Chapter 1: Executive Summary

The Finger Lakes are a series of 11 freshwater lakes located in the western part of New York State. The lakes were formed by glacial activity which ended approximately 10,000 years ago. The Finger Lakes include 3 of the largest 10 lakes in the New York State, and represent a significant asset to the Finger Lakes Region and the Empire State in general. All of the lakes, with the exception of Honeoye Lake, are used for public water supply. Permitted water withdrawals total approximately 180 million gallons per day. The Finger Lakes Region is also a well known tourist destination and generates an estimated $1.5 billion annually. The lakes and surrounding landscape of the region are a primary focus for tourism activity.

Water quality conditions within the Finger Lakes are generally good. However, there are water quality concerns as reflected by the fact that all 11 of the lakes are currently on the New York State Department of Environmental Conservation (NYSDEC) Priority Waterbodies List. Water quality issues of concern within the Finger Lakes are approximately equally split between water supply, swimming, and fish consumption issues. Pollutants of concern include nutrients, sediments, priority organics, pathogens, and salts.

Watershed management activities are underway in all 11 of the Finger Lakes watersheds. Management activities vary in level of complexity and stages of development. Canandaigua Lake and Keuka Lake are furthest along the watershed management continuum and have, to a degree, acted as a guide for management activities within several of the other Finger Lakes.

The Finger Lakes have been studied sporadically for nearly a century. The lakes were the focus of pioneering limnological studies by Birge and Juday during the early part of the 20th century. Following this initial foray, there would be a rather lengthy hiatus of nearly half a century before a comprehensive assessment of the lakes would occur. This later effort was conducted by a group of academicians, and culminated in publication of Lakes of New York State – Ecology of the Finger Lakes. Since the early 1970s, little systematic study of water quality conditions within the Finger Lakes has occurred, until the current investigation. There have been monitoring activities on a number of specific Finger Lakes over this time frame – these are largely locally-driven efforts focused on a single lake. However, comparative investigations of the Finger Lakes have been absent over the past several decades.

The purpose of the current study is to conduct such comparative investigations and to assess water quality conditions and trends within the Finger Lakes. The study is composed of two distinct components, *Synoptic Water Quality Investigation* and *Sediment Core Investigation*. The Synoptic Water Quality Investigation is designed to assess current limnological conditions, and to evaluate water quality trends within this important set of lakes. This portion of the Study was initiated in 1996 and is continuing at present. The Sediment Core Investigation is designed to assess chemical trends within the Finger Lakes over time. This portion of the Study is designed as a one-time effort, and sample collection occurred between 1997 and 1998.

The Synoptic Water Quality Investigation involves the collection of water samples and vertical water column profiles at a single deep water location within each lake – the only exception is for Cayuga Lake where there are 3 monitoring locations. Samples from both the epilimnion and hypolimnion are collected monthly during the growing season. In addition, vertical profiles of temperature, dissolved oxygen, pH, and conductivity are collected during each sampling run. The primary focus for this portion of the study is to assess the current trophic status of the lakes and evaluate trends in trophic indices. A secondary focus of the investigation is to assess the status and trends for major ions in the lakes.

Trophic conditions within the Finger Lakes, as reflected in conventional trophic indicators (total phosphorus, chlorophyll *a*, and Secchi Disk depth), have fluctuated significantly over the past century. Trophic conditions are thought to have increased significantly in most of the lakes between the early 1900s and the early 1970s, as evidenced by a marked decline in water clarity levels in most of the lakes. This increase in trophic state, generally considered undesirable, was likely the result of increased phosphorus loading to the lakes over this timeframe – phosphorus is the limiting nutrient within the Finger Lakes. The trend in trophic conditions from the early 1970s to present are somewhat less uniform. In general, the *larger* Finger Lakes have exhibited moderate to substantial declines in trophic state, while trophic conditions within the *smaller* lakes have remained static or increased moderately. The declines in trophic state observed in the larger lakes are believed the result of environmental management actions (e.g., phosphate detergent ban, construction of wastewater facilities, implementation of best management practices, etc.) implemented over the last several decades. Given that these management actions are not unique to the larger lake basins, raises the question "*why are the smaller lakes not responding accordingly*?". This apparent dichotomy in system response is thought to be the result of differences in hypolimnetic dissolved oxygen levels between the larger and smaller lakes, and resultant differences in phosphorus cycling within the respective lakes. It is believed that dissolved oxygen depletions in the smaller lakes trigger an internal release of phosphorus from lake bottom sediments, which, in effect, compensates for realized phosphorus load reductions from the watershed. This is consistent with dissolved oxygen observations in that the larger lakes exhibit little oxygen depletion with depth during the growing season, while the smaller lakes exhibit significant dissolved oxygen depletion during the summer months. The hypolimnion of a number of the Finger Lakes (Otisco, Honeoye, Canadice, Hemlock, and Conesus Lakes) drop below existing dissolved oxygen criteria. Furthermore, New York State's total phosphorus guidance value of 20 ug/l is exceeded in Conesus and Honeoye Lakes, as well as in the southern terminus of Cayuga Lake in certain years.

A secondary focus of the Synoptic Water Quality Investigation is to assess the status and trends for major ions within the Finger Lakes. Findings indicate that water column concentrations of certain ions within the Finger Lakes have changed somewhat over the past 3 decades. *First*, sodium and chloride levels have declined significantly in the two largest lakes (Seneca and Cayuga Lakes), while trends for these ions in the other Finger Lakes indicate increasing concentrations. Sodium and chloride levels have historically been much higher in Seneca and Cayuga Lakes than in the other Finger Lakes, likely due to the proximity of these deep lake basins to underlying salt strata and/or mining operations in the areas. This differential remains the case today, however the gap has narrowed somewhat. The increases in sodium and chloride levels observed in the other Finger Lakes are likely the result of increased use of deicing agents (e.g., sodium chloride) within the watersheds. With respect to water quality concerns, the sodium levels in both Seneca Lake and Cayuga Lake remain above water supply criteria (20 mg/l) for those on severely restricted sodium diets, and the levels within Conesus Lake are approaching this level. *Second*, calcium levels have increased within several of the Finger Lakes over the past few decades, which may raise concerns about Zebra mussel infestations. Zebra mussels, an exotic bivalve introduced into the US in the late 1980s, can cause substantial disruption to aquatic ecosystems, and result in significant impacts to human-made structures (e.g., clogging of water intake pipes). Calcium is often the limiting nutrient to Zebra mussel productivity and growth, thus increased calcium concentrations may lead to an exacerbation of Zebra mussel impacts. It is interesting to note that as of this time Zebra mussels have been found in all of the Finger Lakes with the exception of Canadice Lake. Furthermore, the lowest calcium levels observed in the Finger Lakes are in Canadice Lake, and occur at levels believed to inhibit establishment of Zebra mussel populations. However, given that calcium levels appear to be increasing in Canadice Lake, it is probable that Zebra mussels will eventually become established within the lake. *Third*, alkalinity levels within several of the Finger Lakes appear to have declined somewhat during the past several decades. While this is not of concern within most of the Finger Lakes due to their substantial buffering capacity, conditions within Canadice Lake bear watching due to its relatively low buffering capacity as compared to the other Finger Lakes.

The primary focus of the Sediment Core Investigation is to assess chemical trends within the Finger Lakes. A sediment core taken from the bottom of a lake can provide a chronological history of lake conditions. A single sediment core was collected from the deep water portion of each of the 11 Finger Lakes. Of the 11 sediment cores collected, 9 of the cores provide adequate radiometric profiles to support establishment of sediment dates (using cesium-137 and/or lead-210) – which provides the context for chemical chronologies within the given lake. Exceptions were Cayuga Lake and Hemlock Lake cores which failed to provide acceptable radiometric profiles. Computed sediment accumulation rates within the Finger Lakes ranged from approximately 0.2 cm/year for Canadice Lake and Skaneateles Lake to 0.7 cm/year for Otisco Lake, and were fairly consistent with findings of primary productivity for the lakes – lakes with higher levels of primary productivity show greater sediment accumulation rates. Chemical findings from the sediment core investigation are used as a means for assessing spatial differences between the 11 lakes, temporal trends within individual lakes, and comparisons to sediment quality guidance values – threshold effect level (TEL) and probable effect level (PEL).

The primary *organic* chemicals detected within the Finger Lakes sediment cores are *dichlorodiphenyl-trichloroethane (DDT)* and its metabolites, and *Polychlorinated biphenyl's (PCBs)*. These anthropogenic compounds are currently banned for use in the United States. In general, findings for DDT and its metabolites indicate that peak concentrations occurred several decades ago and that concentrations have declined markedly since that time. Although levels have declined, surficial sediment DDT concentrations remain above the TEL for total DDT in Keuka, Seneca, Conesus, and Canandaigua Lakes. As expected from the existing fish consumption advisory, Keuka Lake sediments show the highest DDT levels. However, indications from both sediments and fish flesh analyses suggest that DDT levels continue to decline in Keuka Lake. Findings for PCBs are somewhat less certain due to detection limitations associated with the analytical methods employed. PCB Aroclors, which were the primary focus of the PCB investigation, were detected in only a single core segment from Canadice Lake. PCB congener analyses (a more sensitive and also more expensive analysis) were also run on a single core segment from each of the lakes. PCB congeners were detected in all of the lakes in which testing was conducted (10 of 11 lakes). Total PCB results (summation of all measured congeners) indicate that sediment PCB levels within several of the lakes exceed upper sediment quality guidance values. Unfortunately, no trend analysis is possible from the data due to the fact that only a single core segment was evaluated from each lake. Furthermore, the core segment chosen for analysis on each of the lakes was taken from several centimeters below the top of the core, and thus may not represent current conditions. One intriguing finding concerning PCBs is that the total PCB concentrations detected in Conesus Lake and Seneca Lake are somewhat higher than the level detected in Canadice Lake, despite the fact that Canadice Lake has a fish consumption advisory currently in place.

A number of *inorganic* chemicals were also detected in the sediment cores extracted from the Finger Lakes. It is important to note that most of these substances can originate from natural, as well as, human sources. The most noteworthy findings are as follows. *First*, arsenic levels within upper sediments of several of the Finger Lakes are significantly enriched. The surficial sediments in several of the lakes exceed both lower and upper sediment quality values (TEL and PEL). There are several plausible explanations for this enrichment ranging from loading issues to geo-chemical processes, however, no definitive conclusions are possible at this juncture. Preliminary water column sampling was initiated in 1999 in response to the sediment core arsenic findings in an effort to assess possible drinking water implications. Preliminary findings are encouraging in that most samples were below the analytical detection level (10 ug/l). However, given the limited nature of the sampling (analytical, spatial, and temporal), and the fact that the USEPA is currently evaluating the existing maximum contaminant level (MCL) for arsenic, would suggest that additional study is warranted. *Second*, nickel levels while relatively homogeneous throughout each core, are above the TEL and PEL in many of the lakes. *Third*, several contaminants (chromium, copper, lead, and zinc) were found to exceed TEL values. In the case of copper, Otisco Lake was found to exceed the upper guidance values – likely due to copper sulfate treatments for algal growth. *Fourth*, while lead levels continue to exceed lower sediment quality values, the levels have decline markedly in many of the Finger Lakes. The declines observed in many of the lakes

coincide very well with known restrictions on the use of leaded gasoline. *Fifth*, calcium levels within the sediments of many of the Finger Lakes show a marked increase over the past half century. Sediment calcium levels have increased by as much as 5-8 fold in some of the lakes. While the reason(s) for this increase are not certain, possibilities include the effects of acid rain, agriculture practices, among others. As discussed above, calcium increases might lead to an exacerbation of Zebra mussel related effects within the Finger Lakes.

Summary findings for each of the Finger Lakes are as follows. *Otisco Lake*, which is one of the smaller Finger Lakes, is a multi-purpose lake located in the Seneca-Oswego River Basin. The lake serves as a source of water supply for the City of Syracuse, and is best characterized as *eutrophic*. Trophic conditions within Otisco Lake have increased somewhat since the early 1970s, as evidenced by moderate increases in total phosphorus and chlorophyll *a* levels within the lake. The lake also undergoes sustained periods of hypolimnetic anoxia during the growing season. 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 indicate a *sediment accumulation rate* of 0.74 cm/year, which is one of the highest rates measured within the Finger Lakes. *Organic* chemical findings from the Otisco Lake sediment core indicate a total PCB concentration of 245 ppb at a sediment depth of 3-4 cm (~ 1990s) which is in the middle range of total PCB levels observed within the Finger Lakes, and is above the TEL for total PCBs. *Inorganic* chemical findings from the Otisco Lake sediment core indicate elevations in copper and nickel levels. Surficial sediments exceed the TEL for copper and the PEL for nickel. There is also a significant increase in sediment calcium levels over the past half century. Finally, sediment core findings indicate a substantial reduction in lead levels over the past several decades. *Recommendations* for Otisco Lake include: (1) Continue efforts to control nutrient inputs to the lake; (2) Evaluate the cause(s) and ecological effects of anoxia within the lake; (3) Implement control measures to minimize inputs of salt to the watershed and the lake; (4) Continue to periodically monitor biota for chlorinated organic chemicals; (5) Evaluate the cause(s) and ecological effects of sediment nickel levels; and (6) Monitor Zebra mussel population dynamics within the lake and assess the ecological effects associated with this invasive exotic.

Skaneateles Lake, which is one of the six larger Finger Lakes, is a multi-purpose lake located in the Seneca-Oswego River Basin. The lake serves as a public water supply for the City of Syracuse, and is best characterized as *oligotrophic*. Trophic conditions within Skaneateles Lake have declined substantially over the past several decades, as evidenced by marked declines in total phosphorus and chlorophyll *a* levels, and a moderate increase in water clarity. The lake continues to be 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 for Skaneateles Lake indicate a *sediment accumulation rate* of approximately 0.2 cm/year, which is one of the lowest accumulation rates observed in the Finger Lakes. *Organic* chemical findings from the Skaneateles Lake sediment core indicate a total PCB concentration of 286 ppb (from 2-3 cm depth which represents the mid 1980s), which is in the middle range of total PCB levels observed within the Finger Lakes, and is above the TEL and slightly above the PEL. *Inorganic* chemical findings from Skaneateles Lake indicate a marked increase in arsenic and manganese levels within surficial sediments. Subsequent water column sampling, albeit limited, has not detected arsenic above 10 ug/l (detection level). There are also elevated levels of nickel within the sediments of Skaneateles Lake, with levels exceeding the TEL and PEL. Sediment core findings also indicate a moderate decline in lead levels over the past several decades. *Recommendations* for Skaneateles Lake include: (1) Efforts to control the input of nutrients to the lake have apparently been successful, and such efforts should continue; (2) Efforts to control inputs of salt to the watershed and the lake should be implemented and/or enhanced; (3) Continue periodic monitoring of biota for chlorinated organic chemicals; (4) Investigate the cause(s) of arsenic enrichment within surficial sediments and further assess possible environmental consequences of such increases; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) Monitor Zebra mussel population dynamics within the lake and assess the ecological effects associated with this invasive exotic.

Owasco Lake, which is one of the six larger Finger Lakes, is a multi-purpose lake located within the Seneca-Oswego River Basin. The lake serves as a drinking water supply for the City of Auburn, and is best characterized as mesotrophic. Trophic conditions within Owasco Lake have shown some limited change over the past several decades, with a moderate decline in chlorophyll *a* levels, but generally stable phosphorus concentrations and water clarity levels. As in the past, the lake remains 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. Sediment core findings for Owasco Lake indicate a *sediment accumulation rate* of 0.38 cm/year, which is in the middle range of accumulation rates observed in the Finger Lakes. *Organic* chemical findings from the Owasco Lake sediment core indicate a total PCB concentration of 374 ppb (from 3-4 cm depth representative of the late 1970s), which is in the upper range of total PCB levels observed within the Finger Lakes, and is above the TEL and PEL for PCBs. The PCB pattern was dominated by lower chlorinated congeners. *Inorganic* chemical findings from the Owasco Lake sediment core indicate a slight increase in arsenic levels within surficial sediment layers, and levels exceed the TEL but are slightly below the PEL. Subsequent water column sampling from Owasco Lake showed one measurement at 10 ug/l (which is below the current MCL). Nickel levels within lake sediments are consistently above the TEL and PEL. Sediment core findings also indicate a marked decline in lead levels with Owasco Lake over the last several decades. *Recommendations* for Owasco Lake include: (1) Continued efforts to control release of nutrients within the Owasco Lake watershed are warranted; (2) Management efforts regarding the use and storage of salt within the watershed are suggested; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Investigate the cause(s) of arsenic enrichment within surficial sediments and further assess possible environmental consequences of such increases; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) Monitor Zebra mussel population dynamics within the lake and assess the ecological effects associated with this invasive exotic.

Cayuga Lake, which is one of the two largest Finger Lakes, is a multi-purpose lake located within the Seneca-Oswego River Basin. The lake serves as a public water supply for the City of Ithaca, and several other communities within the basin. The Synoptic Water Quality Investigation of Cayuga Lake is divided into an assessment of the main lake (deep basin) and the southern shelf of the lake. The reason for this bifurcation is that water quality conditions vary substantially between these two lake segments, and that a number of water quality concerns (water supply, swimming, etc.) have been raised specifically about the southern end of Cayuga Lake. The main portion of Cayuga Lake is best characterized as borderline between oligotrophic and mesotrophic. Trophic conditions within the main lake have declined over the past several decades, however, the level of decline has varied substantially between major trophic indicators. Findings from this study indicate a substantial decline in total phosphorus levels over the past several decades, with much smaller declines in chlorophyll *a*, and a moderate increase in water clarity since the early 1970s. These changes would indicate that nutrient control measures within the Cayuga lake watershed have been fairly effective with respect to the deep lake. As has been the case historically, Cayuga Lake appears to remain 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. Historically, there has been a marked longitudinal gradient in trophic conditions within Cayuga Lake moving from the southern shelf northward to the deep basin, with decreasing levels of total phosphorus and chlorophyll *a*, and increasing water clarity levels. The marked elevation in certain trophic indicators within the south lake continues at present, although there are indications of possible changes. Results from this investigation indicate that total phosphorus levels within the south shelf segment are substantially higher than in the main lake, and that the mean seasonal total phosphorus concentration exceeds the NYSDEC total phosphorus guidance value (20 ug/l) in certain years. Other recent studies confirm this finding (UFI, 2000, Sterns and Wheler, 1997). Findings for chlorophyll *a* and Secchi Disk depth are somewhat more equivocal with respect to longitudinal differences. While early findings from this investigation indicate marked longitudinal differences in chlorophyll *a* and water clarity levels, more recent findings suggest less apparent differences. It is believed that increases in Zebra mussel population numbers in the south lake may be causing a downward trend in chlorophyll *a* and an upward trend in water clarity within the

south shelf area. Findings from the Cayuga Lake sediment core are limited due to the lack of an intact radiometric profile within the core, and anomalously low chemical findings. *Recommendations* for Cayuga Lake include: (1) Efforts to control nutrient (particularly phosphorus) and sediment loads within the Cayuga Lake watershed should be continued. This is particularly important within the south-lake catchment where use impairments are present. Additional study of water quality dynamics within the south lake should be pursued – this should include development of accurate estimates of nutrient and sediment loads to the southern catchment, and a coupled watershed/lake mass balance model for the south lake. Furthermore, a thorough assessment of use impairment issues (water supply, primary contact recreation, and aesthetic concerns) should be initiated, and should include evaluation of remedial measures; (2) Collection of an additional deep water sediment core(s) is also recommended for Cayuga Lake; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; and (4) Establish a Zebra mussel monitoring program within the lake to understand population dynamics and assess ecological effects associated with this invasive exotic.

Seneca Lake, which is one of the two largest Finger Lakes, is a multi-purpose lake located within the Seneca-Oswego River Basin. The lake serves as a source of public water supply for the City of Geneva and the Villages of Ovid, Waterloo, and Watkins Glen. Trophic conditions within Seneca Lake have declined substantially over the past several decades, as evidenced by marked declines in total phosphorus and chlorophyll *a* levels, and a substantial increase in water clarity. Furthermore, the lake continues to be well oxygenated throughout the growing season. 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. Sediment core findings for Skaneateles Lake indicate a *sediment accumulation rate* of 0.23 cm/year, which is one of the lowest accumulation rates observed in the Finger Lakes. *Organic* chemical findings from the Seneca Lake sediment core indicate a substantial decline in total DDT levels over the past several decades, but levels remain above the TEL. Sediment core findings indicate a total PCB concentration of 466 ppb (from 4-6 cm sediment depth representative of the late 1970s), which is in the upper range of total PCB levels observed within the Finger Lakes, and is above the TEL and PEL for PCBs. *Inorganic* chemical findings from the Seneca Lake sediment core indicate that arsenic levels are near or slightly above the PEL, although arsenic levels do not show the marked surficial enrichment seen in several of the other Finger Lakes. Subsequent water column sampling within Seneca Lake, albeit limited, has shown no detectable arsenic concentrations above 10 ug/l (analytical detection limit). Cadmium levels within the sediments were stable, and were above the TEL but below the PEL. As with many of the Finger Lakes, calcium concentrations within the sediments of Seneca Lake have increased substantially over the past several decades. Lead levels within Seneca Lake sediments have declined precipitously over the past several decades, and are below the PEL – however, they remain above the TEL. Mercury levels within Seneca Lake sediments have declined by approximately 50 percent over the past 40 years, and surficial concentrations are below the TEL and the PEL for total mercury. Nickel levels within the sediments of Seneca Lake are basically stable over the past half century, and concentrations are above the TEL but below the PEL. *Recommendations* for Seneca Lake include: (1) Efforts to control nutrient inputs to the lake have apparently been successful, and such efforts should be continued; (2) Investigation of sodium and chloride dynamics within Seneca Lake should continue, and control measures for salt discharge within the watershed and the lake should be continued; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Investigate the cause(s) of arsenic enrichment within lake sediments and further assess possible environmental consequences of such increases; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) Monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic.

Keuka Lake, which is one of the six larger Finger Lakes, is a multi-purpose water body located in the Seneca-Oswego River Basin. The lake is a source of public water supply for the Villages of Hammondsport and Penn Yan. Trophic conditions within Keuka Lake have declined markedly over the past several decades, as evidenced by substantial declines in total phosphorus and chlorophyll *a* levels, and a moderate increase in water clarity. The lake continues to be well oxygenated throughout 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 rates observed within the Finger Lakes. *Organic* chemical findings for Keuka Lake indicate that total DDT levels within the sediments of Keuka Lake have declined markedly, from a peak of nearly 400 ppb in the late 1970s to current levels of 72 ppb - this is consistent with recent fish flesh findings. While trends are encouraging, DDT levels remain above the TEL, but below the PEL. Sediment core findings also indicate a total PCB concentration of 449 ppb (289 ppb when adjusted for DDE) from a single sediment core segment (mid 1980s). The later value (289 ppb) is more appropriate given historical DDT levels in the lake, and is in the middle range of levels measured in Finger Lakes sediments – this is above the TEL and PEL for total PCBs. *Inorganic* chemical findings from the Keuka Lake sediment core indicate a marked increase in arsenic and manganese levels within surficial sediments. Subsequent water sampling, albeit limited, did not detect arsenic above 10 ug/l (analytical detection level). There are elevated levels of nickel within the sediments of Keuka Lake, and levels exceed the TEL and PEL. Findings also indicate a substantial decline in lead levels within Keuka Lake sediments over the past several decades. *Recommendations* for Keuka Lake include: (1) Efforts to control the input of nutrients to Keuka Lake have apparently been successful, and should be continued; (2) Management efforts to control the use salt within the watershed should be implemented and/or enhanced; (3) Continue periodic monitoring of biota for chlorinated organic chemicals; (4) Further investigation is warranted regarding the cause(s) of arsenic enrichment within lake sediments and possible consequences of this phenomenon; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) Monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic.

Canandaigua Lake, which is one of the six larger Finger Lakes, is a multi-purpose water body located in the Seneca-Oswego River Basin. The lake serves as a source of public water supply for the City of Canandaigua, and several other communities within the watershed. Trophic conditions within Canandaigua Lake have declined substantially over the past several decades, as evidenced by marked declines in total phosphorus and chlorophyll *a* levels, and a substantial increase in water clarity. The lake continues to be well oxygenated throughout 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 within Canandaigua Lake indicate a *sediment accumulation rate* of approximately 0.2 cm/year, which is one of the lowest sediment accumulation rates within the Finger Lakes. *Organic* chemical findings from Canandaigua Lake indicate that total DDT levels within the sediments of Canandaigua Lake have declined markedly over the last several decades. However, DDT levels remain above the TEL within surficial sediments. *Inorganic* chemical findings from the Canandaigua Lake sediment core indicate a marked increase in arsenic and manganese levels within surficial sediments. Subsequent water column sampling, albeit limited, has not detected arsenic above 10 ug/l (detection level). There are elevated levels of nickel within the sediments of Canandaigua Lake, with levels exceeding the TEL and PEL. Findings also indicate a substantial decline in lead levels within Canandaigua Lake sediments over the past several decades. *Recommendations* for Canandaigua Lake include: (1) Efforts to control the input of nutrients to Canandaigua Lake have apparently been successful over the past several decades, and such control measures should be continued; (2) Management efforts regarding the use salt within the watershed are suggested; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Further investigation is warranted regarding the cause(s) of arsenic enrichment within lake sediments and assessment of possible environmental consequences; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) Monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic.

Honeoye Lake, which is one of the five smaller Finger Lakes, is a multi-purpose water body located in the Genesee River Basin. While the lake is classified "AA", it is not presently used as a public water supply. Trophic conditions within Honeoye Lake are best characterized as eutrophic, which is similar to the overall trophic status of the lake over the past several decades. However, current levels of major trophic indicators are somewhat different than in the past. Findings suggest an increase in total phosphorus levels, a decline in chlorophyll *a* levels, and a small increase in water clarity within the lake. Total phosphorus levels within the lake are above the NYSDEC total phosphorus guidance value of 20 ug/l, and there are sustained periods of hypolimnetic hypoxia during the growing season. Trends for major ions within Honeoye Lake over the past several decades 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 at the high end of accumulation rates observed within the Finger Lakes. *Organic* chemical findings from the Honeoye Lake sediment core indicate a total PCB concentration of 69 ppb from a single sediment core segment (3-6 cm sediment depth, which equates to approximately 1990). This is at the low end of total PCB levels observed in the Finger Lakes, however, it is above the TEL, but below the PEL. *Inorganic* chemical findings from the Honeoye Lake sediment core indicate that arsenic levels in the sediments increase in the 1970s and remain elevated thereafter. Surficial sediment arsenic concentrations are above the TEL and slightly above the PEL. Subsequent water column sampling, albeit limited, has not detected arsenic above 10 ug/l (detection level). Additional inorganic chemical findings from the Honeoye Lake sediment core indicate nickel levels above the TEL and PEL, and fluctuations in lead levels – initial decline followed by a recent increase. *Recommendations* for Honeoye Lake include: (1) Efforts to control the input of nutrients to Honeoye Lake should be continued and enhanced. Furthermore, efforts to understand nutrient loading to the lake, and to assess dissolved oxygen depletion within the lake are recommended. This should include the derivation of accurate tributary nutrient loads to the lake and review of permitted nutrient loads within the Honeoye Lake watershed; (2) Management efforts regarding the storage and use of salt within the watershed are indicated; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Further investigation regarding the cause(s) of arsenic elevations within lake sediments and assessment of possible environmental consequences of such increases are warranted; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) Implement a program to monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic.

Canadice Lake, which is one of the five smaller Finger Lakes, is located within the Genesee River Basin. The lake serves as a source of drinking water for the City of Rochester, and has fairly stringent watershed protection measures and lake use restrictions. The trophic status of Canadice Lake is best characterized as borderline between oligotrophic and mesotrophic, and trophic conditions are largely similar to those recorded several decades ago. Study findings also indicate sustained periods of hypolimnetic hypoxia within Canadice Lake during the later part of the growing season. 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. Sediment core findings indicate a *sediment accumulation rate* of approximately 0.2 cm/year, which is one of the lowest accumulation rates measured within the Finger Lakes. *Organic* chemical findings from the Canadice Lake sediment core indicate a decline in DDT metabolites within lake sediments in recent decades. Sediment core findings also indicate a total PCB concentration of 352 ppb (4-6 cm sediment depth, representing the early 1970s), which is in the middle range of total PCB levels observed in other Finger Lakes cores, and is above the TEL and PEL for total PCBs. *Inorganic* chemical findings from the Canadice Lake sediment core indicate a significant increase in arsenic levels over the past several decades. This phenomenon of arsenic enrichment within upper sediment layers is also apparent in a number of the other Finger Lakes. The arsenic levels observed in the surficial sediments of Canadice Lake are above the TEL and PEL. Subsequent water column sampling, albeit limited, has not detected arsenic above 10 ug/l (detection level). Sediment core findings also indicate substantial increases in calcium levels within Canadice Lake over the past several decades – a pattern repeated in a number of other Finger Lakes. Manganese levels have also increased within Canadice Lake sediments in recent years, and roughly parallel arsenic changes. Nickel levels are fairly

constant over the observed period, but are above the TEL and PEL. Sediment lead concentrations have declined substantially in recent decades, and are near the TEL for lead. *Recommendations* for Canadice Lake include: (1) Efforts to control the input of nutrients to Canadice Lake should be continued. Furthermore, efforts to understand nutrient loading to the lake, and to assess dissolved oxygen depletion dynamics within the lake are recommended; (2) Management efforts regarding the use and storage of salt within the watershed are suggested; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Additional investigation is warranted regarding the cause(s) of arsenic/manganese elevations within lake sediments and possible environmental consequences of such increases; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) A program to monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic should be implemented – with particular attention on ambient calcium availability.

Hemlock Lake, which is one of the five smaller Finger Lakes, is located in the Genesee River Basin. Hemlock Lake is a source of public water supply for the City of Rochester, and has fairly stringent watershed protection measures and lake use restrictions. The trophic status of Canadice Lake is best characterized as borderline between oligotrophic and mesotrophic, as evidenced by current levels for major trophic indicators. 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 equivalent to levels measured during the early 1970s. Furthermore, 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. 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 are limited due to the lack of an intact radiometric profile. Thus, no sediment accumulation rate could be determined for the lake, and chemical findings must be viewed as composite values (no temporal, or trend information is discernable). *Organic* chemical findings from the Hemlock Lake sediment core indicate total DDT levels range from 25-49 ppb. Sediment core findings from Hemlock Lake also indicate a total PCB concentration of 67 ppb (4-6 cm sediment depth), which is at the low end of total PCB levels observed in other Finger Lakes cores, but is above the TEL for total PCBs. *Inorganic* chemical findings for Hemlock Lake indicate that sediment arsenic levels are above the TEL and PEL. Subsequent water column sampling, albeit limited, has not detected arsenic above 10 ug/l (detection level). Additional inorganic chemical findings for Hemlock Lake indicate nickel levels exceed the TEL and PEL. *Recommendations* for Hemlock Lake include: (1) Efforts to control the input of nutrients to Hemlock Lake should be continued. Furthermore, efforts to understand nutrient loading to the lake, and to assess dissolved oxygen depletion dynamics within the lake are recommended; (2) Management efforts regarding the use and storage of deicing agents within the watershed are indicated; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Further investigation regarding the cause(s) of arsenic elevations within lake sediments and assessment of possible environmental consequences of such increases are warranted; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; (6) A program to monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic should be implemented; and (7) It would be beneficial to collect an additional deep water sediment core on Hemlock Lake for the purpose of assessing a sediment accumulation rate and chemical chronology within the lake.

Conesus Lake, which is one of the five smaller Finger Lakes, is a multi-purpose water body located in the Genesee River Basin. The lake serves as a source of public water supply for the Town of Livonia, and the Villages of Avon and Geneseo. The trophic status of Conesus Lake is best characterized as eutrophic, as evidenced by the levels of major trophic indicators. Findings indicate that trophic conditions within Conesus Lake have increased somewhat since the early 1970s. The mean annual total phosphorus level of the lake has increased slightly and is above the New York State total phosphorus guidance value of 20 ug/l, and water clarity has declined moderately. Furthermore, the hypolimnion of Conesus Lake becomes anoxic during mid to late summer, with dissolved oxygen levels dropping to near zero in a significant portion of the hypolimnion. 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 from the Conesus Lake sediment core indicate that total DDT levels declined from the early 1960s to the early 1970s, and plateau thereafter. The total DDT levels observed are above the TEL but below the PEL. PCB findings from the Conesus Lake sediment core indicate a total PCB level of 490 ppb (at 4-6 cm sediment depth, which represents sediments deposited during the mid 1980s). This is the highest level of total PCBs observed within the Finger Lakes cores, and is above the TEL and PEL for total PCBs. *Inorganic* chemical findings for Conesus Lake indicate fairly high arsenic concentrations within benthic sediments. However, in contrast to some of the other lakes, there was not a marked increase in arsenic levels within surficial sediment layers. The arsenic levels observed were above the TEL and near or above the PEL for arsenic. Subsequent water column sampling, albeit limited, has not detected arsenic above 10 ug/l (detection level). Additional inorganic chemical findings from the Conesus Lake sediment core indicate fairly constant nickel concentrations that are above the TEL and PEL. Sediment core findings also indicate a substantial decline in lead levels within the sediments of Conesus Lake over the past several decades. *Recommendations* for Conesus Lake include: (1) Efforts to control the input of nutrients to Conesus Lake should be continued and enhanced. Furthermore, efforts to understand nutrient loading to the lake, and to assess dissolved oxygen depletion within the lake are recommended. This should include the derivation of accurate nutrient load estimates to the lake, and an assessment of existing nutrient load allocations within the watershed; (2) Management efforts regarding the storage and use of salt within the watershed are recommended; (3) Continue periodic monitoring of aquatic biota for chlorinated organic chemicals; (4) Further investigation regarding the cause(s) of arsenic elevations within lake sediments and assessment of possible environmental consequences of such levels are warranted; (5) Evaluate the cause(s) and ecological effects of elevated nickel levels; and (6) A program to monitor Zebra mussel population dynamics within the lake and assess ecological effects associated with this invasive exotic should be implemented.