Cortland-Onondaga Federation of Kettle Lake Associations Best Management Plan Framework

Submitted to:
Tarki Heath
Richard Smardon
Cortland-Onondaga Federation of Lake Associations

By:
Adriana Beltrani
State University of New York College of Environmental Science and Forestry
BS: Environmental Policy, Planning and Law
May 2011

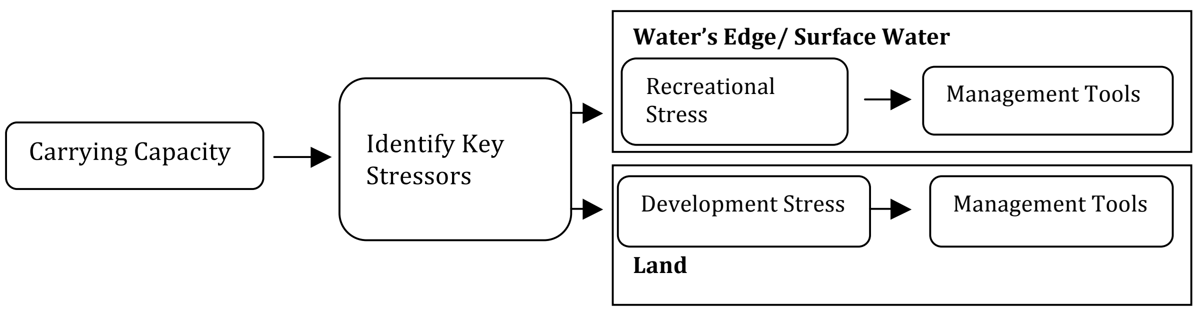
Cortland-Onondaga Federation of Kettle Lake Associations Best Management Plan Framework

Table of Contents

Introduction

The Cortland-Onondaga Federation of Kettle Lake Associations (C-OFOKLA) is a non-profit organization that brings together four individual kettle lake associations. C-OFOKLA was formed to educate lakeside residents and users about water quality and ecosystem issues surrounding the lakes and is therefore taking steps to determine the carrying capacity of each lake ecosystem. Four lakes are represented by C-OFOKLA: Tully Lake, Song Lake, Crooked Lake and Little York Lake.

This framework is meant as a guide for members of C-OFOKLA to assess the carrying capacities of their ecosystems. The framework begins with a brief overview of what carrying capacity is and how it can be beneficial. Next, stressors to a healthy lake ecosystem are described in detail as well as measures that should be taken when determining carrying capacity and how to calculate lake sensitivity. These methods are based on a number of studies but most specifically the "Fair Lake Environmental Carrying Capacity Study" since the parameters of Fair Lake most closely matches that of the four C-OFOKLA lakes to be studied. Recreational stresses are then detailed as well as a method to determine a boater carrying capacity based of a study by the Canandaigua Lake Watershed Association. Finally, appropriate methods of lake management regarding lake sensitivity, recreation and policy are explained.



Understanding Carrying Capacity

What is it?

Carrying capacity is a "threshold that, if exceeded, would lead to an undesirable set of conditions or problems" [1] In the case of C-OFOKLA, that threshold could refer to an excess of pollutants, ecological loss or population crowding.

Carrying capacity is a concern of ecological health. Think of a lake and its watershed as a living body. Every facet of the organism plays an important role in the health and balance of the overall system. In a lake system, everything from the flow of water to the land surrounding it fulfills specific functions to keep the system balanced and healthy. Carrying capacity asks, how much stress can the organism take and still remain healthy and functional?

When is it a concern?

Indicators that an ecosystem has exceeded its carrying capacity can be identified by a number of signs such as frequent algal blooms, the growth of an invasive species, high frequencies of organism die-offs, physical changes in the water etc.[2] Carrying capacity is a concern for the

---

[1] Dearlove, Paul. *Balancing Recreational Use: Lessons Learned from Lake Ripley's Recreational Carrying Capacity Study.* Lake Ripley Management District. Feb 13, 2010.

[2] NY State Federation of Lake Associations. *Diet for A Small Lake*. The Forager Press LLC. 2009.

health of those using it for recreation and for the health of the overall sustainability of the ecosystem.

Song Lake, one of the lakes represented by C-OFOKLA, experienced a need to conceptually determine carrying capacity to support their concerns regarding keyholing. This land use tool is the process by which a single piece of land provides the access pathway for others[3]. In the case of Song Lake, this meant that a large lot intended for housing development could have access to the lakefront via one lakefront property, even though the development would be located across the street. Keyhole developments increase the density of use and other stress on the lake. Boating traffic would increase on the lake while vehicular traffic would increase surrounding it, sending stress into the system as pollutants and physical disturbance.

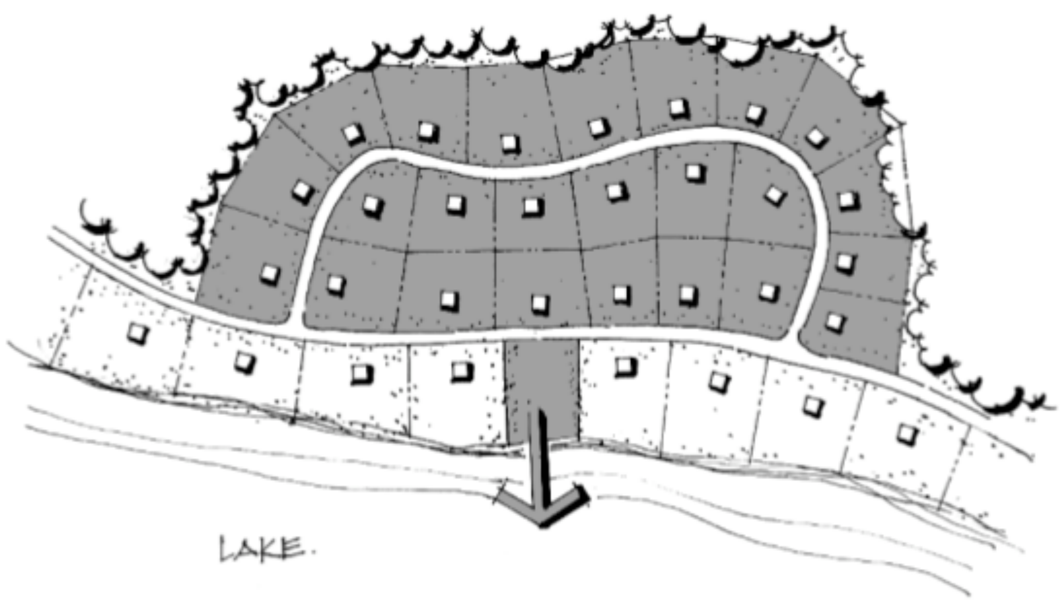
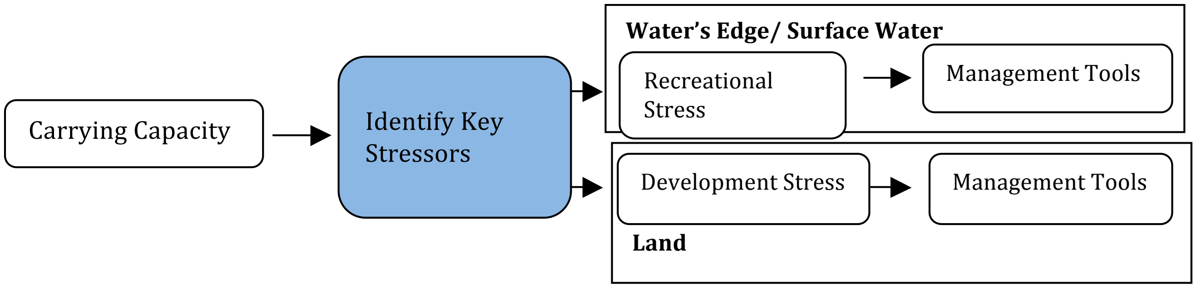


Figure 1- Depiction of a keyhole development[3]

Song Lake had proactively identified issues of storm water runoff to the lake and the negative impacts of keyhole developments before an actual keyhole development was proposed. By determining that Song Lake's ecology would be adversely affected with increased intensity of use due to any keyhole development, Song Lake was able to protect itself from excess development and secure a local ordinance.

Song Lake's example shows that knowing and understanding your lake in terms of carrying capacity can legally protect against unwanted development or overuse as well as protect the lake ecologically and aesthetically, offering a higher quality of life to all those living on its shores while protecting the surrounding watersheds and groundwater.

[3] *Fair Lake Environmental Carrying Capacity Study*. Progressive AE: July 2005



Identifying Key Stressors

Many case studies regarding lake carrying capacity pertain to large lakes with high recreational use. Fair Lake in Barry County Michigan is the most applicable study for COFOKLA to focus on based on the similarities in surface area acreage and maximum depth.

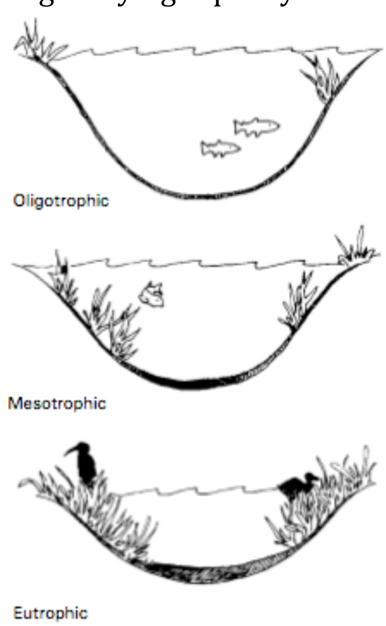
Table 1- Statistics of Kettle Lakes Compared to Fair Lake, MI

Lake Name	Surface Area (acres)	Maximum Depth (ft)	Land Use
Tully Lake	234	32	144 private homes/ some public
Crooked Lake	111	30	Private
Song Lake	114	30	~98 private homes/ private camp
Little York Lake	102	70	Private
**Fair Lake	226	30	~100 private homes/ agriculture

**Fair Lake, MI Environmental Carrying Capacity Study, July 2005[3]

Step 1: Identify Lake Parameters

Lakes grow older, just like humans, and each life stage requires and supports a different range of nutrients and species. It is important to determine classification/ life stage of lake before determining carrying capacity.



Oligotrophic: Young lake. Deep and clear with little aquatic plant growth. Maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold-water fisheries.

Eutrophic: Old lake. Shallow, turbid, and support abundant plant growth. Cool bottom waters usually contain little-no dissolved oxygen.

Mesotrophic: lakes that fall between the two extremes.

Figure 2- Lake bed cross section during each life stage[3]

Lakes ultimately evolve into eutrophic states. As the lake becomes shallower due to sedimentation and organic buildup, the lake becomes more eutrophic, eventually becoming a marshland. This process is called eutrophication and can be greatly accelerated if excessive sediments and nutrients enter the water from the surrounding watershed.

It is important to determine the watershed of your lake for this reason. A watershed boundary can be drawn simply by connecting the highest elevations surrounding the lake, or by contacting the United States Geological Survey (USGS) [4]. Knowing where the water in the lake derives from helps highlight the paths that pollutants enter from.

<u>Wetlands:</u> Wetlands scientifically include three main components: Presence of standing water, unique soil conditions and flora and fauna uniquely adapted to surviving under saturated conditions. Wetlands serve an important function of water quality and ecosystem health. In a human body, a wetland can be functionally compared to a kidney as they receive water and waste from natural and anthropogenic sources, stabilize the water supply and ameliorate many flood and drought situations. They are known to protect shorelines and recharge groundwater aquifers as well as support rich biodiversity of flora and fauna[5].

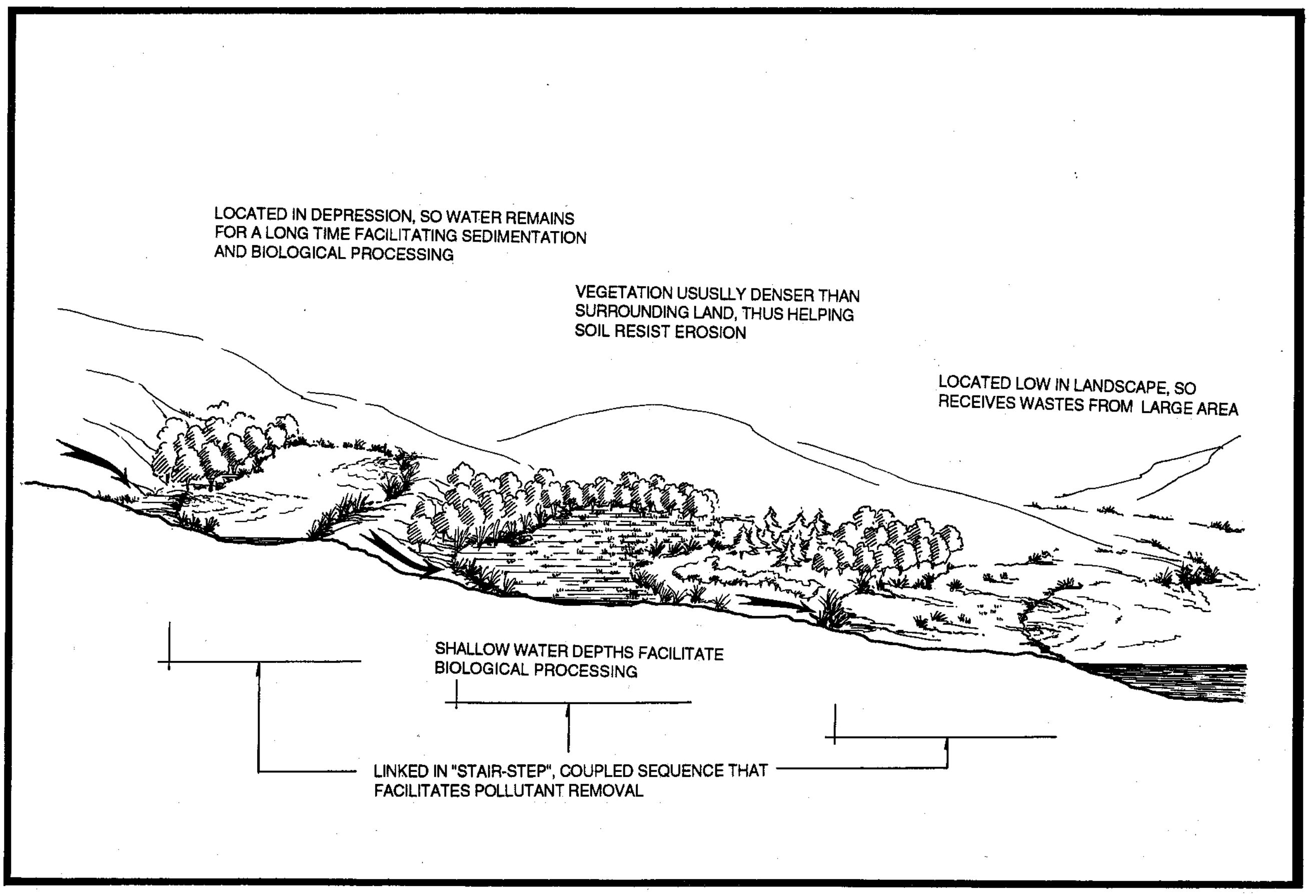


Figure 3- Why wetlands are a key to water quality[5]

[4] *Vilas County Lake Resource Guide.* 2010

[5]N. Pasi and R. Smardon. *Urban and Rural Treatment Wetlands Manual: A New/Old Green Infrastructure*. Syracuse Center of Excellence: 2011

Step 2: Identify Physical Characteristics of the Lake

Much like the age of a lake, the physical characteristics are a key to understanding predisposed conditions of the lake. In addition to the Fair Lake study, Vilas County, WI created a resource guide with a series of lake sensitivity criterion that also include:

Shoreline Development Factor (SDF): A size independent description of lake shape that relates shoreline length to the circumference of a circle with the same lake area. A perfectly circular lake would have a SDF of 1.0. Higher values (figure 2 -Fair Lake SDF) indicate a more irregular shoreline, clustering more houses per acre along the shore and therefore inviting a higher density of pollutants as stormwater runoff. Higher values may imply greater safety risks as well as greater negative ecological consequences.

$$SDF = \frac{L}{2\sqrt{\pi A}}$$

Where L= Shoreline length in meters and
A= surface area in meters squared[6]

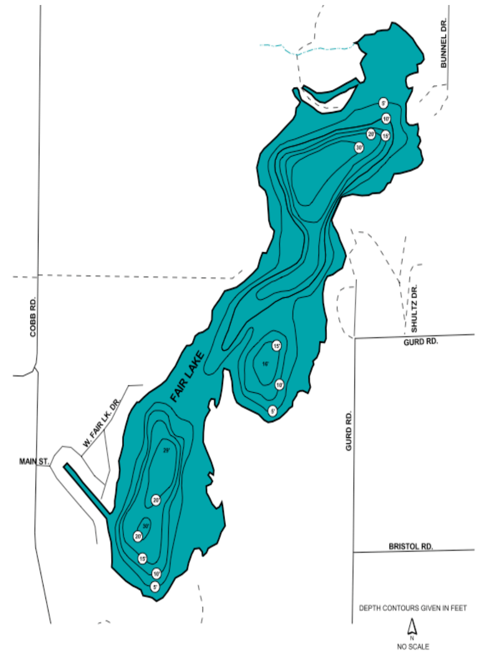


Figure 4- Fair Lake has calculated its SDF to equal 2.4[6]

Flushing Index: Flushing measures the number of times per year that a lake's total water volume is replaced. Flushing can be approximated by dividing the lake's watershed area by the lake's volume. Flushing can also be expressed as residence time, the period of time it takes for water entering the lake to flow through and eventually leave the lake (i.e. a flushing rate of 0.5 times per year = a residence time of 2 years)[3].

When calculating carrying capacity, the amount of stress, especially in the form of runoff pollutants, can rely heavily on the natural flow of water through the system. A system that rarely flushes would be more prone to the stresses placed on it.

Soil Development: Understanding soil types found in the watershed are important. Soils types depend on parent material, climate, topography, biological factors and time and influence surface water runoff - both how much gets to the lake, and its quality. Information for these may be available from the United States Department of Agriculture (USDA) or the National Resource Conservation Service (NRCS)[7].

Species Inventory: Knowing the species naturally living in the lake ecosystem will be helpful in determining lake changes through population fluctuations. Important species to inventory are: aquatic vegetation, shoreline vegetation, fisheries, wildlife and exotic species.

---

[6] Formula citation:
Habitat Suitability Index Models: A Low Effort System for Planned Coolwater and Cold Water Reservoirs. U.S. Fish and Wildlife Service, Department of the Interior. November 1984.

[7]Source: http://soils.usda.gov/

Step 3: Identify Key Stressors

Carrying capacity refers to the balance of numerous entities within the system. An over or under-abundance of these entities can result in an unhealthy ecosystem. Just like with people, the health of the ecosystem can be determined by measuring key entities that create stress if unbalanced. Parameters outlined by the *Fair Lake Environmental Carrying Capacity* Study that are important to determine lake health are:

Temperature: helps determine type of organisms living in the lake as well as how water mixes in the lake. In spring, water is uniformly mixed from top to bottom. As surface waters warm, colder and denser water settles to the bottom. In the fall as the top layer of water begins to cool, the water begins to mix again. Shallow lakes do not stratify, but lakes 15-30 feet deep may stratify many times during the year due to storm events.

This turnover is important to understand because it determines where pollutants will settle within the lake and for how long.

Dissolved Oxygen: Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis[8]. Bacteria that decompose organic matter at the bottom of the lake consume oxygen, a common occurrence in eutrophic lakes. Lakes with little oxygen in the cold, deeper stratified water cannot support cold-water fish. Dissolved oxygen levels should not exceed 110% at the risk of harming aquatic life.

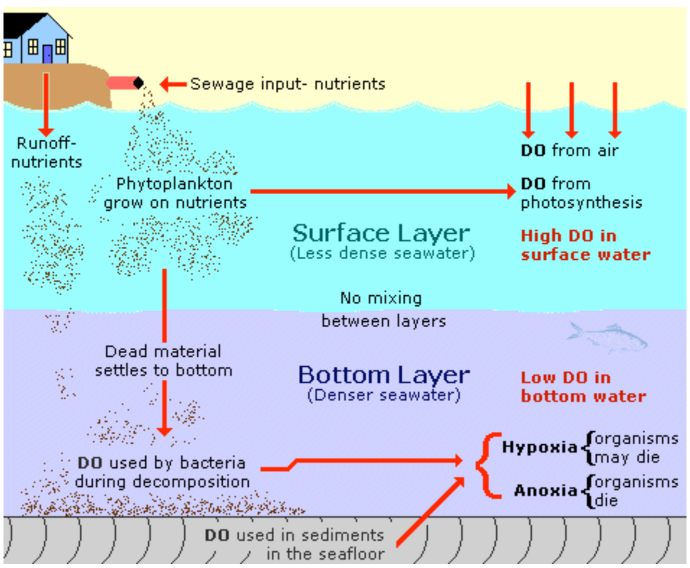


Figure 5- The exchange of dissolved oxygen in water bodies[9]

Phosphorous: Is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages. In the presence of oxygen, lake sediments act as a phosphorous trap, retaining the nutrient and making it unavailable for plant growth. If bottom water oxygen is depleted (as in eutrophic conditions) phosphorous will be released from sediments and may be available to promote aquatic plant growth. Phosphorous is a nutrient found in many soaps and fertilizers and can become a pollutant when it runs off from human use.

Chlorophyll-a: A pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in lake water can be made by measuring the quantity of chlorophyll in the water column.

Secchi Transparency: Measures the transparency of the water. A disk is lowered over the deepest point of the lake until it is no longer visible and that depth is noted. The disk is then raised

[8] source: http://www.state.ky.us/nrepc/water/wcpdo.htm

[9] source: http://omp.gso.uri.edu/ompweb/doee/science/physical/choxy1.htm

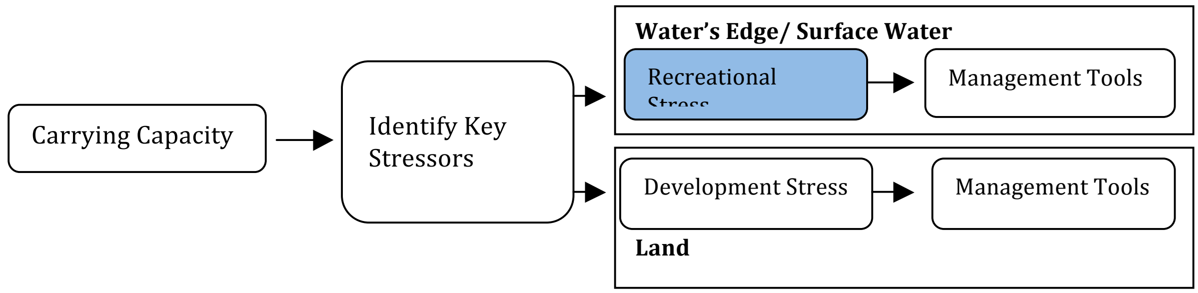
until it reappears. The average between these depths is the Secchi transparency. Eutrophic lakes often have a reduced Secchi transparency due to an increase of algae growth.

Recreation and Development: These stressors are physical disturbances that can cause many of the imbalances in the above parameters. As they are complex to understand and manage, these stressors are detailed later in this paper.

Step 4- Determine Lake Sensitivity

Table 2- Lake Classification Rating Factors from Vilas County, WI[4]

Criterion	**Significance**	**Criterion Classes**	**Units of Measure**	**Points**	**Comments**
Lake Surface Area	Smaller lakes more vulnerable to water quality problems	1-50 51-100 101-500 500+	Acres	4 3 2 1	Very small lakes/ponds Small lakes Medium lakes Large Lakes
Shoreline	Irregular shoreline more vulnerable to high development	3+ 2-2.99 1.5-1.99 1.0-1.49	Unitless	4 3 2 1	Very irregular/ less lake area per lot Close to circular/ more lake area per lot
Flushing Index	Lakes with rapid water exchange rates allow nutrients to flush out quickly	All seepage lakes 1-15 16-30 30+	Times per year	4 3 2 1	Low flushing rate Medium flushing rate High flushing rate Very high flushing rate
Stratification Factor (pollution sensitivity)	Lakes strongly stratified are less able to assimilate different nutrients	13.5+ 0-13.4	Unitless	2 1	Strongly stratified Weakly stratified
Soil Development	Lakes with severe soils are more likely to experience water quality problems from erosion and septic systems	Average soil factor rating within 300' buffer around lake	Unitless	4 3 2 1	Most severe soils Moderately severe soils Less severe soils Least severe soils
Total Sensitivity Score	**Higher sensitivity score= more sensitive to shoreline development**	**Sum of above criteria**	**Sensitivity score**	**5-11 12-13 14+**	**Low sensitivity Medium sensitivity High sensitivity**



Recreational Stressors

Background

Boating, fishing and swimming are activities that commonly take place on lakes however, if not properly managed these activities can have negative effects on the lake ecosystem. Recreational activities have a high propensity to spread species from location to location; this is especially a concern when invasive species are involved. Additionally, high-speed boats can rip out native subaquatic vegetation and disturb shallow areas that may be home to nesting fishes. The large wakes created by these boats also act as an eroding force on the shoreline [2]. Boats also can leak fuel and spread invasive species that may stowaway on the boat hull.

Fishing can spread invasive species in a similar fashion to boats, as organisms stowaway on waders and fishing gear, and overfishing can of course, decimate populations of native species. It is important then to understand where it is appropriate to engage in recreational activity by determining the usable lake area. Finally, swimming can also disturb the ecosystem, increasing sedimentation, which, as previously noted, decreases the transparency of the water and influences the nutrient balance in the water[2].

Step 1: Determine Recreational Stress

In addition to the utilization of previous information, boating capacity requires an understanding of boater density as a form of stress.

Usable Lake Area: The amount of lake surface that can support a mix of activities (generally refers to boating), calculated by subtracting a *shoreline buffer zone* from the total lake acreage. This zone is generally off limits to boating due to shallow water depths, piers and other navigational hazards but should also include areas around aquatic vegetation, marinas, and public swimming areas or other protected riparian areas[1].

Shallowness Ratio Factor: Is a description of lake shallowness. It is calculated by dividing the area of a lake less than 5-ft. deep by total area. High ratios imply shallow lakes and greater vulnerability to boating impacts[1].

Lake-Use Characteristics: Evaluating lake-use patterns involves collecting sufficient data to document how the lake is being used, and by whom. First, estimate the number and types of boats during peak and non-peak times, and the distribution of use between shoreline residents and visitors. Methods to achieve this include: on the water surveys, on the ground contact surveys, mail-back surveys, aerial flyovers and parking lot vehicle counts[1].

Riparian Use Rate: This is a measure of the estimated proportion of lake use originating from private lakeshore facilities versus public access sites. On-Lake boat counts combined with public launch data can often be used to generate more refined, lake-specific estimates[1].

Area per Boat: Describes the amount of lake surface a boat requires for safe operation at a certain speed or when engaged in a certain activity. This range can be found in published works, as well as in the next section[1].

Aggregate Boating Density Standard: This is a weighted average of the area-per-boat requirements for all boats actively using the lake. Boats are likely to be operating at different speeds while engaged in different activities. These each have unique area requirements. The weighted average is the number of each boat type, times its area-per-boat requirement, divided by the total number of boats[1].

Step 2: Determine Boating Capacity

While Canandaigua Lake is a vastly larger lake than the scope of the kettle lakes, boating capacity equations are generally proportional to lake size. The *Canandaigua Lake Peak Boat Use Inventory and Carrying Capacity Analysis*[10] details four different methodologies. This study will focus on the Water Recreation Opportunity Spectrum and the Weighted Average Approach. "This approach is based on estimating percentages of boats (by type) that are on the lake…Suggested density of boats by type is often shown as a range." The Regional Sediment Management Draft Environmental Impact Statement (RSM-DEIS) for Canandaigua Lake suggests that the density for power boats range from 15-20 acres/boat. The formula then is:

Percent Type x Density of Type = Weighted Density
Overall Density= Weighted Density Power + Sail + Non-Power

Completing this calculation for each suggested density by type, you will have the tools to determine a more or less stringent boater carrying capacity[10].

Table 3- Canandaigua Weighted Average Approach[10]

		OPTION ONE		**OPTION TWO**		**OPTION THREE**		**OPTION FOUR**	
Type	**% of type**	**Density for type**	**Weighted density**	**Density for Type**	**Weighted density**	**Density for type**	**Weighted density**	**Density for type**	**Weighted density**
Power	**70%**	**20**	**14.0**	**20**	**14**	**15**	**10.5**	**15**	**10.5**
Sail	**20%**	**10**	**2.0**	**8**	**1.6**	**10**	**2**	**8**	**1.6**
Non-Power	**10%**	**8**	**.8**	**5**	**.5**	**8**	**.8**	**5**	**.5**
Overall Density			**16.8**		**16.1**		**13.3**		**12.6**

The same study also details the use of the Water Recreation Opportunity Spectrum (WROS) developed by the US Department of the Interior Bureau of Reclamation. "The overarching goal of WROS is to provide planners and managers with a framework and procedure for making better decisions for conserving a spectrum of high quality and diverse water recreation opportunities." WROS provides a decision tool for capacity coefficients and then provides a decision tool to determine the range[10].

Table 4- WROS range of boating capacity coefficients[9]

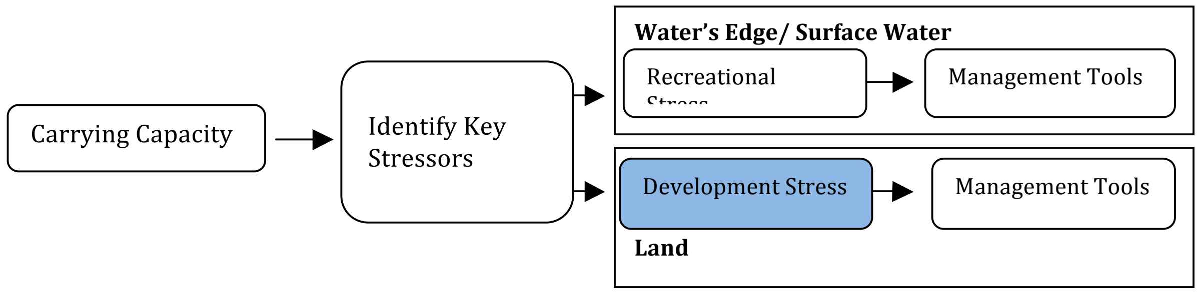
WROS Class	**Range of Boating Coefficients**	
	Low End of Range (acre/boat)	**High End of Range (acre/boat)**
Urban	1	10
Suburban	10	20
Rural Developed	20	50
Rural Natural	50	110
Semi Primitive	110	480
Primitive	480	3,200

[10] Olvany, Kevin. *Canandaigua Lake Peak Boat Use Inventory and Carrying Capacity Analysis*. Canandaigua Lake Watershed Council: September 2008.

For example, Tully Lake may be considered Rural Developed, which ranges from 20-50 acres/boat. After filling out table 5, Tully Lake may discover that they should choose a conservative range from 20-29 acres/boat, a moderate range from 30-49 acre/boat or a more liberal range from 40-51 acres/ boat.

Table 5- WROS Boating Capacity Range Tool[10]

Typical Size of Boats	< 15 feet	16-25 ft	>25 ft
Typical Speed of Boats	< 10 mph	10-25 mph	>mph
Diversity of Boating: 1. Different types of boats 2. Different size of boats 3. Different speed of boats	 Low Low Low	 Moderate Moderate Moderate	 High High High
Boater Visitation Pattern	Simple/ predictable	Moderate	Complex/ unpredictable
Level of boater stewardship/ civility/ respect for resource and other visitors	High	Moderate	Low
Shoreline Configuration	Simple/ circular	Moderate	Complex/ meandering
Boater destination or pass- through area	Pass through corridor/ in transit	Mixed	Destination area/ overnight area
Extent of sensitive resources/ potential for impact	Low	Medium	High
Compatibility with adjacent land uses	High	Moderate	Low
Islands/ shallows/ hazards	Infrequent	Occasional	Frequent
Historic public safety record/ accidents/ complaints/ conflicts	Infrequent	Occasional	Frequent
Level of boater management/ rules/ information/ education/ compliance	High	Moderate	Low
Other Factors: **Suggested Capacity Range**	 **Lower end (more boats)**	 **Mid-range**	 **Higher end (fewer boats)**



Developmental Stress

Background

The density of residences, type or intensity of residential land use and amount of disturbance all strongly affect the amount of stress put on the ecosystem, especially near water bodies. Vegetation, fauna and the natural contours of the land all serve an inherent ecological function and when development alters these functions, the ecosystem becomes stressed.

Step 1: Identify Development Level [11]

Urban: Extensively developed and populated cities and metropolitan areas. Virtually the entire landscape consists of human created structures. Land use is predominantly municipal, industrial, commercial and residential. Natural features may be found in small neighborhood parks, courtyards, riverways, residential gardens or landscaping. Water resources tend to be highly channelized and manipulated.

Suburban: Located on the fringe of urban areas. The development of built structures is widespread and tends to be commercial and residential. Natural settings may be found in community parks, greenways, trails, open space, natural areas, wetlands, estuaries and tidal marshes. Water resources are still highly channelized and manipulated and recreation management such as personnel, facilities, signs and services are prevalent.

Rural Developed: Beyond the metropolitan area and suburban ring of development. This area may contain working farms and ranches, towns and primary road networks. Development is still prevalent and common however, the setting is pastoral due to interspersing forests, water resources, hills, wetlands, open spaces and agricultural land use. Natural shoreline edges are common although water control structures are also common. Recreation management is common is but not excessive.

Rural Natural: A considerable distance from metropolitan areas and communities. Natural features are predominant and development is occasional or infrequent. Agriculture, tourism and outdoor recreation are often primary land uses due to high instances of large enclaves of public lands and waters. Water control and recreation management are occasionally noticeable but infrequent.

Primitive: A large expanse of natural resources very far from development and settlement. Any human activity is rare and very minor. The water resources and shorelines are natural and show little, if any evidence of human use, such as historic homesteads and roadways. Management revolves around stewardship and activities are often protection and restoration focused.

---

[11] *Water Recreation Opportunity Spectrum Users' Guidebook*. Bureau of Reclamation. 2010. http://www.fs.fed.us/recreation/programs/planning/index.shtml

Step 2: Identify Sources of Pollution Stress

Point Source Pollution: Point source pollution originates from a single point and is monitored by the State Pollution Discharge Elimination System (SPDES) under the Clean Water Act of 1972. The Department of Environmental Conservation requires that every point source discharger obtain a permit in order to legally use New York State's waters for waste disposal. Each permittee must also conduct effluent monitoring to assure the approved discharges meet the limits outlined in the permit[2]. There are penalties for not complying with SPDES[12].

Nonpoint Source Pollution: Nonpoint source pollution involves complex transport and delivery mechanisms within the lake watershed. It often arises over a large land area and enters watercourses at many locations. This pollution can originate from many places, including runoff from agricultural fields, residential lawns, highways or urban streets, seepage from on-site disposal systems, forestry operations, construction sites, stream bank disturbances etc.

Nonpoint sources of pollution are likely to be important in large watersheds (another reason to plot out the watershed!). In small watersheds (for example a 1:1 ratio of watershed to lake area) the closest sources of organic matter and nutrients, such as septic systems and runoff from lawns and gardens, might represent the primary contributors of pollutants to the lake. Runoff from paved areas can be additional sources of stress in the form of nutrients, sediments and heavy metals[2].

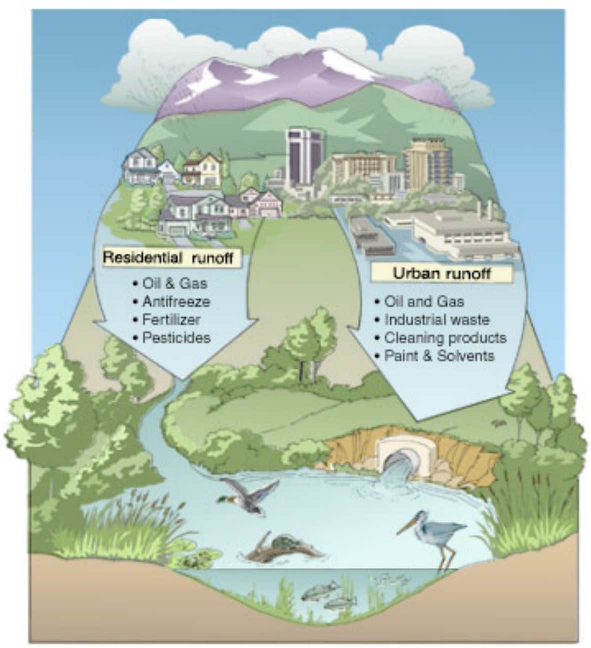


Figure 6: Nonpoint source pollution stressors, does not include agricultural runoff in the form of animal wastes and additional levels of fertilizer and pesticides[13].

---

[12] Responsible agencies for SPDES are: NYSDEC Division of Water; DEC Office of Regulatory Affairs; City and County Health Departments; USEPA

[13] Source: The Rain Garden Alliance, Cincinnati OH http://www.millcreekwatershed.org/rain-gardens/sustainable-yard-care-practices.html

Step 3: Identify Land Disturbance Stressors

Construction: The removal of vegetative cover through activities such as construction, filling, grading or excavating exposes bare soils to wind and water erosion. Erosion of those soils can result in increased nutrient and sediment loading to the lake[4].

Impervious Surfaces: These surfaces impede the infiltration of water and therefore compound the effects of water runoff as soil erosion and nutrient loading. Impervious surfaces are a large vector of nonpoint source pollution as it provides a path of least resistance for flowing water, allowing the water to pick up contaminants from the surface and carry those into a main water body such as lakes and streams. This results in increased volumes and velocities of stormwater runoff. Limits on the amount of impervious surfaces (decks, driveways, walkways, parking lots) on a shoreline lot reduce the potential for runoff to adversely affect water quality and provide areas for the retention and infiltration of runoff [4].

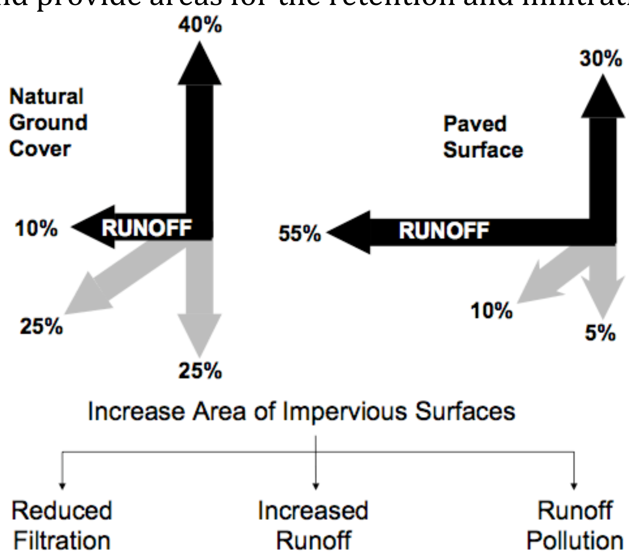
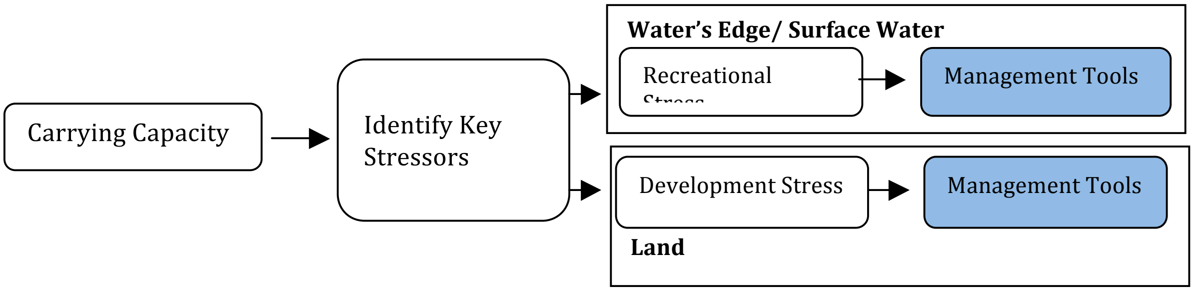


Figure 7- Increased imperviousness and stormwater runoff[3]

Septic Systems: Old or failing on-site septic systems are also a nonpoint source pollution issue. A system fails when wastewater bubbles up to the ground surface. This can mean that the local soils are too impervious or too thin. Failures can also be less detectable when soils are too porous or the water table is too high. Algal blooms and groundwater contamination will result from these failures. The best prevention of septic system failure is homeowner involvement and education[3].

Increased Nutrient Sources (Agricultural and Residential Fertilizers): Agricultural land use can be a source of nonpoint pollution through the use of fertilizers, pesticides and the production of animal waste. These compounds contain excess levels of nutrients and chemicals that, when carried through stormwater runoff, can create algal blooms and even fish kills due to contamination. The use of fertilizers and soaps containing phosphorous on residential property has the same effect[3].



Management Tools

Step 1: Develop Lake Management Objectives

Diet for a Small Lake recommends that management objectives must be relevant to the unique symptoms, or key stressors of the lake as well as be reached by the consensus of all involved. The kettle lakes are lucky in this respect, as most of the lakes are private/residential use and therefore the audience (resident, fisherman, boater, swimmer etc.) is relatively homogenous and easy to contact. Although the management objectives should be specific to the lake in question, *Diet for a Small Lake* gives a few broad classes:

Water Quality: Measures such as pH, dissolved oxygen or transparency, the amount and types of macrophytes (algae and rooted plants) etc. Objectives are related to the degree of wastewater treatment, stormwater management and in-lake efforts such as weed harvesting (See Appendix A: Tully Lake- Management)

Water Quantity: Variables such as lake level, water depth and availability of water for domestic consumption, industry, power generation and agriculture.

Management of Private Land Resource: Goals related to land zoning and growth management.

Management of Water-based Recreation: Boating, navigation and fishing issues etc.

Public Land Management: Land acquisition for parks and public access points.

Urban Enhancement: The aesthetic appearance of the buildings and landscaping in the developed areas surrounding the lake.

Critical Environmental Resources: Scenic vistas, endangered species, significant wildlife habitat etc.

Step 2-Identify Appropriate Control Techniques

Diet for a Small Lake lists in great detail many physical, chemical and biological control techniques to balance stressors on the ecosystem[14]. A few are listed below.

Option 1: *Physical Control Techniques*

Bottom Barriers:

Principle

Bottom barriers are screens used on the lake bottom to prevent the growth of aquatic plants by reducing or eliminating the amount of light needed for plant survival. This method is

[14] I strongly recommend reading *Diet for a Small Lake* in its entirety; a comprehensive list of control techniques starts at chapter 6, page 6. The following techniques are those most applicable to C-OFOKLA based on ecological applicability, success rates and cost.

used for controlling plants directly under the barriers. Plant growth is prevented by blocking out the light required for growth while also providing a physical barrier for growth.

Applicability

Bottom barriers should be limited to areas of intensive use or significant concern. They are most often used around docks, in swimming areas and to open boat access channels. They are effective in maintaining native and controlled plant communities. Screening material should be removed and cleaned at the end of the growing season to protect against ice damage.

Potential Side Effects

The advantage of bottom barriers is that the ecological side effects can be practically insignificant. Barriers may eliminate some species of benthic invertebrates and possibly may interfere with warm water fisheries spawning.

Bottom barriers are the safest and most ecologically sound in-lake physical control technique. They have been effectively used in a wide variety of conditions and for many varieties of nuisance vegetation.

Cost

$2000-$8000 per acre depending on screening material.

Dilution and Flushing:

Principle

Dilution and Flushing involves using high quality dilution water to reduce the concentration of limiting nutrients and increase the rate at which these nutrients are flushed from the lake. It reduces the concentration of limiting (stressful) nutrients and the period of time that aquatic vegetation is exposed to these nutrients. This may ultimately reduce the levels of algae and other vegetation but will also increase transparency.

Applicability

This method can be used at lakes with an external supply of dilution water. The dilution water does not have to be significantly higher quality, just better quality than the existing lake water. This method may not be appropriate for large lakes with poor water quality.

Potential Side Effects

Dilution water with nutrient concentrations higher than those in the lake may exacerbate the existing water quality problems. An increased flushing rate may create problems for sensitive plant and animal species that live immediately downstream from the lake.

This method is among the oldest lake restoration techniques, dating back to the 1920's and has been limited almost exclusively to eutrophic lakes.

Cost

If dilution water is readily available, costs for this control can be very low. Costs increase proportionally with the decreased availability or increased cost of low-nutrient water.

Mechanical Harvesting:

Principle

Mechanical harvesting is the physical removal of rooted aquatic plants from the lake using a machine to cut and transport the vegetation to shore for proper disposal. This is the most common method of aquatic vegetation control in New York State. This process not only removes excessive vegetation growth but the nutrients stored in that plant such as phosphorous.

Applicability

Since the aquatic harvesting program is aimed at controlling nuisance levels of vegetation, the species of plants and their growth patterns should be identified before harvesting. Harvesting should involve areas where public use is most impaired. Certain areas should be restricted from harvesting either because they are important as a fishery or wetland area, or because they receive little or no use. The location of unloading sites should be identified and mapped before the harvesting season begins.

Potential Side Effects

The most significant side effect of this process is when plant fragments are not picked up and removed by the conveyor. Fragments can move by wind or currents, creating problems downstream.

Cost

The cost of equipment ranges from $50,000-$120,000 for the harvester and on shore conveyor. ~$200 per acre. Equipment can be leased usually from about $50-150 per hour with a set up and transport fee of about $200.

<u>Shading:</u>

Principle

Shading involves the use of non-toxic vegetable dyes to inhibit light penetration to the lake bottom, ultimately controlling the growth of nuisance vegetation by limiting photosynthesis.

Applicability

This method is usually not used on large lakes due to cost limitations. Dyes are most effective in small water bodies where the appropriate concentration can be maintained (quiet water with little or no flow). The duration for treatment is a function of water retention time.

Potential Side Effects

These dyes are non-toxic however it is not yet clear which plant species are affected by treatment so non-target plants may be adversely affected by the dyes. There have been few attempts to use this method in New York State.

Costs

$50/gal, which treats four acre-feet of water at a concentration of 1ppm.

Option 2: *Chemical Control Techniques*

<u>Algicides:</u>

Principle

Algicides are primarily copper-based chemicals that kill excessive algae in lakes, and can be used to reduce snail populations that may result in outbreaks of swimmer's itch. This process addresses neither the cause nor the source of this water quality problem and while its effects are immediate, they are temporary.

Applicability

Algicides may be restricted in certain lakes such as potable water supplies. This method has been used in a wide variety of lake conditions, from small swimming ponds and lakes, to swimming beaches of very large lakes.

Potential Side Effects

Other non-target organisms may be adversely affected by copper sulfate treatment. Some fish species are sensitive to even moderate copper sulfate levels and the treatment will also kill zooplankton, the microscopic animal that feeds on algae, creating a "rebound" effect where algae levels increase faster than zooplankton levels shortly after application. Some kinds of blue-green algae have been shown to develop a tolerance for copper compounds. Additionally, decaying algae may fall to the lake bottom and cause significant oxygen depletion, resulting in fish kills, increased nutrient release and changes in the benthic community.

Cost

$5-25 per acre-foot plus application costs.

Option 3: *Biological Control Techniques*

<u>Grass Carp:</u>

Principle

Grass Carp physically remove vegetation from lakes without reducing nutrient levels beyond plant sequestration. This fish is an invasive species and can ultimately consume 20-100% of their body weight per day in vegetation. Eating habits may not be reproducible from lake to lake.

Applicability

Sterile grass carp are the predominant type of grass carp allowed for stocking as biological control. In states which allow their use, grass carp are restricted to lakes with no sustainable outflow to reduce the possibility of escape and to maximize vegetation control within the lake.

Potential Side Effects

Grass carp are not an ideal candidate for introduction to an aquatic system as they do not coadapt with other species, do not have a narrow niche, are not easily controlled after escape and are not free from exotic diseases or parasites. However NYS experimentation may be able to dispute this, as it has been found that properly stocked carp lack these disadvantages.

The most significant drawback is the potential for complete eradication of vegetation or the control of non target plants.

Costs

$50-100 per acre

Step 3: Identify Land Use Management Techniques

Diet for a Small Lake lists three broad topic measures to take against pollution under *Agricultural Management Practices* (p 7-9). These broad categories are also applicable on a residential property level and it is recommended that C-OFOKLA determine which of the three, or which combination of the three are most applicable.

<u>Operational Measures</u>: Generally these measures involve changes to the way things are done, such as banning the use of pesticides or fertilizers. Operational practices often control availability of pollutants, but can affect detachment and transport as well. Many municipalities take the initiative to create a local ordinance banning lawn fertilizers containing phosphorous, such as that enacted by the town of Cazenovia. However, the state of NY has enacted a law prohibiting the use of lawn fertilizer containing phosphorous as of 2012.

<u>Vegetative Measures</u>: These measures involve practices that increase soil stability and plant cover. Increased vegetative cover dissipates rainfall intensity than can cause soil particles to detach and erode. Vegetation also reduces pollutant transport by acting as a filter.

<u>Structural Practices:</u> Generally these practices involve engineering design for successful implementation. They alter pollutant transport by controlling water and sediment movement. Typical structural controls reduce overland flow and change the length of slopes to limit the transport capacity of water moving off-site.

<u>Low Impact Development:</u> The *Fair Lakes Environmental Carrying Capacity Study* describes this process as an approach to land development that uses various land planning and design practices and technologies to simultaneously conserve and protect natural systems and reduce infrastructure costs. It accomplishes this by:

- Preserving open space and minimizing land disturbances

- Protecting natural features and natural processes
- Reexamining the use and sizing of traditional infrastructure (lots, streets, curbs, gutters, side-walks) and customize site design
- Integrating natural site elements (wetlands, stream corridors, mature forests) into site designs
- Decentralizing and managing storm water at its source

Effective low impact development shortens road lengths and the amount of impervious surface, allows the natural ability of natural site elements to filter and trap pollutants, avoid the development of erosion prone areas and natural infiltration of storm water can be sustained[15].

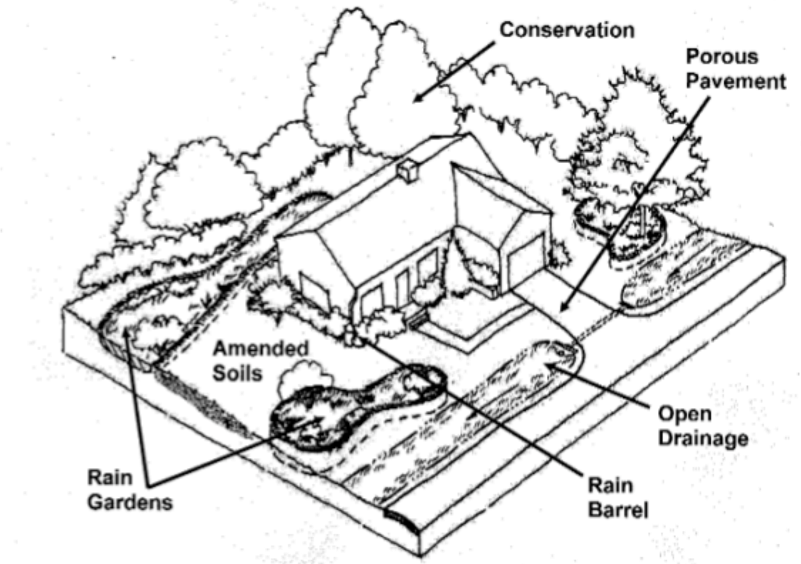


Figure 8- Low impact development for lot level control[3]

Step 4: Identify Litigation/Operational Measures

Zoning: This is a direct way for local governments to protect natural resources by using regulations to control land use activities. Land is divided into districts and laws are then established by the local government to regulate how that land is used.

Zoning variances can be used to address environmental limitations such as steep hillsides and scenic vistas. These arrangements are made to allow cooperative management between individual property owners and the community[2].

Overlay districts: An overlay district is useful in protecting specific geographic area by creating a zoning district that sets additional conditions over those of the originally zoned district. This could include additional building setbacks, use of low impact development, limits of impervious surfaces and/or the prohibition of other potentially detrimental activities[3].

Conservation Easements: A legal document that restricts the type and amount of development that may take place on a parcel of land and is transferred with any future sale of the land. An easement is individually tailored to the preferences of the landowner or the organization/agency and is a private legal agreement stronger than local zoning laws[2,16].

[15] Syracuse Save the Rain Campaign: http://savetherain.us/about-2/

[16] For More Information: Environmental Conservation Law Article 43, Title 3; NYS's General Municipal Law 247 (local government land acquisition)

Land Trusts: A Land Trust is a private not-for-profit group controlled by local citizens that acquires land for the protection of open space, recreation or resources[17]. There are over 25 trusts in New York State and 560 across the county totaling almost 700,000 acres[2].

NYS DEC Stormwater Management

As of August 2010, the New York State Department of Environmental Conservation released an updated *Stormwater Management Design Manual*. The manual is intended to address runoff reduction and planning and the design of green infrastructure for new developments[18].

Stormwater Management Practices (SMP's): The *Stormwater Management Design Manual* describes five matrices that can be used as a screening process to select the best SMP or group of SMPs for a development site.

1. Land Use
2. Physical Feasibility
3. Watershed/ Regional Factors
4. Stormwater Management Capability
5. Community and Environmental Factors

Green Infrastructure Requirements: NYS DEC requires that new developments treat stormwater management through green infrastructure that avoid impacts first, reduce impacts second and manage impacts third. Practices outlined include: Stormwater ponds, stormwater wetlands, infiltration practices, filtering practices and open channel practices.

Step 5: Identify Recreation Management Techniques[1]

Boat Launch Restrictions: Places a limit on the number of boats that can launch and therefore operate on the lake at one time.

Launch Fees: Increase boat launching fees to maximum allowable rates and reinvest into maintaining the facility.

Increase Enforcement: An enforcement presence will help improve safety and rule compliance but will not control the number of boats on the lake.

Speed Limits: Must apply to all boat types to be legally enforceable. Slower moving boats create smaller wakes and require less operation area.

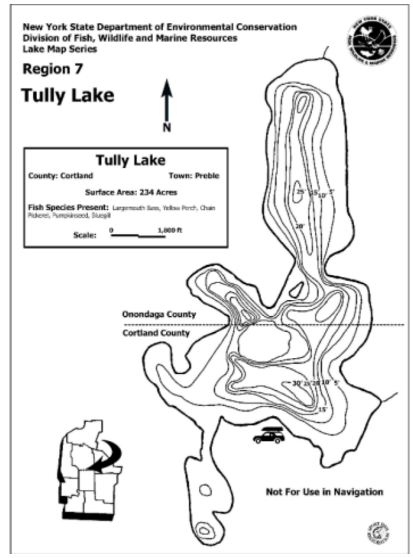
Time Zoning: Allocate timeframes when certain activities can occur. For example special morning and evening slow-no-wake times can be reserved for more passive, quieter activities.

[17] More information on Land Trusts can be found through the 1984 Adirondack Land Trust, the Adirondack Conservancy and the Trust for Public Lands: http://www.tpl.org/

[18] If a new development is proposed near your lake, it is strongly recommended that you review this document, which can be downloaded by chapter or in its entirety at: http://www.dec.ny.gov/chemical/29072.html

Appendix A- Details of C-OFOKLA's Lakes [19]

Tully Lake



Hydrology

Tully Lake "receives surface water inflow from Green Lake and the West Branch Tioughnioga River and receives ground water seepage from the east, north and west- shore areas. Water discharges from Tully Lake through 1) evapotranspiration 2) as surface water through the southern outlet and 3) as ground water underflow that seeps into the aquifer from the southern part of the lake." [1]

The deepest part of Tully Lake is only 32 feet and spans 234 acres. The shallow characteristics of this lake make it susceptible to eutrophication and algal blooms.

Development

Tully Lake land use encompasses both private residential use and public park use. There are 144 homes surrounding Tully Lake and a public boat launch and recreation area at the southern end. Additionally, road crosses the thinnest part at the southern end of the lake. Tully lake also receives outflow from a nearby water treatment plant.

Tully Lake maintains a boat launch on its southern end with fifteen parking spaces and a hand launch, accommodating boats that can be physically carried to the water, no trailer capacity. Boat motors cannot exceed 7-horse power, regulated by the NYS DEC.

The lake is a very popular ice fishing location for panfish and pickerel. Fish species found in the lake are largemouth bass, chain pickerel, Bluegill, pumpkinseed, redbreast sunfish, yellow perch, black crappie, rock bass and some walleye, which were stocked by the Tully Lake Association with a low survival rate.

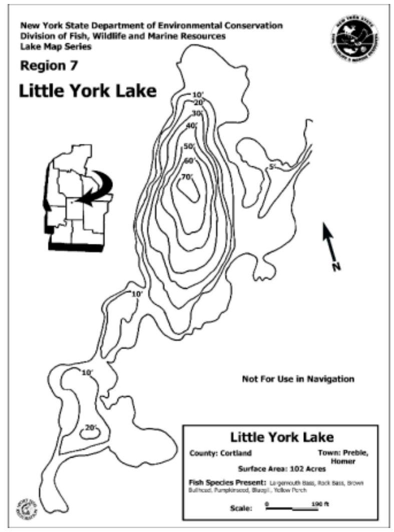
Management

Cortland and Onondaga Counties have provided a grant for the use of a weed harvester during mid-summer. Mechanical Harvesting is the "physical removal of rooted aquatic plants" and according to *Diet for a Small Lake* is the most common method of vegetation control in NYS. It serves to eliminate the symptoms of a common lake problem.

It serves to remove not only the plants themselves but nutrients such as phosphorous stored in the plant structure. Areas that serve as a important fishery or wetland area use should not be harvested and the NYS DEC can help identify these areas.

[19] For more information see: www.dec.ny.gov or contact a lake president:
Tully Lake- Chris Kruth: chkruth@aol.com
Little York Lake- Karen Lang: klang@twcny.rr.com
Crooked Lake- Tom Cappa: tcappa@hotmail.com
Song Lake- Tarki Heath: c3thk@aol.com

Little York Lake



<u>Hydrology</u>

Little York Lake has a surface area of 102. The lake's deepest point is 75 feet however the surrounding shoreline is generally shallow, creating an abundance of aquatic vegetation and hindering the aesthetic and recreational value of the lake.

<u>Development</u>

Little York Lake has many residences along its shore, as well as Dwyer Memorial Park at its northern end. The lake is a popular and active recreational spot however the shallow waters of the lake encourage the growth of aquatic vegetation, encouraging the eutrophication process.

The lake also has an earthen dam at the southern end. It is 7 feet high and 145 feet long with a maximum discharge of 300 cubic feet per second and a capacity of 350 acre feet.

<u>Recreation</u>

Dwyer Memorial Park, at the lake's northern end, contains facilities to camp, picnic, play softball, horseshoe, boat, and children's play areas. The park also has many nature trails and fishing spots.

Fish species found in Little York Lake are rainbow and brown trout, chain pickerel, largemouth bass, bluegill, pumpkinseeds, black crappie, yellow perch, brown bullhead and rock bass.

<u>Management</u>

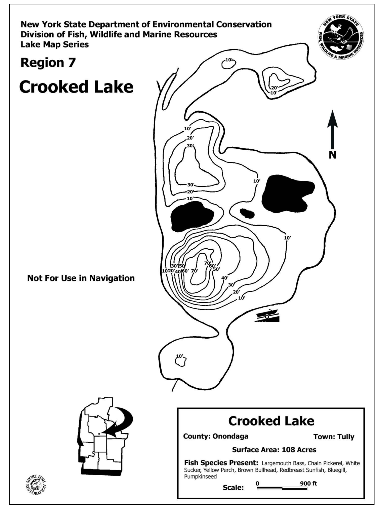
In 1997, Little York Lake investigated the use of dredging to slow the growth of surplus aquatic growth in three areas around the lake. A mechanical harvester had been previously used to control this growth. The dam was recently inspected (Spring 2011) and documentation can be obtained from the president of the Little York Lake Homeowners Association Karen Lang: klang@twcny.rr.com

Additionally, Little York Lake is stocked in the spring with approximately 800 year-old brown trout.

Crooked Lake

Hydrology

Crooked Lake has a surface area of 130 acres. The water surface elevation in feet above mean sea level is 1195.39, (measured on April 26, 2000).The deepest point is 80 feet however, much of the shoreline is generally shallow, creating an abundance of aquatic vegetation and hindering the aesthetic and recreational value of the lake. Water enters the lake from a small stream on the south end of the lake, which borders Song Mountain and a small stream on the western side.



Crooked Lake loses water through evapotranspiration and through lateral seepage into the surficial aquifer at its northern end. Crooked Lake also loses some water as surface outflow through its manmade channel connection to Gatehouse Pond during periods of high flow. Seepage from Gatehouse Pond generally moves northward into the Tully Valley, and is part of the St. Lawrence Valley drainage basin.

Development

Crooked Lake has a rich history of supporting industry through use of its waterpower in the 1800s. It was used by Solvay Process in the 1900's as a recreation lake for its employees and as a water supply for its salt mining. In 1975 the Town of Tully approved construction of the first 50 homes on the shores of the lake. Today all property is privately owned.

Recreation

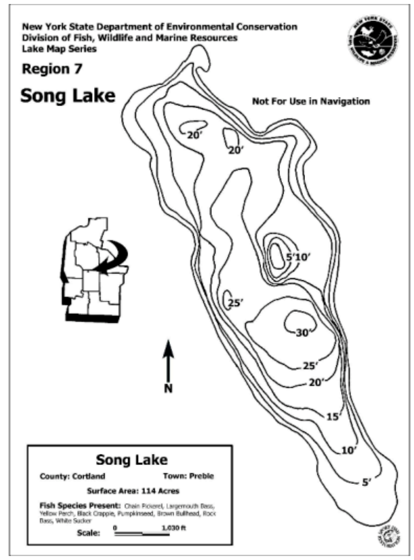
The lake is enjoyed for its clean water for swimming, canoeing, and fishing. The fish species found in the lake are largemouth bass, chain pickerel, bluegill, pumpkinseed, redbreast sunfish, yellow perch, black crappie, rock bass and carp and bullhead. The Lake Covenants for Homeowners has a number of regulations including a prohibition of combustion driven water craft on the lake. There is no public access on the lake.

Management

All homeowners of Crooked Lake are members of the Crooked Lake Homeowner's Association, which manages the activities within the guidelines set forth in the Lake Covenants. The Association was inactive for a short time but has once again begun to take the following initiatives: monitoring the water quality through CSLAP, being involved in C-OFOLKA, assessing the weed population for better control, and generally informing and educating the homeowners regarding major issues of concern.

Monitoring the stream entering the south end of the lake demands attention because there has been a past incident of identified pollution emanating from the Song Mountain Ski Area.
The future use of the land surrounding the lake has two concerns. The first is the issue of "hydrofraking" because the test gas well that has been drilled is located on the west plateau above the lake and it exists in the drainage area for the lake.
Additionally, the issue of keyhole developments has special relevance because Crooked Lake has larger building lots and a greater potential for development just beyond the existing shoreline resident structures

Song Lake



Hydrology

Song Lake has no outlet or inlet, but is fed by precipitation, surface water runoff and groundwater. It has a surface area of 114 acres and a maximum depth of 30 feet, making it susceptible to eutrophication.

Development

Song lake has ~98 private homes running from the southernmost end to the west shore and over to the upper northeast shore. The majority of the eastern shore is the property of a Girl Scout camp, Camp Hoover. Song Lake is highly conscious of overdevelopment.

Recreation

Many shoreline residents own and operate their own boating units and maintain their own docks/ boat slips. Boating and fishing are residential affairs and residents have been asked to remain cautious about allowing outside boats onto the lake.

Management

The Song Lake watershed committee has worked hard to promote resident awareness of invasive species, riparian vegetation, boater ethics and chemical fertilizer use through the dispersal of community surveys and mailbox handouts[20].

Through the NYS DEC, Song Lake introduced Grass carp in 2001 for weed control. Unfortunately, the weeds have been reduced too much, making way for an abundance of algae, including Cyanobacteria and Mycrocistis. There has been a moratorium in place since 2005 on any fish stocking.

Recent research has identified the presence of two macrophytes listed on the NYS DEC list of threatenend specises: *Myriophyllum farwellii,* (Farwell's watermilfoil) and *Neobeckia aquatica* (lakecress) Also under study is the presence of the Lake Chubsucker, also on the list of NYSDEC threatened fish species.

For more information contact Tarki Heath, the association president: C3thk@aol.com

[20] Information on lake efforts is readily available at: www.songlakewatershed.org

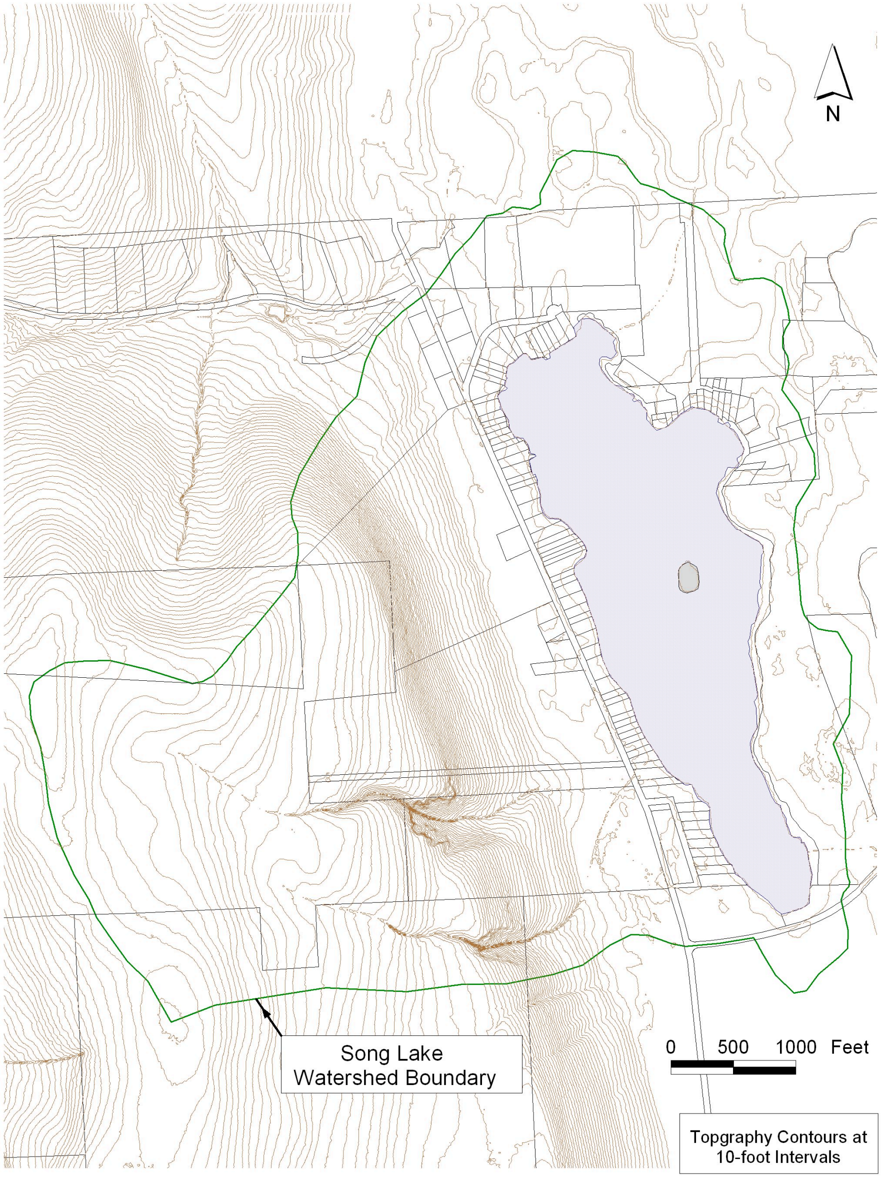


Figure 9- Song Lake surface and subsurface watershed regions[17]