused the unusually high alkalinity in August 2006. Algal blooms are highly episodic, so the absence of similar alkalinity peaks on other sampling dates would not be unusual.

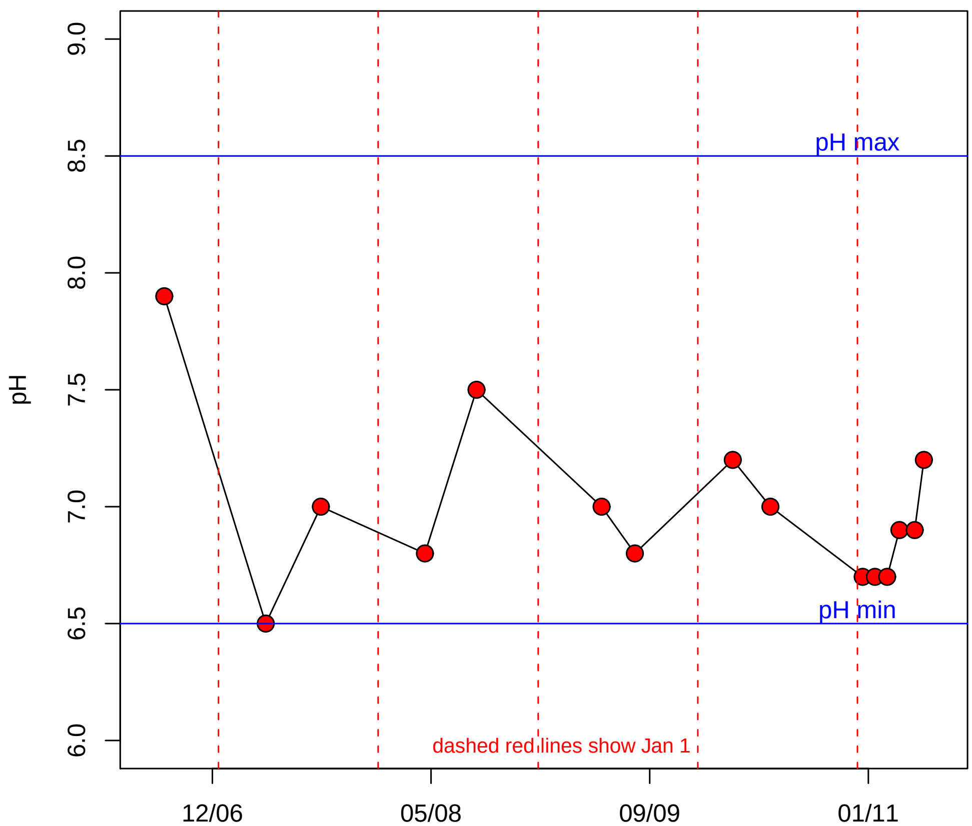


Figure 5: Reed Lake pH results, August 2006 - June 2011. Alkalinity, pH, and specific conductance (conductivity) are related in surface waters. The pH in water is determined by the concentration of H^+ ions. During photosynthesis, algae remove dissolved CO_2 from the water, which can temporarily raise pH by reducing the concentration of dissolved carbonic acid, which is formed when CO_2 reacts with water: $H_2O + CO_2 \leftrightarrow H_2CO_3$ (carbonic acid). The influence of photosynthesis is illustrated by the Reed Lake pH values, which were usually lower in the spring compared to the summer. Despite the seasonal changes, the Reed Lake pH values fell within the range needed to sustain salmonid and indigenous warm-water fishes (horizontal blue lines; WAC–173–201A–200).

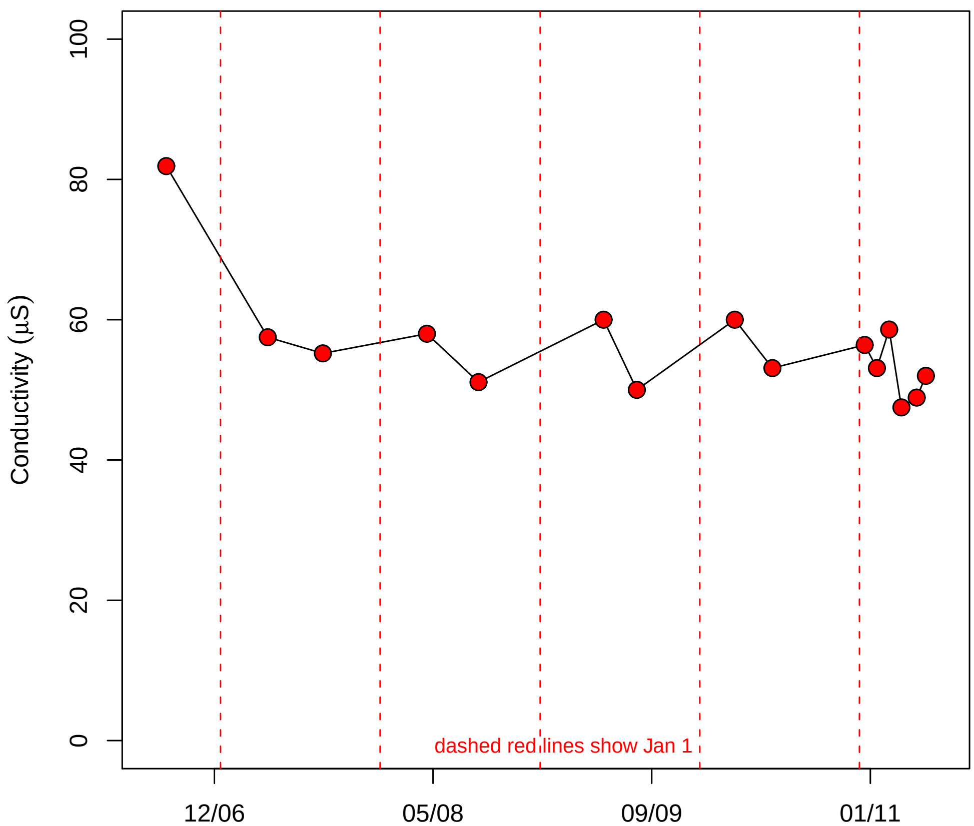


Figure 6: Reed Lake conductivity results, August 2006 - June 2011. Alkalinity, pH, and specific conductance (conductivity) are related in surface waters. Conductivity is determined by the types and amount of dissolved ions in the water. The soil type and land use in the watershed influence the amount of dissolved ions entering the lake from runoff and groundwater. Biological activity and chemical interactions determine whether dissolved ions remain in the water column. The conductivity levels were fairly low in Reed Lake, which is typical for low-alkalinity lakes in this region.

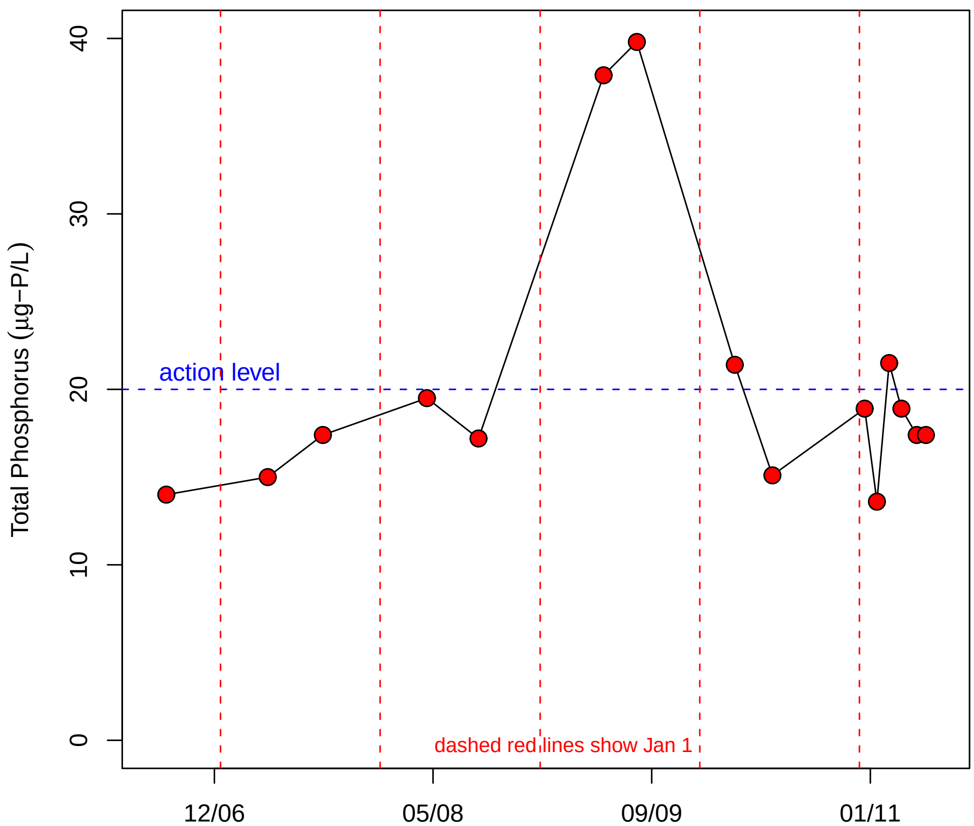


Figure 7: Reed Lake total phosphorus results, August 2006 - June 2011. Total phosphorus includes organic phosphorus (phosphorus associated with algae and other biota) and dissolved or soluble phosphate. Phosphorus is an important nutrient for algae, and is generally considered the nutrient that limits the amount of algae in a lake. The total phosphorus level was occasionally above the "action level" described in WAC–173–201A. This action level is used to identify lakes that may be impacted by high phosphorus levels and should be considered for a more extensive water quality assessment. The phosphorus level does not indicate a specific human health threat or threat to aquatic life, but it does identify lakes that are likely to have high chlorophyll concentrations and algae blooms.

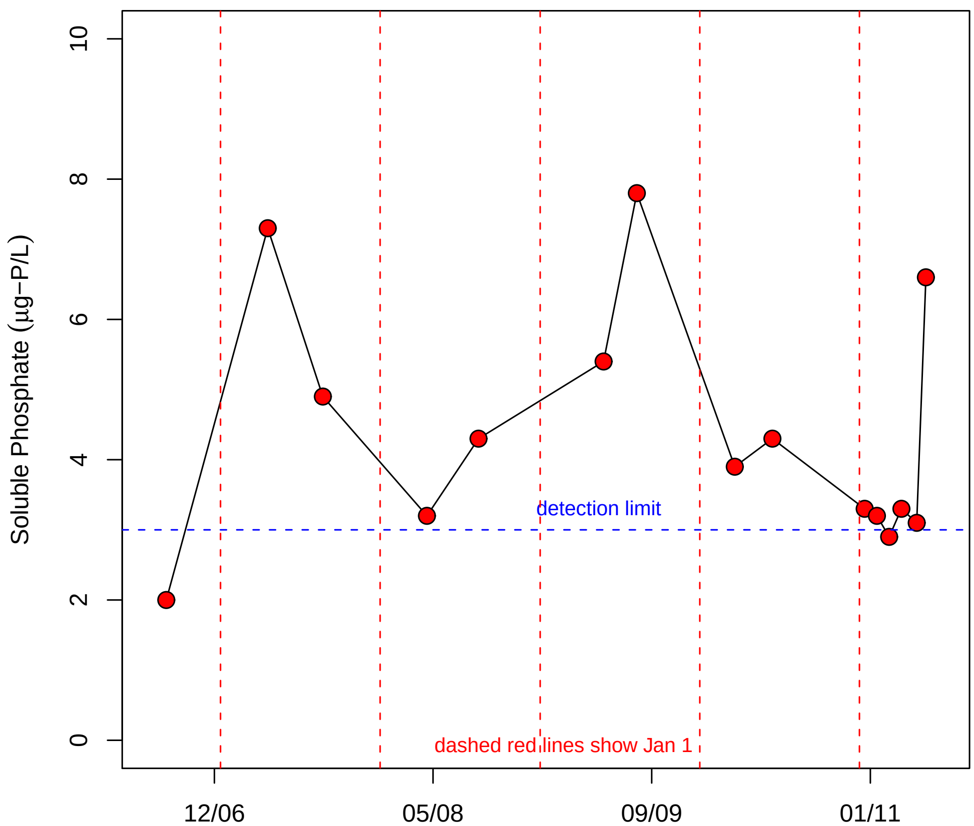


Figure 8: Reed Lake soluble phosphate results, August 2006 - June 2011. Soluble phosphate is the soluble inorganic portion of total phosphorus. Soluble phosphate concentrations are often low in the water column, even when algal concentrations are high, because this form of phosphorus is easily and rapidly taken up by algae and other microbiota. The soluble phosphate concentrations in Reed Lake were usually low (<10 μg-P/L) and occasionally were below the IWS analytical detection limit (3 μg-P/L).

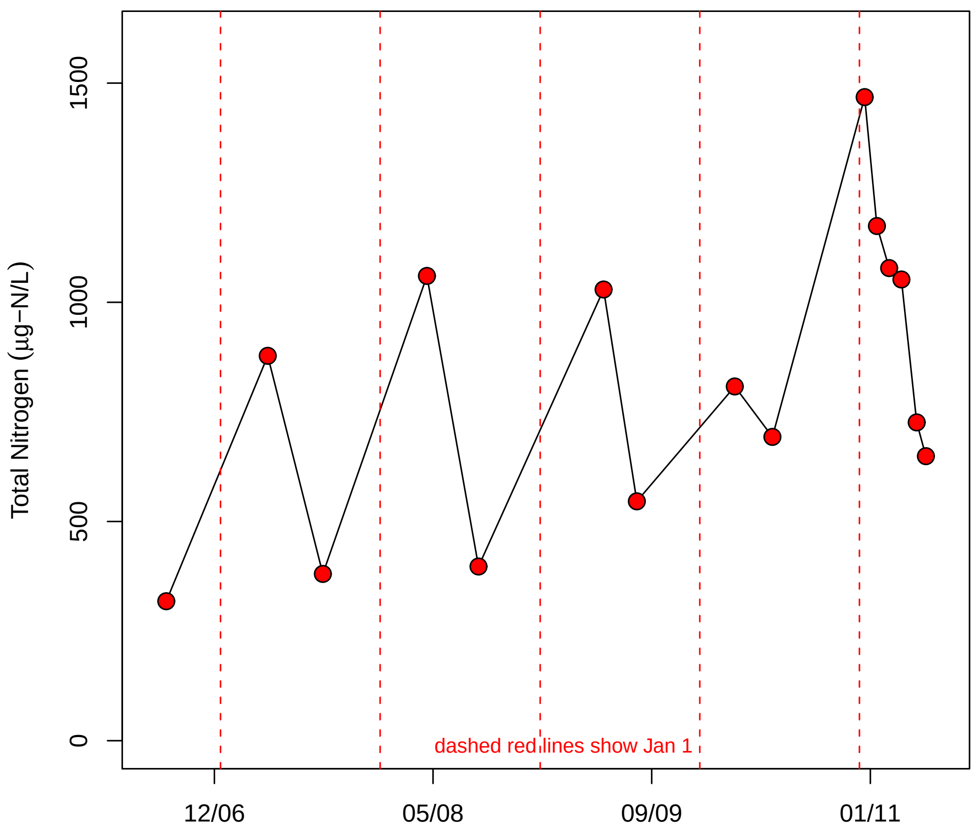


Figure 9: Reed Lake total nitrogen results, August 2006 - June 2011. Total nitrogen represents the combined concentrations of organic nitrogen (nitrogen associated with algae and other biota) and dissolved inorganic nitrogen (nitrate, nitrite, and ammonium). Total nitrogen concentrations are often similar to nitrate/nitrite concentrations, especially during the winter and spring. During the summer, however, the type of nitrogen present in lake samples is more difficult to predict. Algae may take up nitrate and other forms of inorganic nitrogen during photosynthesis, while algal blooms and organic matter decomposition may cause organic nitrogen and ammonium concentrations to increase. Reed Lake had high total nitrogen concentrations in the winter and spring samples, matching similar peaks in the nitrate data (Figure 10, page 15). The summer total nitrogen concentrations were lower, but not as low as nitrate levels, confirming the presence of ammonium and organic nitrogen.

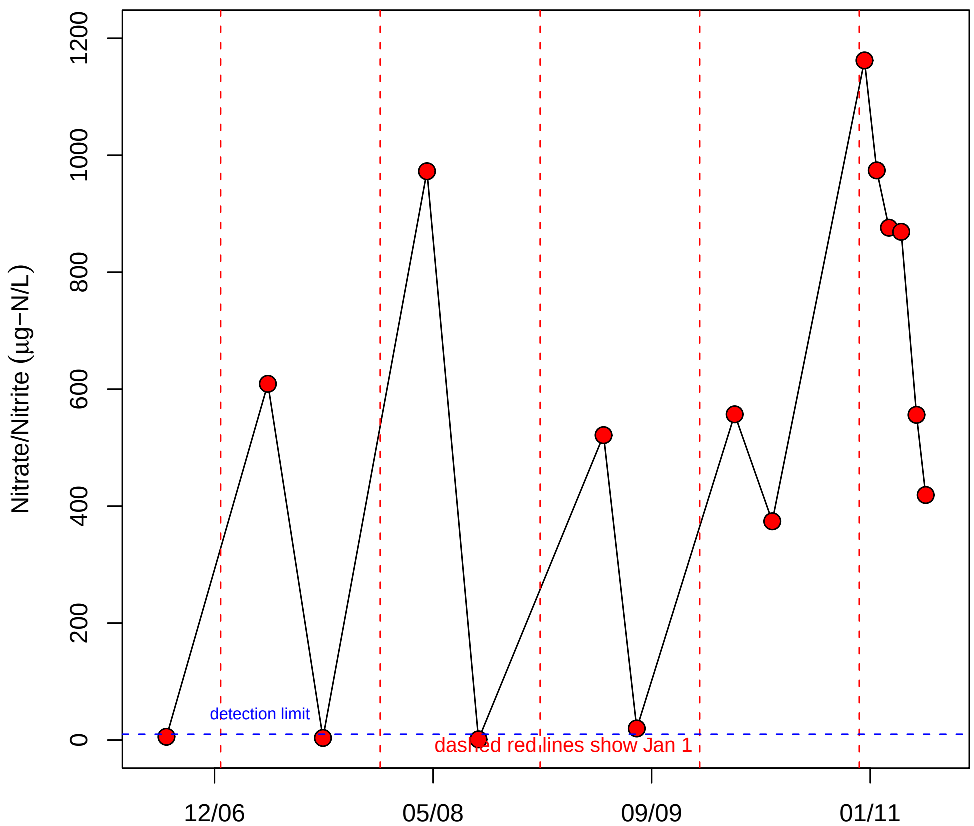


Figure 10: Reed Lake nitrate/nitrite results, August 2006 - June 2011. Nitrate (NO_3) and nitrite (NO_2) are often measured simultaneously because nitrite concentrations are usually negligible and below analytical detection levels. Nitrate/nitrite is often the major component of dissolved inorganic nitrogen (DIN), which also includes ammonium (NH_3). Inorganic nitrogen is an important nutrient for most algae. When the DIN concentrations are low, conditions favor the growth of cyanobacteria or bluegreen algae because cyanobacteria can use dissolved N_2, which is replenished from the atmosphere. During the summer, the Reed Lake nitrate/nitrite concentrations dropped below the IWS detection limit (10 μg-N/L), indicating the cyanobacteria blooms are likely to occur.

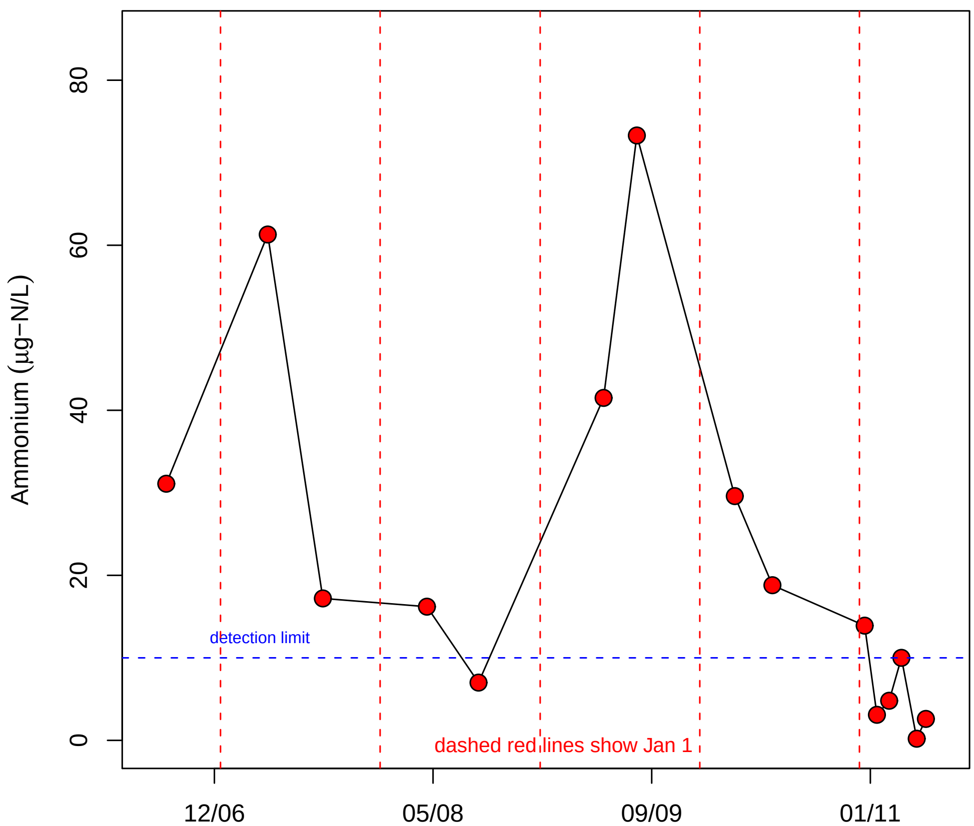


Figure 11: Reed Lake ammonium results, August 2006 - June 2011. Ammonium concentrations are usually very low in oxygenated water, and are typically associated with anaerobic lake sediments or other low oxygen environments. In Reed Lake, the ammonium concentrations were near or below the IWS analytical detection limits (10 μg-N/L) on most dates from January through June, 2011, but were detectable, and often elevated during many of the summer sampling dates. There was no obvious pattern for the ammonium peaks, but typical sources would include the lake sediments and runoff from a local source (e.g., septic overflow, fertilizer leaching, ammonium from marshy soils).

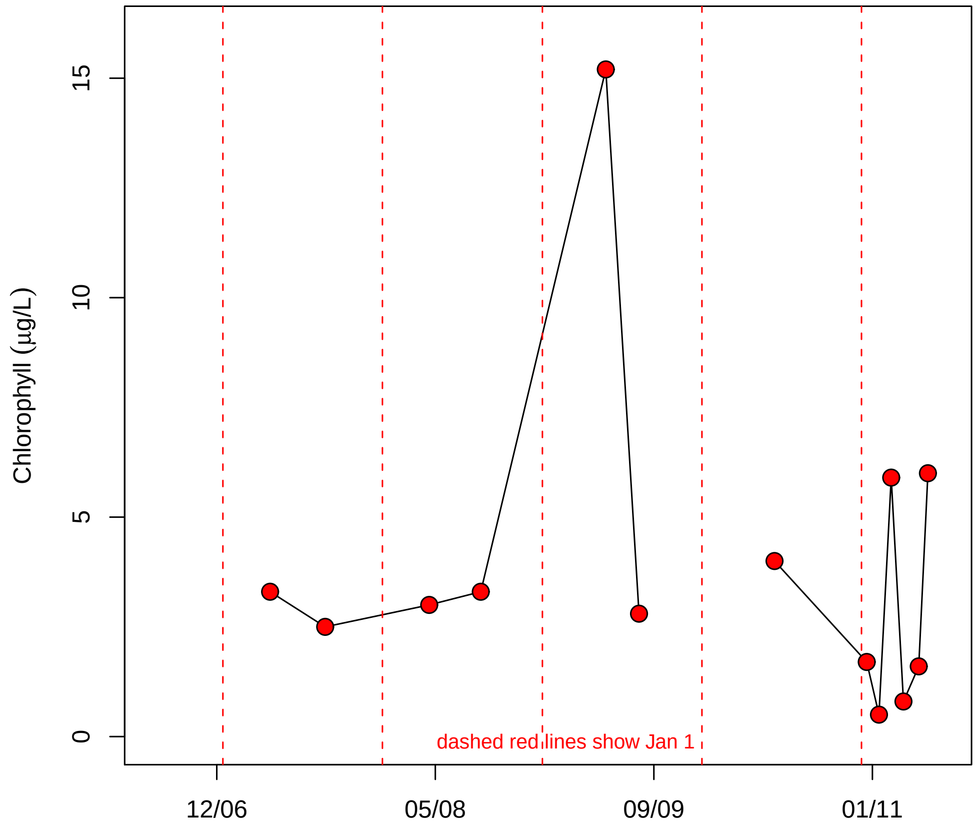


Figure 12: Reed Lake chlorophyll results, August 2006 - June 2011. Chlorophyll is the primary photosynthetic pigment in algal cells and is generally the best indicator of the amount of algae present in lakes. In Reed Lake, the chlorophyll concentrations were fairly low (≤ 6 μg/L), with the exception of one high value (15.2 μg/L) collected on May 26, 2009. There were no obvious differences between the spring and summer values, but that is not entirely unexpected. The IWS sampling approach is designed to collect spring algal blooms (dominated by diatoms and other “chrysophytes”) followed by summer algal blooms (dominated by green algae and cyanobacteria). The only unexpected result was in March 2011 when there was a small chlorophyll peak (5.9 μg/L) between low values in February and April. Algal blooms are episodic, so this peak probably represents a small, short-lived algal bloom.

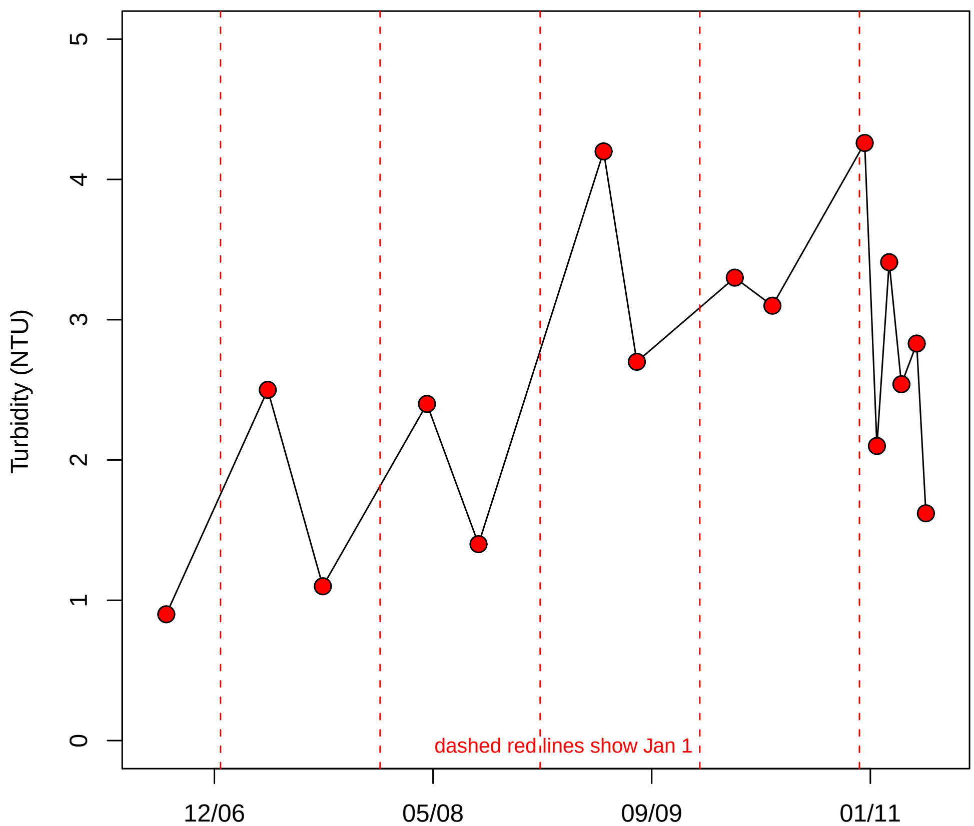


Figure 13: Reed Lake turbidity results, August 2006 - June 2011. Turbidity is a measure of the suspended particles in water, which includes algae, inorganic particles, and non-living organic matter. When most of the suspended particles in the water column are algae, chlorophyll concentrations are closely related to turbidity. If non-algal particles are abundant, there is little relationship between chlorophyll and turbidity. In Reed Lake, the turbidity levels were relatively low (<5 NTU) and unrelated to chlorophyll. Some of the spring and winter turbidities were slightly elevated, which might reflect the influence of storm runoff.

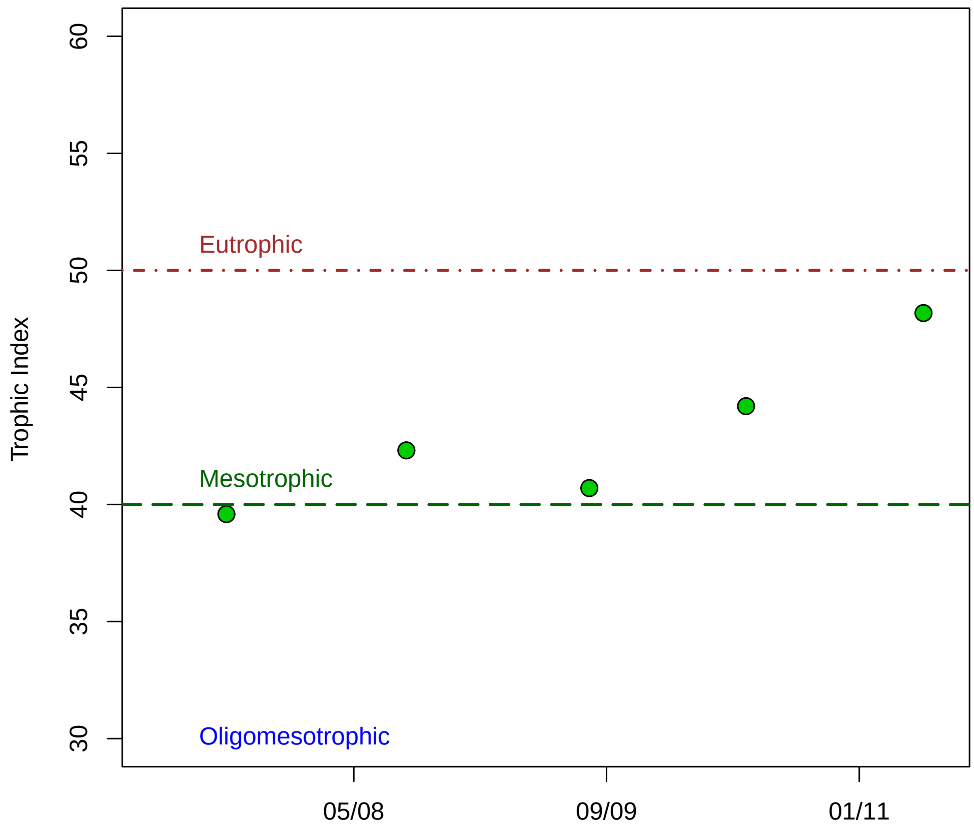


Figure 14: Carlson's Trophic State Index for Reed Lake (June - October samples). Carlson's Trophic State Index is a simple tool used to classify lakes based on the chlorophyll concentrations collected during peak algal growth period (usually late summer and early fall). Lakes with low concentrations of chlorophyll are biologically unproductive or *oligotrophic* ($TSI_{chl} < 30$); lakes that have high chlorophyll concentrations are biologically productive or *eutrophic* ($TSI_{chl} > 50$); lakes that fall between these classifications are moderately productive or *mesotrophic* (TSI_{chl} 40–50) or *oligomesotrophic* (TSI_{chl} 30–40). Carlson's Index is calculated as: $TSI_{chl} = 9.81(\ln \mathrm{Chl},\ \mu\mathrm{g/L}) + 30.6$. Reed Lake TSI_{chl} values were calculated using summer data (June through October). Most of the values were in the mesotrophic range. The values appear to be increasing slightly, but due to the very small sample size (n=5), this pattern should not be interpreted as a trend.

4 Lake Management Issues

The Glenhaven Lakes Committee expressed many goals for water quality protection and improvement of the recreational capabilities of Reed Lake (Appendix A, page 26). Some of the specific concerns expressed by residents include sediment infilling, spread of aquatic macrophytes, contamination by waterfowl, and nutrient loading. The following section contains general information addressing some of the stated concerns. It is beyond the scope of this study to provide specific lake management guidelines, but we hope that this section will provide a baseline for making lake management decisions.

4.1 Summary of Water Quality Problems

Recreation in the form of boating, fishing, and swimming is the predominant use of Reed Lake, so maintaining good recreational quality in the lake is a central goal to community members. Expanding growth of aquatic macrophytes impedes the passage of boats especially near the south end of the lake. The abundant plant growth is aesthetically displeasing to some of the residents. Plants may limit access to shoreline areas and can create hazardous conditions for swimmers. The quality of swimming beaches and docks has been reduced as sediment deposition decreases the water depth in these areas, resulting in muddy, shallow conditions.

The extensive plant growth is may be associated with the decreasing water depth and, possibly, increasing nutrient availability. Plants require three inputs in order to grow: light, nutrients, and carbon dioxide. As the lake fills, light is able to penetrate to a greater portion of the lake bottom, and rooted macrophytes can become established. Nutrient runoff, particularly phosphorus, also stimulates macrophyte growth. Currently the macrophytes seem to be out-competing the algae for nutrients because the chlorophyll concentrations are relatively low in the water column (Figure 12, page 17). Extensive removal of vegetation could make more nutrients available for algal uptake, triggering unwanted algal blooms.

Residents also expressed concern with deteriorating water quality. Development around the lake can increase the amount of sediment and nutrients in runoff, while impervious surfaces decrease the ability of the landscape to absorb and filter precipitation. Nutrient loading may increase as a result of inputs from fertilizers, manure, leaking septic systems, compost, and pet waste. Excessive phosphorus inputs have the potential to increase algae and plant growth. Over time, rising amounts of decaying organic matter can lead to eutrophication, producing more frequent algal blooms. Waterfowl can also contribute negatively to nutrient loading as well as fecal coliform contamination.[3] Scientists attribute over one-half of nutrient loading to resident waterfowl in Seattles Green Lake (www.ecy.wa.gov/programs/wq/plants/algae/lakes/BestManagementPractices.html, downloaded July 27, 2011).

These types of lake management issues are complicated, difficult to resolve, and may require a balance between aesthetic, functional, practical, and legal requirements. As with most shared resources, the biggest challenge lies in garnering community support and commitment to individual change. Although a few regulatory options do exist, changing practices on private property must ultimately be central to maintaining this recreational resource.

4.2 Improving/Maintaining Water Quality in Reed Lake

In order to maintain or improve water quality in Reed Lake, the first step would be to develop a watershed management plan. Preparing a watershed management plan was beyond the scope of this project, but in the following sections we list a variety of approaches that can serve as a starting point. At the end of this section we list a variety of online resources that contain additional information related to lake management. Included with this list is the link to the Lake Whatcom "watershed pledge" that was developed by the City of Bellingham. Many of the suggestions in this pledge are relevant to Reed Lake, and could serve as a template for developing a Reed Lake watershed pledge program for local residents. We also include links to several professional organizations that focus on lake management. In particular, we recommend attending the annual meeting of the The Washington Lake Protection Association (WALPA, www.walpa.org). This organization provides a forum for discussing lake management problems with members who are dealing with many of the same issues facing the Reed Lake community.

[3] Fecal coliforms are bacteria found in the intestinal tract of most warm-blooded animals. Their presence in surface water usually indicates a near-by contamination source. Most fecal coliforms are not harmful, but their presence is used to indicate that other pathogens might also be present.

4.2.1 Reducing Shoreline Erosion

The biggest area of concern expressed by the Reed Lake community is the slow infilling of the lake. Although there is no single identifiable source for this sediment, erosion-reduction programs could help minimize deposition into the lake.

Stabilization of shoreline sediments can reduce erosion from wave action and seasonally high water levels. Two of the most common restoration methods include planting native shrubs and installing large boulders known as “riprap.” Native riparian plants have a natural ability to stabilize banks that can be utilized in developed landscapes. Domesticated grasses lack the root depth and strength to withstand aquatic weathering, resulting in undercut banks and slumping lawns that add to sediment loading. Native plants also have the additional advantages of requiring little maintenance, filtering nutrients and contaminants, and improving fish habitat through increased shade and habitat complexity.

In April 2011, the Glenhaven Lakes Committee held a native plant workshop in cooperation with the Native Plant Society of Washington designed to encourage and enable local residents to use local plants in their shoreline landscapes. Continuation and expansion of this program in the future could be an effective educational tool for restoring riparian zones on private property.

Riprap installation generally requires more financial investment, professional consultation, and labor than planting native plants, but riprap can also aid in the reduction of erosion. Professional consultation is highly recommended to ensure riprap longevity and effectiveness. Additionally, because riprap involves the movement of large boulders, the lake must be accessible to large machinery. Both of these considerations mean that the total cost can quickly add up. Rocky riparian buffers also carry the additional disadvantage of stimulating increased erosion in nearby shorelines. “Living” shorelines tend to dissipate erosive energy of water while rock can merely displace it, especially if incorrectly installed.

4.2.2 Construction Best Management Practices

Construction companies are required to take mitigating steps to avoid storm water contamination. Private projects, however, are not subject to the same level of oversight, and the impact to water quality can be significant. Exposed sediments can easily be carried into the lake during storm events. Following “construction best management practices" could help reduce the impacts of small projects in the watershed. Maintaining as much existing vegetation as possible, especially around waterways, can minimize runoff from construction sites during storm events. Avoid construction projects on steep grades with loose soils. Cover piles of topsoil with plastic and use at earthen berms limit runoff. Mulch all disturbed areas plant a cover crop as soon as possible. Finally, discuss storm water and lake protection with any hired contractors to guarantee that best management practices are implemented at the work site.

4.2.3 Preventing Contaminant Runoff

Nutrients and other contaminants usually enter lakes from surface runoff. A significant amount of contaminant loading can be avoided by reducing the amount of nutrients or contaminants on the site and minimizing the runoff leaving the site. Relocate compost bins farther from the shoreline. Wash vehicles and boats at licensed car washes or on pervious surfaces at a distance from the lake. Clean up pet wastes quickly. Animal wastes contain potentially harmful bacteria and high concentrations of nutrients, so pet wastes should be placed in the trash, not your compost bin.

Reducing or eliminating the use of fertilizers, especially within 75 ft. of surface waters, can help cut down on nutrient loading into the lake. By having your soil tested, home gardeners can determine the amount of fertilizer required for their soils. This saves money and reduces the likelihood that excess fertilizer will runoff into the lake. In addition, native plants require less fertilizer, so they are an excellent choice for lake shore vegetation.

Elimination or reduction of pesticide use also protects water quality by reducing the probability that aquatic biota will be harmed by pesticide drift or runoff. The Washington State University Cooperative Extension Services in Whatcom and Skagit Counties can provide further resources about alternative pest control methods. If pesticides must be applied, use the least toxic and most easily degraded products. Buying only the amount needed and appropriately disposing of excess pesticides can also reduce release into local water systems.

4.2.4 Waterfowl Management

Aquatic birds such as geese and ducks provide aesthetic pleasure for many people, but can cause problems if they take up residence around a lake. Concerns include contamination by feces that may contain harmful bacteria and nutrients, and damage to landscape. Although it is difficult (and usually undesirable) to eliminate all local waterfowl, several steps can be taken to discourage waterfowl from becoming a problem.

First, do not feed the birds! Providing an easy food source encourages birds to return for more food and desensitizes them to the presence of humans. This makes the waterfowl more likely to populate local parks and contaminate areas where people commonly recreate. Second, reduce short grasses near the shoreline. Waterfowl prefer areas where predators are easily visible, and many are grazers that prefer short green grass for food. Lawns extending into the water provide the ideal habitat for these birds. Low-growing native bushes can discourage waterfowl from flocking in shoreline areas and also reduce erosion into the lake. Physical barriers can also prevent waterfowl from flocking on land. Many waterfowl prefer to land on the water, then walk to the nearest shoreline. Installing a fence or hedgerow can block waterfowl movement. Finally, dogs, reflective material, small pyrotechnics, and other loud noises can all be effective if used regularly, but these techniques may be prohibited, and are likely to be annoying to other lake shore residents.

Please note that nesting waterfowl are protected by federal law. If a nest is discovered in an undesirable location, federal regulations allow certain types of management options, but this needs to be coordinated with the Fish & Wildlife Service.

5 Online Resources

5.1 Lake Associations and Related Information

- Washington Lake Protection Association
  www.walpa.org
- North American Lake Management Society
  www.nalms.org
- How to Form a Lake Association
  www.ecy.wa.gov/programs/wq/plants/lakes/LakeAssociation.html

5.2 Lake Management Documents

- The Washington Lake Book
  www.ecy.wa.gov/programs/wq/plants/lakes/BookContents.html
- Best Management Practices for Lakes
  www.ecy.wa.gov/programs/wq/plants/algae/lakes/BestManagementPractices.html
- About Lake Management
  www.nalms.org/home/lake-management/about-lake-management
- Waterline
  www.walpa.org/waterline
- Lake Whatcom watershed pledge
  www.cob.org/services/environment/education
- Lake-Friendly Gardening
  lakewhatcom.wsu.edu/gardenkit
- Shoreline Management
  www.ecy.wa.gov/programs/wq/plants/lakes/ShorelineMgt.html
- Construction best management practices
  www.ecy.wa.gov/programs/wq/plants/algae/lakes/BestManagementPractices.html

A Reed Lake Public Comments

The following is a reformatted copy of the December 2010 summary document, "The Reeder's Digest" listing major concerns, goals, and action items from lake shore residents.

The Reeders Digest
Summary Document

Core Concerns: Identified by committee members for WWU intern Maggie Taylor.

1. Loss of lake depth.
2. Lake turbidity.
3. Water quality (pollutants, dissolved oxygen content, fecal coli, storm water runoff).
4. Maintaining a healthy wildlife and fish habitat.
5. Control of invasive lake weeds and pests (Geese).

Primary Lake Uses: Fishing and boating. The current overgrowth of weeds has negatively impacted the use of boats and canoes. In the past, members could enjoy swimming and playing in the lake; however, Reed has deteriorated to the point that is no longer desirable or feasible for most people. Muddy, dark water – feet sink into the mucky bottom as people enter the lake.

Historical Documents:

1. November 12, 1993, Baseline Survey of Cain Lake, Whatcom County, Washington by Letitia Wheeler.
2. January 10, 1994, Graduate Student Report, Impacts on the Water Quality from Development in Cain & Reed Lake Watersheds.
3. March-April 1994, Cain & Reed Lake Watersheds Newsletter.
4. September 1994, Cain & Reed Lake Watersheds Newsletter.
5. November 14, 1994, Cain & Reed Lakes Watershed Association proposal to Whatcom County Health Dept.
6. January 1995, Cain & Reed Lake Watersheds Newsletter.
7. February 23, 1995, Cain Lake Monitoring Project.

8. Soil Survey of Whatcom County Area, Washington (undated).

9. December 14, 2006, “Cains View Timber Sale” letter from DNR.

Past Efforts: Include but are not limited to:

1. Volunteer cutting and removal of aquatic weeds.

2. Implantation of 50 Grass Carps in 2008.

   (a) Impact on weed growth has been negligible.

   (b) Grass Carp have not been sighted in lake since spring.

Goals:

1. Prevent further loss of lake depth.

2. Find cost effective methods for eliminating bottom slit and restoring depth to previous levels.

3. Achieve optimal water clarity while maintaining a vibrant fish and wildlife habitat.

4. Control of aquatic weeds.

5. Community education of homeowner impacts on lake. Garner community support and solicit volunteer help.

6. Find possible funding sources for remediation actions.

7. Restore recreational swimming environment.

8. Identify and develop positive relationships with the various regulatory agencies that we are required to work with.

9. Identify possible liability issues. (Example: the discovery of a species like salmon that could possibly cost GLC extra money to comply with more stringent regulations.)

Action Items: Based on the committees core concerns and goals.

1. Determine current water constituents and chemistry.
   - (a) Locate sampling sites.
   - (b) Obtain and record accurate lab analysis.
   - (c) Develop a report on current conditions.
2. Identify all likely sources of contaminates (storm water runoff, lawn fertilizers, pesticides, geese, animals, failing septic systems, up stream pollutants, etc.).
3. Collect and correlate existing historical data to determine extent of lake deterioration (in process).
4. Identify and map the depth of actual lake bottom.
5. Identify and map depth of slit covering the actual lake bottom.
6. Identify all contributors to lake infilling (decaying lake weeds, erosion, sediments in streams etc.).
7. Develop a list of possible solutions to each of the problems that have been identified through our research. (Example: Catch basins for storm runoff.)
8. Based on finding of items 1–7, establish target goals for Reed Lake.
9. Develop a plan of action to achieve target goals, including estimated costs, and a chronology of milestones.
10. Identify and apply for grants and other possible funding sources.
11. Prepare a report with a list of recommendations for the Board of Directors.

B Reed Lake Water Quality Data (2006–2011)

Date	Alk	Cond	DO	pH	Temp	Turb
August 30, 2006	35.9	81.9	8.3	7.9	18.9	0.9
April 19, 2007	15.6	57.5	9.5	6.5	11.5	2.5
August 23, 2007	18.9	55.2	8.2	7.0	19.7	1.1
April 17, 2007	13.7	58.0	11.2	6.8	9.2	2.4
August 13, 2008	16.3	51.1	7.8	7.5	21.3	1.4
May 26, 2009	18.0	60.0	7.8	7.0	19.5	4.2
August 10, 2009	15.5	50.0	5.6	6.8	18.8	2.7
March 22, 2010	16.5	60.0	12.0	7.2	9.5	3.3
June 16, 2010	15.8	53.1	8.7	7.0	15.8	3.1
January 13, 2011	11.7	56.4	12.5	6.7	4.9	4.3
February 10, 2011	11.5	53.1	12.1	6.7	5.7	2.1
March 10, 2011	13.5	58.6	12.6	6.7	5.5	3.4
April 7, 2011	10.5	47.5	11.4	6.9	7.2	2.5
May 12, 2011	12.6	48.9	9.9	6.9	10.2	2.8
June 2, 2011	15.0	52.0	11.1	7.2	14.0	1.6

Date	TN	NO_3	NH_3	TP	SRP	Chl
August 30, 2006	318.1	5.6	31.1	14.0	2.0	NA
April 19, 2007	877.9	609.1	61.3	15.0	7.3	3.3
August 23, 2007	380.4	3.6	17.2	17.4	4.9	2.5
April 17, 2007	1060.1	972.5	16.2	19.5	3.2	3.0
August 13. 2008	397.3	1.2	7.0	17.2	4.3	3.3
May 26, 2009	1029.2	521.3	41.5	37.9	5.4	15.2
August 10, 2009	546.0	19.8	73.3	39.8	7.8	2.8
March 22, 2010	808.0	556.9	29.6	21.4	3.9	NA
June 16, 2010	693.0	374.0	18.8	15.1	4.3	4.0
January 13, 2011	1468.0	1162.0	13.9	18.9	3.3	1.7
February 10, 2011	1174.0	974.0	3.1	13.6	3.2	0.5
March 10, 2011	1078.0	876.0	4.8	21.5	2.9	5.9
April 7, 2011	1052.0	869.0	10.0	18.9	3.3	0.8
May 12, 2011	726.0	556.0	0.2	17.4	3.1	1.6
June 2, 2011	649.0	419.0	2.6	17.4	6.6	6.0

Alkalinity (Alk, mg/L)
Conductivity (Cond, μS)
Dissolved oxygen (DO, mg/L)
pH (pH units)
Total nitrogen (TN, μg-N/L)
Nitrate/nitrite (NO_3, μg-N/L)
Ammonium (NH_3, μg-N/L)
Total phosphorus (TP, μg-P/L)
Soluble phosphate (SRP, μg-P/L)
Chlorophyll (Chl, μg/L)