I. Lake Information

Schroon Lake is a 4,126-acre lake situated in the eastern region of New York State's Adirondack Park. The lake has two distinct basins and is bounded by two counties (Essex and Warren) and three townships (Chester, Horicon, and Schroon). It is part of the Hudson River drainage system and possesses a mean depth of roughly 56 feet and a maximum depth of 152 feet.

The watershed area of Schroon Lake is about 202,575 acres (Schroon Lake Watershed Management Plan, 2010) and it ranges in elevation from 807 feet at the lake surface to 4,857 feet at the summit of Dix Mountain located roughly 15 miles north of the lake. The lake receives direct hydrologic influence from at least 12 major and minor inlets. The flushing rate of Schroon Lake has been estimated at 2.5 times per year by the New York State Department of Environmental Conservation **(NYSDEC),** and at 1.75 times per year by Market Decisions, Inc. of South Portland, Maine.

The most significant tributaries to the lake are the Schroon River, Alder Brook, Spectacle Brook, Sucker Brook, Mill Brook, Thurman Pond Outlet, Horseshoe Pond Outlet, and Rogers Brook. Schroon Lake has one outlet, the Schroon River, which is located at the southern end of the lake. The lake level is controlled via bottom-release gates at Starbuckville Dam.

Schroon Lake has a 24.8-mile long shoreline, and is surrounded, for the most part, by paved or gravel roads which, in some areas (e.g., East Shore Road), are located within a few feet from the water's edge. In addition, sections of Route 9 and the Northway (I-87) run parallel to the lake's western shoreline for roughly 8 miles.

The lake is utilized primarily for recreational purposes such as boating, swimming, fishing, and ice-skating, and has a surface water classification of AAT. This classification qualifies water from Schroon Lake to be used as a source of water for drinking, and culinary or food processing purposes, as well as for recreational purposes. A public bathing beach is located in Schroon Lake on the western shore of the lake. A number of non-profit organizations operate private retreats on the lake, the largest of these being the various summer camps administered by Word of Life Ministries.

In addition to mooring docks and launch sites owned by riparian landowners, the lake is accessed by a number of larger private and public boat launch sites. The **NYSDEC** operates two launch sites. One is situated at the Eagle Point State Campsite and the other at the southern tip of the lake in the township of Horicon. The Town of Schroon maintains a smaller public launch site at the end of Dock Street, in the center of the Village of Schroon Lake. One private marina, the Schroon Lake Marina, is situated at the northern end of the lake.

II. Study Background

Adirondack Ecologists, LLC (***AE***) first became involved in the management of Schroon Lake in June of 1994 after being contacted by John Kelly, the Supervisor of the Town of Schroon. A growing interest on the part of local and seasonal residents and sportsmen in determining the current limnological condition of the lake inspired town officials to commission a study. At the request of Mr. Kelly, ***AE*** submitted a research proposal for the completion of a three-year limited limnological investigation of Schroon Lake. Based upon information obtained from a review of bathymetric maps and existing historical data, a study regimen was designed and incorporated into the proposal.

The primary objective of the limnological investigation was to determine the current quality of Schroon Lake water and to also assess the quality of incoming water from the lake's larger tributaries. To accomplish this objective in a cost-effective manner, ***AE*** recommended that both of the lake's basins and four of the lake's tributaries (Schroon River, Rogers Brook, Spectacle Brook, and Mill Brook) be tested three times per year. Starting in 1996, four additional tributaries (Sucker Brook, Thurman Pond Brook, Horseshoe Pond Brook, and Alder Brook) and the outlet were added as sampling sites.

A secondary objective of the study was to assist in the creation of a scientific database that could be used as a historical "benchmark" to compare the results of future water quality monitoring efforts with. It was hoped that this database, once established, would serve as an educational and informational resource for lakeshore property owners, local government officials, sportsmen, state regulatory officials, municipal and private planners, and local high school students, and as such, would be viewed as a community asset.

The initial 3-year research regimen called for both tributary and lake water testing during the spring, summer, and fall of each year. Water quality parameters analyzed consisted of ortho and total phosphorus, total nitrogen, nitrate, chloride, sulfate, pH, alkalinity, conductivity, total dissolved solids, and turbidity. Surface water chlorophyll a and calcium levels were also measured each summer. A dissolved oxygen and temperature profile was performed at both of the lake basin testing stations during each sampling trip, and secchi disk transparency readings were also obtained.

The Towns of Chester, Horicon, and Schroon and the Schroon Lake Association (**SLA**), a group of riparian property owners and individuals interested in the protection of Schroon Lake, contributed funding for the water quality testing. A newly formed Schroon Lake Study Committee made up of representatives from town government, the **SLA**, and various sportsmen's organizations, provided oversight for the research effort.

The principal investigator for the study was Steve LaMere, a Certified Lake Manager and Board Certified Environmental Scientist, and also the president of ***AE***. The ground breaking research performed by the firm during this 3-year research effort provided a tremendous amount of insight into the ecology and health of Schroon Lake. It also identified a few areas of concern with regard to water quality on the lake and these discoveries lead to several short- and long-term management recommendations.

One of the recommendations was to continue monitoring the water quality of the lake each summer on an annual basis. Based on this recommendation an annual monitoring program was initiated in August of 1998 and since then it has continued every year during the month of August or September without interruption. The **SLA** has been the sole funding entity of this monitoring effort since 2000 and without the existence of this continuous and comprehensive database it would have been very difficult, if not impossible, to secure the state grant that was awarded to fund the preparation of the Schroon Lake Watershed Management Plan.

III. Methods

Water samples have been collected from Schroon Lake every year by ***AE*** since 1995. Each summer, epilimnetic ("surface") and hypolimnetic ("bottom") lake water samples are collected once each summer from both the north and south basins, and every third year samples are collected once from the mouth of each of the significant tributaries to the lake (i.e., Schroon River, Alder Brook, Spectacle Brook, Sucker Brook, Mill Brook, Thurman Pond Outlet, Horseshoe Pond Outlet, and Rogers Brook) and from the outlet.

In order to ensure the collection of accurate "base flow" data, ***AE*** has tried to avoid taking water samples within 48 hours of a major storm event, with the exception of samples collected on February 26, March 8 and March 17, 1998, which were part of a specially-designed testing regimen to determine the "first flush" water quality conditions (conductivity and chloride levels only) of the various tributaries during a storm event.

All epilimnetic and hypolimnetic samples were collected from Schroon Lake by boat using a Van Dohrn Sampler. These samples were obtained at locations representative of the lake's two basins (see map in *Appendix C*). The Van Dohrn was utilized to collect a epilimnetic sample of water 1.5 meters below the lake's surface and a hypolimnetic sample 1.5 meters above the lake bottom. Outlet water samples were collected underneath the bridge on Glendale Road.

The tributary samples were taken via "grab" sampling at various locations around the lake. Rogers Brook, which receives influence from Big Pond, North Pond, and Bullet Pond, and Mill Brook, fed by outflow from Whortleberry Pond, Pharoah Lake, and the Desolate Swamp, were both sampled just before they enter the lake. Thurman Pond Brook (Outlet) and Horseshoe Pond Brook (Outlet) samples were obtained just east of Route 9 where these brooks each respectively pass underneath the road via culverts. The Schroon River and Alder Brook, which is fed by the outflow from Crane Pond and Goose Pond, were sampled just downstream of their intersection with Alder Meadow Road. Spectacle Pond Brook (Outlet) was sampled just upstream of the culvert that intersects NESA Road, and Sucker Brook, which is spring fed, was sampled just downstream of the culvert that intersects the East Shore Road.

Water samples obtained on August 24, 2017 at the two lake basins were stored on ice and transported to the laboratory at the Darrin Fresh Water Institute (**DFWI**) in Bolton Landing, New York within six hours of collection. The following parameters were analyzed during each routine sampling trip: soluble reactive phosphorus, total phosphorus, chloride, total nitrogen, nitrate, sulfate, conductivity, pH, alkalinity, calcium, and turbidity. In addition, the epilimnetic sample obtained from each basin was analyzed for chlorophyll a and the hypolimnetic samples were analyzed for iron and sulfate.

A secchi disk was employed to obtain secchi disk transparency (SDT) measurements at both of the lake basin testing sites. A secchi disk is a heavy plastic disk quartered in alternate black and white that is used to measure the transparency or clarity of lake water. Because of 23 years of continual, professionally-designed and managed water sampling and analyses, we have a running track record of the quality and clarity of Schroon Lake. This program, along with the biological testing performed by ***AE***, represents one of the most comprehensive lake databases in the Adirondack Park.

III. Results

The following narrative consists of a summarized interpretation of the data collected on Schroon Lake by ***AE*** from 1995 to 2017. *Appendix B* consists of six graphs (figures). The first three graphs (*Figures 1-3*) plot lake basin data obtained in August or September on three important trophic parameters (i.e., secchi disk transparency, total phosphorus and chlorophyll a). *Figure 4* is a pictorial illustration of the conductivity data obtained on the lake's various tributaries since 1995. *Figure 5* and *Figure 6* track epilimnetic basin calcium and chloride levels, respectively, over the past 23 years.

For information detailing the **DFWI's** laboratory procedures, please refer to *Appendix A*, which also contains a printout of the results of the water quality testing for 2017.

Dissolved Oxygen

An analysis of dissolved oxygen (DO) provides a measurement of the amount of gaseous oxygen (O_2) dissolved in the lake water. Oxygen is introduced into the water column by diffusion from the surrounding air, as a byproduct of photosynthesis, and from aeration caused by turbulence (e.g., wave and wind action). In addition, the various tributaries contribute dissolved oxygen to the lake.

Oxygen is necessary to all forms of life, and aquatic organisms generally need at least 5.0 parts per million (ppm) of DO to thrive. Bacteria living in the bottom sediments of the lake decompose detritus and other material accumulating there, and the decomposition process consumes DO. During periods of extended and extensive thermal stratification, DO levels in the hypolimnion - particularly in those areas of the hypolimnion closest to the lake bottom – can become so depleted that the survival of fish is threatened.

The results of nineteen years (1995-2012 and 2017) of DO and temperature profiles performed at both the north and south basin lake testing sites clearly indicate that sufficient levels of DO for fish and other aquafauna can be found throughout the entire water column of Schroon Lake during the summer. This is excellent news for the fishery of Schroon Lake and, in part, explains why a quality coldwater fishery exists in the lake.

In addition, a review of the DO profiles obtained since 1995 indicates a tremendous amount of similarity between the two basins, with respect to both dissolved oxygen concentrations and thermal stratification. The depth of the thermocline (typically 5 to 6 meters by mid-August) and the width of this zone were remarkably similar from year to year between the two basins. Like many deeper Adirondack lakes, thermal stratification of Schroon Lake normally begins sometime in June and persists until fall overturn occurs in November.

Secchi Disk Transparency & Turbidity

Turbidity is a measurement of the amount of suspended materials such as clay, silt, algae and other constituents in water. These particles can cause light to be scattered and absorbed, not transmitted in straight lines through water, and thus they can affect the transparency of water. Water clarity or transparency is generally measured using a secchi disk.

Secchi disk transparency readings observed in the south basin were consistently higher than those observed in the north during the month of August. North basin SDT readings averaged 15.6 feet from 1995 to 2017, while south basin readings averaged 17.4 feet during the same time period.

This phenomenon is likely a result of two factors. First, the prevailing wind on Schroon Lake normally blows from south to north. This means that the majority of the fetch or wind turbulence occurs on the northern shore of the lake. Second, the inflow of water from several tributaries (including the Schroon River) into the northern end of the lake continually introduces suspended particulate material into the water column of the north basin. This material decreases water clarity by partially filtering out sunlight penetration into the water column. The resulting effect is a decrease in water clarity.

A third possible reason for increased water clarity in the south basin is that there is less development in the south as compared to the north basin. The higher the amount of available nutrients - nutrients that potentially could be introduced into the water column by construction-related activities - the higher the potential for increased algal abundance. Increased algal abundance normally results in decreased water clarity.

Figures 2 and *3* in the appendix plot the SDT data versus chlorophyll a levels on the lake since 1995. A review of the data and the corresponding trend lines suggest that the SDT levels of both the south and north basins have decreased slightly over this time period.

Historical turbidity readings obtained at basin locations were found to be within expected ranges during the same time period, and this suggests that high amounts of dissolved solids are not the primary cause of the decrease in water clarity.

Ortho & Total Phosphorus

Total phosphorus (TP) measurements include organically bound phosphates, condensed phosphates, and orthophosphates, and each water sample collected was analyzed for TP. The term phosphate is sometimes used interchangeably (and erroneously) with the term phosphorus. Phosphates are chemical compounds that contain the element phosphorus.

Since phosphorus is the most limiting nutrient in New York State lakes, it usually serves as the focus of most nutrient abatement strategies. Phosphorus is measured in parts per billion (ppb) or micrograms per liter (ug/L) and TP levels greater than 20 ppb are often found in bodies of water with significant algal growth. Conversely, oligotrophic lakes normally have TP levels less than 10 ppb.

Ortho phosphorus (OP) was also measured in the samples collected. Common cultural sources of OP may include fertilizer runoff, human waste from failing septic systems, effluent from sewage treatment plants that do not employ tertiary treatment, and detergent wastewater. Some natural sources include leachate from phosphorus-rich bedrock and decomposing organic matter. Soluble reactive phosphorus (SRP) is a measure of orthophosphate, the filterable (soluble, inorganic) fraction of phosphorus, which is the form directly taken up by plant cells.

Lake water total phosphorus concentrations suggest that Schroon Lake is an oligotrophic lake. Average summer time TP readings for north and south basin epilimnetic water samples collected during the 22year period from 1995 to 2016 were 7.0 and 5.3 ppb, respectively. In August 2017, however, a noticeable "spike" in the north basin TP level was observed in the dataset with a reading of 27 ppb being found at the surface of the water column. This high reading was also confirmed in the CSLAP data taken on the same date. A similar increase was not observed in the south basin water sample obtained by ***AE***, and the cause for the elevation in the north basin phosphorus level is unknown.

The north basin epilimnetic TP levels are almost always higher than the south basin epilimnetic levels, but never to the extent seen this past sampling season. A review of *Figure 1,* suggests that despite a spike in north basin TP levels in 2017, the phosphorus levels of Schroon Lake have changed relatively little over the past 23 years. In addition, historical Schroon Lake basin and tributary water OP and SRP concentrations have been relatively low suggesting that available phosphorus is rapidly captured by algae.

Nitrate & Total Nitrogen

Total nitrogen (TN) is a measure of all nitrogen present, including that bound in cellular materials. Nitrogen is an essential plant nutrient required by all living plants and animals for building protein, and as such, it influences the productivity of aquatic systems. Measured in ppm or milligrams per liter (mg/L), TN concentrations are usually less than 1 mg/L in most of our relatively pristine Adirondack lakes, with concentrations in the neighborhood of 0.1 to 0.6 mg/L being commonly found.

Readily available plant nutrients are mainly nitrite (NO_2), nitrate (NO_3) and ammonia (NH_4), with nitrate normally playing the most significant role. Nitrate occurs naturally, but it can also be found in agricultural fertilizers, livestock manure, and in sewage and industrial wastes. Nitrates in excessive amounts can result in negative human health effects like methemoglobinemia ("blue baby syndrome") in infants less than six months of age, and they can contribute significantly to the eutrophication of a body of water.

Adirondacks, nitrate levels are usually below 0.3 mg/L.

Total nitrogen (TN) and nitrate (NO_3^-) levels were within normal limits for all of the lake and tributary water samples analyzed over the twenty-three year period. The TN and NO_3^- lake water levels normally ranged from between 0.1 to 0.6 mg/L and from between lt0.01 and 0.2 mg/L, respectively, and no significant trends were observed.

pH & Alkalinity

A measure of the number of hydrogen ions in solution, pH is measured on a scale ranging from 1 to 14, with a "1" being extremely acidic in nature and "14" being extremely alkaline or "basic" in nature. Most lakes are circum-neutral (i.e., a pH range of "6" to "9"); an acceptable range for most aquatic organisms. (Note: Pure rainwater has a pH of around "5.6", while acidic precipitation can have a pH as low as "4").

The epilimnetic water of Schroon Lake enjoys a circum-neutral pH. The August/ September epilimnetic pH for both the north and south basin averaged 7.2 over the course of the twenty-three year study. The pH of the various tributaries flowing into the lake ranged between 7.0 and 7.6 on August 25, 2016, the last year they were tested.

Alkalinity measures the capacity of a lake to "buffer" or neutralize acidic inputs. Alkalinity usually refers to the quantity and kinds of compounds present in an aqueous solution that tend to shift the pH towards basic. These compounds usually consist of carbonates, bicarbonates and hydroxides. Usually hard water lakes exhibit higher alkalinities than do soft water lakes.

The alkalinity of Schroon Lake water and many of its tributaries is relatively low, as is the case with many Adirondack waters. This means that the buffering capacity of these waters to resist sudden shifts in pH is relatively low. From 1995 to 2017, the north and south basin, alkalinity readings averaged 13.2 and 13.0 mg/L $CaCO_3$ (calcium carbonate), respectively. Waters that possess alkalinities less than 10 mg/L are considered poorly buffered, so these values put Schroon Lake just above that theoretical threshold.

Conductivity & Chloride

Electrolytic conductivity is the ability of a solution to pass an electric current. Current is carried by inorganic solids, such as nitrate, sulphate, chloride, and phosphate ions, in water, as well as cations such as sodium, magnesium, calcium, iron, and aluminum. High specific conductance levels can sometimes be indicative of pollution from sources like septic or salt leachate. This is because chlorides (Cl^-), which are present in road de-icing agents (e.g., calcium chloride, sodium chloride, and magnesium chloride) and human waste (Note: On average, one liter of waste contains 5 grams of Cl^-), are electrolytic in nature.

Specific conductance is measured in micro Siemens per centimeter (uS/cm). Soft water lakes have relatively few dissolved ions, generally resulting in conductivity readings less than 100 uS/cm. Hard water lakes often have conductivity levels higher than 300 uS/cm. Comparatively speaking, Schroon Lake basin conductivity levels fall within normal limits for the majority of our soft water Adirondack lakes, with basin samples always registering less than 100 uS/cm.

With the exception of those tributaries that enter the lake along its western shoreline (i.e., Thurman Pond Brook, Horseshoe Pond Outlet, and Rogers Brook), the various streams flowing into Schroon Lake have normally exhibited relatively low levels of conductivity and chloride. It is theorized that the elevated readings observed in the waters along the western shoreline are due to a long-term build-up of chlorides in the soil as a result of the application of de-icing agents by highway crews on the Northway and other nearby roads.

Figure 4 presents tributary conductivity data collected from 1995-2000, 2002-2004, 2007, 2010, 2013 and 2016. Tributary samples were collected during the spring, summer and fall during the time period of 1995 to 1999. Starting in 2000, tributaries were only sampled during the summer, and in 2004 this sampling was changed to once every 3 years.

The graph clearly shows that during those years when spring, summer and fall sampling occurred, conductivity levels were generally higher during the summer on most of the tributaries tested than during any other time of the year. This is likely due to the fact that there is usually less volume of water (less flow) in the summer than there is in the spring or fall, and because of this, electrolytes tend to be more “concentrated” in the water.

In addition, a “first flush” sample collection was performed during a late winter storm event in 1998, and the resulting data is also included in *Figure 4*. The “first flush” testing was conducted in order to ascertain the dynamics of conductivity level fluctuations associated with a surge or “pulse” of melt water during a warm, rainy spell in March. Water samples were collected before (February 26), during (March 8) and after (March 17) the storm event, and these samples were analyzed for conductivity and chloride.

A noticeable "spike" in conductivity levels occurred in water samples collected from both Horseshoe Pond and Thurman Pond outlets during the peak flow of the storm event. These two tributaries have consistently possessed the highest conductivity readings observed since testing began in 1995, and it is hypothesized that the causative agent for these elevated levels is runoff from road salt-saturated soils adjacent to I-87 and Route 9.

Figure 5 plots chloride data obtained from an analysis of lake water samples collected for the past twenty-three years. This graph clearly indicates that lake wide chloride levels have remained relatively stable since 1995. The north and south basins have averaged 10.3 and 9.5 mg/L, respectively, during the timeframe between 1995 and 2017. Thus, it appears that even though some of the tributaries on the western shore have elevated levels of chloride that these inputs have not yet significantly affected the chloride levels of the lake itself, and that these levels still remain within normal limits.

Calcium

Calcium is a metal found naturally in lake systems. It is an important parameter to monitor since zebra mussels (*Dreissena polymorpha*), an invasive species of bi-valve mollusk discovered in North America in 1988, normally require between 10 and 12 mg/L of calcium in order to form their calcareous shell. Zebra mussels, if accidentally introduced into a body of water, can cause profound damage to the aquatic ecosystem by filtering massive amounts of phytoplankton out of the water column and consequently disrupting the food web from the "bottom up".

Schroon Lake surface water calcium concentrations normally range between 4 and 7 mg/L, with the north basin averaging about 5.7 mg/L and the south basin averaging roughly 5.4 mg/L over the 23-year study period. In addition, a review of *Figure 6* clearly indicates that lake wide calcium levels have changed very little over the past twenty-three years. These levels will continue to be monitored and documented.

The relatively low concentrations in the lake water suggest that Schroon Lake is at low risk for *large-scale* zebra mussel colonization. However, the discovery of zebra mussels in Lake George - a nearby water body with calcium levels comparable to Schroon Lake – should certainly act as a potential warning for all area lakes.

In addition, zebra mussels in the relatively short period of time that they have been in North America have exhibited the ability to adapt much quicker than originally expected to the environmental conditions of our region. It is now widely believed by scientists that the environmental tolerances of zebra mussels are much broader than anticipated, and that this exotic species has the ability to take advantage of certain areas within a water body (e.g., mouth of a stream possessing high calcium levels) to thrive. These areas are often referred to as "microrefugia".

A review of historical tributary data does indeed indicate that several inlets on the western side of the lake routinely possess calcium levels theoretically high enough to support zebra mussels, though this is unlikely to occur. The assumption, however, cannot necessarily be made based on the relatively low calcium concentrations observed in the basins, that Schroon Lake is protected from zebra mussel colonization.

Chlorophyll a

Schroon Lake surface water samples collected during the two decades of monitoring were analyzed for chlorophyll a, a plant pigment that scientists often measure to indirectly assess algal biomass. A review of the data collected during this time period indicates that there appears to be a long-term trend of increasing chlorophyll a levels in the epilimnion of both lake basins during August/September (see *Figures 2* and *3* in *Appendix B*). While the increase over time appears to only be slight, this parameter should continue to be monitored in order to ascertain the nature of this change.

Despite this observation, the amount of chlorophyll a present in the surface waters of Schroon Lake is certainly still at normal levels for a lake possessing its morphological and chemical characteristics. North and south basin chlorophyll a levels from 1995 to 2017 averaged 3.75 ug/l and 3.34 ug/l, respectively.

Sulfate

Sulfate levels normally observed in Adirondack lakes not significantly impacted by atmospheric deposition normally range between 1 and 3 mg/l. Historically, the sulfate analyses performed on samples obtained from the lake water and tributary water stations have indicated levels less than 3 mg/l, with most samples ranging in between 0.5 and 2 mg/L over the course of the past 23 years. These data support the theory that Schroon Lake does not appear to be suffering from the impact of acid deposition.

IV. Discussion

The total nitrogen (TN) to total phosphorus (TP) ratio (TN:TP) can often be used as an indicator of what type of algae may become dominant in any given body of water. Since blue-green algae or cyanobacteria are capable of nitrogen fixation, these planktonic organisms tend to do well in lakes with low total nitrogen levels. Some research has suggested that TN:TP ratios of less than 30 favor blue-green and diatom production.

AE evaluated the total nitrogen and total phosphorus data collected from Schroon Lake basin samples over the past seven years (2010-2017) and discovered that the TN:TP ratio of the epilimnion exceeded 30 in every case except for the north basin in 2012 and 2014. Based on this information, it would seem likely that the prevalence of cyanobacteria in Schroon Lake is relatively low.

Figure 1 in *Appendix B* plots the past twenty-three years worth of total phosphorus data collected by ***AE*** at the two basins. Based upon a review of this graph, it appears that there has been relatively little change in epilimnetic phosphorus levels in Schroon Lake since 1995, except for a spike observed in August 2017 in the north basin. Generally, phosphorus levels are consistently higher in the north basin, but never to the extent observed this past season. ***AE*** will continue to monitor this situation in future years.

A review of *Figures 2* and *3* seems to indicate a long-term correlation between chlorophyll a levels and secchi disk transparency in the lake. North basin water clarity or transparency (SDT) has changed relatively little over the past twenty-three years with a very slight increase in chlorophyll a levels being evident (*Figure 3*). During the same time period, chlorophyll a and secchi disk transparency levels in the south basin have, for the most part, remained stable (*Figure 2*). Clearly, water clarity in the south basin is consistently higher than in the north basin.

Applying the theory of Carlson's Trophic State Index to a comparison of epilimnetic total phosphorus, chlorophyll a, and SDT levels in both north and south basin water samples collected from 1995 to 2017 suggests that Schroon Lake is either a late oligotrophic or early mesotrophic lake.

V. Conclusions

1. Schroon Lake enjoys excellent water quality and clarity. Data suggest that the lake is a soft water, circum-neutral, late oligotrophic or early mesotrophic lake.

2. The performance of dissolved oxygen profiles from 1995 to 2012 and 2017 indicate that sufficient levels of dissolved oxygen needed to support aquatic life are present throughout the water column of Schroon Lake.

3. Historical secchi disk data from the past 23 years suggests that water clarity in both the north and south basin have remained relatively stable. A slight increase in algal biomass seems to have occurred long term in the north basin. Surface water total phosphorus levels have, however, remained relatively stable, except for a spike observed in the north basin in 2017.

4. Tributary conductivity and chloride data continues to suggest that the long-term use of de- icing agents on the Northway and other roads has saturated wet areas adjacent to these highways with chloride. Fortunately, it appears that this phenomenon has not seemingly altered the lake's chloride levels significantly since monitoring started in 1995. In addition, lake wide calcium levels are still relatively low and have changed very little over the past 23 years.

VI. Recommendations

1. The lake should continue to be monitored by ***AE*** on an annual basis. Lake water samples should be taken once per year and tributary water samples should be collected once every three years in order to maintain and embellish on the already-established water quality database. In addition, the **SLA** should continue to participate in the **CSLAP** testing. More extensive testing than that which is currently provided by ***AE*** and the **CSLAP** is not needed at this time.

2. Buffer strips along the shoreline of the lake, utilizing existing or transplanted native species of plants, bushes, or trees, should be encouraged. If properly designed and maintained, buffer strips can add to the aesthetic and economic value of shorefront property, while providing a means of nutrient interception.

3. Routine sanitary surveys of septic systems situated on shorefront parcels, including commercial operations, should be performed. In addition, shore owners and other property owners within the immediate watershed area of the lake should exercise good judgment in the maintenance of septic systems (i.e., regular pump-outs, repairs to dysfunctional systems, upgrades of inadequate systems, etc.).

4. A guidance document should be prepared for the education of shoreline property owners on the proper practices of shoreline management as it pertains to environmental (lake) stewardship.

APPENDIX

Table 1.

Darrin Fresh Water Institute

A Research Center of Rensselaer Polytechnic Institute

Steve LaMere - Adirondack Ecologists **Schroon Lake** **24-Aug-17**

Analyte	Sample ID: / units:	LM 17-06 North epi	LM 17-07 North hyp	LM 17-08 South epi	LM 17-09 South hyp
pH	S.U.	6.73	6.14	6.90	6.36
Alkalinity	mg/l CaCO3	12.5	10.5	12.5	10.0
SRP	ug P/l	5.4	3.1	1.1	1.2
TP	ug P/l	27.0	8.7	3.9	4.4
TN	mg N /l	0.34	0.34	0.19	0.25
Cl	mg Cl/l	10.2	7.66	9.2	9.2
NO3	mg N/l	lt 0.01	0.16	lt 0.01	0.12
Sulfate	mg S/l	--------	0.823	--------	0.95
Chla	ug/l	3.1	--------	2.0	--------
Calcium	mg Ca /l	6.2	5.1	5.3	5.7
Fe	mg Fe /l	--------	0.33	--------	lt 0.05

lt = less than

Submitted by: Laurie Ahrens
Date: 13-Oct-17

Methods:

Anions: Ion Chromatograph, EPA Method 300
Total Nitrogen (TN): Persulfate Method, Standard Methods, 19th Ed., 4500-N D.
Total Phosphorus (TP): Colorimetric- Persulfate Oxidation, Standard Methods, 19th Ed., 4500-P E.
Soluble Reactive Phosphorus (SRP): Colorimetric, Standard Methods, 19th Ed., 4500-P E.
pH: Electrometric, Standard Methods, 19th Ed, 4500-H
Metals: Atomic Absorption Spectroscopy- Flame, Standard Methods 3111
Chlorophyll a (Chla): Fluorometric, Standard Methods 10200
Alkalinity: Titrimetric, pH 4.5. EPA Method 310.1

Table 2. Schroon Lake Limnological Analysis – August 2017

Lake: Schroon Lake (North Basin) **Town:** Schroon
County: Essex **State:** New York

Date: 8/24/17 **Secchi Disk Transparency:** 17.0 feet **Cloud Cover:** 20%
Time: 7:30 am **Weather:** Warm with slight breeze

Depth (feet)	Temperature (C)	Dissolved Oxygen (mg/l)
1	22.3 (72.1°F	8.4
2	22.6	8.3
4	22.7	8.3
6	22.7	8.3
8	22.7	8.3
10	22.7	8.3
12	22.7	8.2
14	22.8	8.2
16	22.8	8.2
18	22.7	8.1
20	22.2	7.9
22	20.4	7.0
24	17.3	6.5
26	14.0	5.9
28	12.5	6.2
30	11.4	6.5
32	10.4	6.8
34	9.8	6.9
36	9.5	7.0
38	9.1	7.1
40	9.0	7.1
42	8.9	7.0
44	8.8	7.0
46	8.5	7.1
48	7.9	7.3
50	7.6	7.4
52	7.1	7.5
54	6.6	7.8
56	6.5	7.9
58	6.4	7.9
60	6.3	7.9
62	6.1	7.9
64	6.0	7.8
66	5.9	7.8
68	5.8	7.9
70	5.8	7.8
74	5.7	7.8

Table 2. Schroon Lake Limnological Analysis – August 2017 cont'd

78	5.6	7.7
82	5.5	7.5
86	5.4	7.4
90	5.3	7.4
94	5.2	7.4
98	5.2	7.6
102	5.1	7.6
106	5.1	7.4
110	5.1	7.3
114	5.1	7.2
118	5.0	7.1
122	5.0	6.6
126	5.0	6.2
130	5.0	6.2
134	5.0	6.1
138	5.0	6.1
142	5.0 (41°F)	6.0

Table 3. Schroon Lake Limnological Analysis – August 2017

Lake: Schroon Lake (South Basin)
County: Essex
Date: 8/24/17
Time: 9:00 am
Secchi Disk Transparency: 19.0 feet
Weather: Warm with slight breeze
Town: Schroon
State: New York
Cloud Cover: 35%

Depth (feet)	Temperature (C)	Dissolved Oxygen (mg/l)
1	22.3 (72.1°F)	8.3
2	22.4	8.2
4	22.5	8.2
6	22.5	8.2
8	22.5	8.2
10	22.5	8.2
12	22.5	8.2
14	22.4	8.2
16	22.5	8.2
18	22.4	8.1
20	22.3	8.1
22	22.3	8.1
24	20.8	6.8
26	18.3	5.8
28	17.3	5.7
30	15.7	5.7
34	13.5	6.1
38	12.0	7.0
42	11.2	7.1
46	10.6	7.1
50	9.9	7.2
54	9.4	7.3
58	9.0	7.4
62	8.6	7.5
66	8.3	7.7
70	8.1	7.8
74	8.0	8.0
78	7.8	8.0
82	7.7	8.0
86	7.3	8.1
90	7.2	8.2
94	6.9	8.2
98	6.6	8.2
102	6.5	8.1
106	6.3	7.6
110	6.3	7.6
114	6.2	7.6
118	6.1 (43°F)	7.5

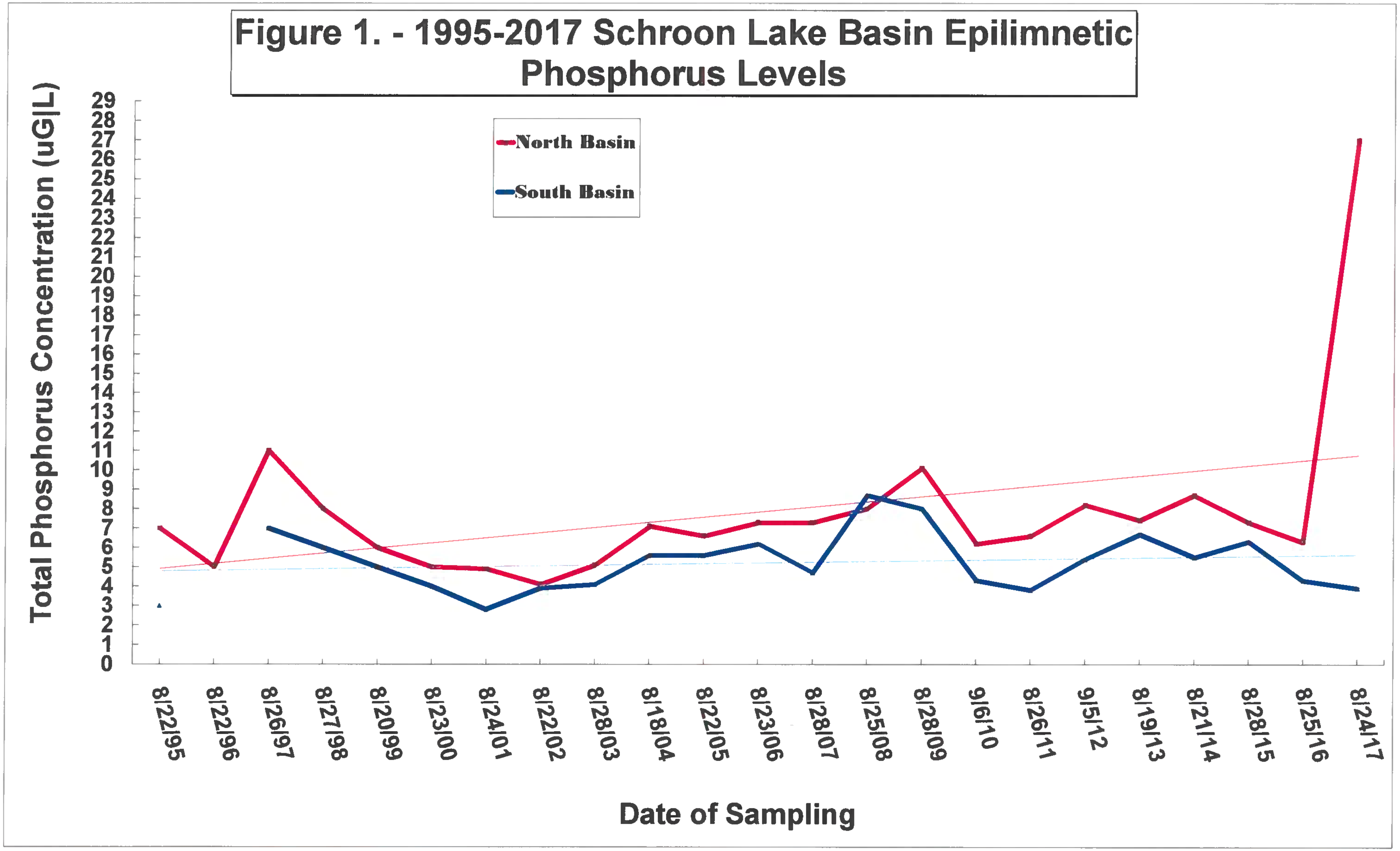
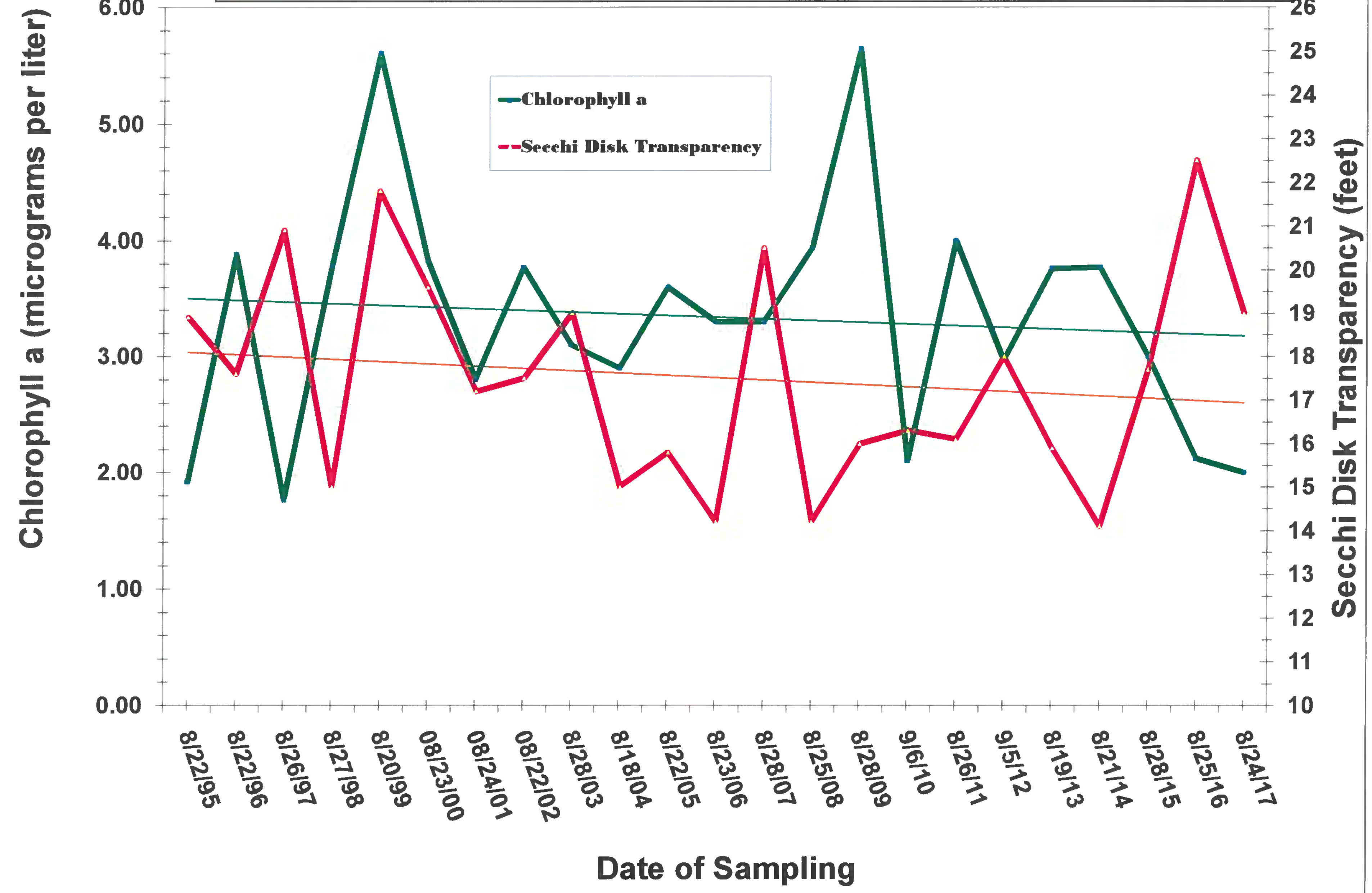


Figure 1. - 1995-2017 Schroon Lake Basin Epilimnetic Phosphorus Levels
North Basin
South Basin
Total Phosphorus Concentration (uG|L)
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
8/22/95
8/22/96
8/26/97
8/27/98
8/20/99
8/23/00
8/24/01
8/22/02
8/28/03
8/18/04
8/22/05
8/23/06
8/28/07
8/25/08
8/28/09
9/6/10
8/26/11
9/5/12
8/19/13
8/21/14
8/28/15
8/25/16
8/24/17
Date of Sampling

Figure 2 - 1995-2017 Schroon Lake South Basin Chlorophyll a vs. Secchi Disk Transparency



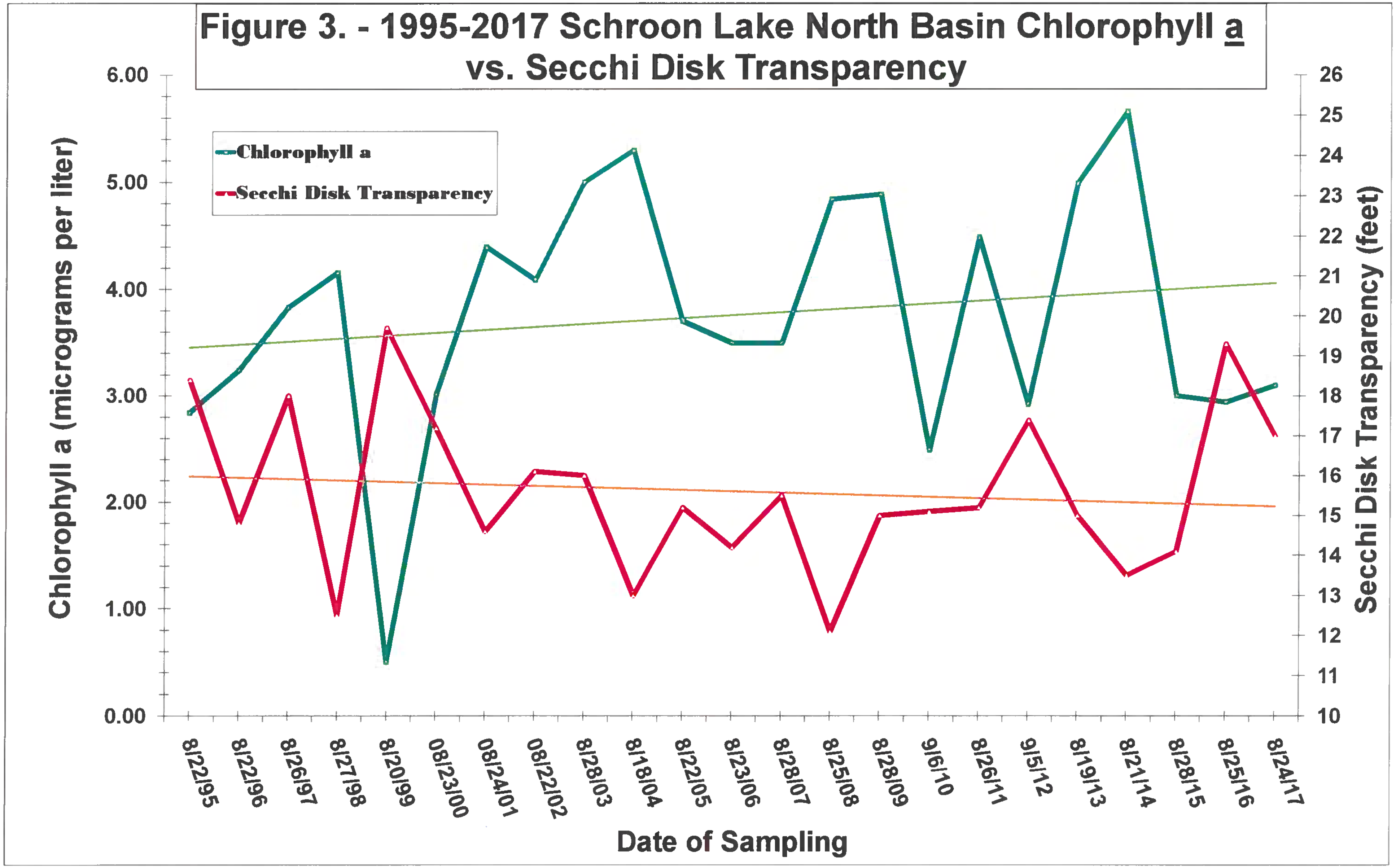


Figure 3. - 1995-2017 Schroon Lake North Basin Chlorophyll a vs. Secchi Disk Transparency
Chlorophyll a
Secchi Disk Transparency
Chlorophyll a (micrograms per liter)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Secchi Disk Transparency (feet)
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
8/22/95
8/22/96
8/26/97
8/27/98
8/20/99
08/23/00
08/24/01
08/22/02
8/28/03
8/18/04
8/22/05
8/23/06
8/28/07
8/25/08
8/28/09
9/6/10
8/26/11
9/5/12
8/19/13
8/21/14
8/28/15
8/25/16
8/24/17
Date of Sampling

Figure 4. - 1995-2016 Schroon Lake Tributaries - Conductivity Levels

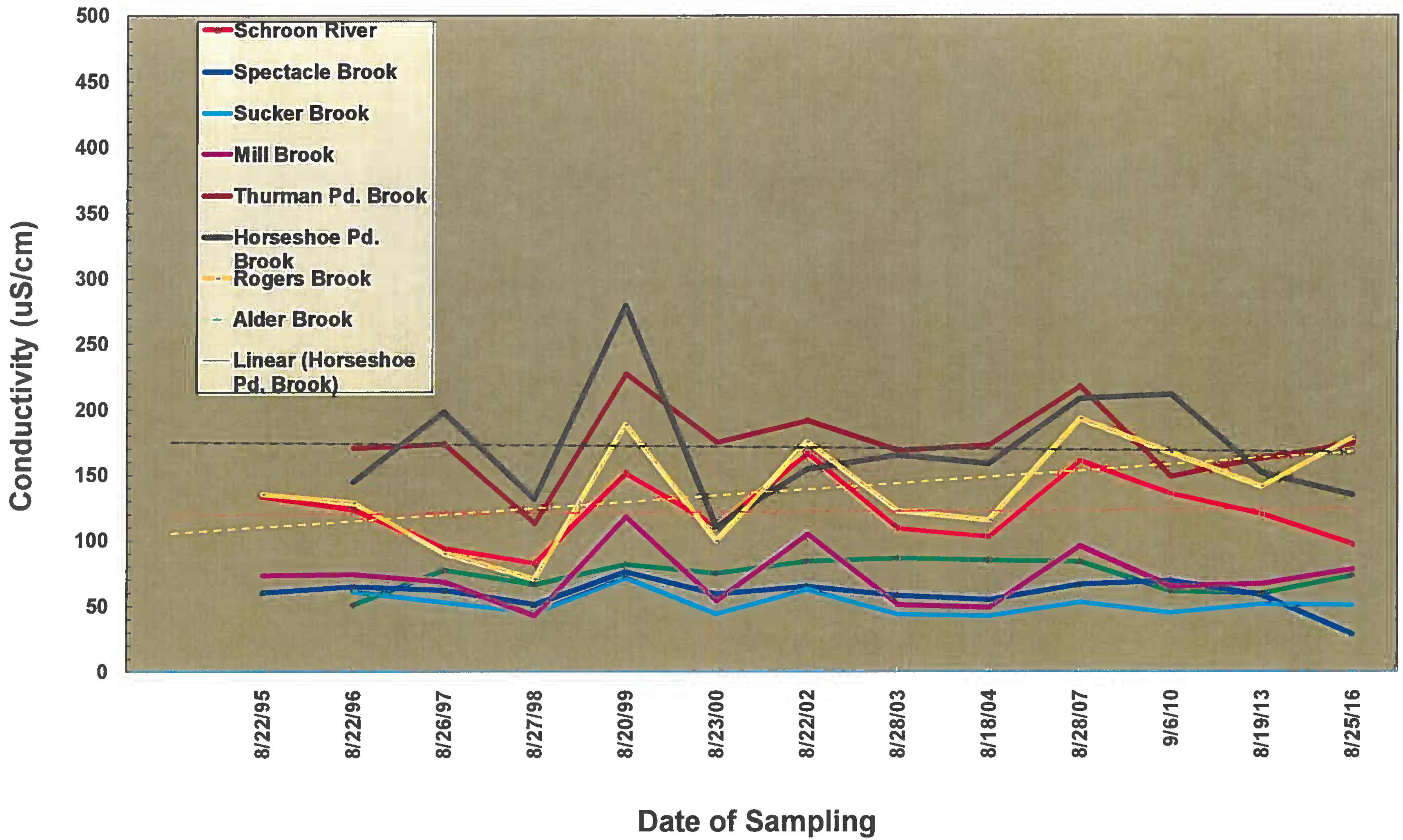
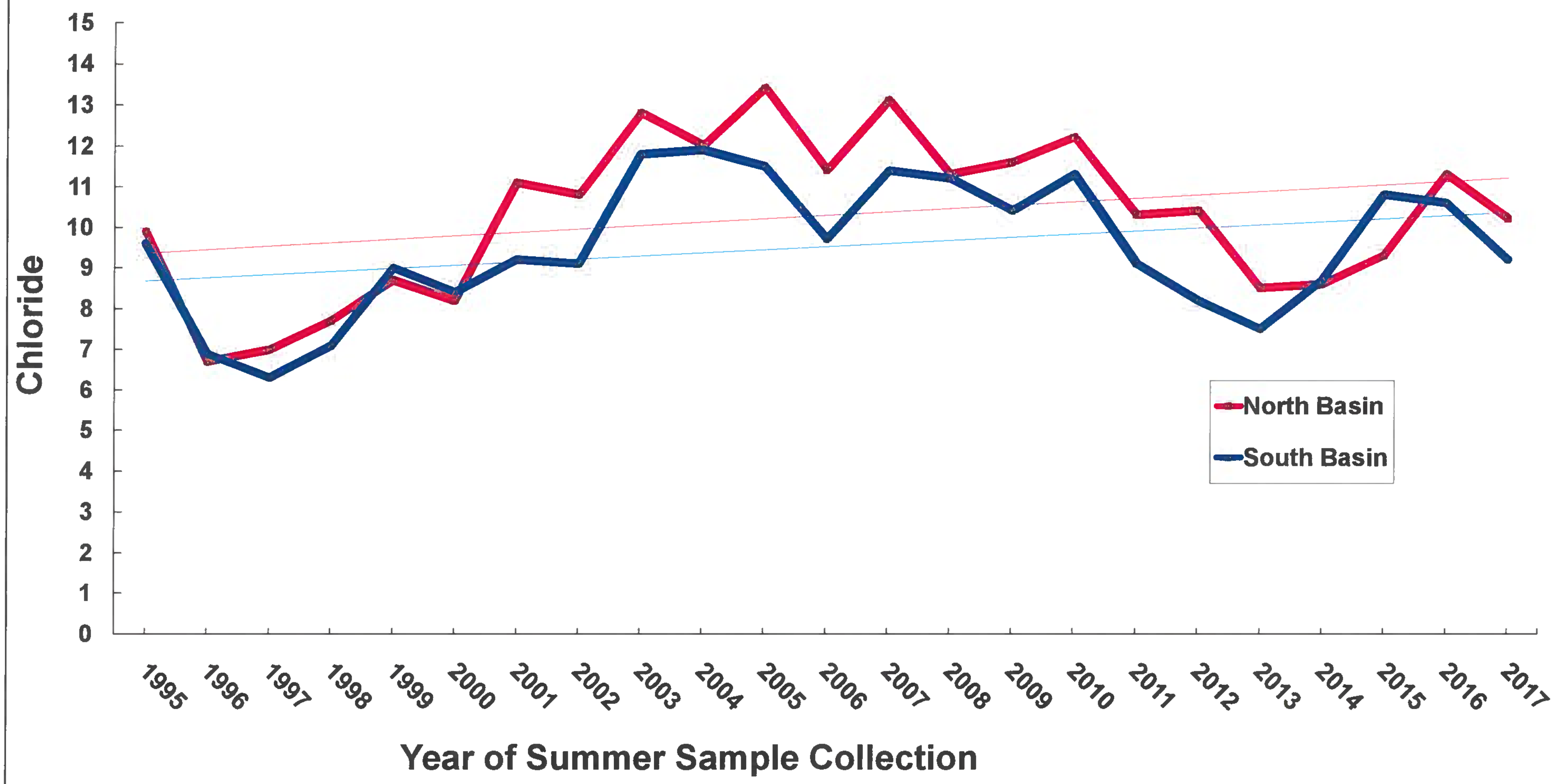


Figure 5. 1995-2017 Schroon Lake Basin Epilimnetic Chloride



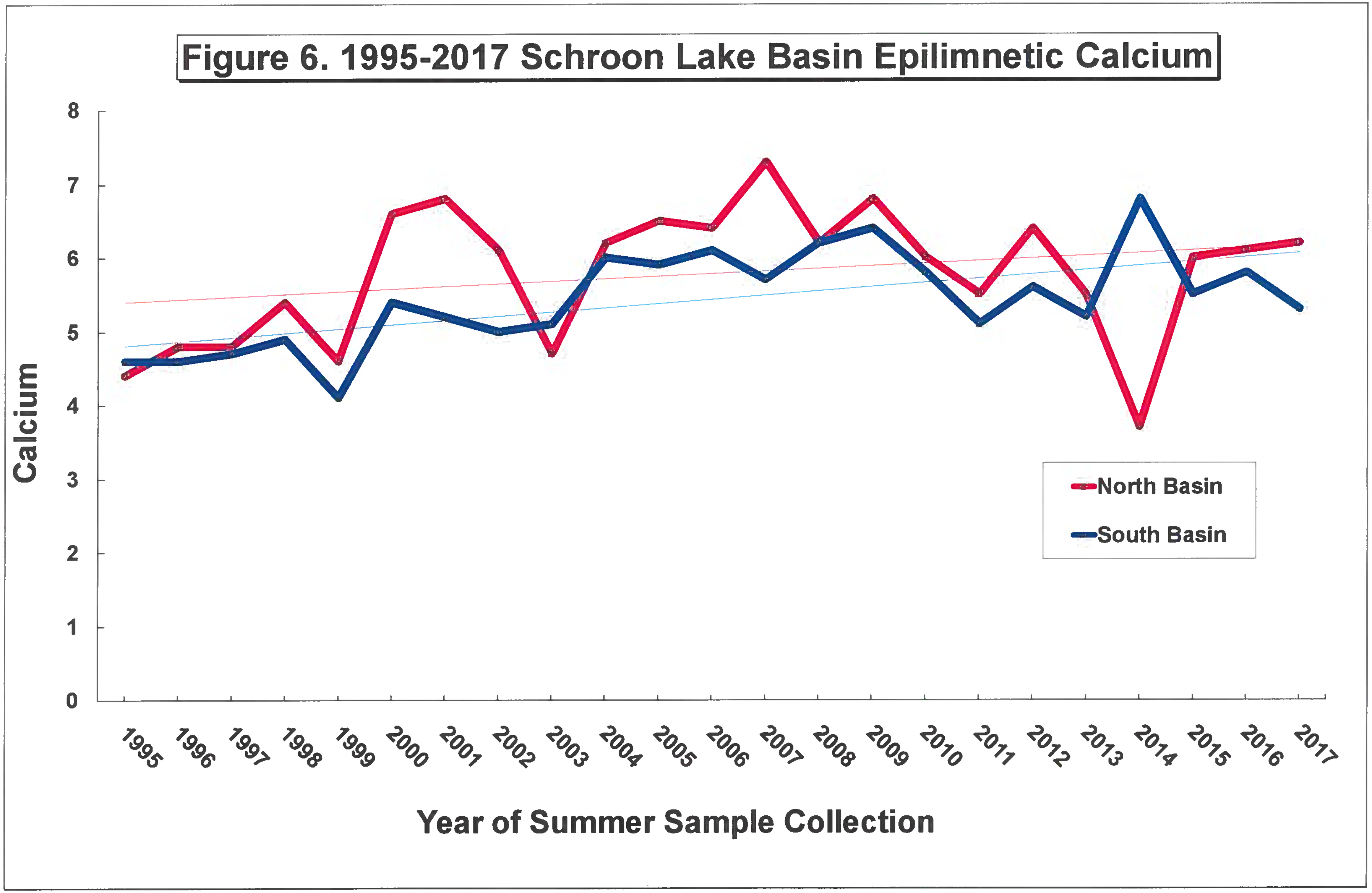


Figure 6. 1995-2017 Schroon Lake Basin Epilimnetic Calcium
Calcium
0
1
2
3
4
5
6
7
8
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year of Summer Sample Collection
North Basin
South Basin