Water Chemistry of the

North and South Basins of Conesus Lake

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Executive Summary

1. The objective of this study was to determine if there were differences in the chemistry of the north and south basins of Conesus Lake during the summer stratification period. To achieve this objective, water samples were taken from 18 May to 2 November 2000 from both basins.

2. A summer hypolimnion exists in the south basin. The north basin has an epilimnion and a "thin" metalimnion, a temperature transition zone, but no hypolimnion The lack of a fully-developed hypolimnion in the north basin is due to the large surface area and the relative shallowness of this basin (~14m). Many of the differences in chemistry observed between the deep waters of the two basins can be attributed to the absence of a hypolimnion in the north basin. Seasonally, May epilimnetic temperatures were slightly higher (~ 2°C) in the north basin compared to the south basin.

1. **Epilimnion and Metalimnetic Waters**

   a) In general, dissolved oxygen, alkalinity, chloride, sulfate, nitrate, magnesium, sodium, calcium, pH, chlorophyll and turbidity levels in the epilimnion and metalimnion of the north and south basins were similar during the study period. Seasonal trends are discussed in the text.

   b) Sulfate levels were slightly higher (2 to 6 mg/L) in the epilimnion of the south basin compared to the north basin during July and August.

   c) In the autumn, chlorophyll levels in the epilimnion were twice as high in the south basin compared to the north basin. This is probably a response to increased phosphorus levels in the epilimnion after fall mixing.

2. **Hypolimnetic Waters**

   a) In general, hypolimnetic levels of chloride, nitrate, pH, magnesium, potassium, calcium and sodium were not dissimilar.

   b) Alkalinity of hypolimnetic waters of the south basin are generally 10 to 15 mg/L higher than the north basin.

   c) Sulfate concentrations in the hypolimnion of the south basin decreased from 20 to less than 10 mg/L by early October. Sulfate concentration in the bottom waters of the north basin did not change.

d) Hypolimnetic total phosphorus and soluble reactive phosphorus levels were significantly higher in the hypolimnion of the south basin compared to the north basin. During August and September, TP levels were at times 500% greater than the north basin.

e) Turbidity increased in both basins in the bottom waters with the development of thermal stratification. However, values were 1 to 5 NTUs higher in the south basin.

Introduction

During a series of meetings in the spring of 2000 sponsored by the Livingston County Department of Planning concerning the "State of Conesus Lake" report, gaps in the basic knowledge of the structure and function of Conesus Lake were identified. A large amount of information exists on the water chemistry of Conesus Lake and is currently being reviewed in the "State of Conesus Lake" (In Press) report. However, much of the historic chemistry data is from the "North" basin of the lake (Fig. 1), particularly those of Makarewicz (1986, 1990, 1991, 1992, 1994, 2001) and his students (Cady 1996, Crego 1998, Puckett 1989, Teall 1989). The question arose as to the applicability of data collected in the north basin to the south basin. Reference to figure 1 demonstrates the issue. The lake consists of two basins – a "North" and a "South" basin. The south basin is relatively deep, reaching a maximum depth of 20m, while the north basin has a maximum depth of only 14 meters. Both basins are separated by the "narrows"- an area bounded by McPherson Point on the east and Long Point on the west. It is possible that the chemistry of the basins were different due to different land use in the basins and due to the difference in depth of the basins. For example, it was known that the deep waters of the south basin were anoxic: that is, devoid of oxygen during the summer. A goal of the "State of Conesus Lake" report is to restore and improve water quality of Conesus Lake. A basic piece of information required in this effort is to determine whether or not both basins are chemically behaving in a similar manner. If the chemistry of the basins were similar, any future monitoring could then be limited to one basin. The objective of this study was to determine if there were differences in the chemistry of the north and south basins of Conesus Lake during the summer stratification period. To achieve this objective, water samples were taken from 18 May to 2 November 2000 in both basins of Conesus Lake.

Methods

A 4-L PVC VanDorne water bottle was employed to collect water samples at a depth of 1, 8 and 12m from the "South Basin" and 1, 8, and 17m from the "North Basin" of Conesus Lake (Fig. 1). Sampling was initiated on 18 May 2000 with water samples subsequently taken every two weeks until the autumn mixing on 2 November 2000. Dissolved fractions for analysis were obtained by filtration of water through a 0.45-μm cellulose membrane filter within 60 minutes of collection. Samples were placed in storage coolers containing ice prior to transportation and analysis in the laboratory. Laboratory analysis included: chlorophyll (fluorometry, extraction in acetone - APHA 1999), turbidity (Turner Nephelometer), sulfate (turbidimetric, APHA 1999), chloride (mercuric nitrate titration method, APHA 1999), soluble reactive phosphorus (autoanalyser - ascorbic acid method, APHA 1999), total phosphorus (persulfate digestion, autoanalyser - ascorbic acid method APHA 1999), nitrate+nitrite (autoanalyser - cadmium reduction method, APHA 1999), conductivity (YSI Model 32 Conductance meter), total Kjeldahl nitrogen (autoanalyser - Technicon Industrial Method 329-74W/B), pH (Beckman Model 45 pH meter) and metals (atomic absorption spectrophotometry – Perkin Elmer AAnalyst 100, APHA 1999). Dissolved oxygen (titration - Winkler modification, APHA 1999) and temperature (YSI 3000 TLC meter) were measured in the field.

Quality Assurance Internal Quality Control: Multiple sample control charts (APHA 1999) were constructed for each parameter analyzed, except total suspended solids. A prepared quality control solution was placed in the analysis stream for each sampling date. If the control solution was beyond the set limits of the control chart, corrective action was taken and the samples re-run.

External Quality Control: The Water Chemistry Laboratory at SUNY Brockport is certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP - # 11439). This program includes biannual proficiency audits, annual inspections and good laboratory practices documentation of all samples, reagents and equipment.

Results and Discussion

Temperature (Figures 2 and 3)

Conesus Lake is thermally stratified from May through early November of each year. That is, there is a warm upper layer of water that by August is ~8 meters deep in both basins. In lakes possessing a "classical" summer stratification, there is a cold layer with a temperature of approximately 4 to 5°C at the bottom of the lake termed the hypolimnion. In Conesus Lake, a hypolimnion exists in the south basin but not in the north basin. The lack of a hypolimnion in the north basin is due to the large surface area and fetch and the relative shallowness of this basin (~14m). The large surface area allows wind to develop enough energy to mix the relatively shallow water column to the bottom. Thus the north basin has an epilimnion and a "thin" metalimnion, a temperature transition zone, but no hypolimnion. The south basin of Conesus Lake has a hypolimnion – but during the summer of 2000 was not a "classical" hypolimnion. A deep cooler layer existed, but temperatures in July reached 10°C suggesting that significant mixing to the depths of the lake had occurred prior to stratification in May

Seasonally, May epilimnetic temperatures were slightly higher (~ 2°C) in the north basin compared to the south basin. This may be related to the influence of warmer stream waters that enter the smaller, surface area of the north basin compared to the larger volume and surface area of the south basin. By June and through the rest of the summer, epilimnetic temperatures were essentially the same (Figs. 2 and 3). During the summer of 2000, maximum temperature was observed August 9 with a temperature of 24.3°C.

Dissolved Oxygen (Figure 4)

Epilimnetic oxygen levels were the same in the north and the south basin (Fig. 4). Hypolimnetic oxygen levels in the south and north basin followed the same pattern in that oxygen levels decreased from highs of >6mg/l at our first sampling in mid-May to non-detectable levels by late June in the south basin and early July in the north basin. In the north basin, oxygen levels stay higher longer in the spring and increase earlier in the bottom waters. This is due to the wind induced mixing that affects the deeper waters of the north basin but not the south basin. Metalimnetic oxygen values in the north basin decrease through August but increase in early September as the epilimnion descends deeper into the lake. The wild variations in metalimnetic oxygen concentrations in the south basin reflect intrusions of oxygen bearing epilimnetic waters into the metalimnion.

Anions (Negative ions)

Alkalinity (Figure 5)

Alkalinity is a measure of the carbonate and bicarbonate ions in water. These ions "buffer" the lake water from the effects of acid precipitation and hydrogen ions. Comparing the north and south basins, it is evident that concentrations do not appear to be different between basins (Fig. 5). There appears to be an increase in alkalinity during the early summer in the epilimnion of the lake. This may be due to influx of ions from the many streams draining the watershed. Alkalinity of hypolimnetic waters of the south basin were generally 10 to 15 mg $CaCO_3$/L higher than the north basin.

Chloride (Figure 6)

Chloride is a molecular component of salt. Seasonally, chloride concentrations were variable in the epilimnion and metalimnion (range 36 to 40 mg/L). However, only a 4 mg/L difference in concentration was observed over the entire sampling season. There were no major differences in chloride concentrations between the south and north basins. There is a suggestion that chloride levels in the metalimnion and hypolimnion were slightly (~ 2 mg/L), but consistently higher in the north basin than the south basin in the early summer (Fig. 6).

Sulfate (Figure 7)

Sulfate levels were slightly higher (2 to 6 mg/L) in the epilimnion of the south basin compared to the north basin during July and August. While metalimnetic values were the same between basins, sulfate concentrations in the hypolimnion of the south basin were reduced from 20 to less than 10 mg/L by early October (Fig. 7). This reduction is related to the anoxic, reducing condition that existed in these deeper waters of the south basin. With mixing in the fall, oxygenated conditions are restored and sulfate concentrations begin to increase. A major reduction in sulfate levels in hypolimnion of the north basin was not observed.

Nitrate (Figure 8)

In both the north and south basins, nitrate decreased to non-detectable levels by mid August (Fig. 8). The reduction in nitrate in the epilimnion and metalimnion is due to uptake by phytoplankton while the reduction observed in the hypolimnion is a result of both uptake by plants and by a decoupling of the nitrification process due to the lack of oxygen.

Total Phosphorus (Figure 9)

Total phosphorus is a measure of both particulate and dissolved forms of phosphorus. In both the south and north basins, epilimnetic and metalimnetic total phosphorus levels were quite variable with no consistent difference between the south and north basins. Hypolimnetic total phosphorus (TP) levels were significantly higher in the hypolimnion of the south basin compared to the north basin (Fig. 9). During August and September, TP levels were at times 500% greater than the north basin (Fig. 9). During the period of anoxia and the resulting reducing conditions that occurs in the south basin in the summer, phosphorous readily moves out of the sediments into the water column as part of the ferrous–ferric phosphate complex. This mechanism can "self-fertilize" a lake. In fact, the increase in TP in the epilimnion and metalimnion of the south basin is likely due to phosphorus being cycled back up into the water column with fall mixing.

Soluble Reactive Phosphorus (SRP) (Figure 10)

SRP represents the dissolved fraction of phosphorus readily available to phytoplankton and macrophytes. As would be expected, SRP levels in the hypolimnion of the south basin increase dramatically during the period of anoxia in the late summer and early fall (Fig. 10). As with TP, hypolimnetic SRP levels are considerably higher in the south basin. There appears to be some seasonality in the epilimnion with a pulse in SRP concentration in late June in both, a reduction by mid-July with steady but lower levels through the summer with an increase in the fall. These increases are likely due to an influx of nutrients from streams during meteorologic events and possibly from phosphorus movement from the anoxic sediments and hypolimnion with autumn mixing.

<u>Cations</u> – Positive Ions

Calcium, Magnesium, Potassium, Sodium (Figs. 11-14)

A comparison of the epilimnion, metalimnion and hypolimnion of the north and south basins revealed no major differences in levels of sodium (Fig. 11), calcium (Fig. 12) and potassium

(Fig. 13). For both calcium and potassium, there was a seasonal downward trend in concentration. Magnesium levels in the epilimnion and hypolimnion of the south and north basins were variable but did not appear to be different. Magnesium levels in the metalimnion were consistently higher in the north basin for the entire summer (Fig. 14). We have no explanation for this.

pH (Figure 15)

pH is a measure of the hydrogen ion concentration. The lower the pH the more acidic the water. Although pH was slightly lower in the south basin metalimnion (~0.5 pH unit) in August and September, there were no major differences between the south and north basins (Fig. 15).

Turbidity (Figure 16)

Turbidity can be defined several ways. Basically, it is a measure of the quantity of particles in the water. These particles could be living, such as phytoplankton and bacteria, and could represent non-living small particles that affect the transparency of the water. In New York State, turbidity levels in surface drinking waters should not exceed 1 NTU. Seasonally, the epilimnion of the south and north basins displayed no difference in turbidity levels. Two peaks in turbidity were observed in the summer – one in mid-June and one in August. These peaks did not correlate with an increase in chlorophyll levels (Fig. 17). The turbidity peak during the autumn correlated well with increased autumn chlorophyll levels suggesting a bloom of algae was the cause of the higher turbidity in the autumn.

South and north basin metalimnetic turbidity levels were similar until September after which south basin turbidity was higher (0.7 to1.0 NTUs) until autumn mixing. Turbidity increased in both basins in the bottom waters with the development of thermal stratification. However, values were 1 to 5 NTUs higher in the in the south basin.

Chlorophyll (Figure 17)

Chlorophyll is a measure of the pigment contained in phytoplankton and thus is an indicator of phytoplankton abundance. Generally, chlorophyll levels were similar between basins throughout the spring and summer. In all basins, hypolimnetic chlorophyll levels increase in the autumn at all depths, probably in response to increased phosphorus levels (Fig. 10 and 11). During the peak of the fall bloom from mid October to November epilimnetic chlorophyll concentrations were nearly twice as high in the south basin than in the north basin.

Acknowledgements

We are grateful for field and lab assistance of SUNY Brockport students Dan White, Peter D'Auito, Betsy Damske, Corey Laxson and Roger Ward. The use of the SUNY Geneseo boat and its dockage on Conesus Lake made our effort considerably easier.

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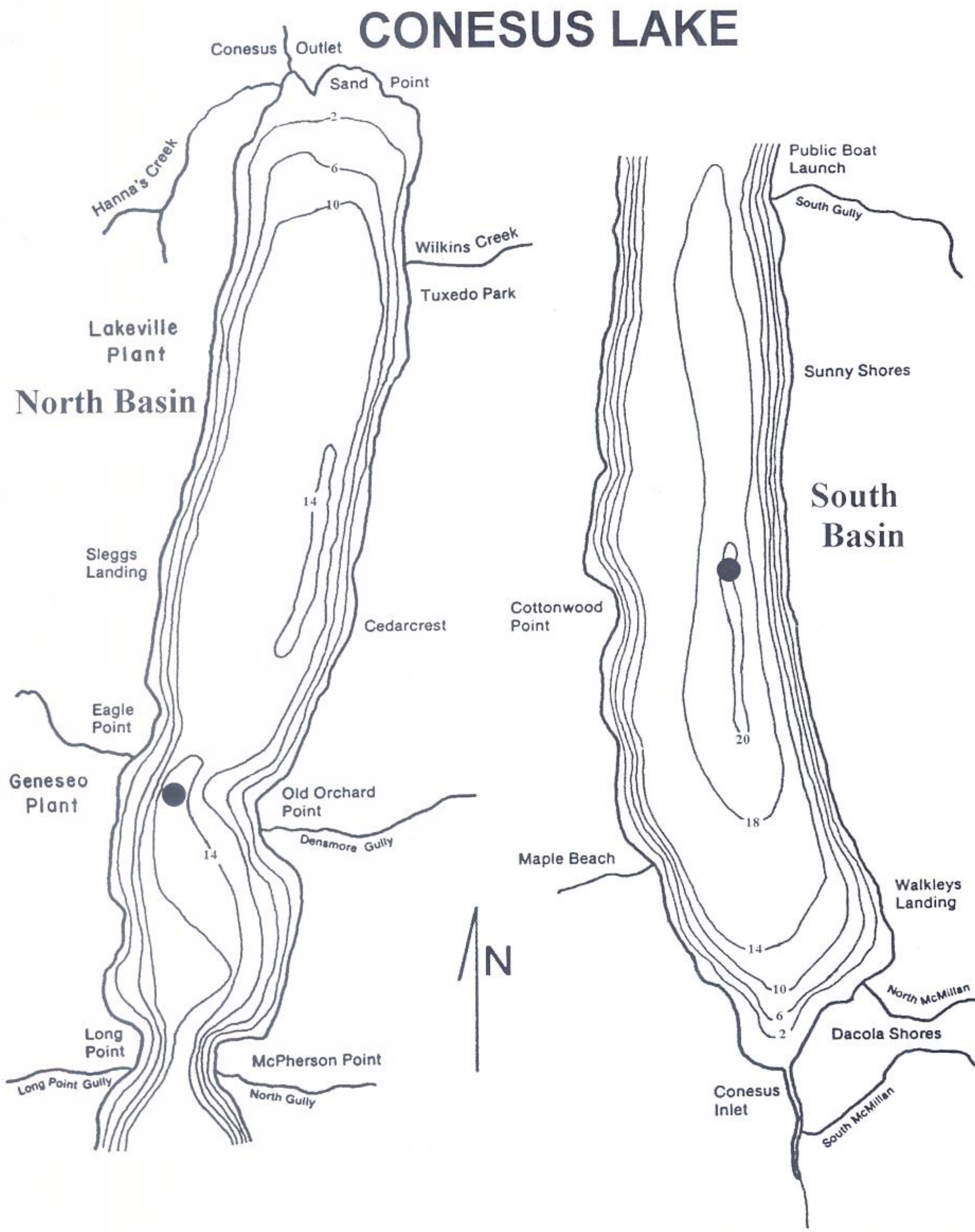

Figure 1. Bathymetric map of Conesus Lake showing the North and South basins. Isopleths of depth are in meters. Dark circles are the sampling locations during the summer of 2000.

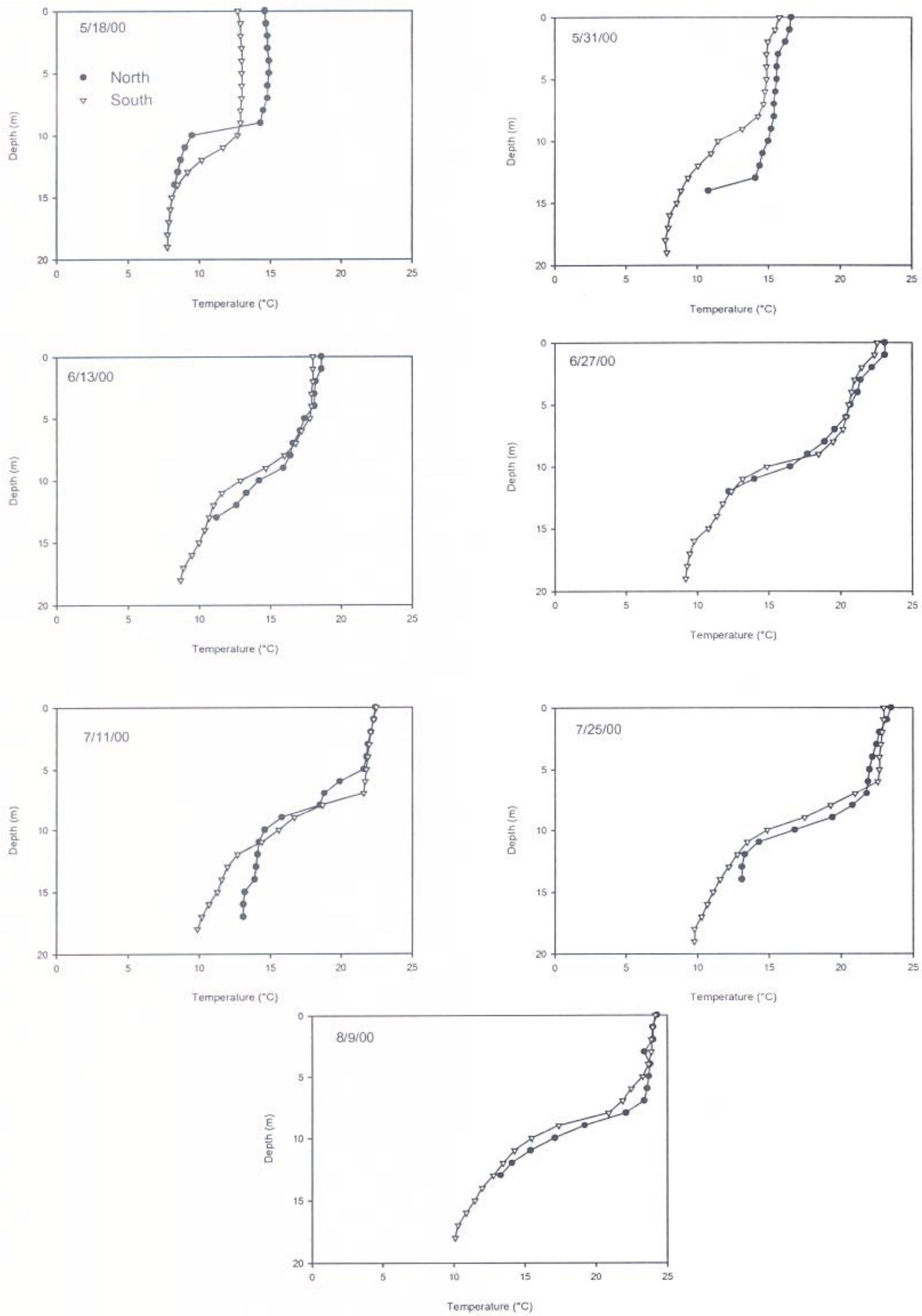

Figure 2. Seasonal temperature profiles in the north (circles) and south (triangles) basins of Conesus Lake.

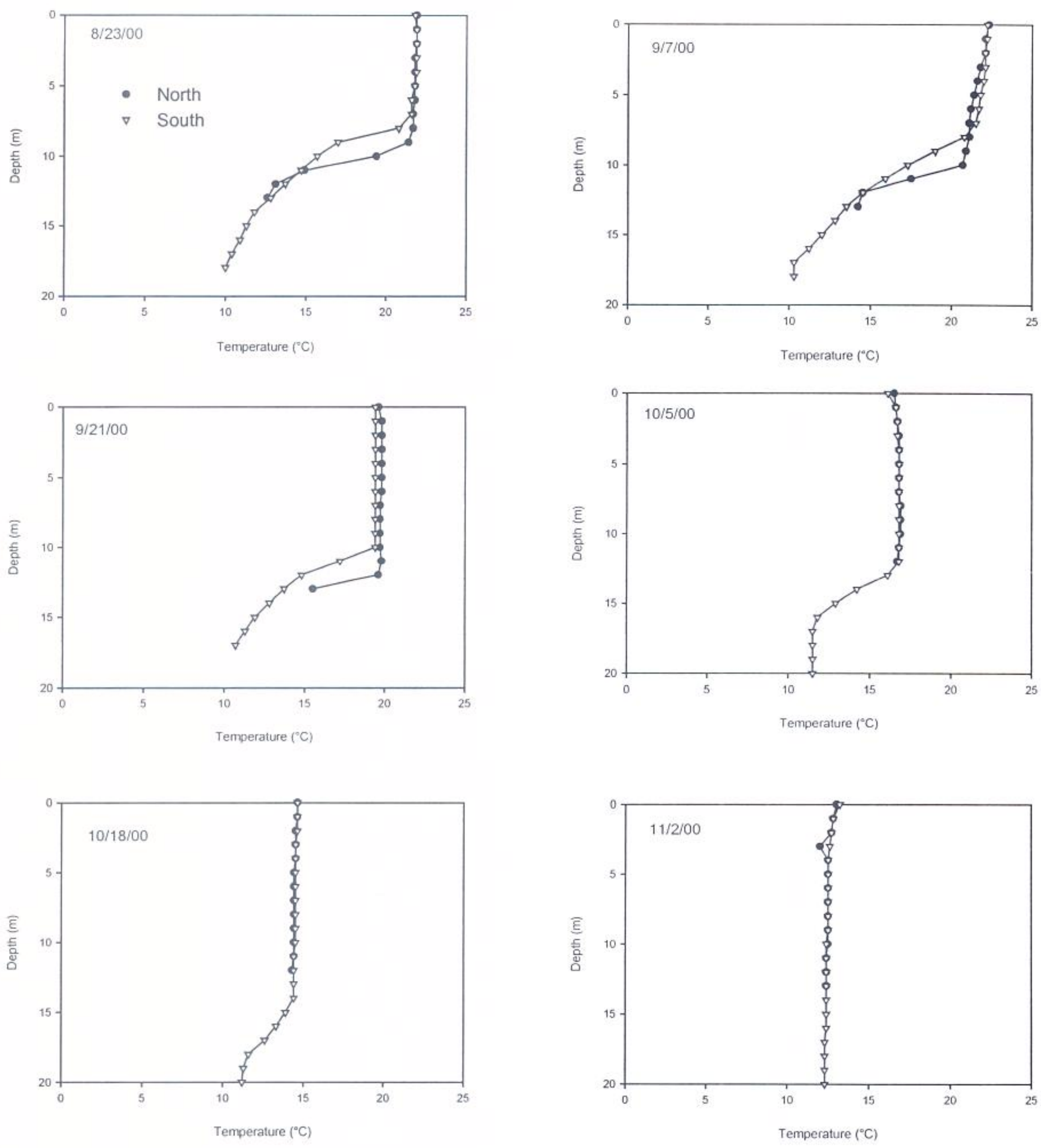

Figure 3. Seasonal temperature profiles in the north and south basins of Conesus Lake.

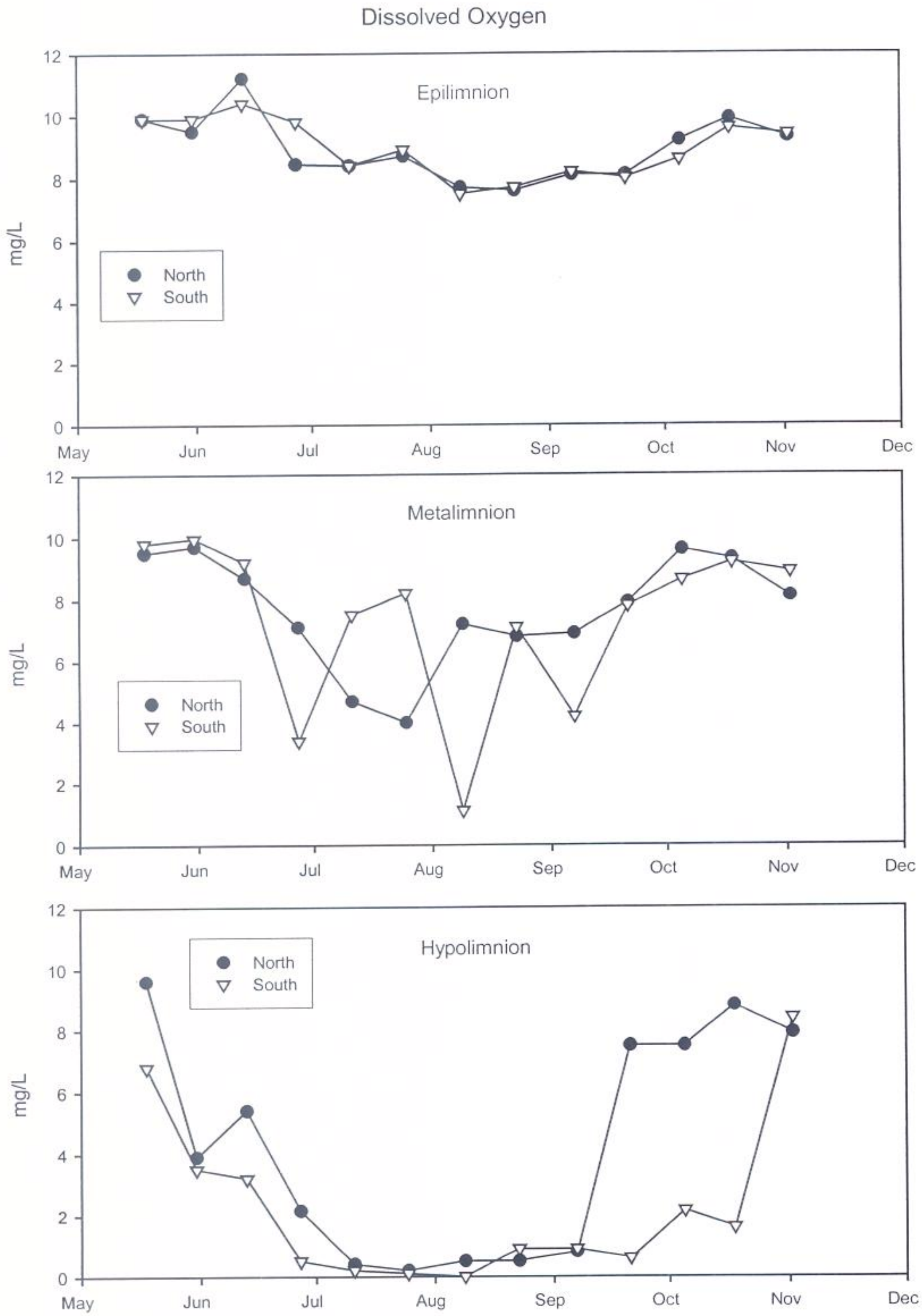

Figure 4. Seasonal dissolved oxygen concentrations in the north and south basins of Conesus Lake.

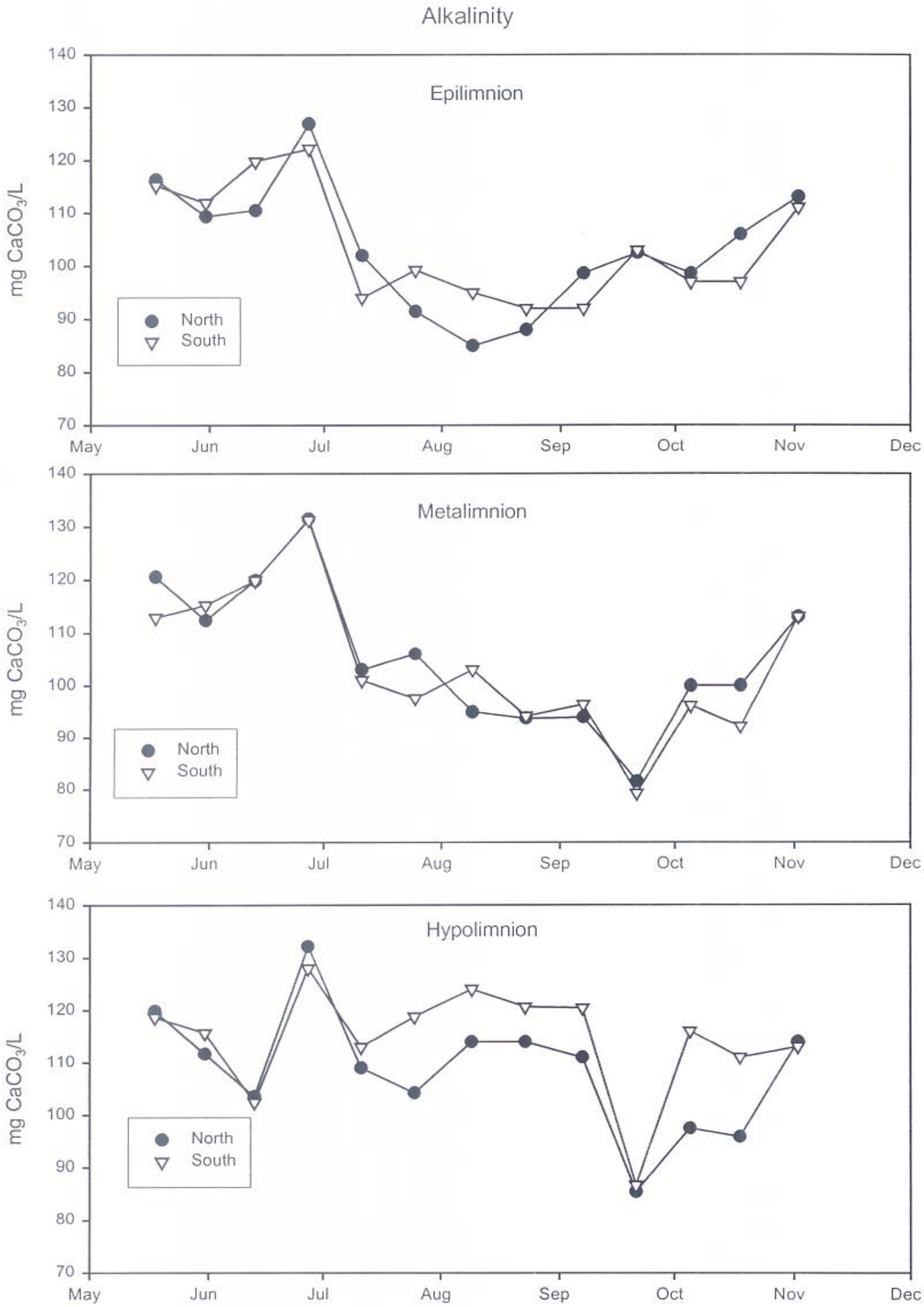

Figure 5. Seasonal alkalinity levels in the north and south basins of Conesus Lake.

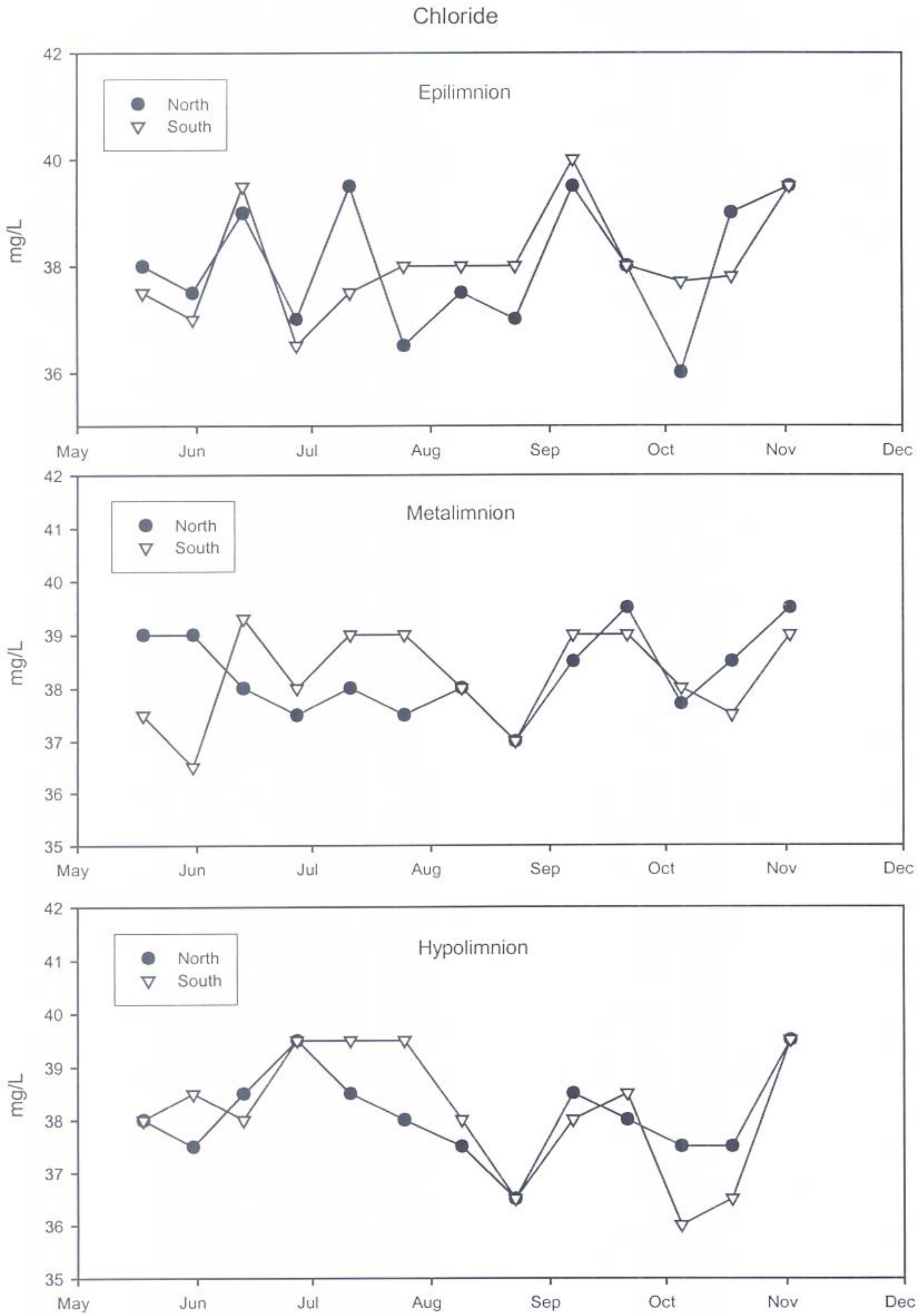

Figure 6. Seasonal chloride concentrations in the north and south basins of Conesus Lake.

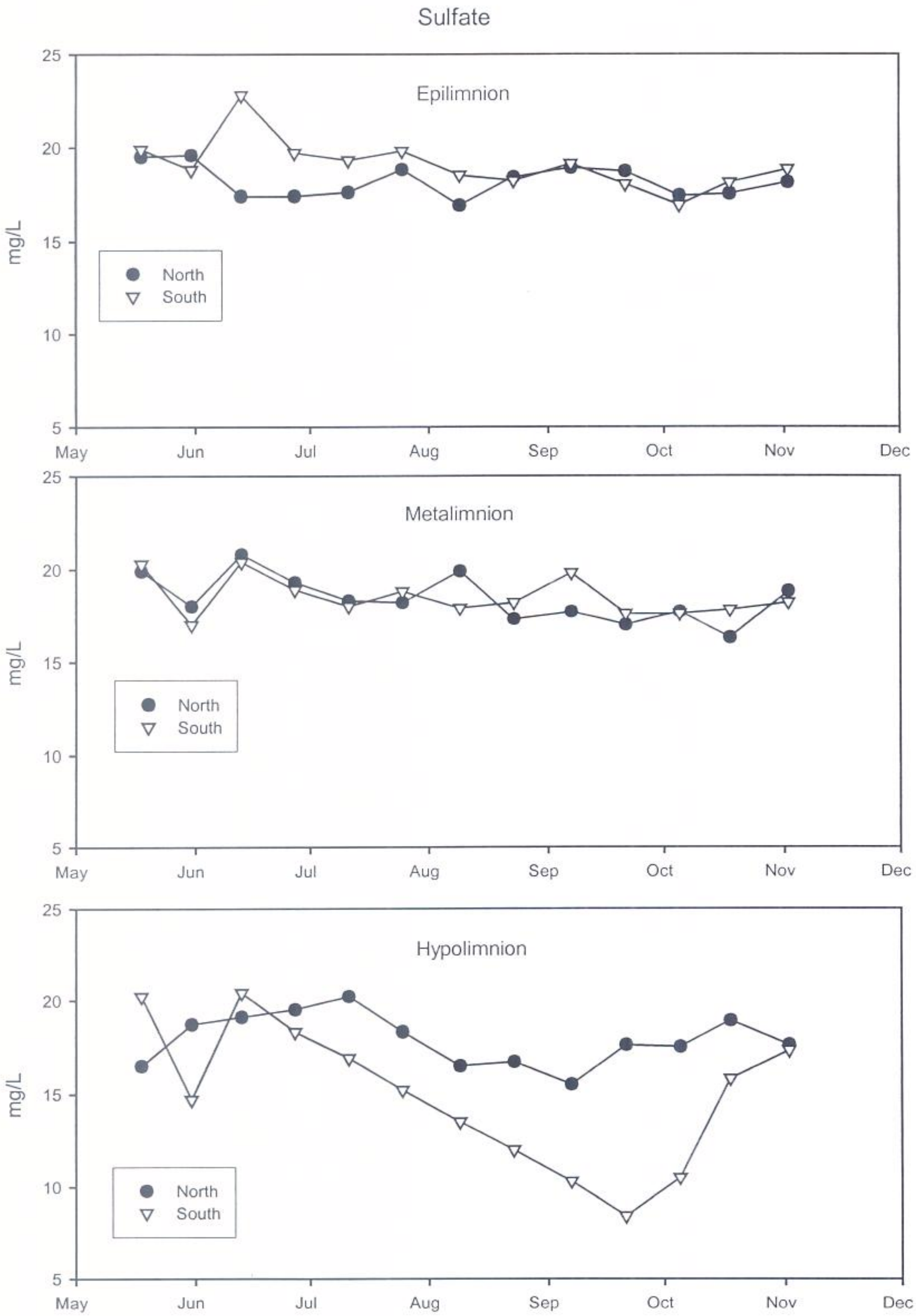

Figure 7. Seasonal sulfate concentrations in the north and south basins of Conesus Lake.

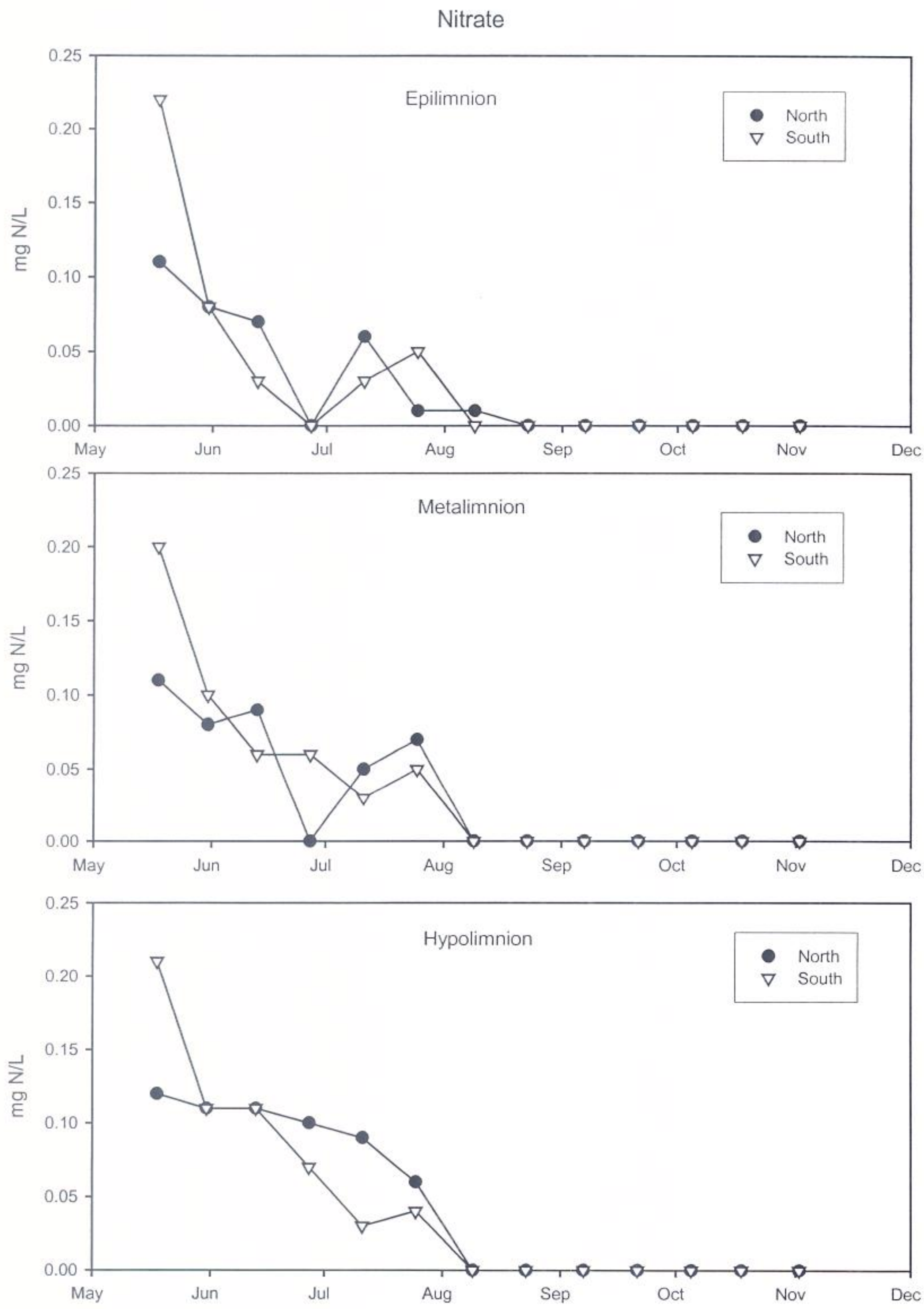

Figure 8. Seasonal nitrate concentration in the north and south basins of Conesus Lake.

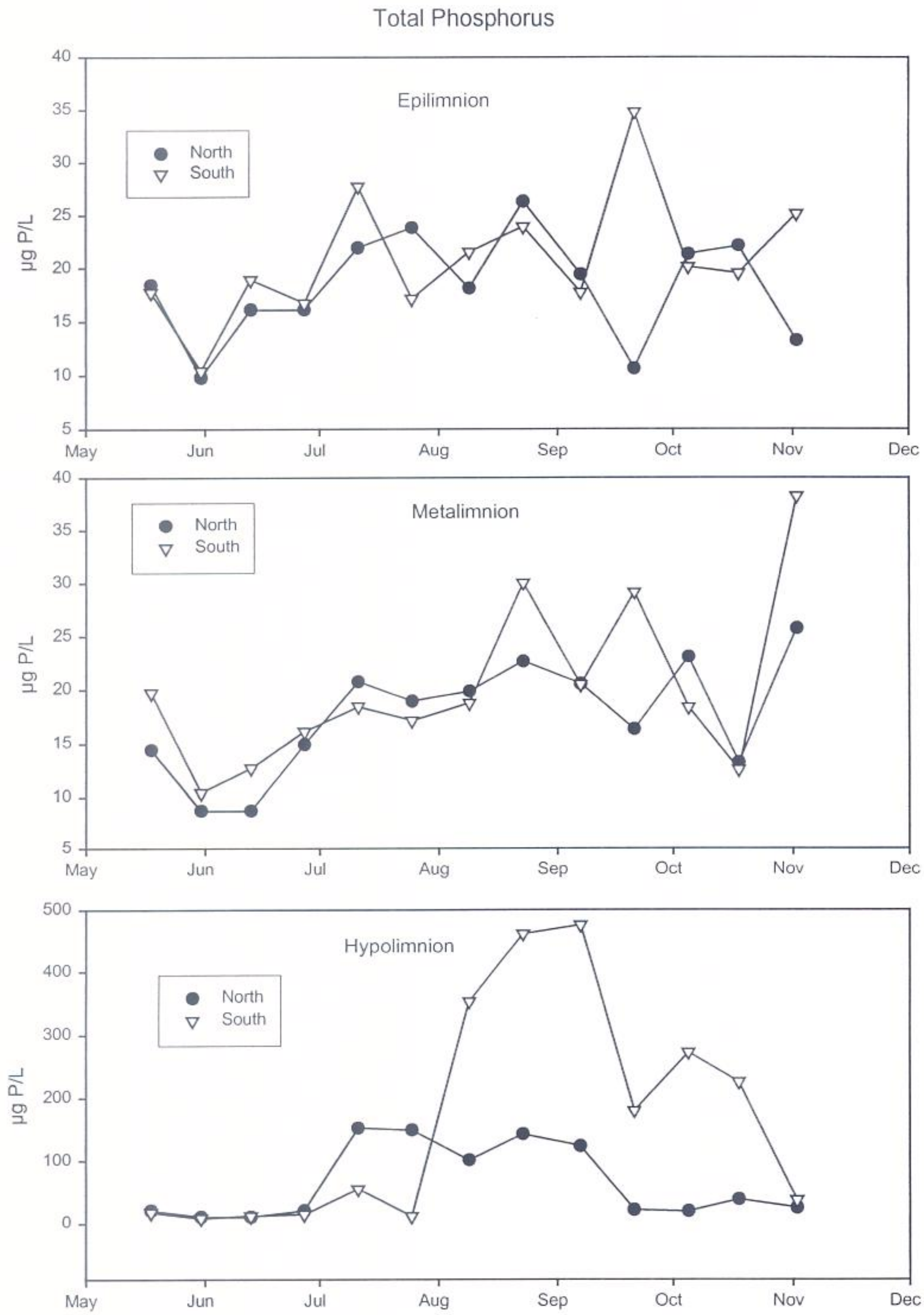

Figure 9. Seasonal total phosphorus concentrations in the north and south basin of Conesus Lake.

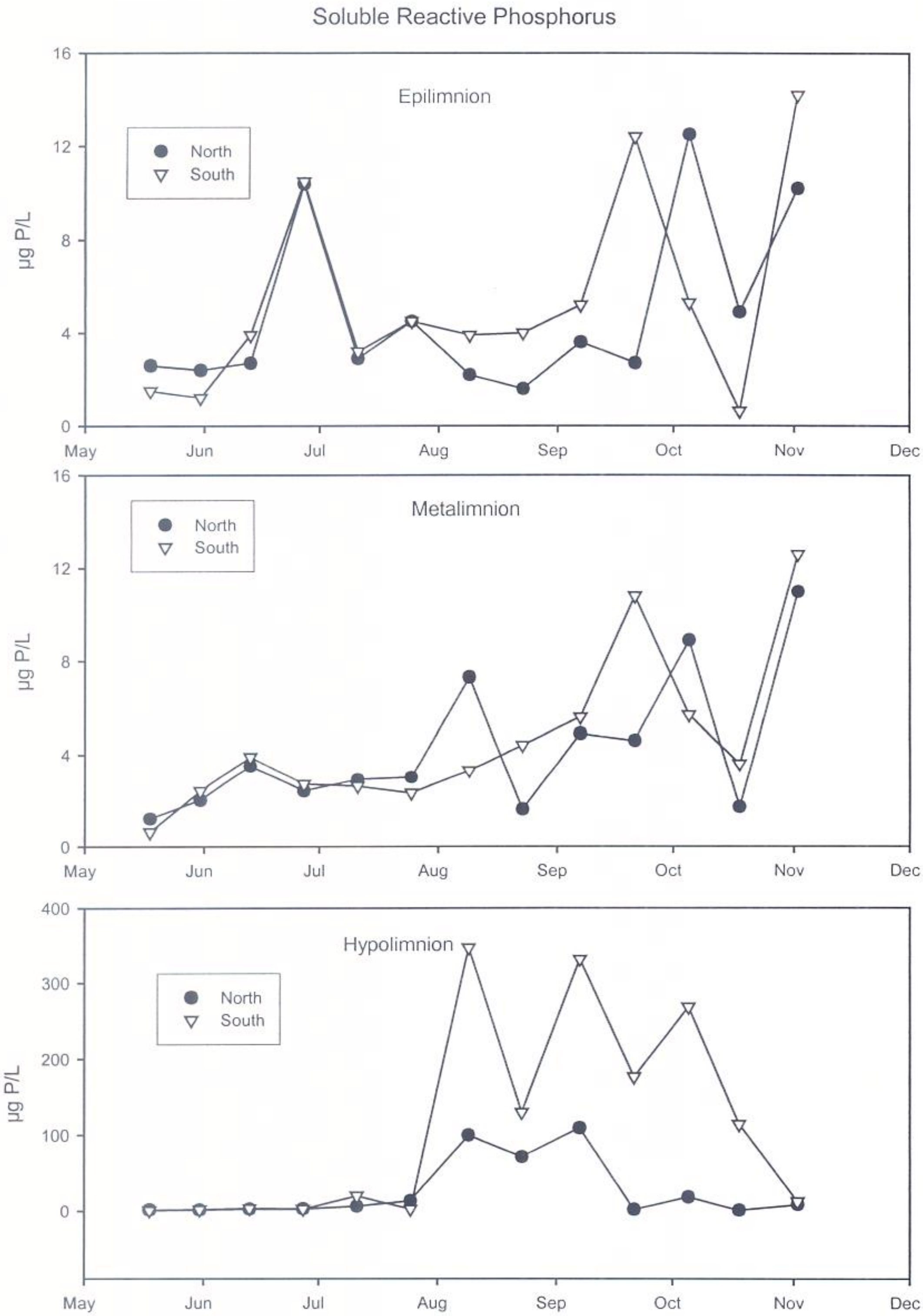

Figure 10. Seasonal soluble reactive phosphorus concentrations in Conesus Lake.

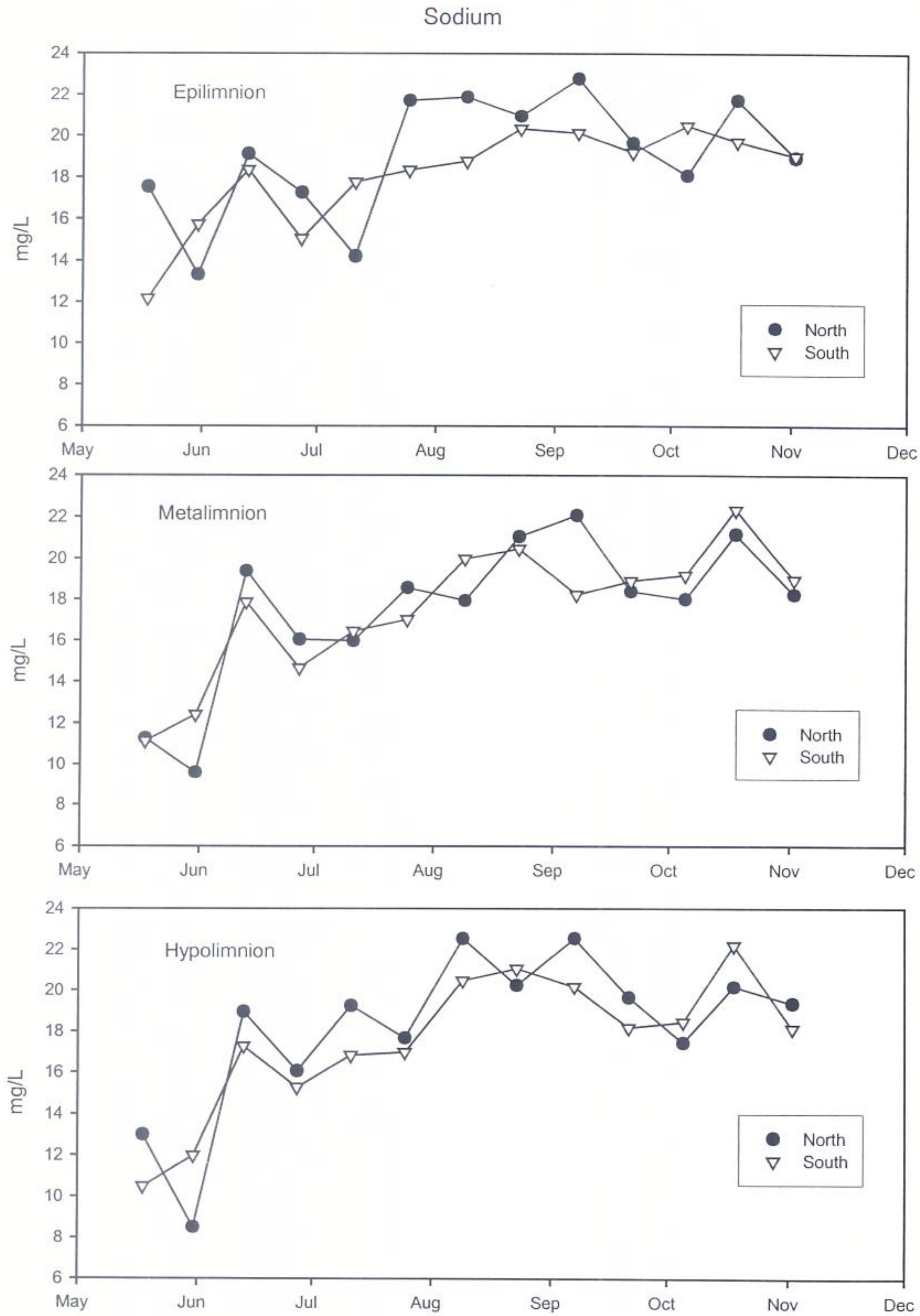

Figure 11. Seasonal sodium concentrations in the north and south basins of Conesus Lake.

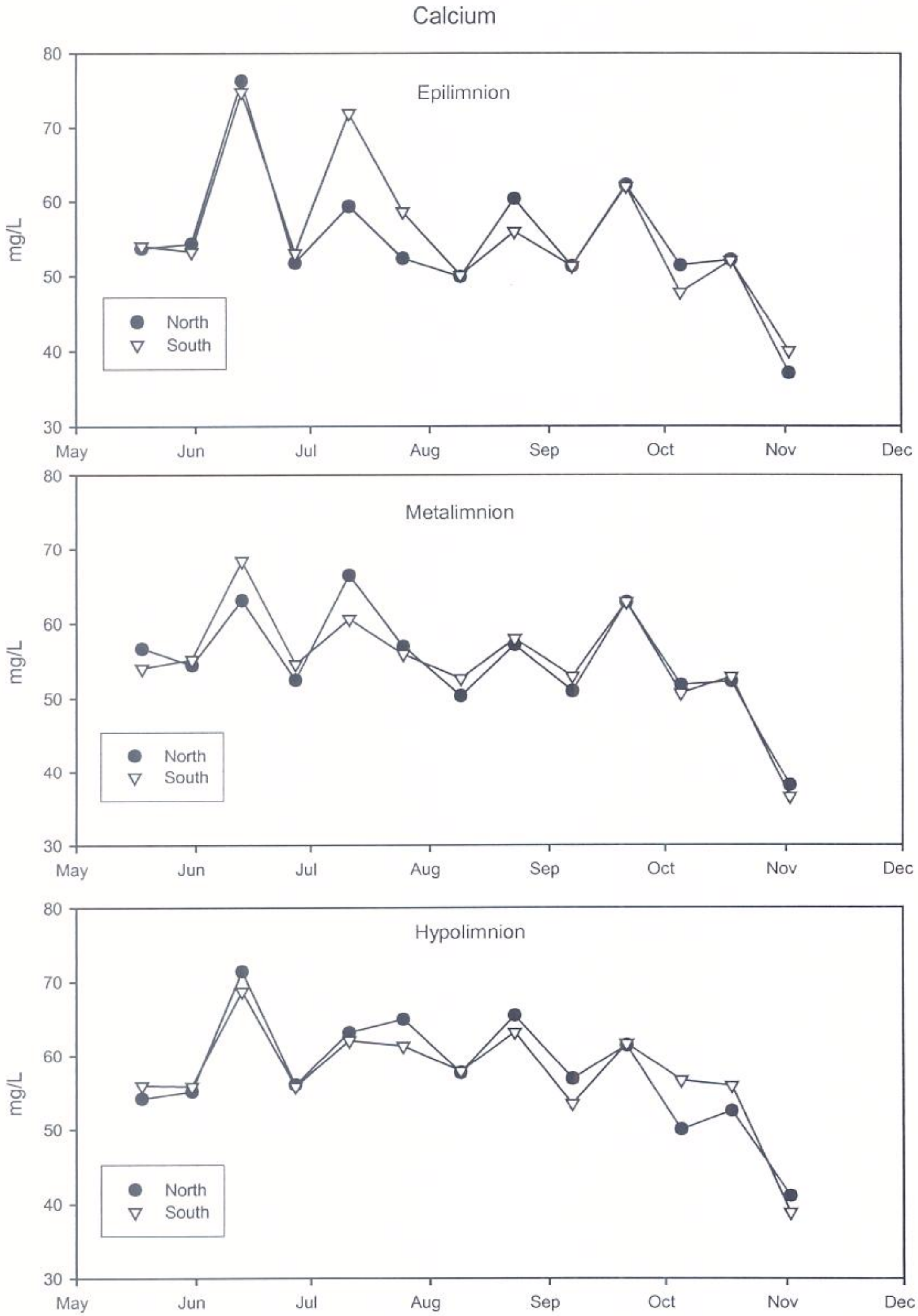

Figure 12. Seasonal concentrations of calcium in the north and south basins of Conesus Lake.

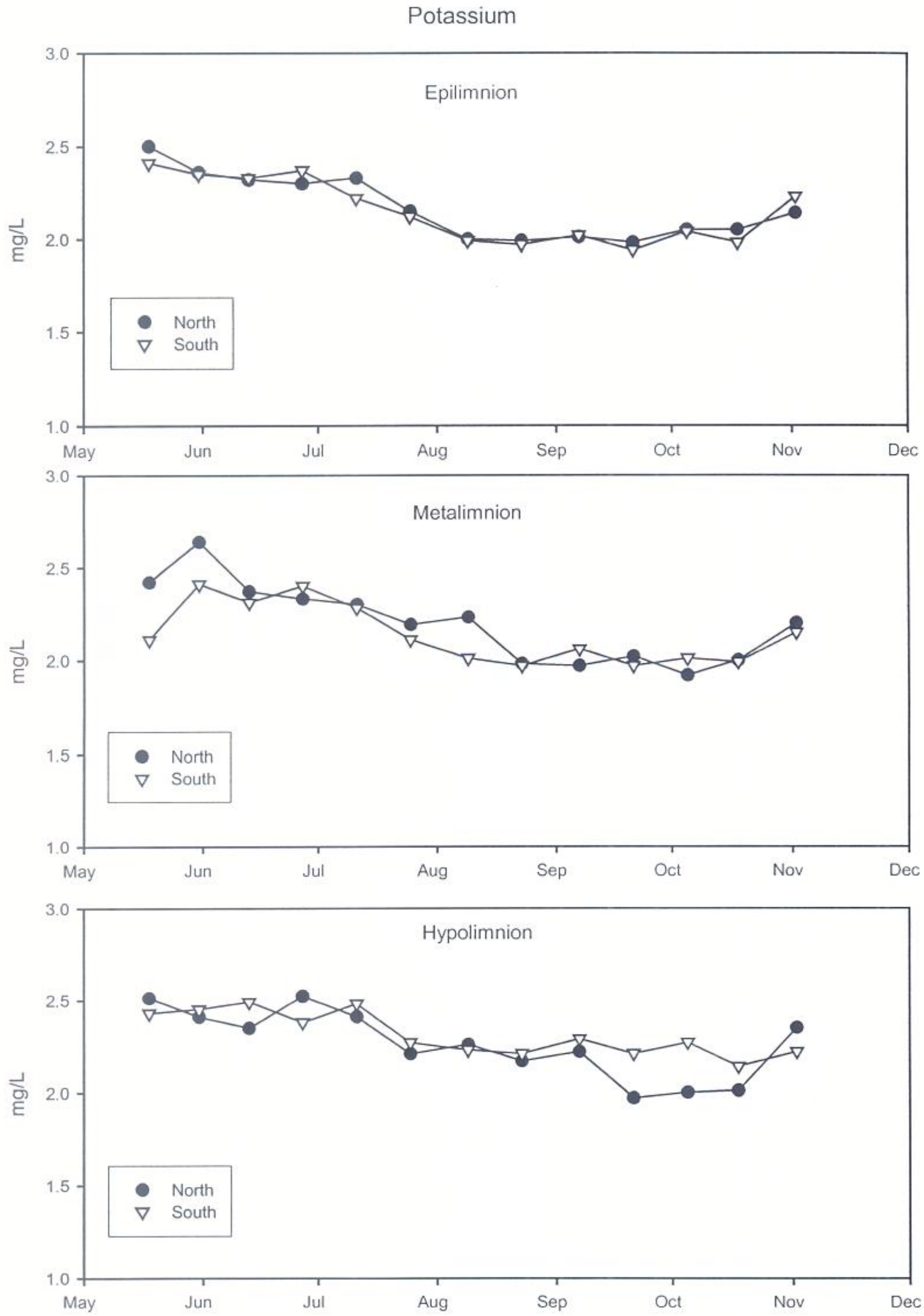

Figure 13. Seasonal potassium concentrations in the north and south basins of Conesus Lake.

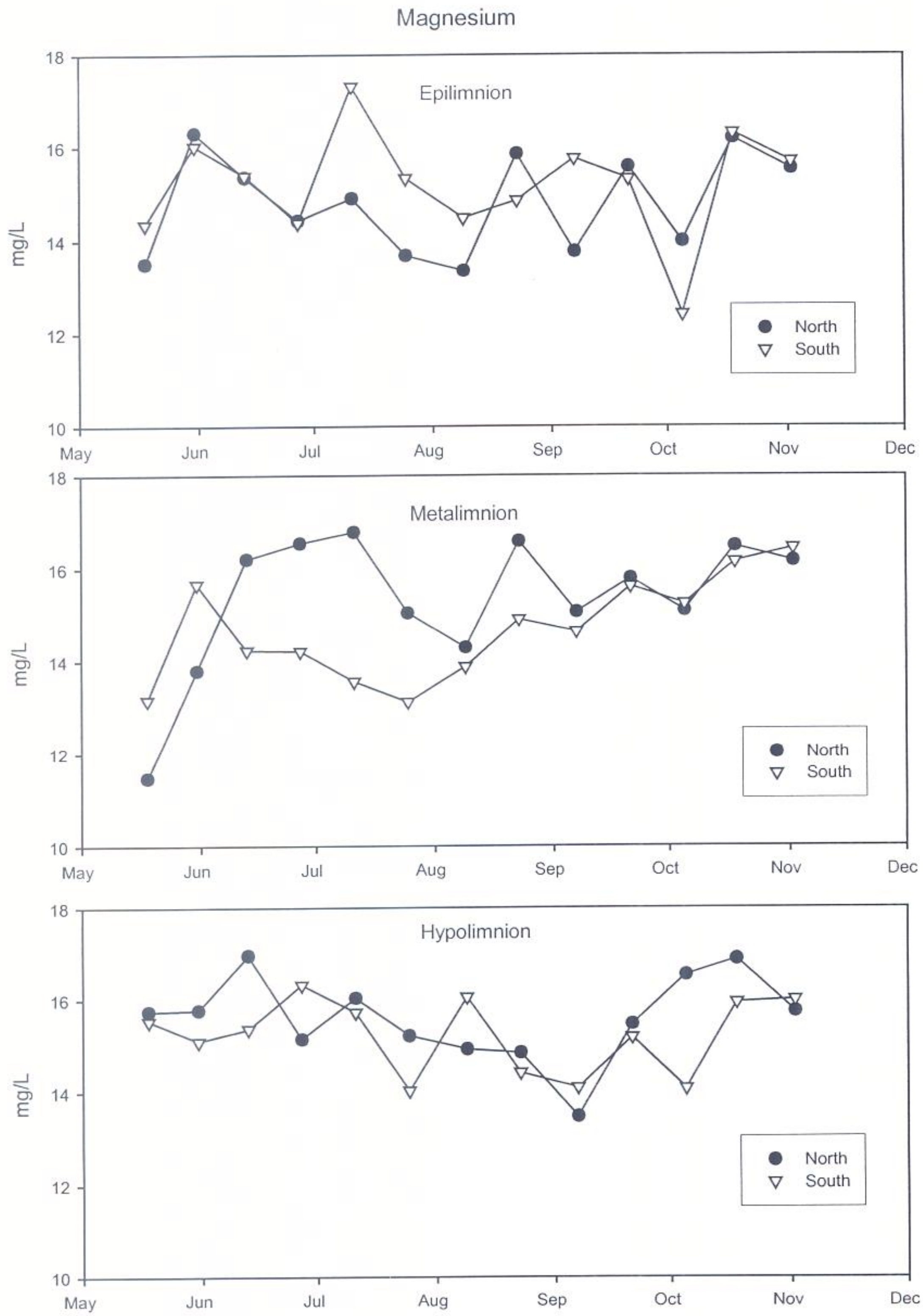

Figure 14. Seasonal magnesium concentrations in the north and south basins of Conesus Lake.

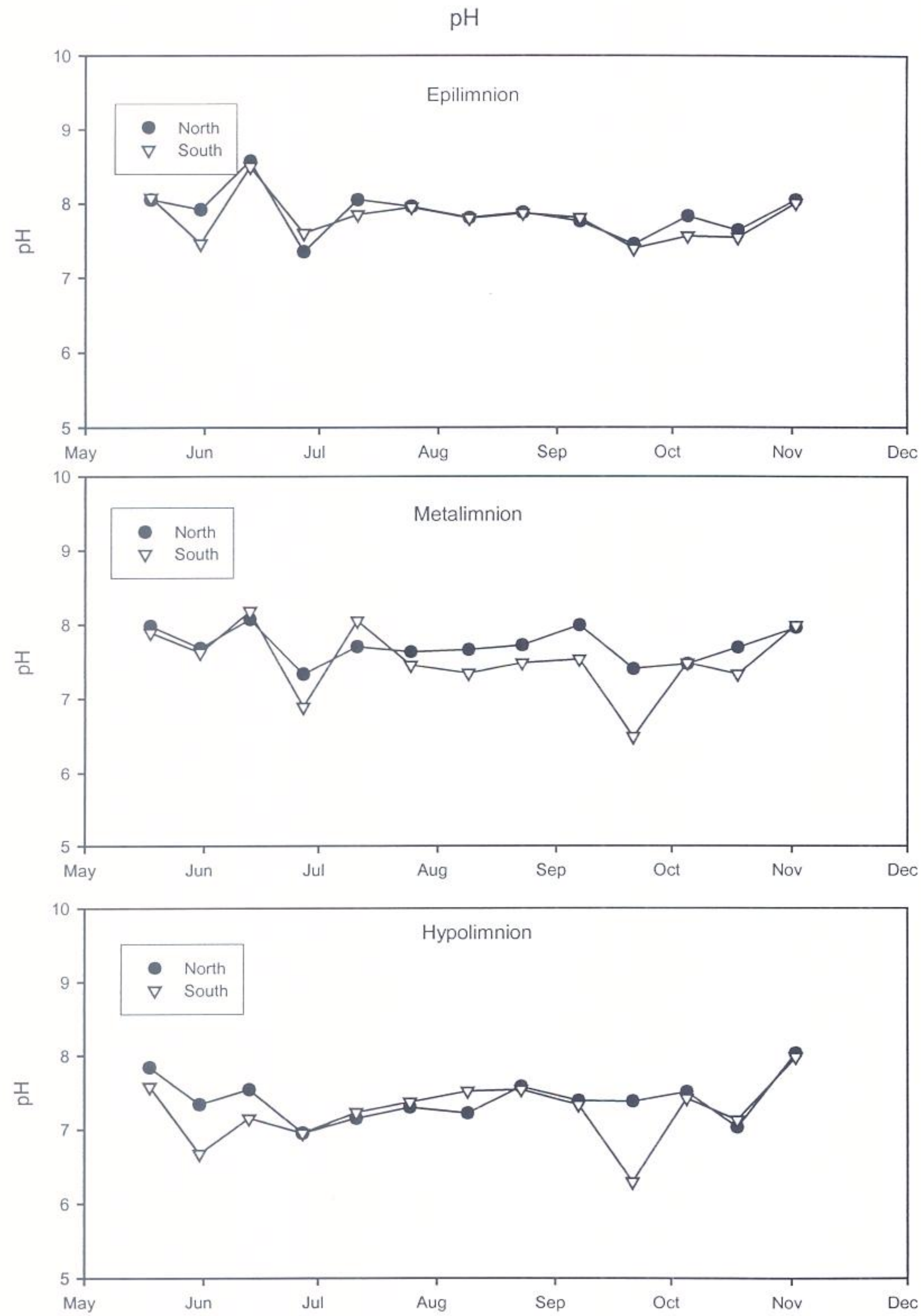

Figure 15. Seasonal pH in the south and north basins of Conesus Lake.

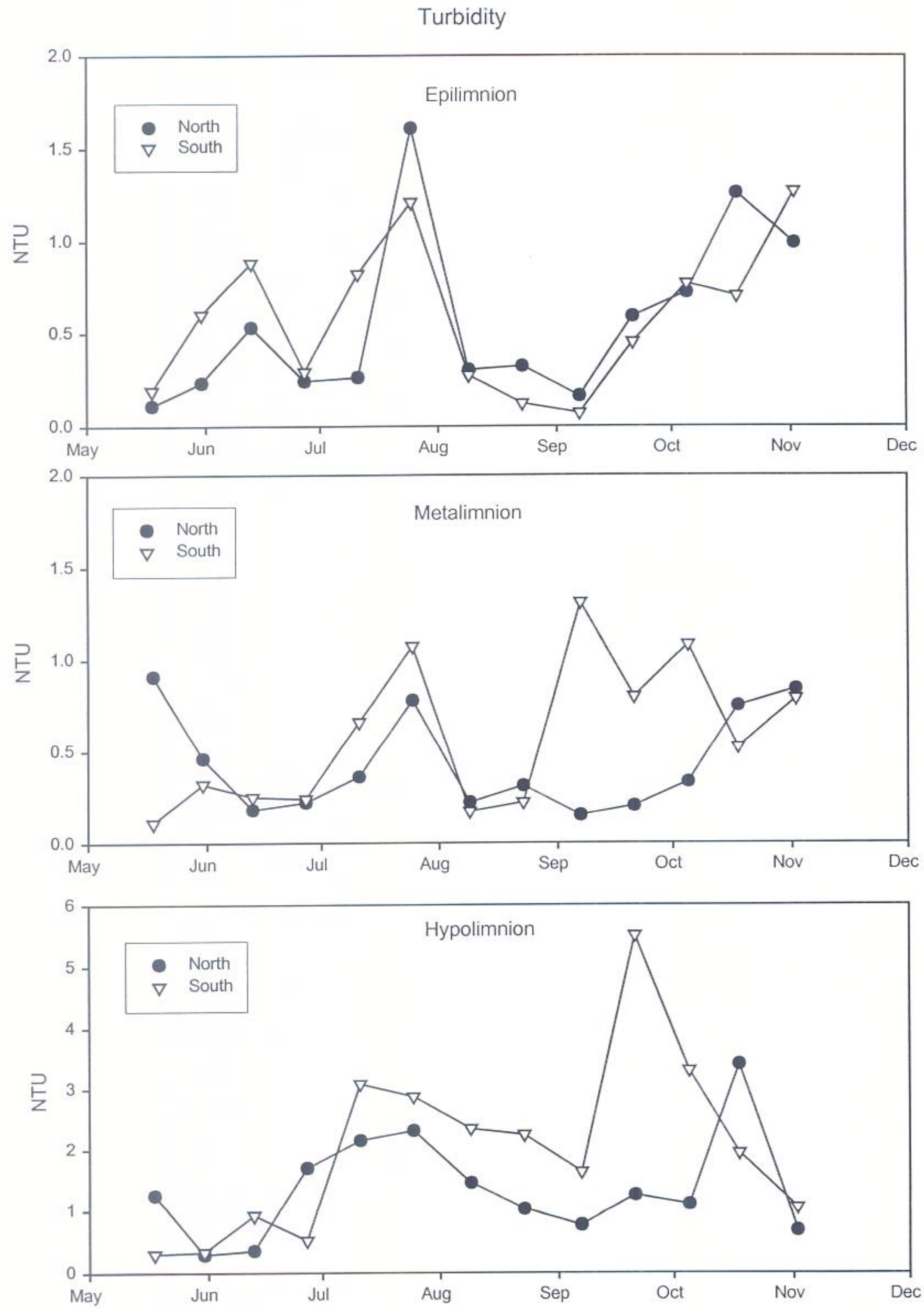

Figure 16. Seasonal turbidity levels in the north and south basins of Conesus Lake.

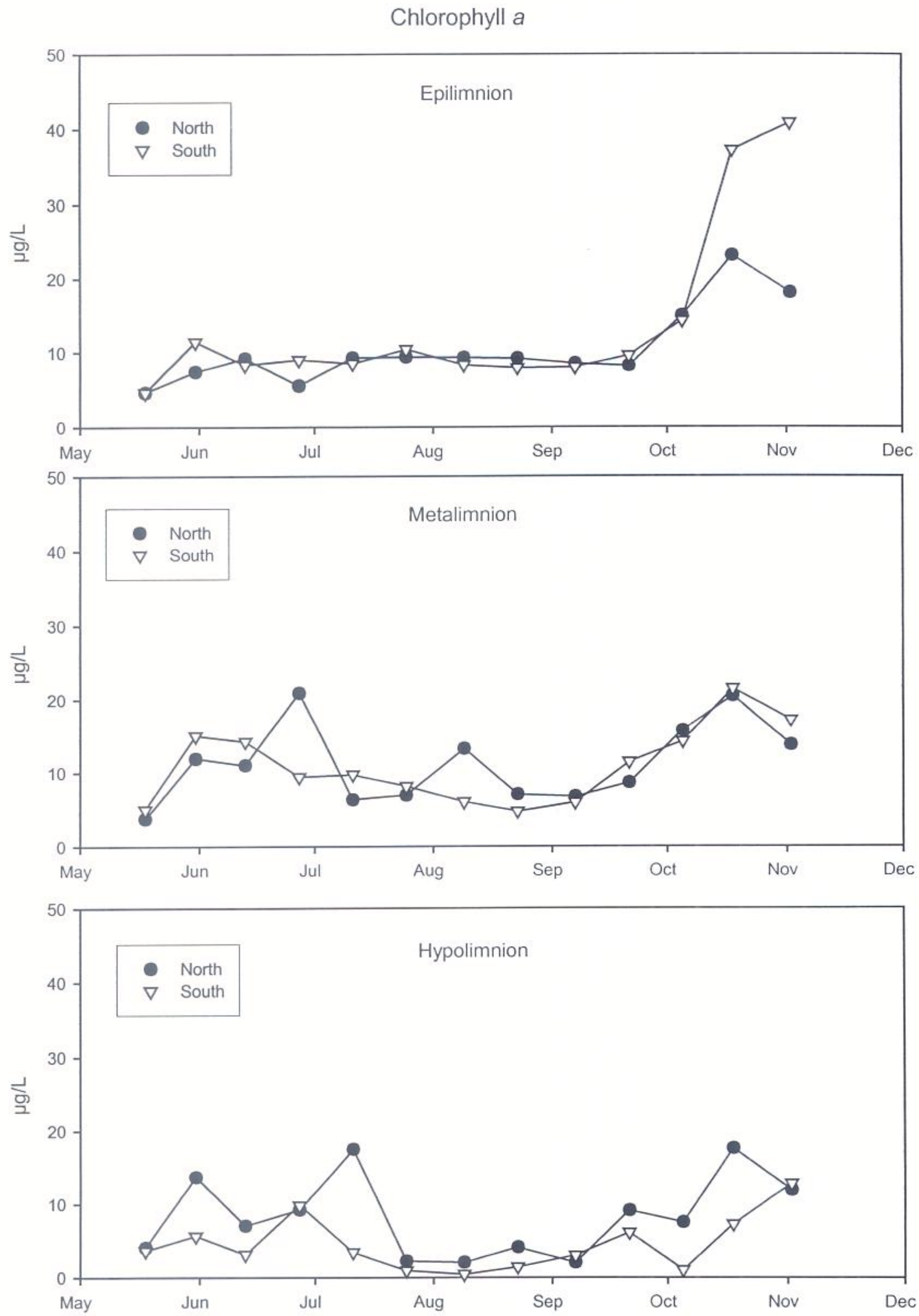

Figure 17. Seasonal chlorophyll concentrations in the north and south basins of Conesus Lake.