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Guide to Understanding and Managing Lakes: Part I (Physical Measurements)

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Inland lakes constitute one of our greatest natural resources. They are immensely popular features, particularly as recreational community developments. Waterfront property has become so popular that in recent years the demand far exceeds the supply. Unfortunately, as a result of increased population growth, intensified use of surface waters, exploitation of shoreline properties, and other human pressures, inland lakes increasingly are being threatened. Declining water quality, nuisance algae blooms, excessive weed growths, deteriorating fisheries, sediment infilling, eutrophication, contamination, shoreline erosion, water-use conflicts, impaired scenic qualities and depreciating property values are common problems being experienced by lake property owners as a result of human activities. These and other critical problems are avoidable.

Inland lakes can be managed successfully and protected or restored. But those who do so must understand the natural processes of the lake environment and be sensitive to its complexities and delicate balance. Successful preservation of any high-quality, multi-purpose recreational lake is contingent upon (1) gathering essential baseline information concerning the existing conditions of the specific lake, (2) formulating a comprehensive lake management plan based on reliable scientific data, and (3) implementing proper lake management techniques based on known facts. An initial lake survey will provide the necessary information about the current state of the lake, the selection of adequate lake management methods, answer specific questions, resolve significant controversies, and serve as a basis for future lake management policy decisions.

Typical Lake Problems

All recreational lakes and their shorelines face three basic types of problems:

1) threats to water quality such as nuisance algae blooms, excessive weed growth, fish kills and declining fisheries, sedimentation, eutrophication, and the presence of toxic chemical substances in the sediments, water, and aquatic organisms;

2) deterioration of the scenic qualities of shorelines and the loss of fish and wildlife habitat through improper use and development; and

3) surface-water use conflicts such as disagreements among fishermen, swimmers, powerboaters, and water-skiers.

All of these problems will increase in severity because the amount of surface water of most lakes is fixed while

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the human pressures upon the lake surface waters is increasing as the number of lake lot owners grows and usage is heavier.

None of the three fundamental types of lake problems are mutually exclusive. For example, physical damage (i.e. erosion) to the lakeshore caused by excessive powerboating can increase sedimentation and turbidity and reduce water quality. Because shorelines act as a buffer between water and land, absorbing the pressures of use, trapping nutrients, and retarding erosion, protecting shorelines must be addressed in a lake management plan. Also, just as shore lands have an optimal development density, the lake surface has a limited carrying capacity. Both the physical and psychological interference conflicts that arise among swimmers, boaters, water-skiers, divers, and fishermen must be considered in a comprehensive lake management plan.

The principal water-quality problems encountered in lakes come from the processes of eutrophication, sedimentation, and contamination. Eutrophication is the process by which lakes are enriched with nutrients, essentially phosphorus and nitrogen. Sedimentation is the deposition and accumulation of both organic and inorganic matter in lake bottoms. Contamination is the process by which a health hazard is created when harmful substances are added to a lake. This classification of water-quality problems draws somewhat arbitrary distinctions. These three processes are not mutually exclusive; for example, soil sediments carried into a lake from erosion and runoff not only cause sedimentation but also can transport absorbed nutrients or toxic substances causing eutrophication and contamination problems.

Eutrophication

The term eutrophication refers to the natural and artificial addition of nutrients to lake waters and the effects of these added nutrients. Eutrophication is an aspect of lake aging; it is a process that increases the rate at which lakes disappear or become unsuitable for human use. Although many lakes naturally are destined to extinction, unwise land and water uses greatly accelerate this aging process. Human activities, which introduce excess nutrients and other pollutants, often termed cultural eutrophication, greatly accelerate this process. The problem is critical in most recreational lakes because of increased population growth, excessive surface-water uses, intensive lake basin development, and greater exploitation of shoreline properties.

Eutrophication results in the deterioration of water quality. Lake waters and bathing areas that were once clear, pure, and refreshing become murky, turbid, coated with algae slimes, and choked with aquatic weeds. Desirable sport fish decline in numbers and size and may taste “off-flavor,” and the species composition shifts toward less desirable trash fish such as carp. These are the obvious characteristics of a eutrophic lake. More commonly, the indicators of eutrophication go unnoticed by the casual observer. However, subtle changes in the abundance of aquatic organisms, shifts in species composition, and the appearance of polluted-water life forms allow skilled lake scientists to determine rate of change and predict changes.

Man-made eutrophication, in contrast to natural eutrophication, is rapid, but can be reduced or reversed by restricting or limiting the rate of supply of nutrients to the lake. Lakes are enriched by nutrients that come from two kinds of sources. Nutrients, which enter the lake, concentrated at a specific location such as upstream sewage treatment plants, canneries, dairies, paper mills, feedlots, and storm drains are referred to as point sources. These sources readily are identified, concentrated, and, therefore, easier to treat. Unfortunately, most recreational lakes are affected by non-point sources such as nutrient-rich runoff from agricultural fields and pastures, fertilized lawns and gardens, leaf litter, and groundwater or rainfall, and seepage from septic tank systems – all high in nutrients. These diffuse sources are much more difficult to pinpoint and to treat.

The filling of lakes by soil sediments (sedimentation) is part of the slow, natural aging process of lakes, taking thousands of years. When enhanced by human activities, rapid sedimentation can result in a lake's premature death. Soil sediments entering a lake can originate from within the lake itself and from external sources. Poor agricultural practices, highway construction, logging, and land development activities contribute sediment inflows and threaten nearby lakes. Within the lake basin, erosion caused by excavation and deforestation on steep shoreline slopes and wave action cause shoreline erosion, furnishing sediments to be transported and deposited elsewhere in the lake. Sedimentation makes the lakes shallower, decreasing the volume of water and, thereby reducing the amount of surface water available for recreation. In addition, sedimentation, promotes water loss and higher evaporation rates, depreciates riparian property values, increases water temperature, depletes oxygen supplies, and causes fish kills.

Man-made lakes (reservoirs) often are created by damming streams and backing the waters into stream valleys. These main-stream impoundments often fill up with silt and sediments at a much faster rate than natural lakes that periodically are flushed of their sediments by strong floods. Artificial lakes, in effect, serve as sediment basins, trapping the eroded soil sediments by sharply reducing the inflowing stream's velocity and, therefore, its capacity to transport sediment loads. Eroded soil sediments suspended in flowing waters rapidly settle out and fall to the bottom in standing waters. Sedimentation dramatically reduces the effective life span of mainstream impoundments.

Proper land-use practices, which prevent soil erosion and limit the input of both sediments (sedimentation) and nutrients (eutrophication), are essential in inland lake management. The most fundamental objective of watershed management and lake preservation is to keep the soil on the land. Eroded soil sediments not only serve to transport weed growth-stimulating nutrients but also reduce the average depth and volume of lakes. It is much easier to limit sedimentation and prevent eutrophication than it is to remove excessive sediments and nutrients once they have entered the lake.

Lake Management Survey

The purpose of a lake management survey is to determine:

1) hydrographic and morphometric features of the lake watershed;

2) water-quality parameters, chemical conditions, and availability of plant nutrients throughout the year;

3) mean standing crop of planktonic and filamentous algae and the maximum standing crop of littoral macrophytes during the growing season;

4) species composition, diversity, and seasonal successional patterns of the phytoplankton, filamentous algae, and macrophyte communities;

5) species composition, standing crop, diversity, and seasonal succession of the zooplankton and zoobenthos; and

6) species composition, age structure, growth rates, feeding habits, and physical condition of the sport-fish populations.

Physical Limnology

Morphometry and Bathymetry

The morphometry (size and shape) and bathymetry (depth relationships) of lakes are fundamental physical factors that regulate many physiochemical and biological events occurring within lake basins. These physical dimensions of a lake, together with climatic and edaphic (soils and geology) factors play a major role in determining the water quality and trophic status of lakes. Drainage patterns, flushing times, thermal stratification, the distribution of dissolved gasses, aquatic life, and many other factors, which govern the productivity of lake ecosystems all are markedly influenced by morphometric and bathymetric attributes of a lake.

Some lakes are relatively long and narrow, some are tree-like (dendritic) in shape, and others are nearly circular. The tree-like shape provides an extensive amount of shore land that is desirable for recreational lake developments. Numerous shallow coves and a highly irregular shoreline margin account for a relatively high shoreline development index. Most main-stream impoundment lakes are shallowest at the inlet and deepest at the dam. Areas and volumes of lakes, which are useful numbers in calculating liming, herbicide, and other chemical treatments, can be measured accurately with a bathometric map. Knowledge of the size of the drainage basin and the types of land use in the watershed (agricultural, forest, fields, urban development) are important variables that relate to water quality and the turnover time of water in a lake.

Light Penetration

Light penetration or transparency is a measure of the depth to which light can penetrate into the water. Transparency is useful in determining the depth of photic zone – the depth to which sufficient light to permit the survival and growth of water plants. The minimum intensity of subsurface light that permits photosynthesis is one percent of the sunlight striking the surface. Thus, the photic zone (plant-life zone) extends from the water surface to the depth at which 99 percent of the surface light has been filtered out. Light penetration, as measured by a Secchi disc, is expressed as the depth at which the Secchi disc disappears when viewed vertically from the shaded side of a vessel. Although Secchi disc transparency is a function of many factors including water color, suspended and dissolved solids, phytoplankton and zooplankton abundances, it serves as a convenient index of water clarity. In clear, oligotrophic waters, Secchi disc visibility is high and water plants grow to great depths. In contrast, in turbid, eutrophic waters Secchi disc transparency is low and plant life is restricted to relatively shallow waters. Observed Secchi disc readings in natural lakes may range from 1 inch to over 130 feet (40 meters) in depth.

Seasonal changes in Secchi disc transparency values correspond to high suspended-sediment inflows and a spring phytoplankton pulse. The midsummer period of maximum light penetration may correspond with maximum zooplankton concentrations, suggesting that grazing by herbivorous zooplankters may, in part, be responsible for increased water clarity. Frequently a down-lake water clarity gradient is observed as a result of high loads of suspended sediments in inflowing waters.

For comparative purposes, Secchi disc transparencies often are converted to vertical light extinction coefficients, which represent the ratio of the photic zone depth to the Secchi disc transparency. A constant of 1.7 (Cole, 1975), which, when divided by the Secchi disc transparencies, provides reasonable estimates of the vertical light extinction coefficients. Light extinction coefficients for natural lake waters range from 0.2 for clear oligotrophic lakes to about 4.0 in highly stained eutrophic lakes (Wetzel, 1975). Light extinction coefficient ranges for lakes of varying trophic status provided by Likens (1975) are: ultraoligotrophic (0.03 - 0.8), oligotrophic (0.05 - 1.0), mesotrophic (0.1 - 2.0), and eutrophic (0.5 - 4.0).

Secchi disc transparency values provide a useful index for evaluating water clarity. Water clarity not only is important in an aesthetic sense to those recreational lake users who prefer clear waters, but the amount of light penetrating into the lake is a major regulating factor that controls aquatic plant production. Clear lakes with high light-transmission values are conducive to water plant growth provided adequate nutrients are available. In general, the relationship between Secchi disc measurements and the depth to which aquatic plant life can exist (photic zone to one percent of the available surface light) is approximately three times the average Secchi disc value. For example, in Lake Caroline with an annual mean Secchi disc value of 3 feet, the maximum depth to which aquatic plants would be expected to grow is 9 feet.

It is important to note that just as clear water does not necessarily indicate clean (unpolluted) water, turbid water is not always representative of polluted water. Lake waters contain inherent colors caused by dissolved humic acids and other substance, which cannot be removed by any practical technique.

Turbidity

Turbidity is a measure of the waters optical properties resulting from the scattering and absorbing of light by suspended particulate matter. The amount of turbidity or degree of opaqueness of lake water depends on the size, shape, refractory indices, and concentrations of suspended particles. Particulate matter may be organic (phytoplankton and zooplankton) or inorganic (colloidal clay and silt). These suspended particles may originate from within the lake itself (autochonous matter) or from an external source (allochthonus matter). Both contribute to the total quantity and quality of lake turbidity. Turbidity largely is responsible for water color and light penetration.

Athough high water turbidity seldom is directly lethal to fish and other aquatic life, excessive turbidity leads to low productivity and poor fish growth. Highly turbid lake waters decrease light penetration, limit photosynthesis by microscopic green plants (phytoplankton), and reduce the abundance of aquatic animals (zooplankton and insects) that feed on these tiny plants and, in turn, serve as important fish food organisms. Ultimately, growth and reproduction of sport fish are inhibited. In addition, turbid waters not only are much less aesthetically pleasing than clear lake waters, they frequently are unsuitable for domestic use. Turbidity serves as a useful index to water quality. Turbidity values, in formazine turbidity units, for natural lake waters range from 0 in very clear water to 100 or more in highly turbid water.

Color

The color of lake waters may range from clear blue through green to yellow-red to brown and include all of the intermediate hues created by a combination of these colors. The observed color of lake waters consists of unabsorbed light reflected upward from the lake surface. Absolutely pure water absorbs all light, reflects none, and therefore appears black. In contrast, white water results from the reflection of all light rays; no light is absorbed. Natural lake waters seldom, if ever, appear pure black or white since they contain both living and dead, dissolved and suspended materials that both absorb and reflect varying parts of the visible light spectrum. Most lake waters appear blue, blue-green, or green due to the molecular scattering of light by water molecules in motion. Light in the shorter wavelengths (blues and greens) is scattered more (absorbed less) than that of the longer wavelengths, hence the dominance of blue or green colored natural lake waters. With increasing amounts of suspended and dissolved matter, particularly humic substances, yellow, red, and brown colors become more apparent.

An infinite variety of dissolved and suspended, living and nonliving materials contribute to the color of natural waters. Suspensions of inorganic materials such as calcium carbonate in marl lakes, clays in turbid lakes, or sulfur and iron compounds in volcanic lakes, account for greenish, yellowish, yellowish-green, and reddish tints, respectively. The dark brown color of bog, swamp, and marsh waters is due to dissolved humus (organic carbon) materials derived from decomposing leaves and soil substances washed into surface waters. Living organisms, notably blooms of blue-green algae, green algae, and diatoms often impart blue-green, green, and yellow-brown colors to the water. Blood-red lakes may temporarily result when purple-sulfur bacteria, brine shrimp, euglenoids, or dinoflagellates (as in the red tide) reach exceptional densities. Water color provides a useful qualitative index of certain limnological phenomenon and lake productivity. In general, oligotrophic (nutrient-poor) lakes with low amounts of suspended materials are characteristically transparent and blue in color. In contrast, highly productive eutrophic (nutrient-rich) lakes with large plankton populations typically appear yellow-green to yellow or brown in color.

The ability of the human eye to discriminate colors is highly variable and subjective. Indeed, color-blind individuals may not distinguish some colors at all. In addition, human visual memory is very poor in comparison to auditory memory. Thus, it is sometimes useful to distinguish the apparent (observed) color of lake water from its true (specific) color. The apparent color of lake water is not only a function of materials suspended and dissolved in the water itself, but it also is influenced by external environmental conditions such as the colors of the sky, the cloud cover, the lake bottom, the shoreline soil, terrestrial and aquatic vegetation, the quality of incident light, and other factors, all of which may change with the time of day as well as the seasons. On the other hand, the true color of lake water results only from dissolved or colloidal substances in the water itself. The true color of lake water is determined by comparing the color of a water sample, after it has been filtered or centrifuged to remove any suspended substances that may contribute to its apparent color, with a standard color scale. The most widely used comparative color scale is based on platinum-cobalt units. The scale ranges from low P+ units in very clear lake water to over 300 P+ units in very darkly stained bog waters.

Water color is not always uniform with depth, or constant through time. A single lake may have highly colored surface waters and very transparent bottom waters or vice versa. Similarly, the color of a lake may change daily or seasonally. For example, heavy rains accompanied by extensive surface runoff can contribute high loads of suspended sediments, which may rapidly alter the color of the water. Massive algae "blooms" temporarily may impart certain colors to a lake. Thus, variations in physical, chemical, or biological phenomena of lakes may alter the water color of a given lake through both depth and time.

Conductivity

Specific conductance is a direct measure of the water's capacity to conduct an electrical current and an indirect measure of the total dissolved mineral content of the water. Conductance is the reciprocal of electrical resistance. The ability of electrons to flow through water is related to its dissolved ionic content (salinity). For example, as water becomes purer, its salinity decreases, its electrical resistance increases, and its specific conductance decreases. Specific conductance, then, provides an indirect measure of the total dissolved-mineral content and serves as a useful index of water quality and the trophic status of lakes. Conductance is normally expressed as micromhos per cm at 25°C (77°F) (literally the reciprocal of resistance). In general, lake waters with low conductivity contain few dissolved salts, are usually clear, and nutrient poor (oligotrophic). In contrast, lake waters with high conductivities contain more dissolved salts, are often turbid, and nutrient rich (eutrophic). With the exception of nutrient-poor (oligotrophic) high mountain lakes, most lakes in Virginia fall into the mesoeutrophic category characterized by intermediate conductivities ranging from about 30 to 100 umhos.

Temperature and Thermal Stratification

Water temperature (measure of heat energy) is a major regulator of physical, chemical, and biological processes occurring in lakes. The unique temperature-related properties of water, including its high specific heat, high latent heat of vaporization, and particular density-temperature relationships govern all life processes. Temperature not only plays a critical role in determining the types of aquatic life that can survive in a lake, but strongly influences spawning times, metamorphosis, and migration and it also controls the reproduction, growth, and development rates of all aquatic species. In general, warmer water temperatures accelerate living processes (chemical and biological reactions double for every 10°C [18°F] increase in temperature), while cooler temperatures suppress these processes. Most organisms have an optimum temperature range above and below which they become stressed, and at extreme temperatures, die.

Water has several unique thermal properties that serve to protect aquatic life by minimizing rapid temperature fluctuations. Water, with a specific heat of one – one calorie of heat is required to raise the temperature of one milliliter of water one degree centigrade – has an enormous heat retaining capacity. Few other substances can match the capacity of water to hold heat. Because water both warms and cools slowly, aquatic environments are much more stable than aerial ones. This property of water also has a large influence on adjacent landmasses. For example, areas along large lakes experience moist, cool summers and mild winters as a result of water's high specific heat.

Another significant thermal characteristic of freshwater is that it reaches maximum density at 4°C (39°F) – only a few degrees above the freezing point. Both above and below 4°C (39°F), water is less dense (lighter). Thus, water differs from most substances because it is denser as a liquid than as a solid. Ice, water in its solid state, floats! This important temperature-density relationship is fundamental to understanding thermal stratification and many of the associated phenomena that are observed in lakes.

Thermal stratification refers to the vertical partitioning of lake waters into three independent layers or "strata" of dissimilar temperatures and densities that act as physical barriers preventing the complete circulation of lake waters. These three layers consist of: (1) a layer of warm, light (less dense) water termed the epilimnion (from epi, meaning on or upon); (2) a middle layer or metalimnion (from meta, meaning among or between) of rapidly decreasing temperature (the zone in which the temperature drops at the rate of at least 10 degrees per meter of depth); and (3) a cold, heavy (more dense) layer of bottom water called the hypolimnion (from hypo, meaning under or below the lake). Most swimmers, upon diving into a stratified lake on a calm summer day, have experienced this vertical temperature gradient.

Thermal stratification is density stratification and if a thermal gradient exists so, by definition, must a density gradient. In general, the greater the differences in temperature and density between these layers, the larger the lake's resistance to mixing. In this manner, the thermal stratification of lakes strongly regulates physiochemical processes, particularly decomposition rates, nutrient availability, and biological production.

Most lakes in the temperate latitudes of North America stratify twice a year, once in the summer (direct stratification) and once in the winter (inverse stratification); during the spring and fall these lakes typically are well mixed, isothermal, and circulate freely. Seasonal temperature-density fluctuations and local climatic conditions govern the extent and duration of lake stratification. Spring is the time when the lake waters, heated by solar energy and mixed by strong winds, have approximately uniform temperatures from top to bottom and circulate freely. As spring progresses, the upper waters heat rapidly, the winds subside, and less heat is transferred to the lower water levels. With increasing solar heating and decreasing wind-driven mixing, the upper waters become substantially warmer than the bottom waters and summer stratification develops. In the fall, as surface waters cool (become heavier [denser]), sink, and mix with the lower layers, the lake becomes uniform in temperature density and once again circulates freely. During the winter, as surface waters cool to freezing and ice cover eliminates wind-induced mixing, cold water near lies under the ice. Warmer (but denser) layers of water near 4°C (39°F) (maximum density) lie near the bottom. This situation is called winter inverse stratification.

Sedimentation

Sedimentation is a process that refers to the deposition and accumulation of both organic and inorganic matter in lake bottoms. Organic sediments are derived from living matter and represent an accumulation of plant and animal remains that settle to the bottom. In contrast, inorganic sediments are composed of nonliving materials and represent an accumulation of eroded soil sediments, particularly silt and fine clay particles.

Lake sediments can originate from within the lake itself (autochthonous matter), or externally from the surrounding watershed (allochthonous matter). Both of these sources contribute to the total amount of lake sediments. Wind and wave-generated shoreline erosion can contribute large quantities of inorganic sediments that are redistributed elsewhere in the lake.

Excessive sedimentation represents a serious threat to the water quality of inland lakes. It is an unfortunate irony that the very same agricultural soil that provides our life-supporting foods, when washed into waterways and carried into lakes, becomes one of our most destructive water pollutants.

As high loads of suspended sediments are transported into lakes and begin to settle they: (1) fill in the lake basin making the lake more shallow, (2) reduce the amount of surface area, (3) decrease the water volumes and lake storage capacity, (4) clog water filters and intake pipes, (5) reduce water clarity and decrease light penetration, (6) increase water temperatures, (7) lower dissolved oxygen levels, (8) smother fish eggs and bottom-dwelling life forms, (9) stimulate nuisance algae blooms, (10) provide additional rooting sites for waterweeds, (11) promote fish kills, (12) inhibit recreational boating, swimming, and fishing, (13) impair the natural scenic beauty, and (14) depreciate property values.

Sediment problems are particularly severe in artificial lakes formed by directly impounding rivers. These mainstream impoundments disrupt natural drainage systems and serve as settling basins for sediments. They are more susceptible to heavy sedimentation than are natural lakes.

One of the most fundamental objectives of inland lake management is to keep the soil on the land and out of the lake waters. Proper land-use practices that prevent soil erosion and limit the movement of soil particles into lakes and their upstream tributaries are essential in controlling sedimentation.

Virtually every activity that occurs in the lake watershed, including upstream agricultural practices, logging operations, road construction, and lakeshore property development, affects the lake. Land- and water-quality problems are, for the most part, inseparable. Lake sedimentation is largely a land-use problem. Reducing sediment yield from the watershed should be a major component in the planning and management of lake watersheds.

Within the upstream watershed, wise agricultural and forestry practices such as: 1) strip cropping and contour plowing, 2) land grading and terracing, 3) efficient crop harvesting and the removal of crop residues, 4) installing soil stabilization structures and sediment traps, 5) prevention of overgrazing by livestock, and 6) maintaining shelter belts along this waterway will reduce sediment rates. The professional manager makes an effort to encourage wise land use by upstream property owners.

Natural freshwater marshes and bog wetlands are a vital part of the lake watershed. Upstream wetlands have a major beneficial influence on lake water quality and quantity. These wetlands serve as natural pollution and sediment control systems by collecting sediments, trapping nutrients and fertilizers, and absorbing toxic contaminants and other materials running off the upstream agricultural lands. Wetlands serve as natural flood-control systems by regulating storm-water flows and, thereby, reducing flood damage.

Erosion control barriers should be required during construction on lakeshore and upland lots. Several inexpensive erosion barriers, particularly earth, straw-bale, and cloth or plastic-mesh berms (similar to those used in highway construction) are very efficient in retaining soil on the site.

Additional measures that can minimize construction-site runoff are: 1) Preserve the natural vegetation and maintain a green belt of native plants between the site and the shore or a drainage ditch running into the lake. Extensive lawns or "fairways" from the site to the shore are not appropriate in high-quality recreational lake developments. 2) Avoid open construction sites and lengthy construction times, 3) limit construction operations during periods of high rainfall. 4) Prohibit the use of topsoil fill or dredge operations, including boat dock construction activities. 5) Construct retention basins or drywells for storm drainage.

In the past, both sanitary sewage and storm water drainage were discharged directly into lakes. Today, although nearly all sanitary sewage is treated before entering the lake, storm-water drainage is still ignored. Long considered harmless, surface water runoff from roads, roadway ditches, parking lots, and similar areas frequently is laden with nutrients, oils, heavy metals, and soil sediments. Storm sewers and drainage ditches that funnel sediments and other pollutants directly into a lake seriously can reduce water quality over time. An acceptable alternative to direct drainage into the lake is to divert contaminated runoff water around the lake, or into dry wells and artificial settling basins.

The best solution to lake sedimentation problems is to prevent eroded soil particles from entering a lake in the first place. "Preventative" solutions are much easier, more efficient, and a lot less costly than "restorative" solutions used to remove sediments after they have reached the lake waters. While it is possible to restore badly sedimented lakes, the process is difficult, lengthy (usually years), and very expensive!

Dredging, the physical removal of lake bottom sediments, is the most common method used to deal with excessive deposition of eroded soils and organic matter. Although dredging is the most direct way to remove unwanted sediments, it does not represent a solution to the problem. Lake dredging, in itself, can provide only temporary, cosmetic relief.

There are many difficulties involved with dredging and careful consideration should be given, particularly to costs, disposal of the dredged materials, and the potentially adverse environmental impacts. Mechanical dredging is expensive, often prohibitively expensive. The costs are dependant on the size of the project, type of material to be excavated, purchase or lease of disposal areas, distance to the disposal site, and the availability of well-equipped dredging contractors. Moreover, dredge spoils often contain large quantities of absorbed nutrients and may contain other pollutants that could be released into the lake water during the dredging process. In addition, the dredging activity itself temporarily increases the amount of suspended sediments that threaten fish eggs and other relatively immobile forms of aquatic life.

In some situations, mechanical aeration has been shown to reduce the organic portion of lake-bottom sediments. Aeration is also a valuable technique for improving general water quality and the aquatic environment for fish and other aquatic life. Small aerators placed in certain bays such as a "marina bay" would decrease the quantity of organic bottom sediments.