Chapter 4: State of Owasco Lake

4.1 Classification and Designated Use

As described in section 3.6, the NYSDEC classifies surface waters-including lakes, rivers, streams, embayments, estuaries, and groundwater--with respect to their designated use. Owasco Lake is a Class AA (T) waterbody. According to NYCRR Part 701.5, the best usages of Class AA waters are:

- a source of water supply for drinking, culinary or food processing purposes;
- primary and secondary contact recreation; and
- fishing (the waters shall be suitable for fish, shellfish, and wildlife propagation and survival).

Further, this classification may be given to those waters that, if subjected to approved disinfection treatment, with additional treatment if necessary to remove naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

The (T) designation means that Owasco Lake water quality and habitat conditions are suitable for salmonids. In December, 2014 NYSDEC released an updated assessment of the extent to which Owasco Lake conditions are consistent with their designated use; the assessment (Priority Waterbodies List) is summarized in Table 4-1.

Table 4-1. Owasco Lake Priority Waterbodies List Status, Revised December 21, 2014

Lake Ecosystem & Human Use Metrics	Attainment Status & Severity	Documentation
Uses Evaluated		
Water supply	Impaired	Suspected
Public bathing	Impaired	Suspected
Recreation	Impaired	Suspected
Aquatic Life	Fully supported	Known
Fish consumption	Fully supported	Unconfirmed
Conditions Evaluated		
Habitat/Hydrology	Fair	
Aesthetics	Fair	

In their December 2014 revision, NYSDEC further reported on the types and sources of pollutants affecting the uses and conditions. The NYSDEC uses CAPITAL LETTERS to indicate their conclusions regarding the MAJOR Use Impacts/Pollutants/Sources.

Type of Pollutant(s)
Known: PATHOGENS, HARMFUL ALGAL BLOOMS, Algal/Plant growth (native)
Suspected: NUTRIENTS (phosphorus), Silt/Sediment

Source(s) of Pollutant(s)
Known: AGRICULTURE, OTHER SOURCE (waterfowl), Habitat alteration
Suspected: Hydrologic alteration, municipal discharges, onsite/septic systems

In 1998, NYSDEC included Owasco Lake on its inaugural List of Impaired Waterbodies, also known as the 303(d) list, in Part 1 - Individual Waterbody Segments with Impairment Requiring TMDL Development. Pathogens were the basis for the listing; the source is cited as wildlife/other. The 303(d) list is a compilation of lakes, streams, and coastal areas where water quality conditions are not adequate to support a designated use. Designated uses may be human-oriented (e.g. drinking water, swimming, boating, shellfish consumption) or ecologically-oriented (e.g. fish propagation, fish survival). The list is named for the section of the federal Clean Water Act requiring states, territories, and authorized tribes to assess water quality conditions within their jurisdictions. Water quality conditions are compared with criteria and standards defined in terms of the specific uses. The 303(d) list is a product of this assessment; water bodies are placed on the list when additional controls are needed to bring water quality into compliance with standards and criteria defined for designated uses.

The Section 303(d) List is updated every two years. The Final 2014 NYS Section 303(d) List (September 2014) which was "partially approved/partially disapproved" by USEPA in January 2015 is now in effect. In this current document, Owasco Lake continues to be listed in Part 1 as impaired by pathogens and requiring a TMDL. However, the NYSDEC December 2014 update to the Priority Waterbodies List notes that “the suspected impacts to water quality and uses may not be sufficient to warrant continued listing” and recommended a re-evaluation of listings for the lake during the 2016 listing cycle.

During the comment period on the draft 2014 listings, the Cayuga County Water Quality Management Agency submitted comments to NYSDEC stating that Owasco Lake should be added to the 303(d) list of impaired waters requiring a TMDL due to excessive phosphorus/nutrients, citing the presence of numerous and widespread cyanobacterial blooms in recent years. Excessive aquatic vegetation growth was also noted. NYSDEC responded that current data for phosphorus concentrations in Owasco Lake demonstrate that concentrations remain well below the agency’s assessment criteria and do not support a listing. However, the cyanobacterial blooms are of concern. Similar to their comments related to pathogens, NYSDEC recommended re-evaluating the lake’s regulatory listing during the 2016 cycle.

4.2 Public Water Supply

Owasco Lake serves as the drinking water supply for more than 44,000 residents of Cayuga County. Two water intakes extend into the lake’s northern basin; the City of Auburn draws water from a depth of 30 feet and the Town of Owasco draws water from a depth of 45 feet. Some lakefront property owners are also known to draw water directly from the lake. Many municipalities purchase treated water from the City of Auburn: Towns of Sennett, Throop, Brutus, Mentz, Aurelius, Springport, Fleming and Montezuma; the Villages of Weedsport, Port Byron, and Cayuga, the Thruway Authority, and the Cayuga County Water and Sewer Authority.[1] The Town of Fleming also purchases treated water from the Town of Owasco.

The City of Auburn is permitted to draw up to 15 million gallons of water per day (mgd) from Owasco Lake. According to their 2013 Annual Report, the transmission main serving the City of Auburn drinking water plant consists of approximately 8,800 feet of cast-iron pipe. The first 400 feet of transmission main was replaced in 2001 as part of the re-construction of the Owasco Lake Seawall**.** The City presently operates two filtration plants: a slow-sand plant, and a rapid-sand plant, which are operated in parallel. The slow-sand filtration plant, constructed in 1916-17*,* has four beds with a total capacity of about 7.5 mgd. The beds consist of about 42 inches of sand supported by 12 inches of gravel. The rapid-sand filtration plant was added in 1969. This plant consists of three dual-media filters with a combined capacity of about 7.25 mgd. In the rapid-sand filtration plant, water is pre-treated with poly-aluminum chloride to facilitate coagulation and sedimentation and settling prior to filtration. All water is disinfected with sodium hypochlorite prior to distribution. Activated carbon is used to prevent development of taste and odor that may be associated with the presence of certain algal species. Reservoirs on Franklin Street in Sennett and Swift Street in the City maintain reserves of 10.25 mg and 3 mg respectively. The City also adds sodium hypochlorite to its raw water intake, to prevent attachment of dreissenid mussels within the intake pipe. On an annual average, the City of Auburn water plant treats and distributes slightly over 4 mgd; the annual peak day produces about 5.6 mgd of water.

The quality of public water supplies is regulated by the NYS Department of Health (NYSDOH), which requires extensive monitoring and sets numerical limits on the presence of chemicals, turbidity (sediment particles), and certain microbes in the treated water supply. The reports of the City of Auburn indicate that the water supply is in full compliance with these regulatory limits and requirements.

The Town of Owasco draws less than 0.4 mgd of lake water to serve its customers in Owasco and Fleming. According to their Annual Report, this utility applies potassium permanganate to its raw water intake as a defense against dreissenid mussels. The lake water is pumped to the filter plant located on East Lake Rd where it is treated with polymer, filtered and chlorinated prior to distribution. Activated carbon is used to prevent development of taste and odor that may be associated with the presence of certain algal species. The water plant has the capacity to pre-chlorinate (ahead of polymer addition) but no longer does so. The NYSDOH-required monitoring indicates that this water supply is also in full compliance with the regulatory limits and requirements.

The NYSDEC reported in December 2014 that, while the City of Auburn and Town of Owasco public water supplies are in full compliance, there have been occasional exceedances in recent years of the limits on disinfection byproducts measured in some of the municipal systems that purchase treated Owasco Lake water. Both water supplies use chlorine for disinfection. Potentially harmful disinfection byproducts, such as trihalomethanes, haloacetic acids, and chlorite, can be formed when chlorine reacts with naturally-occurring organic matter present in the water. The detection of disinfection byproducts in these small municipal systems was cited to support the designation of the lake as impaired for its use as a water supply. The monthly average concentrations of total organic carbon (TOC) measured in the intake to the City of Auburn water treatment plant from 2001 to 2014 are summarized in Table 4-2. Note the variability among months; higher TOC levels are measured during the summer growing season when phytoplankton are at their annual maxima. The table also reveals that the minimum monthly average values over the 14 year period were measured earlier in the record, and the higher

concentrations were measured later in the record. The annual average TOC concentrations over the 14 year period (Figure 4-1) confirm the trend of increasing concentration.

Table 4-2. History of Total Organic Carbon (TOC) Concentrations Measured at the City of Auburn Water Intake, 2001–2014

Month	Total Organic Carbon. mg/L				
	Average (2001-2014)	Minimum	Minimum Year	Maximum	Maximum Year
January	5.4	1.8	2001	25.0	2013
February	4.3	2.2	2002	7.2	2013
March	5.4	2.5	2002	15.0	2012
April	4.1	2.4	2002	7.1	2010
May	4.4	2.4	2002	6.3	2008
June	6.9	2.2	2001	21.0	2011
July	7.7	2.9	2001	20.0	2011
August	7.3	2.6	2004	20.0	2010
September	6.2	2.9	2002	11.0	2008
October	4.3	2.3	2001	6.2	2010
November	5.1	2.4	2003	8.6	2010
December	4.8	2.4	2004	8.7	2013

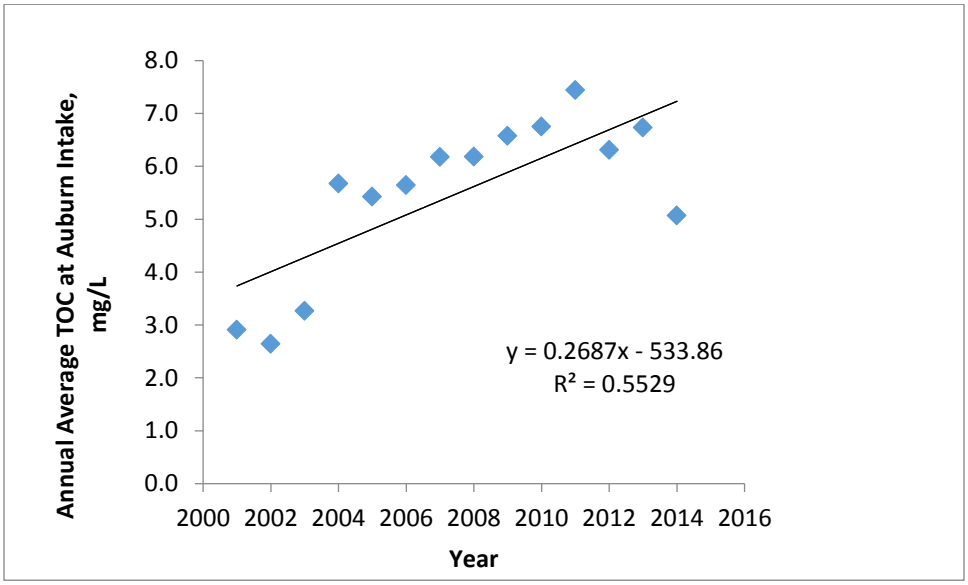

Figure 4-1. Annual Average Total Organic Carbon Concentrations at City of Auburn Water Intake, 2001–2014

4.3 Trophic State Assessment

The level of productivity (trophic state) of a lake is typically defined by three parameters: total phosphorus concentration, Secchi disk transparency, and chlorophyll-*a* concentration (a measure of algal abundance). Trophic state of lakes is a continuum, without clear demarcations of boundaries between nutrient-poor conditions (oligotrophic), moderate levels of nutrients and aquatic productivity (mesotrophic), and productive systems (eutrophic).

In turn, lake productivity is related to the dissolved oxygen (DO) content of the water column, notably the deep waters of thermally stratified lakes such as Owasco Lake. Algal cells produced in the upper waters are decomposed by microorganisms as they settle to the lake sediment. In productive lakes with abundant algal growth, DO concentrations decline in the deeper waters during the summer. When DO is depleted, chemical changes at the sediment surface promote the flux of phosphorus from sediments into the water column. This sediment phosphorus, which may have entered the lake long ago, can eventually become available to support algal production.

In the following sections, the status and trends in the trophic state of Owasco Lake, including deep water DO conditions, are reviewed. The primary data source is the Finger Lakes Institute annual monitoring program led by Professor Halfman of FLI and Hobart William Smith Colleges.

4.3.1 Total Phosphorus, Chlorophyll-a, and Secchi Disk Transparency

Various investigators and regulatory agencies have advanced numerical thresholds to categorize lakes productivity level. As shown in Table 4-3, the limits outlined by USEPA[2] are typically used for New York lakes. Owasco Lake is described as oligo-mesotrophic.[3]

Table 4-3. Limits for Demarcation of Trophic State Condition, Compared with Owasco Lake Measurements, 2006–2014

Metric	Oligotrophic	Mesotrophic	Eutrophic	Owasco Lake (2006–2014)
Summer average total phosphorus, upper waters (µg/L)	<10	10-25	>25	10.5
Summer average chlorophyll-a, upper waters (µg/L)	<4	4 - 8	>8	2.6
Average Secchi disk transparency, m	>4	2-4	<2	4.1
Dissolved oxygen in lower waters (% saturation)	80 – 100	10-80	Less than 10	50-80

Summer average total phosphorus (TP) is used as an index of the lake's trophic state and suitability for use in water supply and recreation. Elevated TP concentrations are coupled to algal abundance and water clarity. NYSDEC has adopted a guidance value for TP in lakes of 20 µg/L summer average (defined as the four month period from June 1 to September 30) to protect recreational uses. NYSDEC is considering adopting numerical nutrient criteria for lakes to protect water supply uses as well; these

criteria may be lower or may extend over a longer averaging period. The summer average TP concentrations in Owasco Lake's upper waters are consistently below the current regulatory guidance value of 20 µg/L for recreational uses (Figure 4-2).

There is also a narrative standard in place for phosphorus and nutrients in waters "None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages". In the summer of 2014, two bathing beaches were closed due to algal blooms. In addition, some residents report that excessive macrophyte growth limits their recreational access to the lake. These observations indicate that the narrative nutrient standard may not be consistently met in Owasco Lake.

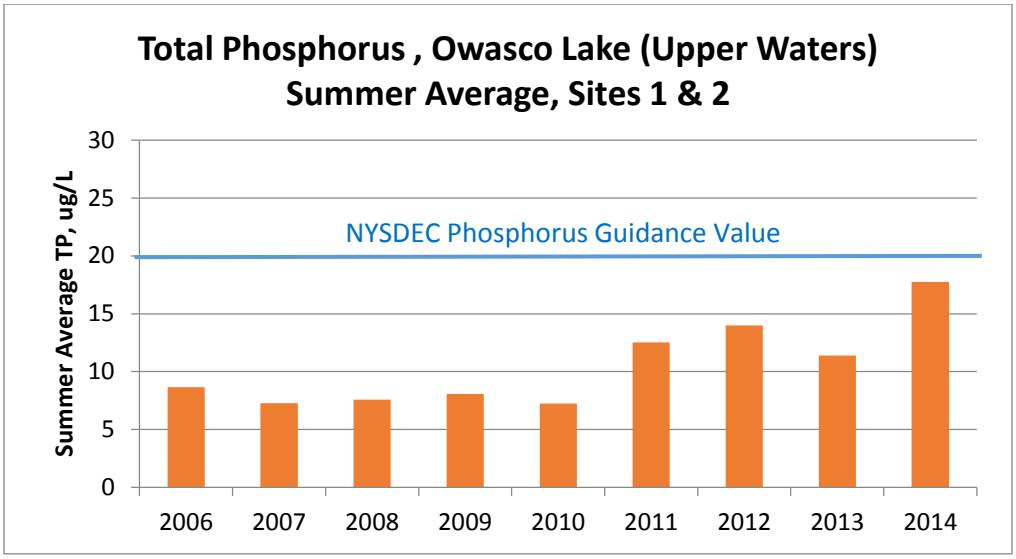

Figure 4-2. Total Phosphorus Concentration, Owasco Lake Upper Waters, 2006–2014 Compared to the Regulatory Threshold for Use Impairment for Recreation

There is no regulatory limit for chlorophyll-*a* concentration in the state's lakes and reservoirs as of February 2015. However, NYSDEC has been working for several years to develop nutrient criteria that will be protective of surface waters used for potable water supply. While the proposed nutrient criteria are not yet released for public review and comment, the draft revisions to NYSDEC Consolidated Assessment and Listing Methodology (CALM) cites a threshold of 4 µg/L chlorophyll-*a* for Class AA waters, such as Owasco Lake. Eventually, statistical modeling will be used to relate this level of algal abundance to ambient phosphorus concentrations. The objective of managing lakes to keep chlorophyll-*a* levels low is to reduce the risk of formation of disinfection byproducts. The chlorophyll-*a* concentrations measured in Owasco Lake are consistently below this threshold, indicating that algal levels are low and the lake's use as a public water supply is not at risk (Figure 4-3). However, conditions in some years (2005, 2009, 2014) approach the proposed threshold of 4 µg/L chlorophyll-*a* for Class AA waters.

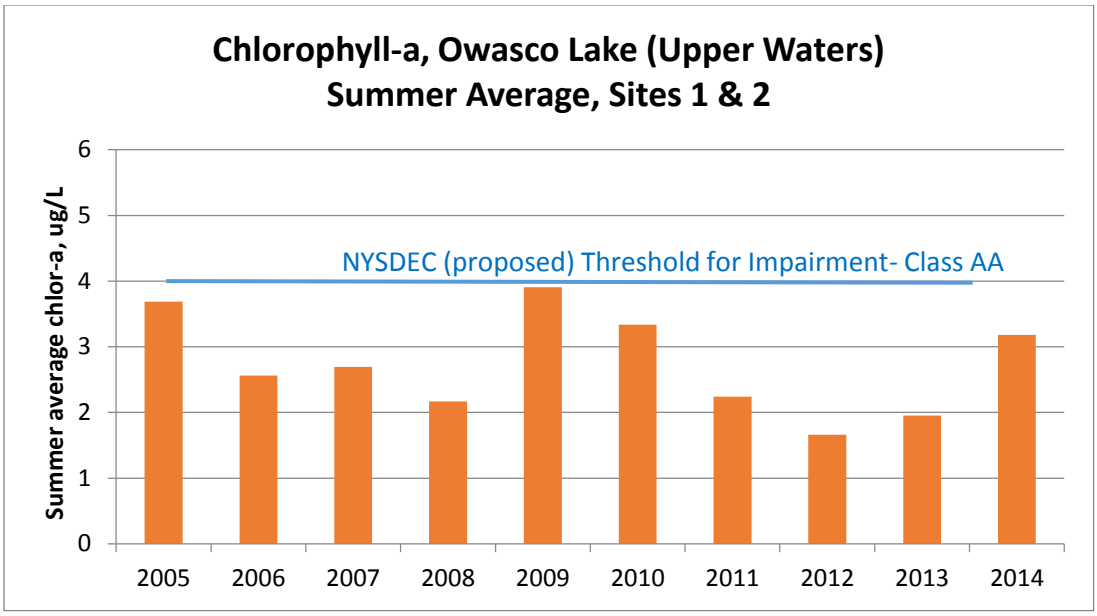

Figure 4-3. Chlorophyll-a Concentration, Owasco Lake, 2005-2014
Compared to the (proposed) Threshold for Use Impairment for Public Water Supply

The third classic metric of trophic state is Secchi disk transparency, a measure of water clarity. The utility of Secchi disk transparency is limited by the extent to which algal particulates are the primary factor affecting water clarity. The NYSDOH has a swimming safety guidance value of 1.2 m (4 ft.) for public beaches. The water quality of Owasco Lake is consistently above this threshold as shown in Figure 4-4.

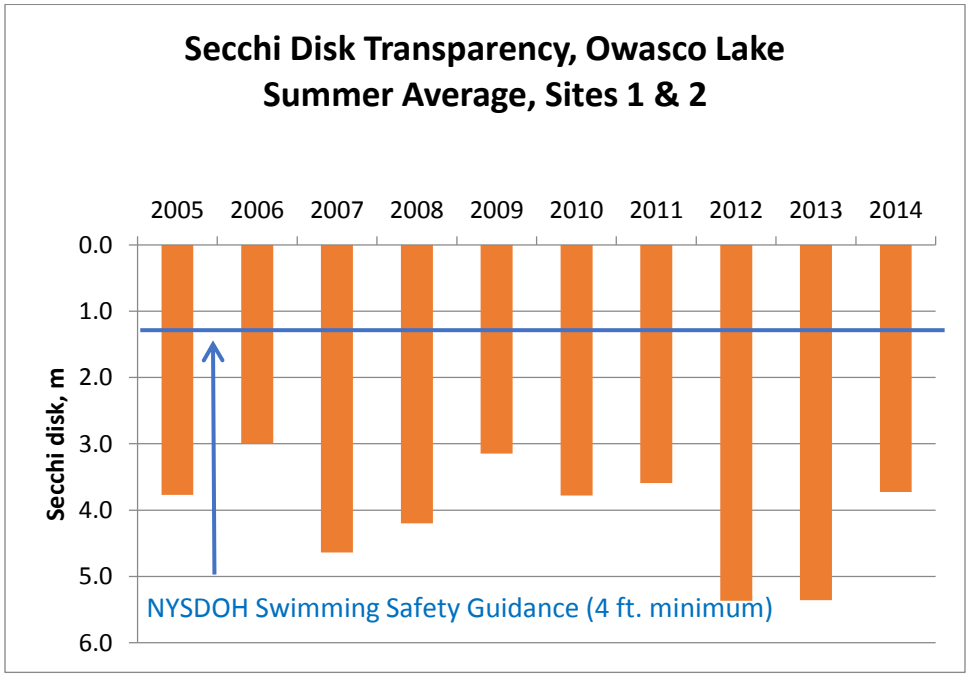

Figure 4-4. Secchi Disk Transparency, Owasco Lake 2005–2014
Compared to Swimming Safety Guidelines

4.3.2 Dissolved Oxygen

The deep waters of Owasco Lake exhibit a progressive decline in DO concentration as the summer period of thermal stratification progresses. These data are documented in the annual reports of the Finger Lakes Institute lake monitoring program (2010–2014). There is much interannual variability, as evident in Figure 4-5. The differences among the years are the result of a complex interaction of weather, i.e., the timing of the onset of stable thermal stratification, and productivity.

There are two important implications to these data. First, the DO concentrations in the deeper colder waters are sufficient to support the cold water fish community. Second, Owasco Lake does not develop seasonal anoxia in the deepest waters, which prevents phosphorus flux from the sediments to the overlying waters.

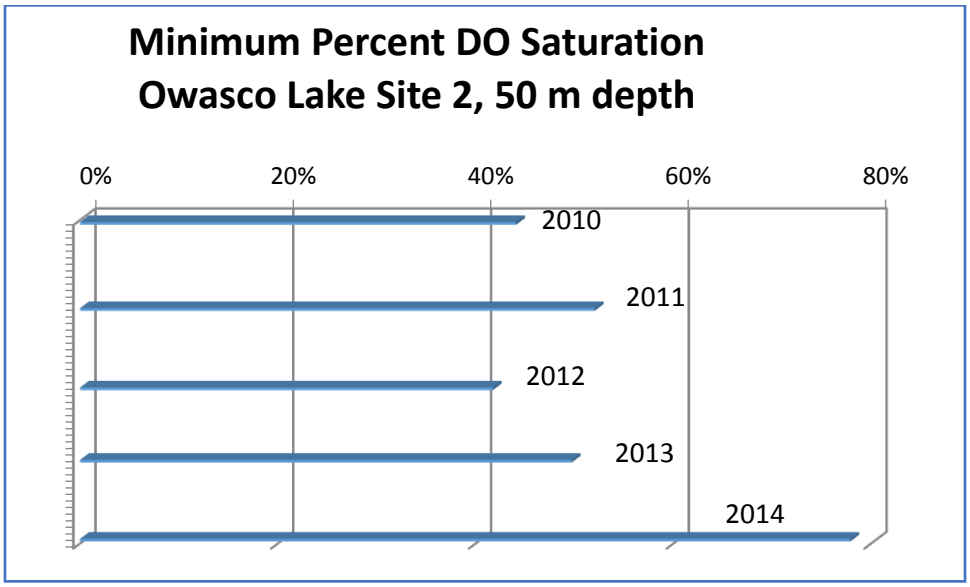

Figure 4-5. Minimum Percent Saturation of Dissolved Oxygen in Owasco Lake's Deepest Waters, 2010–2014

4.4 Bacteriological Quality

Since 1999, the Owasco Watershed Lake Association (OWLA) has conducted a volunteer monitoring program during the summer recreational period, collecting water samples from multiple locations in Owasco Lake and its tributary streams for analysis of fecal coliform bacteria. The program is jointly funded by Cayuga County and OWLA and administered by the Cayuga County Department of Planning & Economic Development. The Cayuga County Department of Environmental Health monitors the bacteriological quality of permitted bathing beaches, including those associated with children's camps. These extensive data sets demonstrate the high degree of variability in laboratory counts of fecal coliform bacteria, both spatially and temporally. A strong correlation between rainfall and bacteria counts is evident in both in the lake and stream samples.

Fecal coliform bacteria are used as an indicator of recent contamination of water by fecal material. While the coliform bacteria may not be pathogenic (disease-causing), their presence means that other harmful microbes may be in the water. Fecal coliform bacteria can originate from wildlife, waterfowl, humans and other mammals including livestock. As reported in the 2000 *State of the Owasco Lake Watershed*, DNA testing of the fecal coliform bacteria was conducted to identify the major source of bacteria in the Owasco Lake samples. Dr. Mansour Samadpour from University of Washington's Department of Environmental Health analyzed microbial DNA from water samples collected in 1998 from Emerson Park beaches, from the confluence of Owasco Inlet, Sucker Brook, Veness Brook, and Dutch Hollow Brook with Owasco Lake, and from the lake outlet. This study concluded that there are multiple sources of fecal contamination to Owasco Lake. For the beaches at Emerson Park, the major source is wildlife, particularly waterfowl (ducks and geese). Agriculture was classified as an intermediate source of fecal coliform bacteria at Emerson Park; human and pet waste was classified as a minor source. Within the tributaries, agriculture and wildlife were the major sources; human and pets were classified as minor sources.

In recent years, the Cayuga County/OWLA monitoring program has collected samples each week at a defined network of monitoring sites: seven lake sites and four stream sites. The volunteers also report their observations of algal type and abundance and rainfall over the week. The New York State ambient water quality standard for fecal coliform bacteria is 200 cells per 100 mL of water, calculated as the geometric mean of a minimum of five samples per month; however, the monitoring program is not designed to assess compliance with this standard. In addition, the NYSDOH applies a single sample limit of 1000 cells/100 mL for bathing beaches. Waters with indicator bacteria counts below these thresholds are considered safe for water contact recreation. The microbiological monitoring data from 2010 - 2014 are summarized in Table 4-4. While the results are variable, conditions appear to be improving. Bacteriological data tend to be highly variable, because the microbial cells may not be dispersed uniformly in the water samples, and due to documented variability among analytical laboratories. The laboratory used for the fecal coliform analysis was changed in mid-2013.

Table 4-4. Summary of OWLA Bacteriological Monitoring of Owasco Lake and Streams, 2010–2014

Location	Type	Percent of samples >1000 cells/100 mL				
		2010 (7 events) Rain- 4.03"	**2011** (12 events) Rain-12.06"	**2012** (11 events) Rain-4.89"	**2013** (12 events) Rain-12.47"	**2014** (15 events) Rain-15.72"
Sucker Brook	Stream	29%	17%	9%	0%	0%
Dutch Hollow	Stream mouth	43%	25%	0%	0%	no samples
Long Point	Lake	0%	0%	0%	0%	0%
Seward Point	Lake	0%	17%	0%	0%	0%
FL 34 E	Lake	0%	8%	0%	0%	0%
Rounds Lane (Inlet)	Stream	86%	83%	82%	25%	7%
Long Hill Rd. (Inlet)	Stream	86%	92%	55%	25%	7%
Cascades Restaurant	Lake	14%	0%	0%	8%	0%
Fays Point	Lake	0%	42%	0%	0%	0%
Buck Point	Lake	14%	8%	0%	0%	7%
Gleason Drive	Lake	no samples	0%	0%	0%	0%

4.5 Lake Biota

4.5.1 Fish Community

At least 49 fish species have been reported from Owasco Lake or its tributaries (Table 4-5). Gamefish present include lake trout, brown trout, rainbow trout, smallmouth bass, largemouth bass, walleye, northern pike, and chain pickerel. Panfish present include pumpkinseed, bluegill, rock bass, bullhead, and yellow perch. The major forage fish species are alewife and yellow perch. Owasco Lake is stocked annually by the New York State Department of Environmental Conservation with approximately 10,500 lake trout, 5,000 rainbow trout and 10,000 brown trout. Owasco Inlet is stocked with 20,000 rainbow trout. Walleye were stocked into the lake from 1996 – 2006; however, walleye stocking was discontinued due to a decline in the rainbow and brown trout fishery that coincided with the emergence of walleye in the fishery.

Owasco Inlet supports notable spawning runs of lake-resident brown and rainbow trout, as well as resident populations of these species. This stream and the other larger tributaries in the watershed also support populations of non-game species such as white sucker, central stoneroller, creek chub, fallfish, blacknose dace, longnose dace, eastern silvery minnow, fantail darter, and tessellated darter, among others.

Table 4-5. Scientific and Common Names of Fish Species Reported from the Owasco Lake Watershed

SCIENTIFIC NAME	COMMON NAME
Anguillidae--freshwater eels	
Anguilla rostrata	American eel
Clupeidae--herrings	
Alosa pseudoharengus	Alewife
Ictaluridae--bullhead catfishes	
Ameiurus nebulosus	Brown bullhead
Noturus flavus	Stonecat
Noturus gyrinus	Tadpole madtom
Noturus insignis	Margined madtom
Catosotmidae--suckers	
Catostomus catostomus	Longnose sucker
Catostomus commersoni	White sucker
Hypentelium nigricans	Northern hog sucker
Cyprinidae--carps and minnows	
Campostoma anomalum	Central stoneroller
Couesius plumbeus	Lake chub
Cyprinus carpio	Common carp
Cyprinella analostana	Satinfin shiner
Exoglossum maxillingua	Cutlips minnow
Hybognathus regius	Eastern silvery minnow
Luxilus cornutus	Common shiner
Notropis hudsonius	Spottail shiner
Notropis spilopterus	Spotfin shiner
Notemigonus crysoleucas	Golden shiner
Pimephales promelas	Fathead minnow
Pimephales notatus	Bluntnose minnow
Rhinichthys atratulus	Blacknose dace
Rhinichthys cataractae	Longnose dace
Scardinius erythrophthalmus	Rudd
Semotilus atromaculatus	Creek chub
Semotilus corporalis	Fallfish

Salmonidae—trouts	
Coregonus artedi	Cisco
Oncorhynchus mykiss	Rainbow trout
Salmo salar	Atlantic salmon
Salmo trutta	Brown trout
Salvelinus fontinalis	Brook trout
Salvelinus namaycush	Lake trout
Osmeridae--smelts	
Osmerus mordax	Rainbow smelt
Umbridae–mudminnows	
Umbra limi	Central mudminnow
Esocidae--pikes	
Esox lucius	Northern pike
Esox niger	Chain pickerel
Fundulidae--killifishes	
Fundulus diaphanus	Banded killifish
Gasterosteidae--sticklebacks	
Culaea inconstans	Brook stickleback
Centrarchidae--sunfishes	
Ambloplites rupestris	Rock bass
Lepomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieu	Smallmouth bass
Micropterus salmoides	Largemouth bass
Percidae--perches	
Etheostoma flabellare	Fantail darter
Etheostoma olmstedi	Tesselated darter
Perca flavescens	Yellow perch
Percina caprodes	Logperch
Sander vitreus	Walleye
Cottidae--sculpins	
Cottus cognatus	Slimy sculpin

Sources: Smith 1985; NYSDEC's Fish Atlas Maps of New York

4.5.2 Macrophytes

The littoral zone of lakes, defined as the region where sunlight reaches the sediment, can support the growth of rooted aquatic plants and algae (macrophytes) if temperature and nutrient conditions are favorable. Owasco Lake has a relatively small amount of littoral habitat, due the lake's depth and bottom contours. The lake's shallow southern basin, northern basin, and limited areas of the eastern and western nearshore areas have suitable conditions for macrophytes.

Macrophytes are a vital component of the lake food web. Not only do the aquatic plants capture radiant energy from sunlight and convert it to living tissue through photosynthesis, they provide surface area for colonization by algae and tiny aquatic insects, mollusks, and worms. These macroinvertebrates are an important food source for fish and other aquatic animals. A vegetated littoral zone provides cover and refuge for adult fish as well as spawning habitat and nursery areas for juveniles. Macrophytes help stabilize sediments, thus reducing the potential resuspension of particles by winds and waves.

In 2007, Bruce Gilman and John Foust (Finger Lakes Community College) and Bin Zhu (Finger Lakes Institute) surveyed the Owasco Lake macrophyte community. The three investigators designed their survey to assess the species richness and relative abundance of the lake's macrophyte community,

estimate productivity, and evaluate the environmental conditions that influence the community structure and distribution (Gilman et al. 2008).[4] A total of 18 species were identified in Owasco Lake in 2007; this species richness is comparable to that of other regional lakes. Two of the macrophyte species detected in 2007, Eurasian watermilfoil and curly-leafed pondweed, are invasives. However, neither invasive species dominated the macrophyte community, as summarized in Table 4-6. Note the shift in macrophyte community composition over the sampling periods. The two plants contributing the most to the overall biomass standing crop are stonewort (a low-growing species of the green alga *Chara*) and elodea, a native submerged plant.

Table 4-6. Percent Distribution of Macrophyte Standing Crop Biomass Owasco Lake, 2007

Common name	Scientific name	Percent Contribution of each Species to Total Biomass			
		June (n=27)	July (n=27)	Aug (n=39)	Total (n=93)
Coontail	*Ceratophyllum demersum*	2.3	0.6	1.4	1.3
Stonewort	*Chara* sp.	36.1	35.3	45.8	40.3
Elodea	*Elodea canadensis*	25.7	37.7	19.8	27.1
Aquatic moss	*Fontinalis antipyretica*	0.0	0.0	0.0	0.0
Water stargrass	*Heteranthera dubia*	0.4	0.4	3.4	1.8
Eurasian watermilfoil	*Myriophyllum spicatum*	9.8	9.2	7.8	8.7
Slender naiad	*Najas flexilis*	0.0	0.4	2.1	1.1
Southern naiad	*Najas guadalupensis*	0.0	0.0	0.0	0.0
Large leaf pondweed	*Potamogeton amplifolius*	0.2	0.2	0.0	0.2
Curly-leafed pondweed	*Potamogeton crispus*	7.3	0.9	1.7	2.5
Leafy pondweed	*Potamogeton foliosus*	11.8	9.2	0.5	5.7
Grass leaf pondweed	*Potamogeton gramineus*	0.0	0.0	0.1	0.0
Sago pondweed	*Potamogeton pectinatus*	5.6	0.0	0.0	1.1
Spotted pondweed	*Potamogeton pulcher*	0.0	0.0	0.1	0.1
Small pondweed	*Potamogeton pusillus*	0.1	0.2	3.6	1.7
Flat stem pondweed	*Potamogeton zosteriformis*	0.0	0.5	0.3	0.3
Stiff whitewater buttercup	*Ranunculus longirostris*	0.2	0.2	0.3	0.2
Eel grass	*Vallisneria americana*	0.5	1.9	11.7	6.1

Source: Gilman et al. 2008

The most dominant macrophyte species in Owasco Lake are displayed in Figure 4-6. The figure denotes the percent contribution of each major species to the total biomass measured in 2007. In addition, the percent occurrence of each species within the sampled plots is included. Taken together, this information demonstrates that four macrophyte species: elodea, Eurasian watermilfoil, leafy pondweed, and eel grass are fairly ubiquitous in their distribution, occurring in more than 55% of the sampled quadrats. However, these species vary widely with respect to their contribution to the plant biomass. The distribution of macrophyte species is patchy in Owasco Lake. Elodea is the most abundant (27.1% of the total macrophyte biomass in 2007), followed by Eurasian watermilfoil (8.7%), eel grass (6.1%) and leafy pondweed (5.7%). Some of this variation in distribution and biomass is due to the size and growth form of the plants.

Physical conditions also affected the standing crop biomass; macrophyte abundance was lower at the deep edge of the littoral zone, especially on coarse substrates, and near the shoreline subject to wave action. Biomass was higher in loam and silt loam substrates enriched with organic matter. Overall productivity of the macrophyte community was high, with a maximum standing crop biomass estimated at 1263 g/m^2 (Gilman et al. 2008).

The Cayuga County Soil & Water Conservation District manages a mechanical harvesting program in several County lakes, including Owasco, to maintain recreational uses. The efficacy of the program in removing weeds varies each year, depending on the number of days of harvesting, the overall plant density, and conditions on the lake during the operation. As shown in Figure 4-7, the mass of plant material removed from Owasco Lake by Cayuga County's mechanical harvesting program can range from a few hundred to over one thousand cubic yards of plant material.

Based on anecdotal information and complaints of shoreline residents, macrophyte abundance in Owasco Lake can reach nuisance levels, interfering with recreational use and access to navigation.

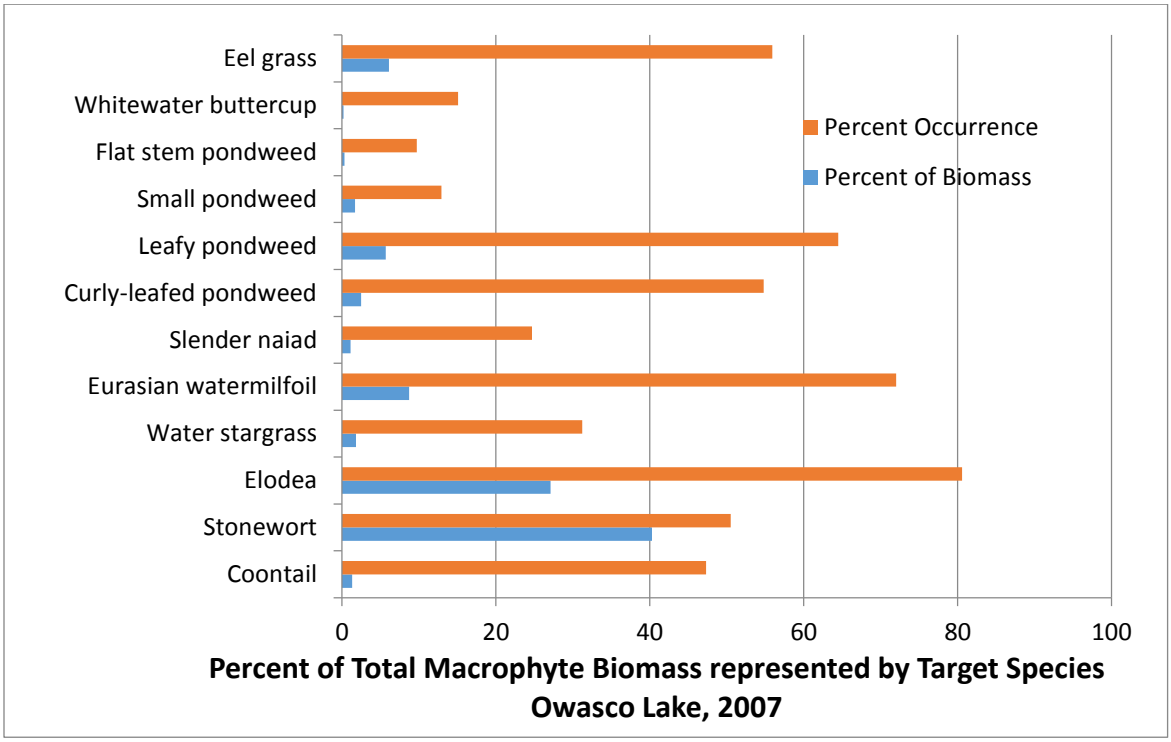

Figure 4-6. Relative Standing Crop of Macrophyte Species (percent of biomass) Plotted with Percent Occurrence (presence/absence) of those Species in 97 Sampled Points (Gilman et al. 2008)

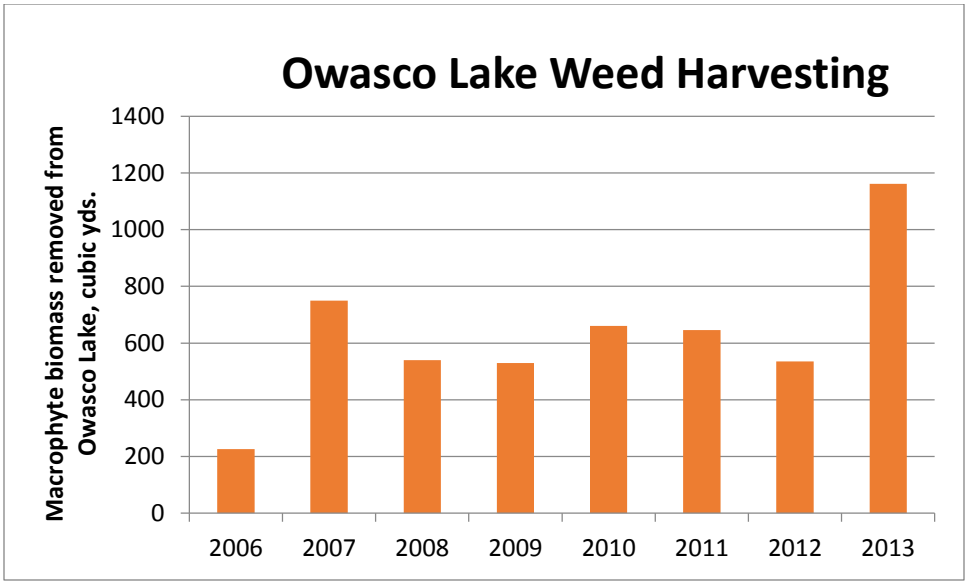

Figure 4-7. Estimated Biomass of Aquatic Plants Removed from Owasco Lake by the Cayuga County SWCD Mechanical Harvesting Program, 2006–2013

4.5.3 Plankton Community

Since 2005, the FLI annual monitoring program has pulled a fine-meshed net through the water column to sample the plankton community, including phytoplankton (microscopic plants and cyanobacteria) as well as zooplankton (microscopic animals). According to Halfman et al. (2014), results are relatively consistent from year to year. The phytoplankton community is dominated by various species of diatoms, especially early in the annual cycle. Diatoms are adapted to low light and cold temperature conditions, and comprise the major component of the spring phytoplankton bloom in many New York lakes. Diatoms are characterized by a siliceous skeleton (frustule). In many lakes, the spring diatom bloom is associated with a rapid decline in the concentration of silica dissolved the lake's upper waters. Once the lake begins to warm, other phytoplankton species become dominant components of the community as well. In Owasco Lake, the plankton net tows tend to capture various species of dinoflagellate in July and August. Cyanobacteria typically appear in the phytoplankton community later in the season. In 2007 and 2010, the cyanobacteria *Microcystis* represented up to 40% of the phytoplankton during late-summer blooms. A second genus of cyanobacteria, *Anabaena,* was a major component of the phytoplankton in 2013, comprising about 30% of the late bloom.

In 2014, multiple samples of Owasco Lake waters were submitted to the NYSDEC Harmful Algal Bloom (HAB) program for microscopic examination and, when appropriate, chemical analysis for the presence and concentration of microcystins and other harmful exudates. Cyanobacterial bloom conditions were confirmed as of September 1, and persisted into the fall. The major species were *Microcystis* and *Anabaena*. Several near-shore samples tested positive for microcystins and exceeded the "high toxins" criteria.

The lake's zooplankton community is dominated by small organisms, namely *Copepods*, *Nauplius*, *Polyarthra* and *Vorticella* with some cladocerans, such as the invasive species *Cercopagis pengoi* (fishhook water flea). The predominance of small zooplankton is considered by limnologists to indicate intense grazing pressure on the zooplankton community by fish (herbivory). The alewife is one of the major forage fish in the Owasco Lake fish community; the presence of this clupeid is correlated with an absence of larger cladocerans such as *Daphnia* in the zooplankton community (Brooks and Dodson 1972). Smaller zooplankton are less efficient grazers of phytoplankton, thus making alewife foraging another factor affecting water clarity. The FLI investigators also reported finding dreissenid (zebra and quagga mussel) larvae in the plankton tows.

4.5.4 Asian Clam

In addition to the invasive species cited above, Owasco Lake has a population of the Asian clam, *Corbicula fluminea.* First detected in September 2010, the area of infestation appears to be limited to the lake's northern basin. This mollusk is considered to pose a threat to the lake benthic community, as it can out-compete native species and may reduce biodiversity. There are water quality impacts as well; the Asian clam is an effective filter feeder and can recycle nutrients into the water column where they are available for the phytoplankton community. The potential impact of the Asian clam on cyanobacteria is not yet fully understood. In other lakes with Asian clam, the most serious impact of the infestation is on biofouling of water intake pipes. To date, no complaints of biofouling have been reported to the Health Department. The Cayuga County water resources management agencies have created a task force to conduct detailed surveys of distribution and abundance of this invasive species, develop an effective public information campaign, and investigate effective means for control.

4.6 Sediment Quality

A sediment core was collected from one location in Owasco Lake during the NYSDEC synoptic survey of the Finger Lakes, which was conducted between 1997 and 1998 (Callinan 2001).[5] The core, collected off Burtis Point at a water depth of 35 m, penetrated approximately 61 cm into the lake bottom. Various chemical parameters were measured at depth horizons within the core, and radiometric dating with the isotope ^{137}Cs allowed the investigators to assign dates to the depth horizons.

The sediment accumulation rate for Owasco Lake was estimated at 0.38 cm/yr. This estimate is comparable to the finding of a sedimentation rate in Owasco Lake of 0.5 cm/yr reported in Brown et al. 2012[6]. Sediments were tested for approximately 25 organic compounds; only a few were present at detectable concentrations. In Owasco Lake, the NYSDEC only reported detectable levels of PCB congeners at the sediment depth horizon estimated to correspond to 1987. These organic compounds were detected throughout the Finger Lakes, suggesting atmospheric deposition as the source.

The results of sediment testing for inorganic compounds are summarized in Table 4-7. The NYSDEC summary of Owasco Lake sediment quality notes the following:

- Arsenic and copper levels demonstrate a slight increase over the past decades, and are above the threshold where sensitive benthic aquatic organisms may be affected
- Calcium levels in sediment have increased since the 1960s
- Nickel concentrations vary, with no trend. Some levels are above the threshold where sensitive benthic aquatic organisms may be affected
- Chromium, manganese, zinc and lead levels are variable with depth. Some measurements are above the threshold where sensitive benthic aquatic organisms may be affected

Table 4-7. Summary of Results of NYSDEC Sediment Sampling Program, 1997–1998 (Source: Callinan 2001)

Inorganic Chemical	Peak Concentration , parts per million (ppm)	Depth Horizon and Estimated Date of Peak Concentration
Arsenic	14 ppm	3-4 cm; 1987
Cadmium	Below detection	Not applicable
Calcium	90,200 ppm	3-4 cm; 1987
Chromium	52 ppm	12-13 cm; 1964
Copper	44 ppm	0-1 cm; 1995
Lead	73 ppm	12-13 cm; 1965
Manganese	3630 ppm	0-1 cm; 1995
Mercury	Below detection	Not applicable
Nickel	66 ppm	12-13 cm; 1964
Zinc	180 ppm	15-16 cm; 1957

Source: Callinan 2001[2]

4.7 Lake Level Management

The outflow of water from Owasco Lake, and thus the lake level, is controlled by the operation of the State Dam, which is located 7,500 feet downstream of the lake outlet. The dam structure is comprised of five lift gates and a taintor gate along the west bank of the outlet channel. The City of Auburn is responsible for operation of the dam and maintaining the lake level, under a set of operating conditions known as the Owasco Lake rule curve. Lake level management throughout the Seneca-Oswego-Oneida basin is coordinated by a series of rule curves to provide protection from flooding while maintaining adequate water levels and flows for the multitude of users and interests; these interests include water supply, navigation, fish and wildlife habitat, recreational use, power generation, and assimilation of treated wastewater.

The current Owasco Lake rule curve (Figure 4-8) was formalized in 1984 by the U.S. Army Corps of Engineers (USACOE) following a systematic analysis of the effect of seasonal water levels on the lake's capacity to support and balance these multiple uses (USACOE 1984)[7]. Currently, lake levels are managed seasonally, higher during the summer recreational period and lower in the winter to provide storage capacity for spring rains and snow melt. The lake level is to be maintained at 713 feet above mean sea level (AMSL) from May through September. The elevation is then dropped sharply during October to a level of 710 feet and maintained at this level during the months of November-February. Beginning on

March 1, the outlet dam is managed to bring the lake level back up to summer conditions (713 feet) by May 1. There is a provision to allow a lower winter water level (to 708 feet) during years with a substantial snowpack when spring runoff conditions are projected to be high and there is an elevated risk of flooding.

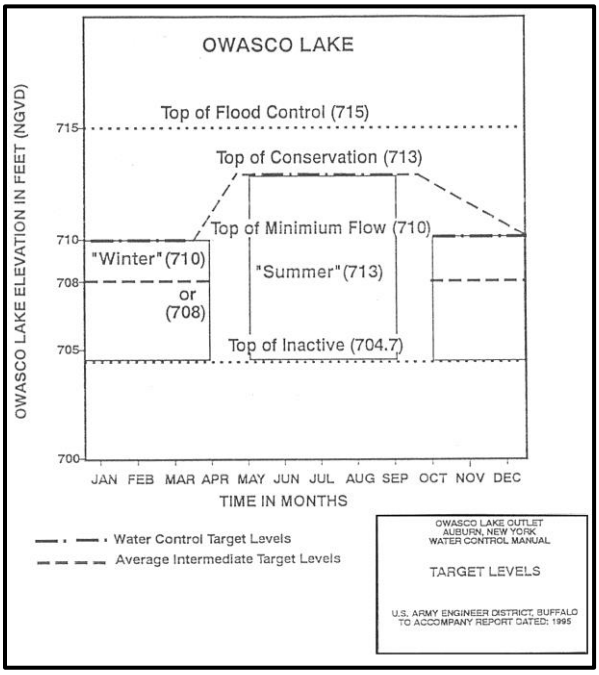

Figure 4-8. Rule Curve Governing Owasco Lake Water Level Management

The rule curve was adopted based on an understanding of the environmental and cultural conditions at that time. The USACOE considered that many shoreline residents draw water from the lake for their domestic supply, and that these lines would be vulnerable to freezing if water levels fell below 709 feet during the winter. Based on a 1984 survey of docks and boat launches (public and private) and boats, the USACOE established a summer water level of 713 feet as the elevation that would optimize this recreational use and economic benefit. A minimum discharge of 30 cfs must be maintained in the lake outlet to provide assimilative capacity for treated wastewater (60 cfs during the month of June). The requirements of the fish community were considered as well. Lake trout spawn in early November in the littoral zone. A drawdown of more than one foot following spawning would place the viability of the eggs of this important fishery at risk of desiccation. Another game fish, the northern pike, spawns in the spring in the wetlands associated with the Owasco Inlet. Water levels must reach 712 feet by March 21st in order to inundate the spawning grounds; this water level should be maintained for about six weeks.

In recent years, the Cayuga County Water Quality Management Agency (WQMA) has expressed their reservations regarding the rule curve to the USACOE and NYSDEC and requested a reanalysis, stating that water quality considerations may support a policy of lower target water levels during the summer. The NYSDEC is responsible for ongoing maintenance of federal flood control works. Four points of consideration have been brought forward by the WQMA:

- A lower lake water level would improve the performance of shoreline onsite wastewater disposal (septic systems) by providing additional separation distance between the leach field and the water table;
- A lower lake level would reduce shoreline erosion and the resulting flux of sediments and sediment-borne phosphorus into the lake;
- Hydrodynamic modeling analysis of the lake's northern basin (Owens 2004[8]) indicated that additional water release through the outlet could improve circulation at the Emerson Park beaches and thus reduce the risk of elevated bacteria counts that may limit recreational usage.
- A lower lake level in the winter would reduce the Asian clam population and may also provide control of certain susceptible species of nuisance macrophytes.

At a meeting in October 2013 with the USACOE and NYSDEC, Cayuga County representatives were informed that the cost of a detailed analysis would be borne locally. Moreover, the USACOE would require reimbursement of its costs to review the submittal (at an estimated cost of $100,000).

4.8 Summary of Changes in Owasco Lake Since 2000

A major change in the state of Owasco Lake since 2000 is its regulatory status as an impaired waterbody. In December 2014 NYSDEC updated the Owasco Lake Priority Waterbodies List assessment to include a designation as impaired by excessive phosphorus. The justification offered includes the increased observation of cyanobacteria, the occasional exceedances of disinfection byproducts in water supplies purchased from the City of Auburn, and the use of activated carbon to control taste and odor at the two water treatment plants. In addition, runoff of liquid manure in the winter of 2014 was noted as a contributing factor. However, phosphorus and chlorophyll-*a* concentrations in Owasco Lake continue to comply with existing and proposed numerical criteria to protect its designated use for water supply and recreation.

Owasco Lake continues to exhibit a low to moderate level of primary productivity, consistent with its designation as an oligo-mesotrophic lake. Water quality conditions are variable and respond to external loading conditions, which are greatly affected by weather. The lake's littoral zone supports a diverse community of macrophytes, with widespread presence of two invasive species—Eurasian watermilfoil and curly-leafed pondweed—in the assemblage. The 2010 discovery of a new invasive species, the Asian clam, in the lake's northern basin is a potentially significant factor affecting water quality and habitat conditions. In 2011, hydrilla was confirmed present in neighboring Cayuga Lake; this invasive macrophyte species has the potential to severely degrade the lake ecosystem. The response to the detection of hydrilla has been aggressive, with application of herbicides, extensive monitoring, and a massive public outreach campaign.

Microbiological monitoring occurs each summer. Overall, bacterial counts in lake and stream samples appear to be in decline, as indicated by the percent of samples that exceed a NYSDOH limit of 1000 cells of fecal coliform bacteria per 100 ml of water. However, fecal coliform data are known to be highly variable. Changes in the analytical laboratories further complicate an ability to draw conclusions.

Notes

[1] NYSDEC. December 2014. Waterbody Inventory for Seneca River (Lower) Watershed. http://www.dec.ny.gov/docs/water_pdf/pwlorflsenl.pdf.

[2] USEPA. 1974. "National Eutrophication Survey Methods for Lakes Sampled in 1972." Working Paper No. 1. EPA Office of Research and Development, Washington, DC 20460, 40 pp.

[3] Halfman, J.D., G. Moralez, K. Coughlin and N. Andrzejczyk. December 2014. *Owasco Lake, NY: Water Quality and Nutrient Sources, 2014 Findings*. Finger Lakes Institute, Geneva NY.

[4] Gilman, B. A., J. C. Foust and Bin Zhu. 2008. *Composition, Seasonal Standing Crop Biomass and Estimated Annual Productivity of Macrophyte Communities in Owasco Lake*. Report to the Finger Lakes Institute.

[5] Callinan, C. E. 2001. *Water Quality Study of the Finger Lakes*. NYSDEC, Albany, NY. 147 pp. http://www.dec.ny.gov/lands/25576.html

[6] Brown, M., T. Curtin, C. Gallagher and J. Halfman. 2012. "Historic Nutrient Loading and Recent Species Invasions Caused Shifts in Water Quality and Zooplankton Demography in Two Finger Lakes (New York, USA)." *J. Paleolimnol.* 48:623-639.

[7] U.S. Army Corps of Engineers. 1984. *Oswego Basin NY Management Plan Analysis.* Owasco Lake, NY (Final Feasibility Report). 136 pp.

[8] Owens, E. 2004. *Application of a Hydrodynamic Model Related to Coliform Contamination of Beaches in Emerson Park.* Report prepared for Cayuga County, NY. 56 pp.