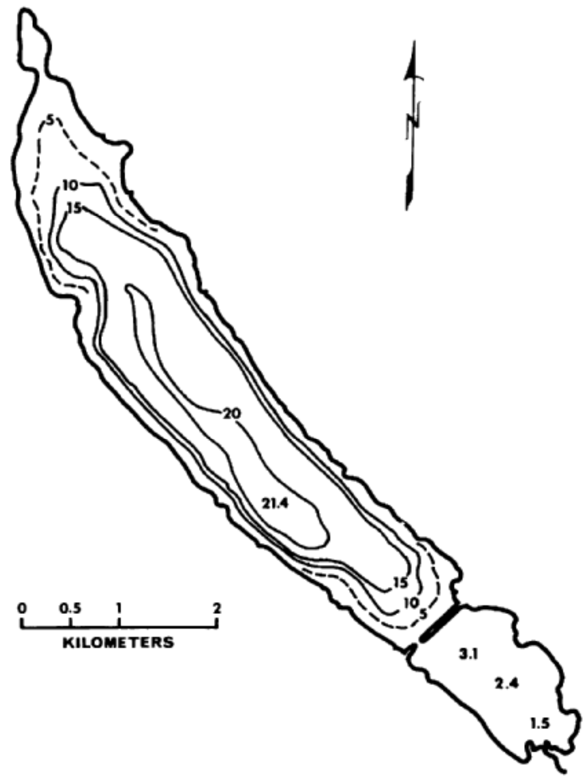
Chapter 11: Individual Lake Summaries

Previous discussions focused upon overall conditions within the 11 Finger Lakes and comparisons between the lakes. The purpose of this chapter is to provide a synopsis for each individual lake with respect to current conditions, chemical trends, and issues of concern. The lakes are discussed moving from east to west, beginning with Otisco Lake and finishing with Conesus Lake.

Otisco Lake

Otisco Lake (see Figure 11.1) is one of the smaller Finger Lakes. The lake and entire watershed are located in Onondaga County. The lake is a multi-purpose water body, and is a source of public water supply for the City of Syracuse. Otisco Lake has a water use classification of “AA”, and is currently listed on the NY State PWL due to bathing impairments related to silt. The lake is somewhat unusual in that it is segmented by a causeway. The two segments are joined by a rather narrow opening on the southwest side of the structure. The southern (or southeast) portion of the lake is quite shallow and receives a large percentage of the inflow to the lake. This situation, coupled with the limited mixing between the two segments, results in significant differences in water quality conditions in the adjoining segments. The southeast portion of the lake tends to show significantly higher concentrations of phosphorus and chlorophyll a, and lower water clarity. The primary focus of this investigation is on the north-west, or main, portion of the lake.

Figure 11.1: Otisco Lake



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Otisco Lake is best characterized as eutrophic due to its chlorophyll *a*, water clarity, and hypolimnetic dissolved oxygen levels. Findings suggest that trophic conditions within the lake have increased moderately over the past several decades. This is reflected by the fact that total phosphorus and chlorophyll *a* levels have increased somewhat since the early 1970s. The hypolimnion of Otisco Lake becomes anoxic during the summer and early fall. It is unclear whether anoxic conditions within the hypolimnion of Otisco Lake are human-induced or natural in origin. Major ion trends within Otisco Lake over the past several decades indicate *declines* in calcium, magnesium, and alkalinity levels, and *increases* in sodium, chloride, and sulfate levels.

Sediment core findings from Otisco Lake show a sediment accumulation rate of 0.74 cm/year. This is the highest sediment accumulation rate of all the Finger Lakes. *Organic* chemical findings from the Otisco Lake sediment core are limited to PCB congeners (organochlorine pesticides were not run on these core samples) from a single core segment. The total PCB congener concentration found in this core segment is 245 ppb, which is in the middle range of levels found in the other Finger Lakes, and is above the TEL and slightly below the PEL for total PCBs. No clear Aroclor pattern was present in the sample. DDT levels were not assessed for Otisco Lake. *Inorganic* chemical findings from the Otisco Lake sediment core indicate that copper levels exceed the TEL within the surficial sediments. Furthermore, historical copper levels exceed the PEL for copper. Copper levels within Otisco Lake sediments raged from 35–308 ppm. Copper levels began to rise markedly in the early 1960s and reached a maximum concentration in the early 1970s. The trend in copper levels is likely the result of copper sulfate treatments for the control of algae that have occurred periodically within the lake since the early 1960s. Additional inorganic findings indicate: (a) Arsenic levels within Otisco Lake range from below detection to 11 ppm, and two of the mid-depth core segments exceed the TEL; (b) Calcium levels within Otisco Lake *sediments* have increased significantly during the past half-century, which is in contrast to *water column* trends over the past three decades. Calcium levels range from 17,600-94,900 ppm; (c) Chromium levels range from 28-58 ppm, and show no clear temporal trend - levels are above the TEL; (d) Manganese levels range from 890-1,660 ppm, and have increased modestly over the past several decades; (e) Nickel levels range from 28-58 ppm, with no apparent temporal trend, and are above the PEL; and (f) Zinc levels range from 120-194 ppm with no apparent temporal trend, and are above the TEL.

Recommendations for Otisco Lake are as follows. *First*, management actions to control cultural eutrophication within the watershed are advisable. There are currently several efforts underway to implement Best Management Practices (BMPs) within the watershed. Addition efforts should be directed at understanding the internal cycling of phosphorus within the lake and the impacts of anoxia within hypolimnetic waters. *Second*, water quality trends indicate an increase in the concentration of chloride and sodium levels within the lake. Thus, measures to control inputs of chloride and sodium to the lake should be implemented. *Third*, sediment core PCB findings would suggest that periodic monitoring of PCB levels in aquatic biota should be continued in Otisco Lake. *Fourth*, calcium increases observed within the sediments of Otisco Lake over the past several decades may lead to an exacerbation of Zebra mussel related issues within the lake in coming years. Thus, as with the other Finger Lakes, it is suggested that Zebra mussel population dynamics be studied within the lake. The study should include examination of population dynamics, investigation of the cause(s) of calcium increases within lake sediments, and the availability of pore water calcium to Zebra mussel populations. *Fifth*, as with a number of the Finger Lakes, nickel levels within Otisco Lake sediments exceed the TEL and PEL. Thus, efforts to understand the origin(s) and implications of these nickel levels are advisable.

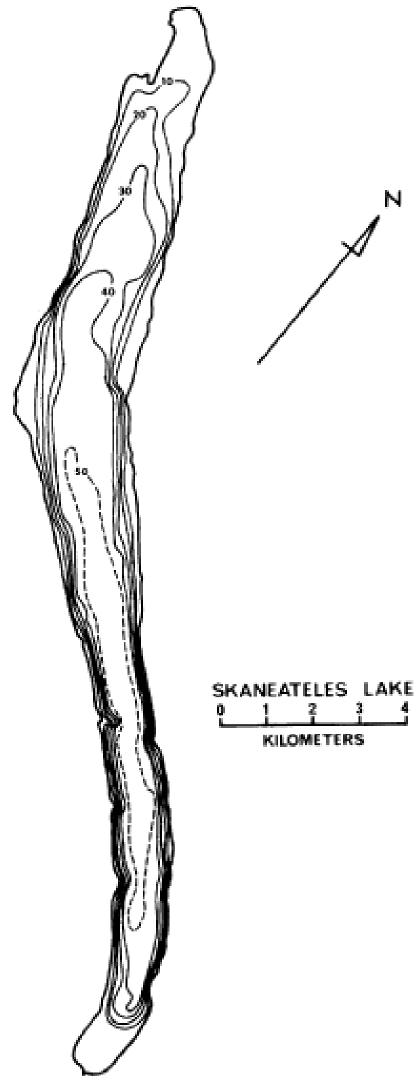
Skaneateles Lake

Skaneateles Lake (see Figure 11.2) is one of the six larger Finger Lakes. The lake itself is located in Onondaga County, with the watershed extending into Cayuga County and a small portion of Cortland County. The lake is a multi-use water body, and is a major source of public water supply for the City of Syracuse. Skaneateles Lake has a water use classification of "AA", and there are significant watershed protection measures in place within the watershed. In fact, Skaneateles Lake is one of only eight lakes within New York State with explicit statutory restrictions with respect to sewage discharge within the lake and watershed. Article 17, Title 17, section 17-1709 of New York State Environmental Conservation Law (ECL) states:

> "*No person or corporation shall cause or permit the fall, flow or discharge into Lake George or Skaneateles lake or any of their tributaries, of any sewage matter, or other foul, noxious or deleterious, solid or liquid matter or effluent from any sewage disposal plant, or any matter that may be declared such by the board of health of any municipality adjacent to such lakes where any such fall, flow or discharge shall occur.*" (NY State ECL, 2000).

Despite this protection, Skaneateles Lake is currently listed on the NY State PWL due to water supply concerns related to pathogens.

Figure 11.2: Skaneateles Lake



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Skaneateles Lake is an oligotrophic lake, as evidenced by total phosphorus, chlorophyll *a*, water clarity, and hypolimnetic dissolved oxygen levels. Findings suggest a marked reduction in trophic conditions over the past several decades. For example, the mean total phosphorus concentration observed during the present study is 4.0 ug/l, as compared to approximately 6.0 ug/l in the early 1970s. Similar reductions are apparent for chlorophyll *a*. The mean chlorophyll *a* concentrations measured in the early 1970s and the late 1990s, are approximately 2.0 ug/l and 0.7 ug/l, respectively. While water clarity levels have not changed by a similar degree, they have increased. Mean Secchi Disk depth measurements for the two periods were 6.6 m (1970s) and 7.7 m (1990s). These changes in trophic indicator levels are likely the result of management actions (e.g., phosphate detergent ban, on-site system controls, etc.) that have taken place over the past quarter century. The hypolimnetic waters of Skaneateles Lake remain well oxygenated throughout the growing season. Major ion trends within Skaneateles Lake over the past several decades indicate *declines* in magnesium, and sulfate levels, and *increases* in sodium, and chloride levels.

Sediment core findings from Skaneateles Lake indicate a sediment accumulation rate of approximately 0.2 cm/year. This is one of the lowest accumulation rates recorded within the Finger Lakes and reflects the relatively low productivity within the lake. *Organic* chemical findings from the Skaneateles Lake sediment core are limited to PCB congener levels from a single core segment. The total PCB congener concentration observed (286 ppb) is in the middle range of levels observed in the other Finger Lakes, and is above the TEL and slightly above the PEL for total PCBs. The pattern is not consistent with any specific Aroclor formulation, however, there were elevations in both lower chlorinated congeners and higher chlorinated congeners. DDT levels were not assessed in Skaneateles Lake. *Inorganic* chemical findings for Skaneateles Lake indicate a marked elevation in arsenic and manganese concentrations within the upper sediment layers of the lake. This pattern is also apparent in several other Finger Lakes cores. Arsenic and manganese levels within Skaneateles Lake sediments range from 10-34 ppm and 1,290-8,810 ppm, respectively. The cause(s) of the surficial sediment enrichment in arsenic and manganese is not certain – see discussion in Chapter 9. The arsenic levels detected in the upper sediment layers of Skaneateles Lake exceed both the TEL and PEL. As indicated earlier, follow-up water column monitoring conducted during 1999, albeit limited, did not detect arsenic within the water column. Additional inorganic chemical findings from the Skaneateles Lake sediment core analysis include the following: (a) Calcium levels range from 8,320-33,300 ppm, and have increased markedly over the past two decades; (b) Chromium levels range from 32-55 ppm, with no apparent temporal trends, and exceed the TEL but are below the PEL; (c) Copper levels range from 44-78 ppm and are generally static over time – levels exceed the TEL but are below the PEL, (d) Lead levels range from below detection to 102 ppm and have declined modestly over time, but remain above the TEL; (e) Nickel levels range from 56-72 ppm and remain largely constant over time, however, levels exceed both the TEL and PEL; (f) Zinc levels range from 155-242 ppm and have increased somewhat in the last decade, or so. Zinc levels exceed the TEL.

Recommendations for Skaneateles Lake and its surrounding watershed are as follows. *First*, efforts to control nutrient loading to Skaneateles Lake over the past several decades appear to have been effective, as evidenced by reductions in primary productivity (algal growth) over the intervening time period. Therefore, it is recommended that these measures continue in the future. *Second*, chloride and sodium levels have increased within Skaneateles Lake over the past several decades. Thus, measures to control the input of salt to the lake should be implemented and/or enhanced. *Third*, sediment core PCB findings would suggest that continued monitoring of PCB levels in aquatic biota is warranted within Skaneateles Lake. *Fourth*, calcium increases observed within the sediments of Skaneateles Lake over the past several decades may lead to an exacerbation of Zebra mussel related issues within the lake in coming years. Thus, as with the other Finger Lakes, it is suggested that Zebra mussel population dynamics be studied within the lake. The study should include examination of population dynamics, investigation of the cause(s) of calcium increases within lake sediments, and the availability of pore water calcium to Zebra mussel populations. *Fourth*, as discussed above, sediment core findings indicate an enrichment of arsenic and manganese within the upper sediment layers of Skaneateles Lake, as well as several other Finger Lakes. It is recommended that additional investigation of this phenomenon be undertaken. Future study should focus upon the following: (a) implications for public exposure to arsenic, particularly via drinking water supplies – while preliminary investigations proved encouraging, additional study is warranted, and (b) the cause(s) for the observed enrichment in arsenic and manganese levels within upper sediments – is the underlying cause(s) of the observed enrichment related to increased arsenic loading within the watershed, physio-chemical processing of the compounds, reductions in primary productivity within the lake, etc. *Fifth*, as with a number of the other Finger Lakes, nickel levels within the sediments of Skaneateles Lake are above the TEL and PEL. Thus, additional study regarding: (a) the source(s) of nickel to the Skaneateles Lake watershed, and (b) possible adverse environmental effects is warranted.

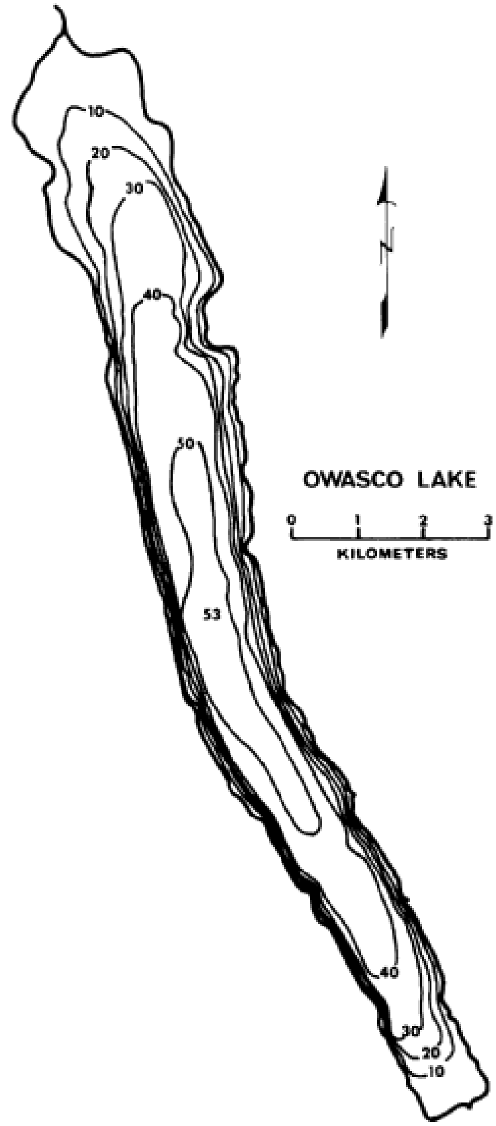
Owasco Lake

Owasco Lake (see Figure 11.3) is one of the six larger Finger Lakes. The lake itself is entirely within Cayuga County, while the watershed includes parts of Cayuga County and Tompkins County. Owasco Lake is a multi-use water body. The lake has a water use classification of "AA(T)", and serves as a source of water supply for the City of Auburn and the Town of Owasco. As with Skaneateles Lake, Owasco Lake is explicitly protected by NY State ECL. Article 17, Title 17, section 17-1704 of New York State Environmental Conservation Law (ECL) states:

> "*No person or corporation shall cause or permit the fall, flow or discharge into the surface waters of the Owasco Lake watershed extending from the city dam on the outlet to the existing Moravia village outfall sewer on the inlet, of any sewage matter, or other foul, noxious or deleterious, solid or liquid matter or effluent from any wastewater disposal system located therein except for those operating under a duly authorized permit from the state or county health departments and except for run-off from accepted agricultural practices*." (NY State ECL, 2000).

Despite this protection, Owasco Lake is currently listed on the NYSDEC PWL due to bathing impairments related to pathogens.

Figure 11.3: Owasco Lake



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Owasco Lake is best characterized as mesotrophic with respect to all three trophic indicators. The lake has shown a moderate decline in primary productivity over the past 2-3 decades as demonstrated by the reduction in chlorophyll *a* levels from 5.5 ug/l in the early 1970s to 3.8 ug/l in the late 1990s. The other two trophic indicators have shown less significant changes, with water clarity levels declining only marginally, and total phosphorus levels remaining, essentially, constant. As in earlier years, the hypolimnion of Owasco Lake remains fairly well oxygenated throughout the growing season. Major ion trends within Owasco Lake over the past several decades indicate *declines* in calcium and sulfate levels, and *increases* in sodium and chloride levels. Owasco Lake was the only one of the Finger Lakes not to show a marked decline in magnesium concentration over the past several decades. The reason for this exception is not clear. Sediment core findings from 1998 regarding arsenic enrichment (see further discussion below) prompted follow-up water column sampling of all the Finger Lakes during 1999. This monitoring recorded only one sample with a detectable level of arsenic – this was an epilimnetic sample taken from Owasco Lake in September 1999 at a depth of approximately 4 m. The arsenic concentration of this sample was 10 ug/l, which is just above the detection level. Interestingly, Owasco Lake did not exhibit the marked arsenic enrichment within surficial sediments that was apparent in several of the other Finger Lakes.

Sediment core findings from Owasco Lake indicate a sediment accumulation rate of 0.38 cm/year. This is in the middle range of sediment accumulation rates observed within the Finger Lakes. *Organic* chemical findings from the Owasco Lake sediment core are limited to PCB congeners from a single core segment. The sediment PCB congener level was 374 ppb, which is in the upper range of levels observed within the Finger Lakes, and exceeds the PEL for total PCBs. The congener pattern was dominated by lower chlorinated congeners, indicative of Aroclor 1242 or 1016. DDT levels were not assessed in Owasco Lake. *Inorganic* chemical findings from the Owasco Lake sediment core are as follows: (a) Arsenic levels range from 4-14 ppm and demonstrate a slight increase over the past several decades. Arsenic levels are above the TEL but below the PEL; (b) Calcium levels range from 33,600-90,200 ppm, and show a marked increase beginning in the early 1960s, with a nearly three fold increase since the 1940s; (c) Chromium levels range from 27-52 ppm and show significant fluctuation over time. Chromium levels are above the TEL, but below the PEL; (d) Copper levels range from 29-44 ppm and are moderately elevated within surficial sediments - levels are above the TEL; (e) Lead levels range from below detection to 73 ppm. Lead levels reach a maximum in the mid-1960s and show a marked decline over the past 3-4 decades. Lead levels are above the TEL, but below the PEL; (f) Manganese levels range from 596-3,630 ppm and show significant enrichment within surficial sediment layers; (g) Nickel concentrations range from 39-66 ppm and fluctuate somewhat over time, but show no consistent trend. Nickel levels are above the TEL and PEL; and (h) Zinc levels range from 115-176 ppm and also fluctuate somewhat over time. Zinc levels are above the TEL but below the PEL.

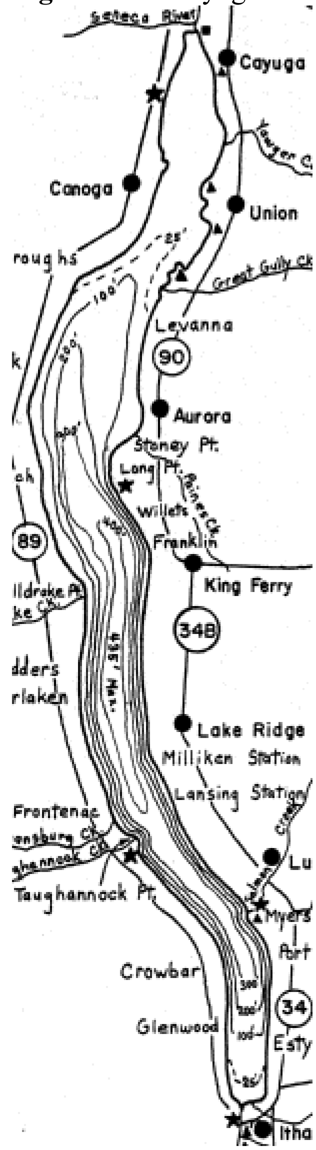
Recommendations for Owasco Lake are as follows. *First*, unlike most of the other large Finger Lakes, Owasco Lake showed little reduction in ambient total phosphorus levels between the 1970s and 1990s. This would suggest that Owasco Lake has not had a significant reduction in external phosphorus loading over the past several decades. Therefore, efforts to reduce external nutrient loading to Owasco Lake should continue. *Second*, chloride and sodium levels within Owasco Lake have increased over the past several decades. Thus, measures to control the input of salt to the lake should be implemented. *Third*, sediment core PCB findings from Owasco Lake would suggest that monitoring of PCB levels in aquatic biota should be continued. *Fourth*, sediment core findings indicate a moderate degree of arsenic enrichment, and a more pronounced, manganese enrichment in Owasco Lake surficial sediments. While sediment arsenic enrichment is less pronounced in Owasco Lake than in some of the other Finger Lakes, the fact that a water column sample did show a detectable level of arsenic, would suggest the need to include Owasco Lake in future arsenic investigations within the Finger Lakes – see Sediment Core recommendations. *Fifth*, calcium increases observed within the sediments of Skaneateles Lake over the past several decades may lead to an exacerbation of Zebra mussel related issues within the lake in coming years. Thus, as with the other Finger Lakes, a Zebra mussel monitoring program is recommended for Owasco Lake. The study should include examination of Zebra mussel population dynamics, investigation of the cause(s) of calcium increases within lake sediments, and an assessment of the availability of calcium in sediment pore water to Zebra mussel populations. *Sixth*, as with a number of the Finger Lakes, nickel concentrations within Owasco Lake sediments are elevated. Thus, additional study of the origin(s) and possible environmental effects of nickel levels may be warranted.

It is important to reiterate that this study did not assess bacteriological conditions within the lakes. Given past issues regarding beach closures and coliform contamination within the lake, it would seem prudent to continue efforts to identify and control bacteriological contaminant sources to the lake.

Cayuga Lake

Cayuga Lake (Figure 11.4) is the longest of the Finger Lakes, and second only to Seneca Lake with respect to lake volume. The lake basin itself is within Cayuga, Seneca, and Tompkins Counties, while the watershed extends slightly into three additional counties, namely, Cortland, Schuyler, and Tioga Counties. Cayuga Lake is a multi-use water body, and supports uses ranging from water supply to wastewater assimilation. Cayuga Lake serves as a source of water supply for a number of municipalities within the watershed, including the City of Ithaca, the Towns of Dryden and Lansing, and the Villages of Aurora, Cayuga, Cayuga Heights, and Seneca Falls. The City of Ithaca, which is the largest municipality within the Finger Lakes Region, is situated at the southern end of the lake. Cayuga Lake carries several water use classifications ranging from “AA(T)”for most of the deep basin to “B” at the northern end of the lake.

Figure 11.4: Cayuga Lake



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Several segments of Cayuga Lake are listed on the NYSDEC PWL. The northern end of the lake is listed on the PWL due to swimming and boating impairments related to aquatic plant growth. The primary pollutant of concern in this portion of the lake is nutrients. The southern end of the lake is listed on the PWL due to water supply issues and swimming impairments. The primary pollutants in this portion of the lake are sediments and nutrients. The southern end of Cayuga Lake is also listed on the 303(d) list.

Given the variation in water quality conditions present in Cayuga Lake, monitoring sites were established in both the main lake (proximate to Taughannock Falls State Park) and within the shallow southern delta (see Table 4.1 for approximate coordinates of monitoring sites). For the purposes of this report, the southern delta or “shelf” of the lake is defined as extending from the south-eastern terminus of the lake north for approximately 2.0 km to McKinney’s Point and on the west side of the lake from the confluence with Indian Creek to the south-west end of the lake – this is approximately the area carrying a water use class of “A” (NYSDOS, 1999). The main, or deep portion of the lake is defined as extending from the northern edge of the south shelf north to Cooneys Corners Road (Lat. 42 47 51, Long. 76 40 47.9). The northern shelf is defined to be from Cooney’s Corners Road north to the end of the lake. The remainder of this discussion will focus upon the main portion of the lake and the southern shelf. Unfortunately, resource limitations and logistical considerations precluded sampling of the northern portion of Cayuga Lake.

Main Lake

Water quality conditions in the main portion (deep basin) of Cayuga Lake are generally good. From a trophic perspective, the main lake is best characterized as borderline between oligotrophic and mesotrophic. Results from this investigation indicate seasonal means for total phosphorus, chlorophyll *a*, and Secchi Disk depth of approximately 10 ug/l, 3.5 ug/l, 4.0 m, respectively. Other studies [Sterns and Wheler, 1997, and Upstate Freshwater Institute (UFI), 2000)] show somewhat different trophic conditions for the deep lake – see Table 11.1. These differences are likely due to variations in site selection, sampling methodology, etc. Trends from this study indicate a decline in the major trophic indices over the last several decades. Total phosphorus levels exhibit the most pronounced decline - from approximately 18 ug/l during the late 1960s to approximately 10 ug/l in the later 1990s. Less pronounced changes are apparent for chlorophyll *a* (4.2 ug/l to 3.5 ug/l) and Secchi Disk depth (3.6 m to 4.0 m). The disparity in the level of change for the various trophic indicators is somewhat puzzling. The reduction in productivity levels within the main lake is generally viewed as a positive development. The marked declines in total phosphorus levels are likely the result, at least in part, of the nutrient control measures discussed earlier. However, it is possible that the introduction of Zebra mussels to the lake have also contributed to observed nutrient reductions. As in the past, the hypolimnetic waters of the Cayuga Lake appear to remain fairly well oxygenated throughout the growing season. The trend for major ions within the main portion of Cayuga Lake over the past several decades indicate substantial reductions in sodium and chloride, and more modest declines in sulfate and alkalinity levels. The trend observed in sodium and chloride levels within Cayuga Lake continues a trend observed during previous studies (Effler, et al. 1989). Effler, et al. modeled chloride concentrations within the lake and concluded that concentrations would continue to decline to a steady-state concentration of approximately 30 mg/l by approximately circa 2000.

Sediment core findings from Cayuga Lake are limited due to several issues. *First*, radiometric findings were not sufficient to establish sediment chronologies from the sediment core (see earlier discussion). Previous studies (Yager, 2001) indicate an average sediment accumulation rate of approximately 0.4 cm/year in Cayuga Lake, which is in the middle range of sediment accumulation rates observed within the Finger Lakes. Given that radiometric dating proved unsuccessful, chemical findings from the Cayuga Lake sediment core can only be interpreted as composite values. *Second*, chemical findings from the Cayuga Lake sediment core indicate remarkably low levels for a number of chemical compounds. *Organic* chemical findings indicate total PCB levels are the lowest observed within the Finger Lakes cores, and total DDT levels were the second lowest for the Finger Lakes. *Inorganic* chemical findings for Cayuga Lake also suggest unusually low levels of many of the trace elements investigated during this study. For example, the concentrations of arsenic, chromium, copper, lead, nickel, and zinc in the Cayuga Lake sediment core are the lowest of all of the Finger Lakes. In some instances, chemical levels observed within the Cayuga Lake sediment core are *less than half* the levels observed in the other Finger Lakes (including Hemlock Lake – which also exhibited a radiometric profile indicative of disturbed sediments). Thus, it is believed that the chemical levels observed within the Cayuga Lake core are not indicative of levels for Cayuga Lake sediments in general.

There are several possible explanations for these observations. *First*, it is conceivable that the Cayuga Lake sediment core is substantially lower in organic material than are cores from the other Finger Lakes. Organic material is particularly effective in sorbing many chemicals. Thus, if the Cayuga Lake sediment core contained less organic material relative to the sediment cores from the other Finger Lakes, it would have a diminished capacity to sorb chemical substances. It is possible that the Cayuga Lake core could have been from a "sand bar" or shelf area – and may have contained a disproportionate amount of large grained or sand particles. Unfortunately, organic carbon levels (and particle sizes) were not assessed in the Cayuga Lake core, so evaluation of this hypothesis cannot be accurately assessed. As indicated earlier, the sample location for the Cayuga Lake sediment core had to be adjusted (moved to shallower water) due to equipment limitations (winch cable length). By comparison, the Cayuga Lake sediment core was collected in approximately 65 m of water, whereas, the Seneca Lake core was collected in approximately 130 m of water. *Second*, it is possible that the sample location for the Cayuga Lake sediment core was subject to elevated depositional rates due to productivity levels within the south lake. If this were the case, the large influx of organic material could have a dilutional effect on other chemical substances in the core and result in lower chemical concentrations – recall that chemical levels are reported on a weight per weight basis. As will be discussed below, productivity levels within the southern end of Cayuga Lake are markedly higher than in the main lake. Furthermore, it is possible to interpret the radiometric data (see Figure 9.3) as indicating a much higher depositional rate than discussed previously. For example, if one assumes this to be an intact sediment core, then the cesium peak occurs at 30 cm, which would indicate a sediment accumulation rate of greater than 1 cm/year. However, the lack of a cesium horizon, as well as past sediment core investigations would suggest that such a high accumulation rate is unlikely.

Recommendations for the main portion of Cayuga Lake are as follows. *First*, comparison of recent findings to those of several decades ago, indicate that trophic conditions within the main portion of Cayuga Lake have declined somewhat over the past several decades. This trend is generally viewed as a positive development, and nutrient control efforts should be continued within the watershed - particularly within the south lake (see following discussion). *Second*, the sediment core findings from Cayuga Lake are not particularly informative, and given recent concerns regarding hazardous waste site(s) in the southern catchment, it would be prudent to collect at least one additional sediment core from the lake. Given the difficulties encountered during the present study several recommendations are suggested regarding future coring efforts. Sediment core(s) should be collected from deep-water locations (> 100 m) to maximize the likelihood of obtaining intact radiometric profiles (undisturbed sediments). In addition, future sediment core investigations should consider extracting multiple sediment cores. The entire set of cores would not need to be fully analyzed, but preliminary analyses (radiometric dating) could be conducted on several of the cores to determine which of the cores would be most suitable for more extensive chemical evaluation. It might also be informative to consider collecting several sediment cores along the north-south axis of the lake to evaluate longitudinal gradients within the lake. Should an additional sediment core(s) be collected from the lake, it is recommended that PCB analyses focus upon congener analyses as opposed to Aroclor analyses. In addition, methods for mercury analyses should be chosen to achieve acceptable detection levels (at least one order of magnitude below existing sediment quality guidance levels).

South Lake

Water quality conditions within the southern end of Cayuga Lake have been of concern to area residents for several decades. Issues of concern include: (1) permanent closure (in the early 1960s) of a public swimming beach due to water clarity and bacteriological issues, (2) drinking water concerns related to sediments and trihalomethane (THM) precursors, and (3) aesthetic concerns related to algal blooms, macrophyte growth, odors, etc.

As was highlighted in the July 4, 1998 issue of the Ithaca Journal (1998), concerns about the absence of a public beach at the southern end of Cayuga Lake have existed for several decades. Up until the early 1960s, a public bathing beach was operational at the southern end of Cayuga Lake (Stewart Park). However, public records indicate that water quality concerns about the Stewart Park beach increased during the early 1960s. The beach went through a series of temporary closures during the early 1960s due to a combination of limited water clarity and bacteriological concerns. There was also at least one drowning at the beach during this time frame that was, at least in part, attributed to lack of water clarity in the area. The beach was closed permanently after the 1964 swimming season. The viability of reopening a public beach in this area is not known at this time due to a lack of understanding regarding water quality dynamics within this portion of the lake.

There are also concerns regarding THM levels in the regional public water supply (PWS) taken from Cayuga Lake. THMs are a class of organic chemicals formed as a by-product of certain disinfection processes (e.g., chlorination). It is important to note that the disinfection of public water supplies has been an extremely successful public health effort and has greatly reduced the threat of waterborne diseases such as typhoid, cholera, and dysentery. However, chlorination of potable water supplies, which is the primary method of disinfection in use today, also results in the production of undesirable chemical compounds such as THMs. This class of organic compounds has been linked to certain forms of cancers and other adverse health effects. THMs are formed as a result of a chemical reaction(s) between chlorine and natural organic matter (NOM). Several factors play a role in the formation of THMs including the concentration of NOM, the chlorine dosage, and the length of chlorine contact time. The USEPA has issued a *Stage 1 Disinfectant and Disinfection Byproducts Rule* which calls for all public water supply (PWS) systems serving greater than 10,000 people to meet certain criteria related to THMs. The current rule requires that total THMs not exceed 100 ug/l based on a running annual average (EPA, 1999). More stringent requirements are also scheduled for implementation in several years under the Stage 2 rule. The Bolton Point Municipal Water System (BP-MWS), which draws water from Cayuga Lake, is located approximately 4 km (2.5 miles) from the southern end of the lake. Total THM levels in finished water from the BP-MWS ranged from 44-116 ug/l during 1999 (Bolton Point Municipal Water System, 2000). Thus, THM levels are a concern within the BP-MWS. The plant has been investigating methods to reduce THM levels over the past few years (BP-MWS, 2000). However, it is likely that reductions in NOM – via reductions in loadings of sediments and nutrients to the south lake would assist plant managers in controlling THM levels within the water supply system.

Finally, there are also concerns within the southern end of Cayuga Lake relating to aesthetics. Citizen complaints include noxious odors, nuisance algal blooms, and extensive growth of rooted aquatic plants, among other complaints. Levels of concern tend to vary over time due to the natural variations in water quality conditions within the lake. The concerns are believed to stem primarily from issues of cultural eutrophication and sediment dynamics.

Findings from this investigation indicate a substantial gradient in total phosphorus levels from the southern terminus of Cayuga Lake to the main lake site. Mean total phosphorus levels within the south lake were 17.2 ug/l, versus approximately 10 ug/l at the main lake site. Other trophic parameters (chlorophyll *a* and Secchi Disk depth) did not show a similar longitudinal gradient during this study. However, other investigations [Sterns and Wheler, 1997, and UFI, 2000)] have documented such gradients for other trophic parameters - see Table 11.1. These studies also indicate that total phosphorus levels within the south lake regularly exceed the New York State total phosphorus guidance value of 20 ug/l. The UFI study, sponsored by Cornell University as part of its Lake Source Cooling (LSC) permit conditions, provides the best spatial resolution in water quality conditions within the south lake. The UFI study indicates that water quality conditions vary substantially within the south shelf area. In general, findings suggest that trophic indicators tend to be higher (elevated total phosphorus and chlorophyll *a*, and lower water clarity) on the eastern side of the southern shelf than on the western side. This is consistent with predominant circulation patterns that exist in the south-lake which tend to move in a counter-clockwise direction, and thus, carry tributary loads to the eastern side of the lake. Unfortunately, historical records (prior to the mid to late 1990s) for trophic parameters in the south lake are not available, and thus, long-term temporal changes could not be assessed. There is also some indication that Zebra mussels may be influencing water quality conditions within the south-lake and may account for the general trend toward lower levels of phosphorus and chlorophyll a, and increases in water clarity. As discussed earlier, the presence of Zebra mussels can significantly modify aquatic ecosystems due to their efficient filtration of suspended particulate material. While a formal investigation has not been a part of this study, visual observations during the latter half of this investigation indicate significant numbers of young Zebra mussels affixed to aquatic macrophytes within the south-lake (see Figure 5.20).

Table 11.1: Trophic indicator findings from past water quality investigations of Cayuga Lake

	Total P (ug/l)		*Chlorophyll a (ug/l)*		*Secchi Disk (m)*		
Year	*Main Lake*	*S. Lake*	*Main Lake*	*S. Lake*	*Main Lake*	*S. Lake*	*Reference*
1994	22.4	30.8	4.1	8.9	2.1	1.5	Sterns and Wheler, 1997
1995	16.3	23.7	4.8	6.8	2.2	1.7	Sterns and Wheler, 1997
1996	13.2	25.7	3.4	7.6	2.5	1.9	Sterns and Wheler, 1997
1998	14.7	26.5	4.8	5.7	-	-	UFI, 2000
1999	10.6	15.9	4.7	4.4	-	-	UFI, 2000

Note: Station(s) varied between studies

Current use impairments within the south end of Cayuga Lake, coupled with water quality findings from this and other studies, indicate that conditions within the south lake are degraded. However, while it is clear that water quality conditions within the south lake are degraded, current understanding as to the causes of the degradation and water quality dynamics within the south lake are limited. There are significant data gaps within both the south lake and the contributory watershed that need to be more fully defined and understood.

There are several studies underway within the Cayuga Lake watershed that should contribute to a better understanding of water quality issues within the south lake. These efforts include both in-lake activities and watershed activities. In-lake activities include: (1) water column sampling by the Upstate Freshwater Institute (UFI) in association with the Cornell LSC discharge permit and by NYSDEC as part of the Long-term Synoptic Study, and installation of a Robotic Underwater Sampling Station (RUSS) unit and associated hydrodynamic study being conducted by Cornell University. Watershed activities currently underway include event-based monitoring efforts on Six Mile creek being conducted by USGS and the City of Ithaca, planned event-based monitoring of Fall Creek and the Cayuga Inlet by the NYSDEC, and watershed modeling efforts being conducted within the Fall Creek watershed by Cornell.

Beyond the ongoing and planned studies discussed above, several additional measures are recommended for the southern end of Cayuga Lake to more fully characterize water quality dynamics within the south lake. *First*, given the reality of limited resources, it is important that the activities already underway be coordinated to maximize the efficiency and minimize the redundancy of existing studies. This should include regular meetings to discuss study plans, findings, and related topics. *Second*, an effort should be initiated to develop detailed material loading estimates for all three major tributaries to the south lake. This effort will require the collection of water samples in conjunction with flow measurements proximate to the mouths of the three major tributaries to the south-lake. Fortunately, the USGS currently maintains flow gages on all three tributaries. In addition to flow measurements, water samples will need to be collected from the tributaries. At a minimum, sample parameters should include total phosphorus, soluble reactive phosphorus, total suspended solids, and chlorides. Tributary material loads are often dominated by high flow events. Thus, it is essential that water samples be collected across a broad spectrum of hydrologic conditions, and that every effort be made to capture significant *storm events*. Given the importance of capturing storm-events, the study should be conducted over a several year period so as to increase the likelihood of capturing as many high-flow events as possible. *Third*, a deterministic, coupled, watershed/lake mass balance model should be developed for the southern catchment to determine the relative importance of the various forcing conditions within the south lake segment. *Fourth*, a total maximum daily load (TMDL) should be developed to address the various issues of concern within the south lake. This effort should focus on current use impairment issues within this lake segment including preclusion of public swimming beach, THM issues, and aesthetic concerns.

Seneca Lake

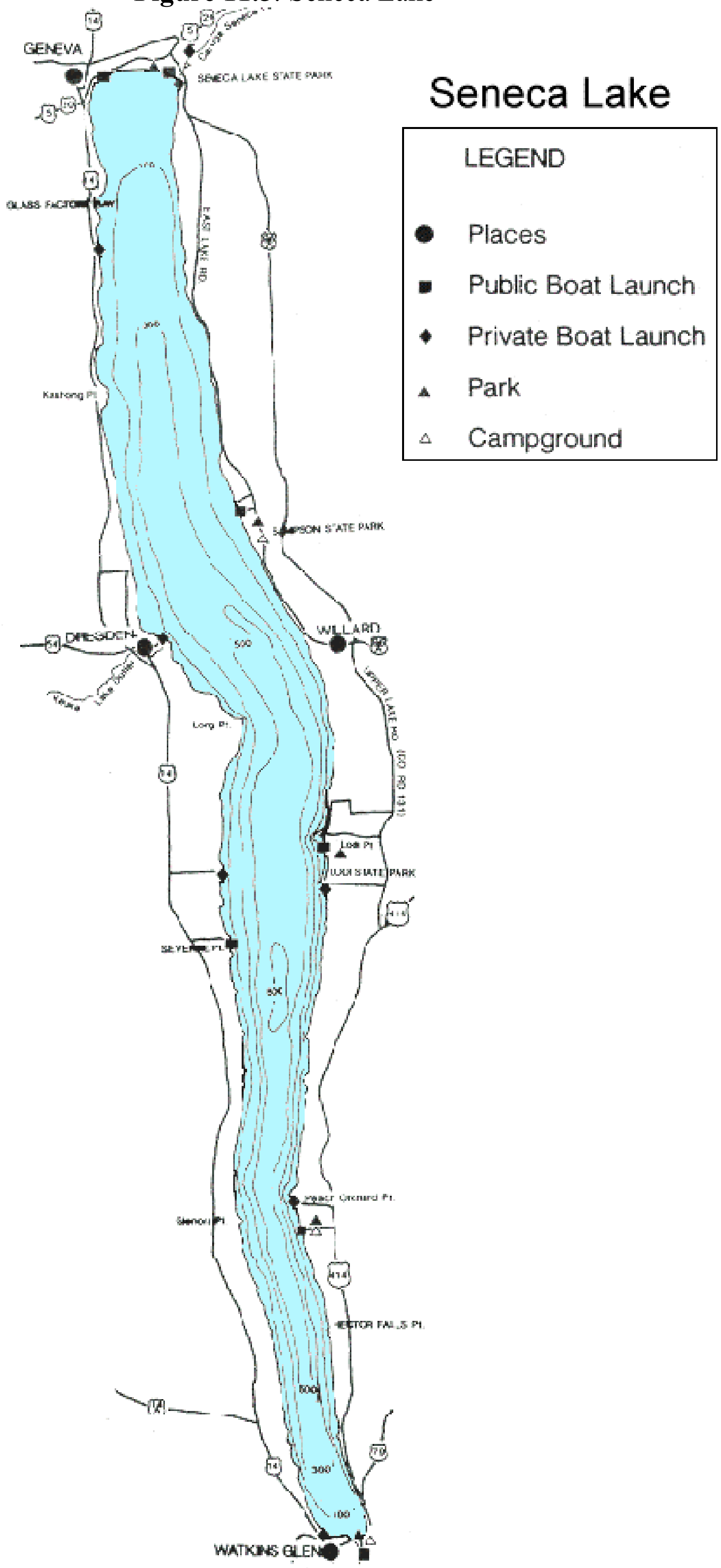
Seneca Lake (see Figure 11.5) is the largest of the Finger Lakes with respect to lake volume, and is the second longest of the 11 lakes. The lake itself is situated in Schuyler, Seneca, and Yates County, while the watershed also extends into Chemung and Ontario Counties. Seneca Lake is a multi-use water body and serves as a source of water supply for the City of Geneva and the Villages of Ovid, Waterloo, and Watkins Glen. As with Cayuga Lake, Seneca Lake has several water use classifications ranging from "AA(TS)" within much of the deep basin to "B" at the northern and southern ends of the lake. Seneca Lake is listed on the NYSDEC PWL due to water supply concerns relating to salt levels within the lake.

The current trophic state of Seneca Lake is best characterized as borderline between oligotrophic and mesotrophic. The mean total phosphorus concentration, chlorophyll *a* concentration, and Secchi Disk depth recorded during the later 1990s are 9.8 ug/l, 2.4 ug/l, and 6.0 m, respectively. These findings suggest that Seneca Lake has exhibited a significant decline in primary productivity over the past several decades. A comparison of the present findings to those from the early 1970s indicate that total phosphorus levels have declined by approximately 30 percent, while chlorophyll *a* levels have declined by more than three fold. In addition, water clarity levels have approximately doubled during the same time period. The findings for total phosphorus and water clarity are similar in magnitude to those observed in a number of the other large Finger Lakes, however, the decline in chlorophyll *a* levels was significantly larger (on a percentage basis) than that observed in most of the other lakes. While it is likely that nutrient control measures instituted in the intervening time frame could account for the observed changes in total phosphorus levels within the lake, the magnitude of changes observed in water clarity and, particularly, chlorophyll *a* seem unusually large. Other researchers have suggested that the introduction and proliferation of Zebra mussel populations within Seneca Lake has had a dramatic effect on these trophic parameters. This would seem a reasonable hypothesis given the magnitude of change and local observations regarding Zebra mussel increases. As with previous studies, hypolimnetic waters within Seneca Lake appear to remain well oxygenated throughout the growing season. It should be noted, however, that due equipment limitations of this study, vertical profiles from this study were limited to 100 m. Thus, given the significant depths of Seneca Lake, it is not possible to draw conclusions regarding deeper portions of the lake. Major ion trends within Seneca Lake indicate significant *declines* in chloride and sodium levels, and a smaller decline in calcium levels, as well as *increases* in sulfate and alkalinity levels. The marked decline in chloride and sodium levels would appear to call into question the premise that concentrations observed during the 1960s and 1970s were the result of natural conditions associated with the depth of the lake basin – see earlier discussion.

Sediment core findings from Seneca Lake indicate a sediment accumulation rate of 0.23 cm/year. This is in the lower range of sediment accumulation rates observed within the Finger Lakes. *Organic* chemical findings from the Seneca Lake sediment core are limited to DDT and its metabolites, and PCB congeners. Total DDT levels within Seneca Lake appear to have declined significantly over the past several decades (see Figure 9.6). Levels peaked at 153 ppb in approximately 1968. Surficial sediment concentrations of total DDT are 40 ppb, which is above the TEL but substantially below the PEL. Total PCB congener levels observed in the Seneca Lake sediment core are 466 ppb (408 ppb after adjustment for DDE), which is in the upper range of PCB levels observed within the Finger Lakes, and exceed the PEL for total PCBs. These values are from a single core segment taken from 4-6 cm in depth, which is estimated to represent sediments deposited in the late 1970s. The levels of PCBs within the surficial sediments were not evaluated. *Inorganic* chemical findings from the Seneca Lake sediment core are as follows: (a) Arsenic levels within the Seneca Lake sediment core range from 12.3-19.0 ppm, and are either slightly below or slightly above the PEL. The upper sediment layer was above the PEL for arsenic. This tendency toward higher arsenic levels within surficial sediments is apparent in several of the Finger Lakes. As discussed earlier, subsequent water column sampling, albeit limited, failed to detect arsenic (> 10 ug/l) in either the epilimnion or the hypolimnion – see further discussion above; (b) Cadmium levels range from 1.6-2.2 ppm and are largely constant over the recorded time period. Sediment cadmium levels are above the TEL but below the PEL; (c) Calcium concentrations range from 5,250-37,200 ppm and have increased substantially over the past several decades – there are no guidance values for calcium; (d) Chromium levels range from 26.2-30.1 ppm, and reach a peak in approximately 1970. Surficial sediment concentrations are below the TEL and PEL; (e) Copper levels range from 44.2-61.8 ppm and reach a maximum in about 1970. Surficial sediment concentrations are above the TEL but below the PEL for copper; (f) Lead levels range from 52.6-80.0 ppm and have declined over the past several decades. Lead levels within surficial sediments are above the TEL, but below the PEL; (g) Mercury levels range from 0.1-0.28 ppm and have declined by approximately 50 percent over the past 4 decades. Surficial concentrations are below the TEL and PEL for total mercury; (h) Nickel levels range from 39.9-46.1 ppm and are largely constant over the past half century. Nickel levels are above the TEL but below the PEL; and (i) Zinc levels range from 139-176 ppm and are largely constant over the past half century. Concentrations are above the TEL but below the PEL for zinc.

Recommendations for Seneca Lake are as follows. *First*, study results indicate that nutrient control measures within the Seneca Lake watershed have been quite successful over the past several decades as evidenced by the decline in total phosphorus levels over the intervening time frame. Thus, continued efforts with respect to the control of nutrient inputs to the lake are warranted. *Second*, while trophic conditions within Seneca Lake have "improved" somewhat over the past several decades, the trophic status of the lake is somewhat complicated by the presence of Zebra mussels (and possibly Quagga mussels) within the lake. Thus, it is recommended that a program to quantify Zebra mussel dynamics within Seneca Lake be initiated. *Third*, findings indicate that sodium and chloride levels within Seneca Lake are in decline, however, these observations would suggest that ambient concentrations are originating from other than natural conditions. Previous investigations have concluded that the elevated levels of sodium and chloride within Seneca Lake are the result of the intersection of the lake basin with salt strata. However, if this were the case one would expect the level of these ions to remain relatively static. The observation that levels are changing would seem to warrant additional study as to the cause(s) of the observed changes. *Fourth*, PCB findings from the Seneca Lake sediment core indicate that total PCB levels exceed the PEL. There have also been indications that PCB levels in certain sport fish are elevated (although, not above current FDA action levels). These findings warrant continued monitoring of biota for PCB levels in the future. *Fifth*, although surficial sediments in Seneca Lake do not exhibit a significant up-tick in arsenic levels as observed in several of the other Finger Lakes, arsenic levels within the sediments of Seneca Lake are fairly high – surficial concentrations exceed the PEL. Thus, additional investigation is warranted regarding: (a) source(s) of arsenic within the Seneca Lake benthic sediments, and (b) environmental cycling and availability of arsenic. *Sixth*, as with a number of the Finger Lakes, nickel concentrations within Seneca Lake sediments are elevated. Thus, additional study of the origin(s) and possible environmental effects of nickel levels may be warranted.

Figure 11.5: Seneca Lake



Not intended for navigation purposes.

Keuka Lake

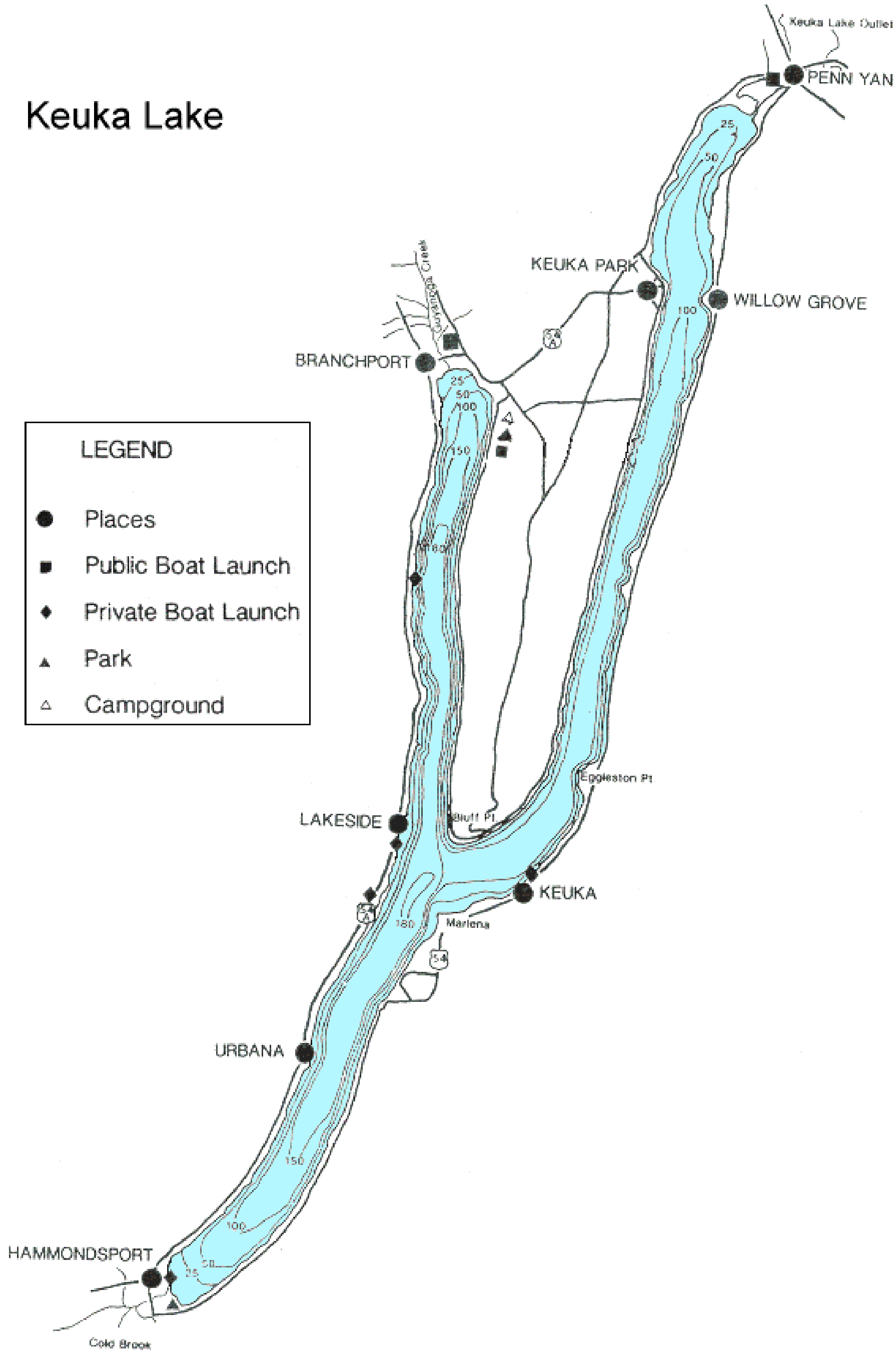
Keuka Lake (see Figure 11.6) is readily distinguishable from the other 11 Finger Lakes due to the characteristic "Y" shaped of the lake basin. The lake and watershed are situated in Steuben and Yates Counties. The lake is a multi-purpose waterbody, and serves as a source of water supply for the Villages of Hammondsport and Penn Yan. Keuka Lake has a water use classification of "AA(TS)", and is listed on the NYSDEC PWL list due to a fish consumption advisory relating to DDT and its metabolites.

The current trophic state of Keuka Lake is best characterized as borderline between oligotrophic and mesotrophic. The mean total phosphorus concentration, chlorophyll *a* concentration, and Secchi Disk depth measured during the later 1990s are 8.0 ug/l, 2.8 ug/l, and 5.6 m, respectively. These finding indicate that trophic conditions within Keuka Lake have declined substantially over the last several decades. A comparison of the present findings to those from the early 1970s indicate that total phosphorus levels and chlorophyll *a* levels have declined by approximately 40 percent. In addition, water clarity levels increased by approximately 15 percent. Furthermore, as has been the case historically, the water column of Keuka Lake remains well oxygenated during the growing season. Major ion trends within Keuka Lake over the past several decades indicate *declines* in magnesium and sulfate levels, and *increases* in calcium, sodium, chloride, and alkalinity levels.

Sediment core findings from Keuka Lake indicate a sediment accumulation rate of 0.37 cm/year, which is in the middle range of sediment accumulation rates within the Finger Lakes. *Organic* chemical findings for Keuka Lake are limited to DDT and its metabolites, and total PCBs. Total DDT levels within the sediments of Keuka Lake have decline markedly over the last several decades, from a peak of nearly 400 ppb in the late 1970s to current levels of 72 ppb (as measured in surficial sediments). This decline is consistent with findings for fish flesh analyses from the lake. While the DDT trends are encouraging, DDT levels remain above the TEL, however, they are below the PEL. Total PCBs were measured from a single sediment core segment taken from Keuka Lake. The core segment represents sediments deposited in the mid 1980s, and measured 449 ppb or 289 ppb when adjusted for DDE levels. The later value is probably more accurate given historical DDT levels within the lake. Thus, total PCB levels within Keuka Lake are in the middle range of PCB concentrations measured in Finger Lakes sediments, and are above the TEL and PEL for total PCBs. Fish flesh data from the mid 1980s showed limited elevation in Aroclors 1254 and 1260 (from below detection to 0.288 ppm) – the current FDA action level for PCBs is 5 ppm. *Inorganic* chemical findings for Keuka Lake indicate a marked increase in arsenic and manganese concentrations in the upper sediments of the lake. This pattern is also apparent in several other Finger Lakes cores. Arsenic and manganese levels within Keuka Lake sediments range from 15.4-47.1 ppm and 1,360-5,650 ppm, respectively. The cause(s) of the surficial sediment enrichment in arsenic and manganese is not certain – see discussion in Chapter 9. The arsenic levels detected in the upper sediment layers of Keuka Lake exceed both the TEL and PEL. As indicated earlier, subsequent water column monitoring conducted during 1999, albeit limited, did not detect arsenic (at > 10 ppb) within the water column (epilimnion or hypolimnion) – see further discussion above. Additional inorganic findings from the Keuka Lake sediment core investigation are as follows: (a) Calcium levels range from 2,160-3,680 ppm and are fairly constant over time, which stands in contrast to many of the other Finger Lakes, which have shown marked increases in calcium concentrations over the past several decades; (b) Chromium levels range from 26.7-30.2 ppm and reach maximum levels in approximately 1960. Surficial sediment chromium levels are below both the TEL and PEL; (c) Copper levels range from 37.3-45.1 ppm and peak in the mid-1980s. Copper concentrations in surficial sediments exceed the TEL but are below the PEL; (d) Lead levels range from 36.1-69.4 ppm and have declined substantially since a peak in the mid 1960s. However, lead concentrations in surficial sediments remain above the TEL, but below the PEL; (e) Nickel levels range from 42.5-50.3 ppm and remain fairly constant over time, however, levels exceed both the TEL and PEL for nickel; (f) Zinc levels range from 128-168 ppm and are fairly constant over the documented time interval, with surficial sediments exceeding the TEL but below the PEL.

Recommendations for Keuka Lake are as follows. *First*, Keuka Lake has exhibited a substantial reduction in productivity levels over the past several decades as evidenced by changes in the levels of trophic indicators. These changes, which are generally viewed as a positive development, are most likely the result of nutrient control measures implemented over the last several decades. Thus, it is recommended that efforts to control nutrient releases within the watershed be continued. *Second*, DDT findings indicate a substantial decline in total DDT levels within the sediments of Keuka Lake over the past several decades. However, DDT levels remain relatively high within surficial sediment layers. Thus, continued monitoring of DDT levels in biota (e.g., fish) within the lake is advisable. *Third*, PCB findings from the Keuka Lake sediment core indicate some elevation in PCB levels within the Lake. However, past analyses of fish tissue do not indicate significant PCB levels within sport fish. Given these somewhat conflicting findings, it is advisable to continue PCB analyses within sport fish in conjunction with DDT analyses discussed above. *Fourth*, as with several of the Finger Lakes, sediment core findings from Keuka Lake show a marked enrichment in arsenic and manganese within surficial sediments. Water column sampling within Keuka Lake, subsequent to the core findings, failed to show detectable levels of arsenic in the water column of Keuka Lake. However, these water column findings should be considered preliminary due to the limited scope of sampling (both spacially and temporally) and the analytical detection levels of the methods employed. Thus, additional study of arsenic and manganese within the watershed is warranted – the focus of future study should include efforts to determine the cause(s) of the observed arsenic and manganese enrichment, and further evaluation of possible human exposure and/or environmental effects of the arsenic levels observed. *Fifth*, elevated nickel levels were also observed within the sediments of Keuka Lake. Assessment of possible sources of nickel to the watershed and the environmental implications of the levels observed is warranted. *Sixth*, as with the other Finger Lakes, it is recommended that a Zebra mussel monitoring program be initiated on Keuka Lake. The study should include an examination of Zebra mussel population dynamics within the lake, and an assessment of possible ecological effects resulting from their presence.

Figure 11.6: Keuka Lake



Not intended for navigation purposes.

Canandaigua Lake

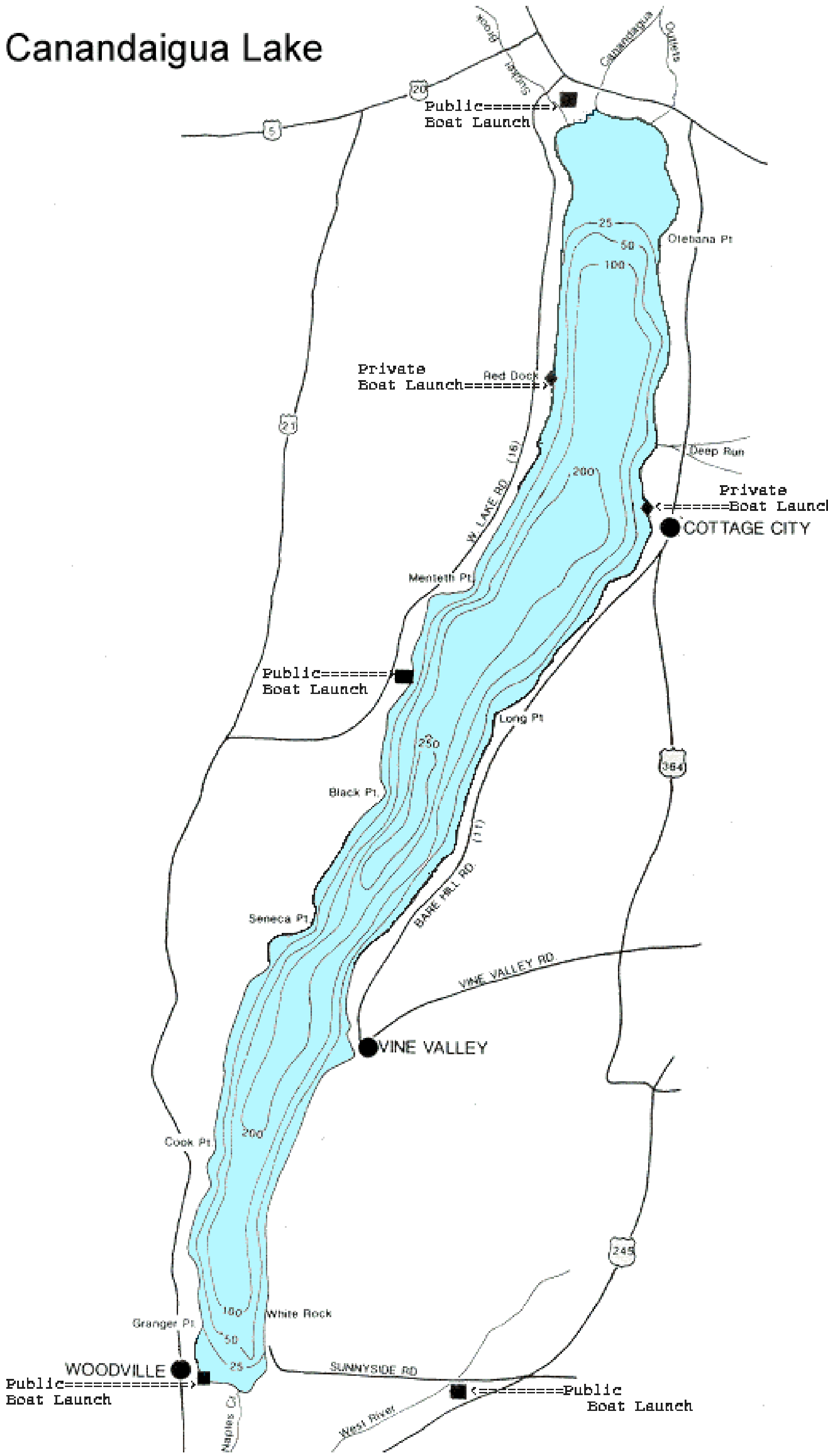
Canandiagua Lake (see Figure 11.7) is one of the six larger Finger Lakes. The lake is within Ontario and Yates Counties, while the watershed also extends into Livingston and Steuben Counties. Canandaigua Lake is a multi-purpose lake and serves as a source of water supply for the City of Canandaigua, and the Villages of Bristol Harbor, Gorham, Newark, Palmyra, and Rushville. The lake has a water use classification of "AA(TS)", and is listed on the NYSDEC PWL due to a fish consumption advisory relating to PCBs.

The current trophic level of Canandaigua Lake is best characterized as oligotrophic, as evidenced by the current level of trophic indicators. The mean total phosphorus concentration, chlorophyll *a* concentration, and Secchi Disk depth measured during the later 1990s are 8.0 ug/l, 2.8 ug/l, and 5.6 m, respectively. These finding indicate that trophic conditions within Canandaigua Lake have declined substantially over the last several decades. A comparison of the present findings to those from the early 1970s indicate that total phosphorus levels and chlorophyll *a* levels have declined by approximately 40-50 percent. In addition, water clarity levels increased by approximately 50 percent. Furthermore, as has been the case historically, the water column of Canandaigua Lake remains well oxygenated during the growing season. Trends for major ions within Canandaigua Lake over the past several decades indicate *declines* in magnesium and sulfate levels, and *increases* in sodium, chloride, and alkalinity concentrations.

Sediment core findings from Canandaigua Lake indicate a sediment accumulation rate of approximately 0.2 cm/year, which is in the lower range of depositional rates observed within the Finger Lakes. *Organic* chemical findings for Canandaigua Lake are limited to DDT and its metabolites. Total DDT levels within the sediments of Canandaigua Lake have declined markedly over the last several decades, from a peak of slightly more than 200 ppb in the early 1960s to current levels of less than 20 ppb (as measured in surficial sediments). The total DDT levels measured in the upper sediments are below the PEL and only slightly above the TEL for total DDT. Unfortunately, total PCB levels for the Canandaigua Lake core were not analyzed due to a study oversight. *Inorganic* chemical findings for Canandaigua Lake indicate a marked increase in arsenic and manganese concentrations in the upper sediment layer of the lake. As discussed above, this pattern is also apparent in several other Finger Lakes cores. Arsenic and manganese levels range from 13.8-45.0 ppm and 1,050-4,960 ppm in Canandaigua Lake sediments, respectively. The cause(s) of the surficial sediment enrichment in arsenic and manganese is not certain – see discussion in Chapter 9. The arsenic levels detected in the upper sediment layers of Canandaigua Lake exceed both the TEL and PEL. Subsequent water column monitoring conducted during 1999, albeit limited, did not detect arsenic (at > 10 ppb) within the water column of Canandaigua Lake – see further discussion above. Additional inorganic findings from the Canandaigua Lake sediment core investigation are as follows: (a) Calcium levels range from 6,660-18,900 ppm within the sediments of Canandaigua Lake and are somewhat atypical, in that while the core exhibits a substantial increase in calcium levels from the 1960s to the 1970s, it also exhibits higher calcium levels prior to the 1940s. This "U" shaped pattern in sediment calcium levels is unique within the Finger Lakes; (b) Chromium levels range from 24.1-27.6 ppm and remain fairly constant over time. The surficial sediment chromium concentration is below both the TEL and PEL; (c) Copper levels range from 33.1-42.2 ppm and are fairly uniform over the recorded time period. The surficial sediment copper concentration is below both the TEL and PEL for copper; (d) Lead levels range from 34.2-70.4 ppm and have declined substantially since the early to mid-1960s. However, lead concentrations in surficial sediments remain above the TEL, although they are below the PEL; (e) Nickel levels range from 45.1-49.5 ppm and are fairly constant over time, however, levels exceed both the TEL and PEL for nickel; (f) Zinc levels range from 133-173 ppm and appear fairly constant over the documented time interval, with surficial sediments exceeding the TEL but below the PEL.

Recommendations for Canandaigua Lake are as follows. *First*, it is likely that nutrient control measures over the past several decades have contributed to a significant reduction in trophic conditions within the lake – this is generally interpreted as a positive development. Thus, efforts to control the input of nutrients (particularly phosphorus) to the lake should be continued in the future. *Second*, while it is probable that nutrient control measures are responsible for a significant portion of the reduction in primary productivity, there are also indications that Zebra mussels may be influencing trophic conditions within Canandaigua Lake. The presence of Zebra mussels within the lake could have significant ecological consequences for the lake. Thus, as with the other Finger Lakes, it is recommended that a Zebra mussel monitoring program be initiated on Canandaigua Lake. The study should include an examination of Zebra mussel population dynamics within the lake, and an assessment of possible ecological effects resulting from their presence. *Third*, as with many of the Finger Lakes, chloride and sodium levels within Canandaigua Lake have increased over the past several decades. Thus, efforts to control the use and release of salt within the watershed should be implemented. *Fourth*, while sediment core PCB results are not available for Canandiagua Lake due to a study oversight, it would be prudent to continue monitoring biota for chlorinated organic compounds, given past findings. *Fifth*, as with several of the Finger Lakes, arsenic enrichment was evident in the surficial sediments of Canandaigua Lake. Additional investigation concerning the cause(s) of the observed enrichment, and possible environmental consequences of these findings is warranted. *Sixth*, as with several of the Finger Lakes, nickel levels within the sediments of Canandaigua Lake are above the TEL and PEL. Additional investigation as to the origins and possible ecological consequences of these nickel levels is warranted.

Figure 11.7: Canandaigua Lake

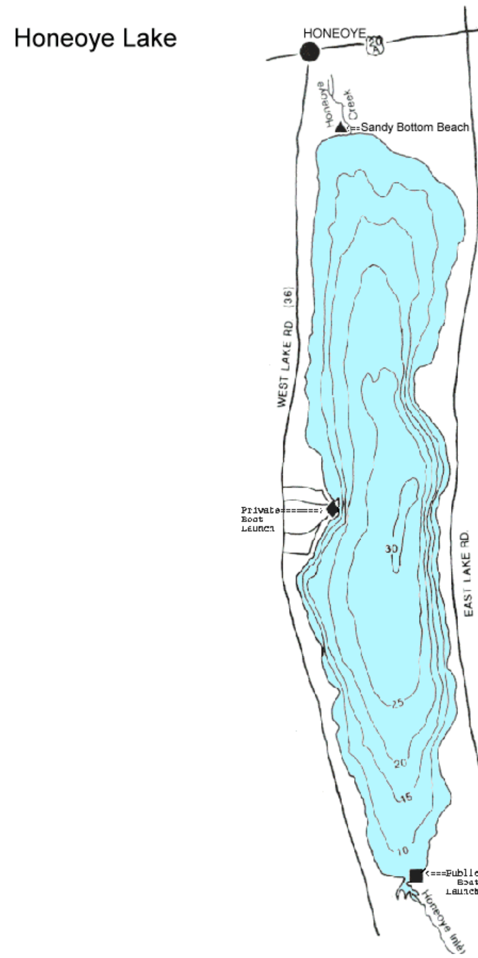


Not intended for navigation purposes.

Honeoye Lake

Honeoye Lake (see Figure 11.8) is one of the smaller Finger Lakes, and has the smallest volume and average depth of any of the lakes. The lake and watershed are located in Ontario County. Honeoye Lake is a multi-purpose lake, and is the only one of the Finger Lakes not currently used as a source of public water supply. However, the lake has a water use classification of "AA", and likely serves as a water supply for individual home owners around the lake. Honeoye Lake is currently listed on the NYSDEC PWL due to water supply concerns relating to nutrients.

Figure 11.8: Honeoye Lake



Not intended for navigation purposes.

The current trophic level of Honeoye Lake is best characterized as eutrophic, as evidenced by existing levels of major trophic indicators. The mean epilimnetic total phosphorus concentration, chlorophyll *a* concentration, and Secchi Disk depth measured during the later 1990s are 24.2 ug/l, 8.4 ug/l, and 3.7 m, respectively. While the trophic level of Honeoye Lake remains similar to that of the early 1970s, the levels of major trophic indicators are considerably different from those observed in the early 1070s. Findings from the early 1970s show mean levels of total phosphorus, chlorophyll *a*, and Secchi Disk depth of 19 ug/l, 25.7 ug/l, and 3.0 m, respectively. Thus, total phosphorus levels have increased, chlorophyll *a* levels have declined, and Secchi Disk depth has apparently increased. The hypolimnion of Honeoye Lake frequently becomes hypoxic during the growing season. The cause(s) and/or consequences of this dissolved oxygen depletion are uncertain. For example, while dissolved oxygen depletion is, no doubt, a consequence of both natural and human-related processes, the relative importance of the two factors is unclear. Trends for major ions within Honeoye Lake indicate an *increase* in calcium, chloride, sodium, and alkalinity levels, and a *decrease* in sulfate and magnesium levels.

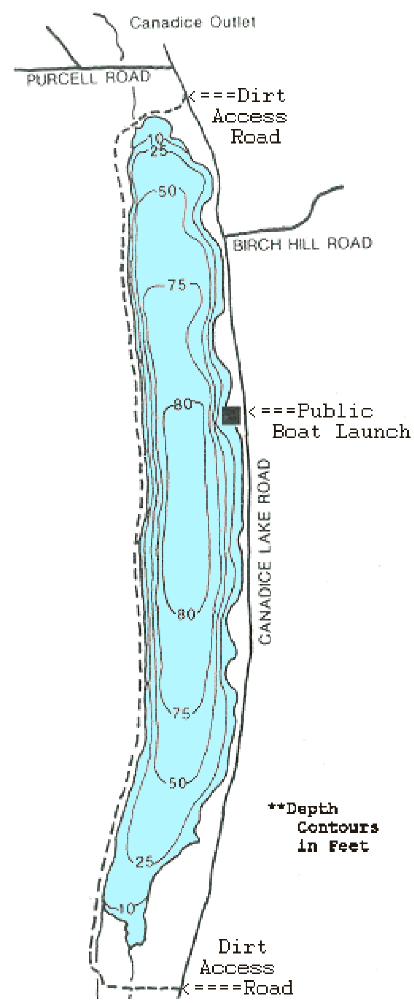
Sediment core findings from Honeoye Lake indicate a sediment accumulation rate of approximately 0.5 cm/year, which is on the high end of accumulation rates observed within the Finger Lakes. *Organic* chemical findings from the Honeoye Lake sediment core are limited to PCB congeners from a single sediment core segment (3-6 cm – approximately 1990). The total PCB concentration from this core segment is 69 ppb, which is on the low end of total PCB levels observed in the Finger Lakes. This is above the TEL for total PCBs, but below the PEL. *Inorganic* chemical findings from the Honeoye Lake sediment core are as follows: (a) Arsenic levels range from 7.4-19.4 ppm, and exhibit an increase in concentration during the 1970s, with a plateau thereafter. Surficial sediment arsenic concentrations are above the TEL and slightly above the PEL. Sediment arsenic enrichment is apparent in a number of the Finger Lakes cores, and the cause(s) of the arsenic enrichment is not certain at this juncture – see discussion in Chapter 9. Subsequent water column monitoring conducted during 1999, albeit limited, did not detect arsenic (at > 10 ppb) within the water column of Honeoye Lake – see further discussion above. (b) Chromium levels range from 25.4-32.5 ppm and remain fairly constant over time. Chromium levels are below both TEL and PEL; (c) Copper levels range from 24.6-44.8 ppm and remain fairly constant over time. Copper levels are below TEL and PEL levels; (d) Lead levels range from 32.2-62.9 ppm and show a decline from the early 1970s until approximately 1990, but appear to have increased of late. This apparent increase is based on a single core segment. However, the observed rate of decline in lead levels in Honeoye Lake from the 1970s to the 1990s (see Figure 9.17) is somewhat less pronounced than observed in several other Finger Lakes. Thus, it is possible that there is a relatively “new” source of lead within the watershed. The lead level within the surficial sediment layer is above the TEL, but below the PEL; (e) Manganese levels range from 661-2,410 ppm and exhibit a significant increase in concentration over time; (f) Nickel levels range from 44.1-58.4 ppm and remain fairly constant over the recorded time interval. Nickel levels are above the TEL and PEL; (g) Zinc levels range from 121-170 ppm and also remain fairly constant over much of the recorded time interval, however, a moderate increase in concentrations is apparent in the surficial sediment layer. Zinc concentrations are above the TEL, but below the PEL.

Recommendations for Honeoye Lake are as follows. *First*, total phosphorus levels observed within Honeoye Lake are above the current New York State guidance value for total phosphorus. In addition, hypoxic conditions occur within the hypolimnion of the lake on a seasonal basis. Thus, it is important that nutrient control measures within the watershed be enhanced. This should include an assessment of nutrient loading to the lake and an evaluation of permitted loads. Furthermore, as with several of the smaller Finger Lakes, nutrient dynamics within Honeoye Lake are not fully understood. Therefore, it is suggested that additional study of nutrient dynamics within Honeoye Lake be conducted. The focus of such a study should be to more fully define both external and internal inputs of nutrients to the lake. *Second*, the presence of Zebra mussels has been documented within Honeoye Lake. Zebra mussels are believed to be having significant ecological effects on several of the Finger Lakes. Thus, a Zebra mussel monitoring program is recommended for Honeoye Lake. *Third*, as with many of the Finger Lakes, chloride and sodium levels have increased over the past several decades. Thus, efforts to control the use and release of salt within the watershed should be encouraged. *Fourth*, as with several of the Finger Lakes, arsenic levels within the sediments of Honeoye Lake have increased of late. Thus, efforts to understand the cause(s) and possible environmental consequences of the observed increases in arsenic is suggested. *Fifth*, as with several of the Finger Lakes, nickel levels within the sediments of Honeoye Lake are above the TEL and PEL. Additional investigation as to the origins and possible ecological consequences of these nickel levels is warranted.

Canadice Lake

Canadice Lake (see Figure 11.9) is one of the five smaller Finger Lakes, and has the smallest surface area and drainage area of any of the lakes. The lake is located in Ontario County, while its watershed also extends into Livingston County. Canadice Lake is primarily used for water supply by the City of Rochester. The lake has a water use classification of "AA", and has fairly stringent watershed protection measures in place. Canadice Lake is listed on the NYSDEC PWL due to a fish consumption advisory related to PCBs.

Figure 11.9: Canadice Lake



Not intended for navigation purposes.

The trophic state of Canadice Lake is best characterized as borderline between oligotrophic and mesotrophic. The mean epilimnetic levels for major trophic indicators during the late 1990s are 8.3 ug/l, 2.5 ug/l, and 5.0 m, for total phosphorus, chlorophyll *a*, and Secchi Disk depth, respectively. These findings indicate a slight reduction in trophic conditions within Canadice Lake over the past several decades. The hypolimnion of Canadice Lake becomes hypoxic/anoxic during the mid to late summer. Dissolved oxygen levels drop below 1 mg/l within portions of the hypolimnion for sustained periods of time. The cause(s) and/or consequences of this dissolved oxygen depletion are uncertain. For example, while dissolved oxygen depletion is obviously a consequence of both natural and human-related processes, the relative importance of the two factors is unclear. Trends for major ions within Canadice Lake indicate an *increase* in the concentration of calcium, chloride, and sodium, and a *decrease* in sulfate and magnesium levels. In addition, there appears to be a slight decline in alkalinity levels.

Sediment core findings from Canadice Lake indicate a sediment accumulation rate of approximately 0.2 cm/year. This is one of the lowest accumulation rates observed within the Finger Lakes. *Organic* chemical findings for Canadice Lake are limited to DDT and its metabolites, and PCBs. DDT results from the Canadice Lake sediment core are fairly limited – most core segments were below detectable levels for DDT and its metabolites. However, two core segments did show detectable levels of the metabolites DDE and DDD. These findings indicate that levels of these chemicals have declined over the past several decades within Canadice Lake. PCB findings from the Canadice Lake sediment core are also quite limited. Study results did show discernable levels of Aroclor 1254 within the 2-4 cm sediment segment (mid 1980s). PCB congeners, analyzed from the 4-6 cm sediment segment (early 1970s), indicated a total PCB concentration of 352 ppb. This is in the middle range of levels observed in other Finger Lakes cores. One unexpected finding worth noting in the Canadice Lake core is that the congener pattern observed in the 4-6 cm section (Aroclor 1242) is different from both the fish flesh pattern observed during the past decade, or so, and from the pattern observed in the core segment immediately above (2-4 cm) which was considered consistent with higher chlorinated Aroclor compounds (Aroclor 1254 and/or 1260). *Inorganic* chemical findings from the Canadice Lake sediment core indicate a significant increase in arsenic and manganese levels over the past several decades. This phenomenon of arsenic and manganese enrichment within upper sediment layers is also apparent in a number of the other Finger Lakes. Arsenic and manganese levels within Canadice Lake sediments range from 10.4-29.3 ppm and 712-1,800 ppm, respectively. The cause(s) of the arsenic and manganese enrichment in surficial sediments is not certain – see discussion in Chapter 9. The arsenic levels observed in the surficial sediments of Canadice Lake are above the TEL and PEL. Subsequent water column monitoring conducted during 1999, albeit limited, did not detect arsenic (at > 10 ppb) within the water column (epilimnion or hypolimnion) of Canadice Lake – see further discussion above. Additional inorganic chemical findings for the Canadice Lake core are as follows: (a) Calcium levels range from 1,500-2,540 ppm and have increased substantially over the past several decades. This pattern is present in many of the Finger Lakes; (b) Chromium levels range from 21.4-28.6 ppm and appear fairly stable over time. Chromium levels are below the TEL and PEL; (c) Copper levels range from 31.1-45.9 ppm and are fairly stable over time, however, levels show a spike in the early 1980s and a subsequent drop in the early 1990s. Copper levels are near the TEL but below the PEL; (d) Lead levels range from 25.6-64.2 ppm and exhibit a marked decline following a peak in the mid-1970s. Lead levels within surficial sediments are very close to the TEL; (e) Nickel levels range from 38.4-48.4 ppm and are fairly constant over time, however, there would appear to be a downward trend in the last decade. Nickel levels within the surficial sediments are above the TEL and slightly above the PEL; (f) Zinc levels range from 123-180 ppm and parallel the patterns observed for nickel, with fairly uniform levels until the last decade and then a slight decline. Zinc levels are above the TEL but below the PEL.

Recommendations for Canadice Lake are as follows. *First*, trophic conditions within Canadice Lake appear to have declined slightly over the past several decades – this is generally considered a positive development. It is recommended that nutrient control measures be continued within the watershed. *Second*, dissolved oxygen levels within the hypolimnion of the lake are reduced to fairly low levels during much of the growing season. The reasons for this dissolved oxygen depletion are not certain, and additional study of this phenomenon is recommended. The focus of future study should be directed at investigation of the cause(s) of the observed depletion, and possible ecological implications of these hypoxic conditions. *Third*, it is unclear, at this time, whether or not Zebra mussels are established in Canadice Lake. However, the presence of Zebra mussels has been confirmed in all of the other Finger Lakes. Thus, a Zebra mussel monitoring program should be initiated for Canadice Lake. This study should attempt to determine if Zebra mussels are present in the lake, and what ecological effects are occurring, or likely to occur, given colonization. The issue of water column calcium levels should be a component of the Canadice Lake study given the apparent increase in calcium levels within the lake and the importance of calcium levels in Zebra mussel ecology. *Fourth*, as with many of the other Finger Lakes, chloride and sodium levels have increased within Canadice Lake over the past several decades. Thus, it is recommended that measures to control the use and storage of salt within the watershed be implemented. *Fifth*, while PCB levels have declined in certain species of fish over the past several years, monitoring of biota for PCB levels is still warranted. *Sixth*, as with several of the Finger Lakes, arsenic levels within Canadice Lake have increased over the past several decades. Thus, additional study of the cause(s) and possible environmental effects of these increases is recommended. *Seventh*, as with many of the Finger Lakes, nickel levels within the sediments of Canadice Lake appear fairly high. Investigation of the cause(s) and possible environmental consequences of these nickel levels is recommended.

Hemlock Lake

Hemlock Lake (see Figure 11.10) is one of the five smaller Finger Lakes. The lake is located in Livingston County, while the watershed also extends into Ontario County. Hemlock Lake is used primarily as a water supply by the City of Rochester. The lake has a water use classification of "AA(T)", and has fairly stringent watershed protection measures in place. Hemlock Lake is listed on the NYSDEC PWL due to water supply concerns relating to hydrologic modification.

The trophic state of Hemlock Lake is best characterized as between oligotrophic and mesotrophic. The mean epilimnetic levels for major trophic indicators during the late 1990s are 10.0 ug/l, 3.0 ug/l, and 4.7 m, for total phosphorus, chlorophyll *a*, and Secchi Disk depth, respectively. These findings indicate a significant reduction in chlorophyll *a* levels and a significant increase in water clarity within Hemlock Lake over the past several decades. However, total phosphorus levels remain approximately the same as was found in the early 1970s. The hypolimnion of Hemlock Lake becomes hypoxic during the mid to late summer, with dissolved oxygen levels as low as 1 mg/l in certain deep-water locations. The cause(s) and/or consequences of this dissolved oxygen depletion are uncertain. While hypolimnetic dissolved oxygen depletion is obviously a consequence of both natural and human-related processes, the relative importance of the two factors is unclear. Trends for major ions within Hemlock Lake indicate an *increase* in the concentration of calcium, chloride, and sodium, and a *decrease* in sulfate, and magnesium levels.

Sediment core findings from Hemlock Lake were not particularly informative, due to the lack of an intact radiometric profile. Thus, no sediment accumulation rate could be determined for the lake, and chemical results can only be viewed as composite values (no temporal or trend information is available). *Organic* chemical findings for Hemlock Lake are limited to DDT and its metabolites, and PCBs. Total DDT levels within the Hemlock Lake sediment core ranged from 25-49 ppb. As discussed previously, the sediment core from Hemlock Lake appears to have been disturbed, therefore, temporal trends for DDT are not possible. However, ratios of DDT to its metabolites (DDD & DDE) indicate that the signal in Hemlock Lake is fairly weathered – in fact, DDT itself is below detection within the sediment core, and there are only detectable levels of DDD and DDE. This would appear to indicate that the source(s) of these chemicals within the watershed stem from historical releases within the basin. PCB findings from the Hemlock Lake sediment core are also quite limited. PCB congeners, analyzed from the 4-6 cm sediment segment (early 1970s), indicate a total PCB concentration of 67 ppb. This is in the low range of levels observed in other Finger Lakes cores, and is above the TEL, but below the PEL for total PCBs. *Inorganic* chemical findings for Hemlock Lake indicate that sediment arsenic levels are above the TEL and PEL. Arsenic levels range from 13.5-21.4 ppm, with a concentration of 21.4 within the surficial sediment layer. Sediment arsenic enrichment is apparent in a number of the Finger Lakes, and the cause(s) of the arsenic enrichment is not certain – see discussion in Chapter 9. Subsequent water column monitoring conducted during 1999, albeit limited, did not detect arsenic (at > 10 ppb) within the water column of Hemlock Lake – see further discussion above. Additional inorganic chemical findings from the Hemlock Lake sediment core are as follows: (a) Chromium levels range from 27-30.5 ppm – these levels are below the TEL and PEL; (b) Copper levels within the sediments of Hemlock Lake range from 39.6-49.8 ppm, which is above the TEL but below the PEL; (c) Lead levels range from 40.7-52.5 ppm, and show little variation within the core. The lack of a pronounced decline in lead levels within the Hemlock Lake sediment core, which stands in contrast to observations in a number of the other Finger Lakes cores, reinforces the idea that the Hemlock Lake sediments had been disturbed. The observed levels of lead are above the TEL but below the PEL; (d) Nickel levels range from 48.0-57.6 ppm, which is above the TEL and PEL for nickel; and (e) Zinc levels range from 136-155 ppm, which is above the TEL but below the PEL for zinc.

Recommendations for Hemlock Lake are as follows. *First*, trophic conditions within Hemlock Lake have declined significantly over the past several decades with respect to chlorophyll *a* and water clarity – this is generally considered a positive development. However, similar declines in total phosphorus levels are not apparent. In spite of this apparent disconnect in trophic indicators, continued efforts to control the release of nutrients within the watershed are recommended. *Second*, dissolved oxygen levels within the hypolimnion of the lake declined significantly during much of the growing season. The reasons for this dissolved oxygen depletion are not certain, and additional study of this phenomenon is recommended. The focus of future study should be directed at investigation of cause(s) of the observed depletion, and possible ecological implications of these hypoxic conditions. *Third*, the presence of Zebra mussels has been confirmed within Hemlock Lake. Zebra mussels can have profound effects on the ecosystem of a lake, and can result in significant problems for water intake systems. Thus, a Zebra mussel monitoring program should be initiated for Hemlock Lake. This study should focus upon Zebra mussel population trends, and possible ecological effects. *Fourth*, as with many of the Finger Lakes, chloride and sodium levels have increased within Hemlock Lake over the past several decades. Thus, it is recommended that measures to control the use and storage of salt within the watershed be implemented. *Fifth*, as with several of the Finger Lakes, sediment arsenic levels within Hemlock Lake have increased in recent decades. Thus, additional study of the cause(s) and possible environmental effects of these increases is recommended. *Sixth*, as with many of the Finger Lakes, nickel levels within the sediments of Hemlock Lake appear fairly high. Investigation of the cause(s) and possible environmental consequences of these nickel levels is recommended. *Seventh*, it would be informative to collect an additional sediment core from Hemlock Lake for the purposes of establishing a sediment accumulation rate and chemical chronology for the lake.

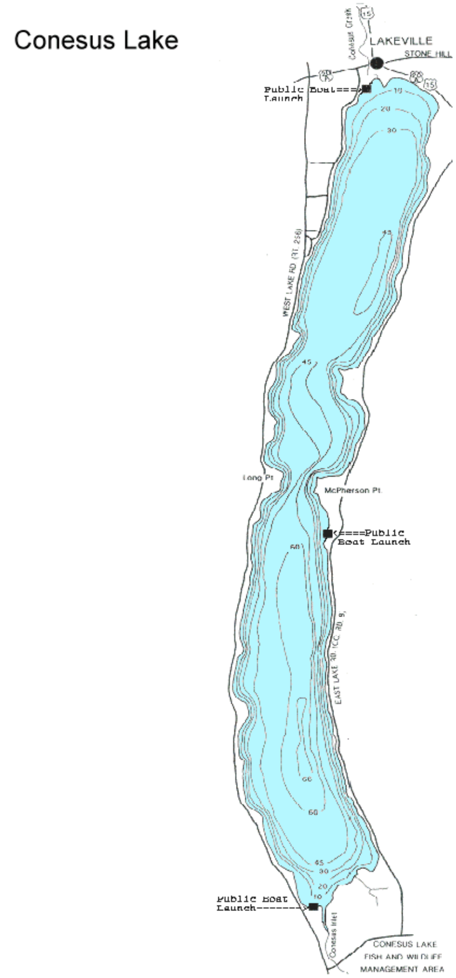
Figure 11.10: Hemlock Lake

Not intended for navigation purposes.

Conesus Lake

Conesus Lake (see Figure 11.11) is one of the five smaller Finger Lakes. The lake and watershed are located in Livingston County. Conesus Lake is a multi-purpose water body, and is used as a source of water supply by the Town of Livonia, and the Villages of Avon and Geneseo. The lake has a water use classification of “AA”, and is listed on the NYSDEC PWL due to swimming concerns relating to macrophytes and nutrients.

Figure 11.11: Conesus Lake



Not intended for navigation purposes.

The current trophic state of Conesus Lake is best characterized as eutrophic. The mean epilimnetic levels for major trophic indicators during the late 1990s are 22.2 ug/l, 7.9 ug/l, and 3.7 m, for total phosphorus, chlorophyll *a*, and Secchi Disk depth, respectively. These findings indicate that trophic conditions within Conesus Lake have increased somewhat since the early 1970s – this is generally considered undesirable. The annual mean total phosphorus level has increased slightly and is above the New York State total phosphorus guidance level of 20 ug/l, and water clarity has declined moderately. Furthermore, the hypolimnion of Hemlock Lake becomes anoxic during mid to late summer, with dissolved oxygen levels dropping to near zero in a significant portion of the hypolimnion. The cause(s) and/or consequences of this dissolved oxygen depletion are uncertain. While hypolimnetic dissolved oxygen depletion is obviously a consequence of both natural and human-related processes, the relative importance of the two factors is unclear. Trends for major ions within Conesus Lake indicate an *increase* in the concentration of sodium, and a *decline* in calcium, magnesium, sulfate, and alkalinity levels.

Sediment core findings from Conesus Lake indicate a sediment accumulation rate of approximately 0.4 cm/year, which is in the mid to upper range of accumulation rates observed in the Finger Lakes. *Organic* chemical findings for Conesus Lake are limited to DDT and its metabolites, and PCB congeners. Total DDT (sum of DDT and its metabolites) findings for Conesus Lake are somewhat puzzling. Total DDT levels within the sediments of Conesus Lake show that peak levels occurred in the early 1960s and then decline somewhat by the early 1970s. Since the 1970s, levels appear to have reached a plateau. This might indicate a continuing influx of DDT and/or its metabolites to the lake. However, the chemical signal is composed of only DDD and DDE, which is generally an indication of historical inputs, as opposed to recent inputs, of the parent product (DDT) to the basin. The total DDT levels observed are above the TEL but below the PEL. PCB findings for Conesus Lake are limited to a single sediment core segment representing sediments from approximately the mid 1980s (4-6 cm core segment). Total PCB levels within these sediments are 490 ppb, which is the highest level of PCBs observed within the Finger Lakes. The PCB signal (see Figure 9.13) from Conesus Lake appears generally consistent with lower chlorinated Aroclors (e.g., Aroclor 1242). The total PCB level observed is above the TEL and PEL. *Inorganic* chemical findings for Conesus Lake indicate fairly high arsenic concentrations within benthic sediments. However, in contrast to some of the other Finger Lakes, there was not a marked increase in arsenic levels within surficial sediment layers. Arsenic levels range from 11.0-20.2 ppm, and the arsenic levels observed are above the TEL and close to or above the PEL for arsenic. The cause(s) of the arsenic enrichment within benthic sediments is not certain – see discussion in Chapter 9. Subsequent water column monitoring conducted during 1999, albeit limited, did not detect arsenic (at > 10 ppb) within the water column of Conesus Lake – see further discussion above. Additional inorganic chemical findings for Conesus Lake are as follows: (a) Cadmium was detected in a single sediment segment (~ 1990), which is above the TEL and slightly below the PEL. However, the cadmium level within all other core segments was below detection; (b) Chromium levels range from 20.0-29.3 ppm, and show a moderate decline over time. These levels are below the TEL and PEL for chromium; (c) Copper levels range from 27.1-44.0 ppm and are fairly stable throughout the core. The copper levels observed are generally below the TEL and PEL; (d) Lead levels range from 49.1-108 ppm. Lead levels reach a maximum in the mid-1960s to early-1970s, and exhibit a marked decline thereafter. However, lead levels within surficial sediments remain above the TEL, but below the PEL; (e) Nickel levels range from 33.3-49.2 ppm and are generally stable throughout the core, with perhaps a slight decline in the upper sediments. Nickel levels are above the TEL and near or above the PEL for nickel; and (f) Zinc levels range from 140-195 ppm. Zinc levels reach a maximum in the late-1960s, and exhibit a moderate decline thereafter. Zinc levels are above the TEL but below the PEL.

Recommendations for Conesus Lake are as follows. *First*, total phosphorus levels observed within Conesus Lake are above the current New York State guidance value for total phosphorus (20 ug/l). Furthermore, anoxic conditions occur within the hypolimnion of the lake for sustained periods during the growing season. Thus, it is important that nutrient control measures within the watershed be enhanced. A nutrient loading study is also recommended for the watershed. Furthermore, as with several of the smaller Finger Lakes, nutrient dynamics within Conesus Lake are not fully understood. Therefore, it is suggested that additional study of nutrient dynamics within Conesus Lake be conducted. The focus of such a study should be to more fully define both external and internal inputs of nutrients to the lake, and to assess the ecological consequences of dissolved oxygen depletion within the hypolimnion. *Second*, the presence of Zebra mussels has been documented within Conesus Lake. Zebra mussels are believed to be having significant ecological effects on several of the Finger Lakes. Thus, a Zebra mussel monitoring program is recommended for Conesus Lake. *Third*, as with many of the Finger Lakes, chloride and sodium levels have increased over the past several decades. Thus, efforts to control the use and storage of salt within the watershed should be encouraged. *Fourth*, total PCB levels within Conesus Lake are above sediment quality guidance values. Therefore, it is recommended that fish tissue analyses be conducted in Conesus Lake. *Fifth*, as with several of the Finger Lakes, arsenic levels within the sediments of Conesus Lake are above certain sediment quality guidance values. Thus, efforts to understand the cause(s) and possible environmental consequences of the observed elevations in arsenic levels are recommended. *Sixth,* as with many of the Finger Lakes, nickel levels are elevated in the sediments of Conesus Lake. Investigation of the cause(s) and possible environmental consequences of these nickel levels is recommended.