Silver Lake Association's

Water Quality Handbook

Summer 2011

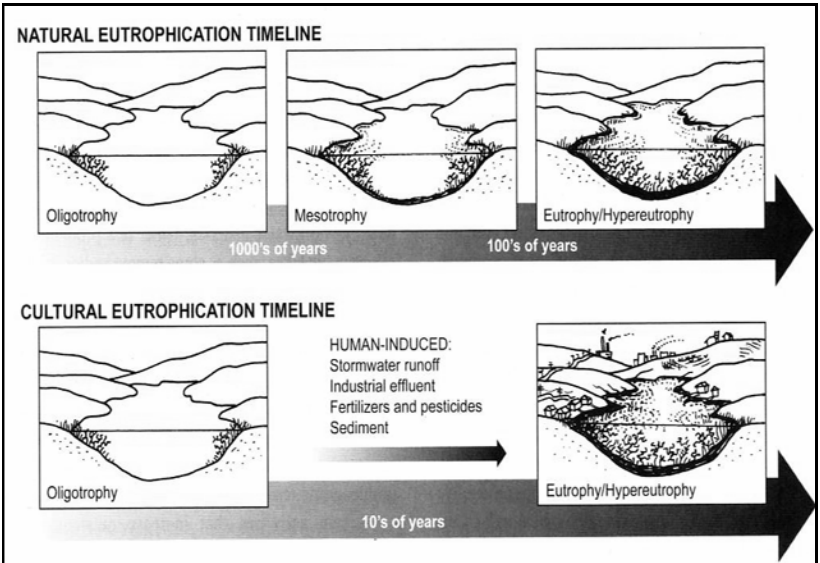

Fig. 1–12. Lakes naturally and slowly progress towards eutrophic conditions. When human activities accelerate the process, it is called cultural eutrophication. (Credit: Wendy Skinner)

Charts copied from "Diet for Small Lake" w/permission.

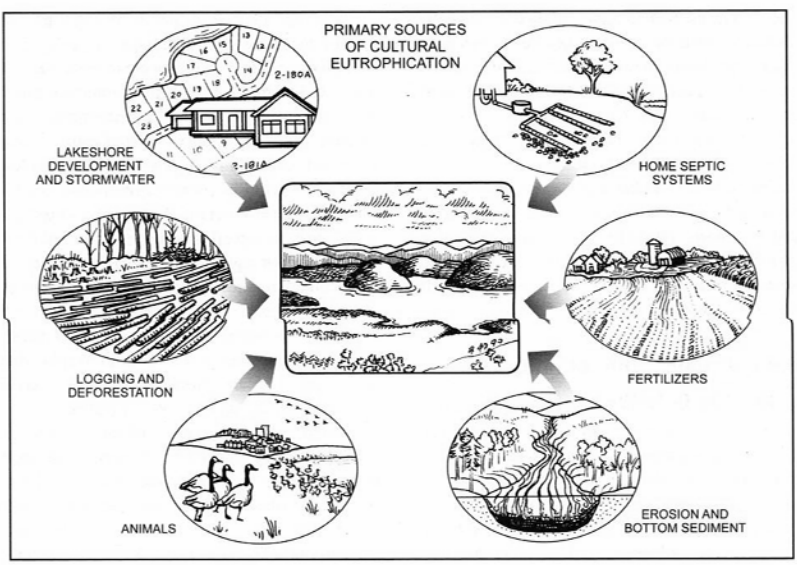

Fig. 1–13. Primary sources of cultural eutrophication. Human activities such as housing, logging, and farming accelerate the rate of natural eutrophication. (Credit: Wendy Skinner)

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Recently Published Documents on Silver Lake

1. "Total Maximum Daily Loads (TMDLs) - NYS Dept. of Environmental Conservation." *New York State Department of Environmental Conservation*. Web. 22 July 2010. <http://www.dec.ny.gov/chemical/23835.html>.

2. "Silver Lake - NYS Dept. of Environmental Conservation." *New York State Department of Environmental Conservation*. Web. 22 July 2010. <http://www.dec.ny.gooutdoor/26918.html>.

3. "Water Quality Programs : Wyoming County Soil and Water Conservation District." *The Wyoming County Soil & Water Conservation District - Education on Soil, Water, and Related Natural Resource in Western, NY.* Web. 22 July 2010. <http://www.wcswcd.org/index.php/programs/detail/water-quality-programs/>

Recommended Further Reading on Water Quality Issues

1. *Diet for a Small Lake: the Expanded Guide to New York State Lake and Watershed Management*. [New York (State)]: NYS-FOLA, 2009. Print.

2. *Mass.Gov*. Web. 22 July 2010. <http://www.mass.gov/dcr/watersupply/lakepond/>.

Threats to the Water Quality of Silver Lake

By Bethany Bzduch , Water Quality Technician,
Wyoming County Soil and Water Conservation District

Preserving water quality is essential to protecting habitats, drinking water, and food sources. Water is essential for the well being of all plants and animals, so maintaining water quality is critical. Silver Lake is the drinking source for five municipalities, a habitat for many different species, and is used for many recreational purposes. There are several different ways water quality in Silver Lake can be degraded. Some common threats to water quality are: runoff, non point source pollution, soil erosion, land development, and invasive species. This article will explain what each of these threats is and will describe several steps that can be taken to protect water quality.

Runoff

Runoff occurs naturally during storm events and snow melts when the ground becomes saturated and no more precipitation can be absorbed. Water will drain over the ground into ditches, streams, or other water bodies. When flowing over surfaces that are well vegetated, the plants will help to slow and trap the runoff. However, when runoff flows over surfaces with little or no vegetation, it will move at a faster velocity which can cause soil or sediment erosion, particularly on roadsides, streambanks, or shorelines. Also, the amount of runoff will increase as the amount of impervious surfaces (i.e. driveways, roads, roofs, etc.) increases. Impervious surfaces reduce the amount of vegetation, prevent the precipitation from absorbing into the ground, and flush them directly to the water supply. During the runoff process many different types of contaminates may be picked up as the excess water washes over the surfaces. Often, the source of contaminates cannot be found and this is known as non point source pollution.

Non Point Source Pollution

Non point source pollution is pollution which cannot be traced back to a single origin. This occurs when runoff from storm events or snow melts becomes contaminated and flows into storm drains and ditches throughout the watershed and eventually into the main water body. When the excess water runs over parking lots, driveways, roads, lawns, or fields it picks up pollutants that may be present on the surfaces. Different types of pollutants commonly found in runoff are oil, gasoline, synthetic fertilizers, other chemicals, and pet or other animal waste. When pollutants overload the water body and are present in high concentrations this can harm or destroy aquatic habitat, cause excessive weed growth and algae blooms, or fish kills.

Soil Erosion

Soil erosion occurs when water or wind eats away at sediments and causes soil to be washed or blown away. This typically happens during runoff events or high winds causing loose soil from construction sites, farm fields, dirt roads, streambanks etc, to enter the water way. Soil erosion causes sedimentation which is when sediment is deposited in water ways. This creates shallow water ways and decreases the amount of space for fish. Sedimentation also causes water ways to become cloudy and turbid which inhibits the fish's ability to breathe and see properly. Sedimentation can be reduced or prevented by keeping the banks of lakes and ditches vegetated. The roots of the plant matter help to hold the soil in place and prevent erosion. Removing vegetation and keeping banks mowed will reduce the presence of roots and will make it easier for soil to erode.

Land Development

When land is developed critical vegetation is removed and bare ground is exposed increasing soil erosion. The amount of impervious surfaces is increased which in turn increases the amount of stormwater runoff and the potential for polluted water. Although development is inevitable, there are many precautions that can be taken to protect water quality during development.

Invasive Species

Invasive species are species (animal or plant) that are not naturally found in the area. They become established due to lack of natural predators and eventually negatively impact native species. Invasive species will use up resources that are needed by native plants or animals making it difficult for them to survive and thrive. Invasives spread quickly and can be introduced through a number of ways. The first is humans. Often times, invasive plant species are planted as ornamentals and when they spread their seeds, they become invasive. Aquatic invasives can be spread on boots, fishing equipment, and boat propellers when moving from one body of water to the next. Exotic pets can become invasive if they are released or escape. Wild animals will help with the spread and introduction of invasive species. Seeds and insects can be moved in the fur or feces of the animals and as a result they can be introduced to new areas. Although there is not much that can be done in regards to wild animals spreading invasives, humans can help to prevent or reduce the spread. Contact your local Soil and Water Conservation District or New York State DEC office for more information regarding invasive species.

BEST PRACTICES TO FOLLOW

- Keep leaves and lawn clippings out of roadways to prevent them from reaching ditches, streams, and other water bodies. DO NOT dump raked leaves and grass into the lake; compost.
- Properly maintain motorized vehicles to prevent oil/gas leaks.
- Do not use fertilizers on lawns or only use phosphorus free, slow release nitrogen fertilizers when absolutely necessary.
- Do not over treat your lawns or gardens with fertilizers or pesticides. This is economically wasteful and the excess will get into the lake, harming water quality.
- Use organic methods of pest control for vegetables and flowers.
- Never pour chemicals of any kind into storm drains, on the ground, in the lake, or any water body that flows into the lake.
- Only plant native shrubs, grasses, and flowers in gardens.
- Properly clean boats and all fishing equipment when moving from one body of water to the next. This will prevent the spread of aquatic invasive species.
- Do not dispose of left over bait in ditches, streams, or lakes. Do not transport fish from one body of water to another.
- Only use onshore toilet facilities and do not dispose of pet waste in the lake or any water body that flows into the lake.
- Obey all boating speed limits and restrictions.
- Never feed waterfowl.
- Maintain a vegetated buffer area on all shore lines, ditches, and stream banks to prevent soil erosion to lake.
- Obtain all necessary permits before any construction project.
- During construction, practice smart sediment control through use of silt fences and temporary plantings.
- Utilize new technologies such as pervious pavements when creating driveways or parking lots. Pervious pavement allows runoff to infiltrate the ground instead of seeping into lake.
- When construction is completed all bare ground should be mulched and seeded to established new vegetation.

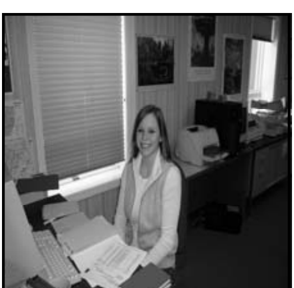
For more tips on best management practices or if you have any concerns please call your local Soil and Water Conservation District.

Education is the first step to progress. Knowing about different threats to water quality will make everyone more aware of their actions and encourage them to take precautions to protect our vital resources. It is essential to identify key areas that are most susceptible to runoff or non point source pollution and take precautions to protect and prevent water quality degradation. We all need to work together in this effort and take a proactive approach towards soil and water conservation. Working together as stakeholders and neighbors is sure to result in more than just improved water quality, but, also an overall better community environment.

Wyoming County Soil & Water Conservation District
31 Duncan St.
Warsaw, NY 14569
(585) 786-5070
wcswcd@frontiernet.net
www.wcswcd.org

New York State Department of Environmental Conservation
Region 9 Office
270 Michigan Avenue
Buffalo, NY 14203
(716) 851-7200
www.dec.ny.gov

Bethany is the Water Quality Technician for the Wyoming County Soil & Water Conservation District and has held this position since November 2008. She is also a 2008 graduate of Rochester Institute of Technology with a Bachelors of Science degree in Environmental Science.



The Silver Lake Watershed Commission
By Stanley Klein, Silver Lake Watershed Commission Member

The Silver Lake Watershed Commission is an organization of five municipalities that depend on Silver Lake, first and foremost as a drinking water source, but also as a year round sporting and recreation destination, as well as for its scenic value and natural environment for a variety of flora and fauna.

The Commission was formed in 1972 with the congressional passage of the Clean Water Act. An agreement was reached under Article 5G of the NYS Municipal Law. There are five voting members of the commission. They include: Village of Castile; Town of Castile; Village of Perry; Town of Perry; and Village of Mt. Morris.

The commission seeks to represent all of the users of Silver Lake water in the use, protection, preservation and improvement of Silver Lake, its sources, and its surrounding land uses, enhancing the quality of life in the watershed area and greater region.

There are numerous supporting organizations which the commission values as important partners in its endeavors. These include: The Silver Lake Association (SLA); The Wyoming County Department of Soil and Water Conservation (SWCD); The National Resources Conservation Services Agency (NRCS); The Farm Service Agency (FSA); The NYS Department of Environmental Conservation (DEC); The Cornell Cooperative Extension Service; and The Wyoming County Farm Bureau.

The stated goal of the Silver Lake Watershed Commission is "a healthy lake which preserves and enhances the potability of the water supply resulting in the lowering of municipal treatment costs, better fishing, boating and swimming. These, in turn, contribute to the increased prosperity of local businesses." The goal of a healthy lake can be achieved by identifying and reducing pollutants, implementation of improved land use and construction techniques, and education of the public in what they can do to help reduce the issues of pollution, erosion and sedimentation into the lake. This proactive approach to lake resource management, utilizing prioritized goals, program identification, and co-ordination of local agencies, is to be commended.

Since 1972, hundreds of thousands of dollars have been spent within the Watershed on mitigation and enhancement efforts. The following accomplishments outline the importance given to Silver Lake by our local governments and the Watershed Commission:

1972-1984	Enforcement of Silver Lake Watershed Rules and Regulations in NYS Public Health Law.
1980-1981	Replacement of S. Federal St. Dam, which controls the lake level.
1981-1985	Support for cooperative completion of Silver Lake sewer system.
1988-1989	Support for regular monitoring & testing with preliminary report.
1989	Economic Impact Study of Silver Lake.
1989-1992	Administration of Member Initiative Grant through NYS DEC to complete Phase I Diagnostic Study by F.X. Brown, Inc.
1990-Present	Assisted area farms in completing Agricultural Best Management Practices.
1994	Completion of Silver Lake Watershed Emergency Plan.
1995	Assisted Cornell Crest Dairy Farm with a concrete manure storage facility.
1996	Silver Lake Reference Material & Informational Database completed.
1997	Silver Lake Watershed Monitoring Study.
1998	Compiled Silver Lake Watershed survey.
1999	Safety improvements at S. Federal St. Dam.
2000-2002	Monitoring & Sampling program in conjunction with Wyoming County Soil & Water.
2001	Assisted Pingrey Farms with bunk silo leachate control project.
2002	Received Mini-grant through Wyo. Co. Soil & Water for Silver Lake Outlet Clean Up project.
2003	Update the Silver Lake Watershed Emergency Plan.
2008	Testing of Silver Lake Outlet soil borings.
2009	Support Silver Lake Monitoring Program Sampling Protocol.
2009	Plan Silver Lake Outlet Sediment Removal Project.

With all these accomplishments there is still much to do. NYS Water quality standards are being revised as of this writing. New technology is enabling us to measure quantities in ever more miniscule amounts, allowing the raising of standards for water quality to levels never before believed achievable. There has always been a watershed management plan. The early years were focused on enforcing Public Health Law and lake level control. Economic impacts of Silver Lake to the surrounding communities were studied. Next came a written Watershed management plan locally dubbed “The

FX Browne Study." Through the 90's, the focus of the plan was mitigation efforts on upland areas in the hope of reducing pollutants and sedimentation entering the lake. The use of voluntary incentives to comply with best management practices, as set forth by Comprehensive Nutrient Management Plans and Agricultural Environmental Management Plans met with great success. Nearly 100% of the food producing land within the watershed is now compliant, reducing sedimentation and nutrient flow into the lake.

As the century turned, the focus of the Commission turned towards monitoring programs to see what effects the upland management programs were having in the lake itself. Monitoring within the lake is also giving us sound data upon which the Commission can base its decisions about future management directions.

Today the Commission is actively engaged in a long term project to enhance the control of lake levels by a dredging project at the outlet. Flood control is currently a priority. The lake management plan is requiring updating to identify the needs of the lake into the future and chart the direction of the Commission for the next 20 years. The Commission is confident that our lake can be maintained and enjoyed as a fun place for a long, long time.

Stanley is a local dairy farmer and long-standing member of the Silver Lake Watershed Commission.

Water Quality Sampling and the Silver Lake Association
By William Soules, Chair, SLA Water Quality Committee

The Silver Lake Association (SLA) participates in New York's CSLAP. Water samples are taken every two weeks, from mid May until mid September, one meter below the surface and at the bottom of the deepest (37 feet/11 meters) part of the lake (160 yards off shore from the Institute Dock) using a Kemmerer Bottle. The collected water is then prepared for analysis, frozen and shipped to a common laboratory. The samples are analyzed for water clarity, chlorophyll a, total phosphorous, total nitrogen, nitrate, ammonia, conductivity, pH, color, and calcium.

The results from past years can be seen on www.nysfola.org. Click on "Lake Management"; then "CSLAP"; then Wyoming County; then Silver Lake or any other participating lake to view the test data. It is interesting to note that there has not been any significant change over the years of monitoring. Additional water testing is currently underway involving Secchi disks. These disks are used to measure the transparency of the water by lowering it down until it disappears from sight. This depth is then recorded. These readings have ranged for 1 to 4+ meters depending on the time of the year and amount of suspended algae. Clearer water can lead to greater weed growth.

In 2008, the Association participated in a study being conducted by the NYSDEC to try and identify the response of lake benthic organisms (the tiny plants and animals in the bottom of lakes) to nutrients, particularly phosphorus, as part of the process for developing nutrient water quality standards. The DEC collected sediment samples (grabs and cores) from about a dozen lakes in the State over the range of nutrient conditions (unproductive to productive), depths (shallow and deep) and regions (Adirondacks and rest of the State). Unfortunately, due to State budget problems, the project has not been completed to date.

The Silver Lake Association has owns a Quanta Hydrolab for monitoring conditions of the water in the Lake.

The parameters to be monitored are:
Temperature – can relate to the rate of biological growth.

Dissolved Oxygen – relates to fish being able to live in certain depths and the release of materials from the Lake bottom, particularly during turnover.

pH – is a measure of the (free) hydrogen ion in solution. A pH between 6 and 9 is necessary to support most types of plant and animal life.

Specific Conductance – measures the electrical current that passes through the water, and is used to estimate the number of ions (charged particles). This may influence the degree to which nutrients remain in the water.

Depth – provides the location (depth) of the sample data.

Turbidity – provides a measurement of the suspended material in the water as compared to a standard unit. This may help in following plumes of material as they enter the Lake during a storm event.

Algae
The following information is from a Lake Algae Symposium held on April 9, 2011 in Honeoye, NY.

Algae are naturally present in all waters and at times appear as scum layers. The algae can add taste to the water, cause odor problems, and consume dissolved oxygen when it falls to the bottom of the lake. In the case of blue-green algae, when viewed under a microscope, it actually is Cyanobacteria and not algae. Of the 35,000 strains of blue-green algae only about 1% produce toxins. It should be noted that boiling the water does not kill the toxins.

Algae growth depends on: nutrient, sun light, warmth, calm winds, seed population, and grazing. The only one that man can control is the supply of nutrients. The other items occur naturally, especially late in the summer.

What precautions should be taken during an algae bloom?
Remember only a few algae may be toxic.
1. Do not drink the water
2. Do not inhale water droplets. These can come from splashing water, use of PWCs, water skiing and spray from wave action, etc.
3. Avoid skin contact with any scum on the top of the water.
4. If using lake water in your cottage, do not use the water if it is off color. Toxins are only removed through specialized filtration.
5. Rinse any food that has been sprayed with this water.
6. Keep pets out of the water and away from any algae that may have been washed up on shore. If they come in contact with the algae, thoroughly rinse them off to remove all algae as the hair will trap the algae and then when the pet grooms itself, it can ingest the algae.

Additional information is available at www.health.stste.ny.us

Nutrient Management Considerations for Lawn Care
By Don Gasiewicz, Cornell Cooperative Extension of Wyoming County Agriculture and Natural Resources Program Assistant

Nitrogen (N) and Phosphorus (P) occur naturally in any ecosystem as byproducts of microbial and animal metabolism and can naturally be kept in a balanced state if uninfluenced by human activities. Eutrophication is used to describe the ecosystems response to excessive amounts of these nutrients entering aquatic ecosystems.

Phosphorus enters the lake through a number of methods such as farm fields, sewage discharge, runoff, and lawn care practices. Excess phosphorus in lakes causes algae blooms, lowering the level of dissolved oxygen in the water body. Excessive weed growth, fish kills, and decreased water quality may soon follow. These factors ultimately lead to an unhealthy ecosystem, decrease water recreation enjoyment, and economic losses.

There are many simple lawn care management techniques the homeowner can utilize to minimize the off-site movement of nutrients into the environment.
Test your soil. A soil test will tell you how much (if any) phosphorus (P) and potassium (K) fertilizer your lawn needs. Contact your local extension office or the Cornell Nutrient Analysis Laboratory for more information.
Focus on fall. If phosphorus and potassium levels are adequate in the soil, nitrogen (N) is the most important nutrient for grass growth. For most low-maintenance lawns, a single application in fall about two weeks after the last mowing is sufficient.
Apply with care. The goal is to get the right amount of nutrients on the lawn and none in our streams and lakes. Rotary spreaders cover a wide swath, but they can also hurl fertilizer into streets and driveways where the next rain carries it into storm drains and then on to waterways. A drop spreader may take a little longer, but it puts the fertilizer exactly where you want it. Use care when loading spreaders. Sweep up spills before they become a problem.
Leave the clippings. Clippings do not create thatch, contrary to popular belief. If you cut only a third of the plant at each mowing, the clippings won't smother the grass either. Mulching mowers work best to chop up clippings so they can settle down through the grass and onto the soil surface. There, earthworms incorporate clippings into the soil, improving both its drainage after storms and ability to hold water during drought. Do not disperse clippings onto pavement or into gutters.
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Who Can Help?

By Judy Baumer, SLA Planning and Zoning Committee Member

As a resident of, or a visitor to the Silver Lake area, you may have had a question about an issue, a complaint, or a comment but did not know whom to contact to find more information. We hope the following listing will provide you with information on whom to contact when you next encounter a question you would like answered.

If you reside in the Town of Perry:
Jim Brick, Supervisor, 237-2241, townofpe@rochester.rr.com
Sarah Ballinger, Town Clerk, 237-2241, topclerk@rochester.rr.com
Valerie Pirdy, Assessor, 237-2270, pirdy_assessor@rochester.rr.com
Lee Frette, Zoning, 237-2241, perryzoning@rochester.rr.com

If you reside in the Town of Castile:
E. Joseph Gozelski, Town Supervisor, 585-493-2218
Vickie Draper, Town Clerk, 585-493-2440
David Swede, Zoning Officer, 585-493-5130
Sue Kibler, Assessor, 585-493-3213
Darryl Nourse, Highway Supervisor, 585-493-5257
Norman Kibler, Public Works (Water/Sewer), 585-237-3450

Wyoming County Contacts:
Wyoming County Sheriff, Dispatch Center for Sheriff's Boat, 585-786-2255 or 585-786-8989
Don Roberts, Code Enforcement Officer, 585-786-8820
Anthony Santoro, Director of Fire and Emergency Management, 585-786-8867

Silver Lake Association Contacts:
Dick Swanson, President, rswanson@rochester.rr.com
Linda Holz, Property Maintenance, lindaholz@rochester.rr.com
Sally Genco, Planning and Zoning, gencosally@aol.com or 716-937-6986

If you have a question or a complaint regarding either property maintenance or construction or remodeling occurring in your neighborhood, please contact your SLA tract director, SLA Property Maintenance, or SLA Planning and Zoning Committee for further investigation or for a referral to the appropriate government personnel. **Your name and inquiry will remain anonymous.**

For more information, please consult the SLA website: www.silverlakeassociation.org

Phosphorus and Lake Aging

By Kelly Addy and Linda Green, University of Rhode Island

Since the early 20th century, scientists have attempted to classify lakes and ponds into categories in order to describe their condition and thus encourage appropriate lake management. Nutrient levels, especially phosphorus, are particularly important in influencing water quality conditions and hastening lake aging. To be useful, a classification system must recognize that lakes change in response to climatic fluctuations, watershed activities, and nutrient inputs. This fact sheet will describe the process of lake aging in northern temperate ecosystems, such as found in New England; explain trophic status classifications; discuss the role of phosphorus in aquatic ecology; introduce Carlson's Trophic State Index; and offer suggestions for limiting phosphorus inputs to lakes.

Eutrophication

Sediment, silt, and organic matter gradually fill lakes as they age. Nutrients flushed into a lake from its watershed stimulate the growth of aquatic plants and algae, creating a more productive waterbody. Productivity is a measure of the amount of plant and algal biomass in a lake or pond. A lake with larger quantities of aquatic plants and algae tends to be more productive than a lake with fewer aquatic plants and algae.

Eutrophication is the natural process that describes increasing lake productivity, nutrient enrichment, and general lake aging. Throughout the eutrophication process the physical, chemical, and biological composition of lakes change (Simpson 1991). In the early 20th century, limnologists, scientists who study lakes and freshwater ecosystems, devised a classification system to describe lakes as they proceed through the eutrophication process. Each trophic state indicates the lake's general level of water clarity, nutrient enrichment, and algal and aquatic plant abundance. However, trophic state should not be considered a discrete category, but rather part of a continuous spectrum.

Lakes in early stages of eutrophication are typically characterized by limited algal and plant productivity and low nutrient levels. These **oligotrophic** lakes have very clear water, are nutrient poor, and maintain high dissolved oxygen concentrations throughout the water column and throughout the summer (Simpson 1991, Moore & Thornton 1988). Sand, stones, or other mineral deposits usually line the lake bottom. These lakes may support cold water fisheries, including trout. Organic matter accumulates slowly on the bottom of the lake basin.

Eutrophic lakes are at the opposite end of the trophic status spectrum. In these highly productive waterbodies, algal and plant growth is stimulated by high nutrient levels (Simpson 1991, Moore & Thornton 1988). In addition to abundant algae and plants, high sediment inputs contribute to decreased water clarity. Bottom sediments are commonly organic muck. These lakes may also experience severe algal blooms. Deep waters become depleted of dissolved oxygen during the summer (see Natural Resources Facts, Fact Sheet No. 96-3, “Dissolved Oxygen and Temperature”). These lakes typically cannot support cold water fisheries. Extremely eutrophic lakes of “pea-soup quality” are further subclassified as **hyper-eutrophic** lakes. Eventually, the lake basin may fill in so much with sediment and plants that it becomes a marsh, bog, or other wetland area.

Mesotrophic lakes are in the range between oligotrophic and eutrophic lakes. These lakes have intermediate nutrient availability with corresponding intermediate algal and plant growth and intermediate water clarity (Simpson 1991, Moore & Thornton 1988). Many Rhode Island lakes and ponds fall into this mesotrophic range.

Some lakes and ponds are naturally eutrophic. This occurs because trophic state is also a reflection of the lake’s physical condition, such as size and shape of the lake, length of time water remains in the waterbody (residence time), geology, soils, and size of the watershed (Moore & Thornton 1988, Monson 1992). In addition, man-made reservoirs tend to become eutrophic more rapidly than natural lakes since there is a tendency for these reservoirs to revert back to their original state, typically a stream system or marsh (Moore & Thornton 1988, Monson 1992). Alternatively, some lakes may become more oligotrophic as they age.

Oligotrophic versus eutrophic lakes is not simply "good" versus "bad." Different trophic classes are more suitable for different lake activities (Monson 1992, NYDEC/FOLA 1990). For example, fishermen may desire a more eutrophic waterbody because abundant aquatic plants provide excellent food and cover for fish. However, swimmers and boaters prefer more oligotrophic lakes with few aquatic plants to tangle legs and boat motors. The goal of lake and fishery managers, biologists, and limnologists is not as simple as oligotrophy, mesotrophy, or eutrophy for all lakes, but to maintain a variety of lake types to satisfy a variety of people (Jones 1995).

Cultural Eutrophication
Natural eutrophication takes place over hundreds, even thousands of years. However, human activities have greatly accelerated the process of eutrophication. **Cultural eutrophication** can take place in as few as ten years. Runoff, especially from urban and agricultural areas, may carry industrial effluent, fertilizers, pesticides, and/or sediment. These by-products of human activity can be discharged into a waterbody and consequently accelerate eutrophication. Most human-oriented land uses, including logging, agriculture, and residential and commercial developments, contribute to cultural eutrophication.

Many water quality monitoring programs, such as URI Watershed Watch, are geared toward monitoring cultural eutrophication in order to provide management information. The good news is that eutrophication is a reversible process, at least to some extent, with sufficient funding (Monson 1992). If problem sources can be identified and land use practices modified, eutrophic lakes can become mesotrophic or even oligotrophic once again.

Role of Phosphorus in Eutrophication
The phosphorus content of increased inputs to a lake frequently stimulate cultural eutrophication. Just as you need nutrients to grow and survive, aquatic plants and algae require certain nutrients for growth. Phosphorus is the limiting nutrient of most freshwater lakes, ponds, and streams. This means that the amount of phosphorus in a lake determines or limits aquatic plant and algal productivity. Without phosphorus, few aquatic plants and algae would be able to grow. However, even minute amounts of phosphorus, parts per billion levels, can cause tremendous increases in growth. The presence of phosphorus in lakes also enables plants to use other nutrients more efficiently, further increasing productivity.

As aquatic plant and algal biomass increases, there is a corresponding increase in the amount of biomass to be decomposed after these plants die. Decomposition by bacteria and fungi consumes dissolved oxygen. Plants and algae undergo night-time respiration which also consumes oxygen. If a lake's dissolved oxygen content decreases significantly, fish kills may occur or fish species composition may shift to those with lower oxygen needs. If lakes lose oxygen faster than it can be replaced by photosynthesis atmospheric exchange, the lake may become **anoxic**, without oxygen. When anoxia occurs, a chemical reaction takes place in bottom sediments which releases sediment-bound phosphorus into the water column. This additional supply of phosphorus perpetuates the cycle of more and more plant and algal growth and decreased water clarity. Nuisance algal blooms may occur more and more frequently.

Typically, any form of land use development contributes more phosphorus to a waterbody than undeveloped forested land. Some significant contributors of phosphorus are: phosphate-based detergents, lawn and garden fertilizers, improperly sited and maintained septic systems, waterfowl, agricultural drainage, urban storm runoff, wastewater treatment effluent, animal wastes, road deicers, and atmospheric deposition.

Total phosphorus in northern lakes typically ranges from 14-17 ppb under natural conditions (Monson 1992). In 1976, the EPA recommended phosphorus limits of 50 ppb for streams where they enter a lake and 25 ppb within the lake to prevent or control eutrophication. Many monitoring programs measure total phosphorus concentrations to detect trends in water quality of lakes and ponds. URI Watershed Watch evaluates total phosphorus concentrations in its lakes and incoming streams on at least a tri-season basis, in May, July, and November.

In coastal ponds, nitrogen often replaces phosphorus as the limiting nutrient. In these waterbodies, total nitrogen concentrations can be measured as an indicator of eutrophication. Similar to freshwater responses to phosphorus, increased nitrogen loads to a coastal pond may shift the pond toward the eutrophic end of the trophic status spectrum.

Carlson’s Trophic State Index

Water clarity is a widely accepted indicator of lake trophic status. The Secchi disk is the typical tool used to measure water clarity. The common assumption is that the deeper the Secchi disk is visible from the surface of the water, the clearer and more oligotrophic the lake. Using Secchi depth measurement data, Dr. Robert Carlson (1977) developed the **Carlson’s Trophic State Index** (TSI). The index was developed to alleviate difficulties in communicating with the public using the traditional oligotrophic, mesotrophic, eutrophic classification system.

Since all lakes classified into the same trophic status are not identical, TSI quantitatively describes the trophic status of a lake within a numerical range of 0-110. Shallow Secchi depth measurements, indicative of low water clarity, correspond to higher TSI numbers. Higher TSI numbers indicate more eutrophic waterbodies. An increase by 10 on the TSI scale correlates to a doubling of lake algal biomass and halving of water clarity (Carlson 1977, Monson 1992).

Two other types of measurements, chlorophyll *a* concentration and total phosphorus concentration, may also be used to calculate TSI. These two measurements can be used to estimate lake productivity. Higher chlorophyll *a* and total phosphorus concentrations translate into higher TSI
numbers. Natural log transformations of Secchi disk values, chlorophyll *a* concentrations, or total phosphorus concentrations are calculated to determine TSI values as such:

TSI=60-14.41 ln Secchi depth (meters)
TSI=9.81 ln Chlorophyll *a* (ppb) + 30.6
TSI=14.42 ln Total Phosphorus (ppb) +4.15

If one of these measurements is known, the other measurements can be predicted from these equations (Carlson 1977, Monson 1992). TSI was developed for use on lakes with few rooted aquatic plants and little non-algal cloudiness, therefore, TSI should only be used on lakes with these characteristics. Scientists associate ranges on the TSI scale with the classic oligotrophic, mesotrophic, and eutrophic trophic
status classifications.

As TSI suggests, total phosphorus, chlorophyll *a,* and water clarity are inter-related components. When additional phosphorus enters a waterbody, aquatic plant and algal growth is stimulated. Chlorophyll *a* concentrations, indicative of algal levels, subsequently increase (see Natural Resources Facts, Fact Sheet No. 96-4, “Algae in Aquatic Ecosystems”). With greater algal and plant growth, water clarity decreases, progressing the lake toward the eutrophic end of the trophic status scale.

What *YOU* Can Do to Limit Phosphorus Inputs to Lakes

Maintain Your Septic System.
Have it inspected every year or two.
Have it pumped regularly, usually every 1-3 years.
Old systems should be replaced to meet new standards.
Avoid using garbage disposals which add excessive solids and grease to septic systems.

Don't Pour Chemicals Down the Drain.
Pesticides, disinfectants, acids, medicines, paint thinner, etc. harm septic system bacteria and can contaminate groundwater.

Manage Lawn and Garden Fertilizer Use.
Most fertilizers contain phosphorus.
Have your soil tested to determine exactly how much fertilizer your lawn needs.
Use a mulching lawnmower; grass clippings recycle nutrients to your lawn.
Avoid fertilizer applications just before a heavy rain.
Use slow-release fertilizers.
Do not rinse spilled fertilizer off paved surfaces, but sweep excess up or onto lawn.
Use native and adapted plants with lower fertilizer needs.
Store fertilizer in a location with a concrete floor.

Plant a Buffer Strip of Plants or Shrubs.
A greenbelt between your lawn and lake will absorb excess phosphorus before it can enter the lake.

Rake and Remove Leaves from Lakeside Property.
Leaves contain phosphorus. Do not dispose of them in the lake.

Use No-Phosphate Detergents (check labels).
Most liquid laundry detergents do not contain phosphorus, but some powdered laundry and dishwasher detergents still do.

Support Maintaining Wetlands
Wetland areas help to filter nutrients and many other pollutants.

Correct Soil Erosion Problems Immediately!
Steep, sloping banks and exposed soil should be seeded or terraced to prevent erosion.

Do NOT Feed the Waterfowl.
Waterfowl, along with all animals and humans, excrete phosphorus in their wastes. Feeding waterfowl encourages them to congregate in your lake.

Direct Roof Downspouts
Direct roof downspouts to broad, grassy areas so the rain water has a chance to seep into the ground rather than run off, carrying sediments and nutrients with it.

Conserve Water.
Use low-flow shower heads or place a brick in the toilet tank.

Join your local lake, pond, or watershed association.

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Addy, Kelly, and Linda Green. "Phosphorus and Lake Aging." *Natural Resources Facts* 96-2 (May 1996). *Uri.edu*. Web. <http://www.uri.edu/ce/wq/ww/Publications/Phosphorus.pdf>.

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Keep leaves out of storm drains and waterways. Leaves are loaded with phosphorus. If they are not managed properly when they fall from trees in autumn, they can end up in surface runoff. If the leaves aren't too thick, simply mow them into fine pieces that are small enough to filter through the grass to the soil surface where they can help improve the soil. A mulching mower works best. Collect grass clippings and leaves for composting. A mix of one part clippings to three parts leaves works well. Make sure your pile is located where the leaves won't blow or wash away. If you don't have a good place to compost leaves, bag them for collection for your local municipal composting operation. The most important thing to remember is to keep leaves out of waterways. Avoid raking them into the road where they can wash away or into storm sewers where they can be carried into rivers and streams.
Lawn care tips compiled from: http://www.gardening.cornell.edu/lawn/lawncare/fertiliz.html and http://www.gardening.cornell.edu/lawn/lawncare/leaves.html

Notes