User's Guide to Shoreland Property

Welcome to the Aitkin County Shoreland Stewards Program

The Aitkin County Water Planning Task Force, the Mississippi Headwaters Board, and your real estate agent are giving this User's Guide to Shoreland Pro-pert to you. Shoreland property owners have certain rights and responsibilities. We hope you will find this information useful in making the most of your shoreland property and its waters, today and for future generations. Please keep the Guide for future reference.

The Guide is an introduction to understanding water quality and how we can maintain and improve it. It includes explanations of the physical and biological processes that occur in lakes and streams, and suggestions for a range of decisions property owners make, from major building projects, landscaping and waste disposal, to purchase of household products.

Your real estate agent has been "certified" by the Aitkin County Water Planning Task Force as a "Shoreland Steward". This means the agent has agreed to participate in educational courses specifically about shoreland property management, and to talk with you before your purchase about these issues. Your agent will discuss the items listed on the Checklist on the back of this page, and has access to other information for you about specific questions that may arise.

For more information about the Shoreland Steward Certification program or for additional questions you may have as a shoreland property owner, please contact the Aitkin County Water Planning Task Force at Aitkin County Soil & Water Conservation District, 218-927-6565. The checklist also provides contact numbers for other frequently asked questions.

This publication stems from a project in celebration of and commitment to America's Clean Water Act of 1972.

The User's Guide to Shoreland Property was originally prepared by the Mississippi Headwaters Board with funding from the Clean Water Act 205(j) 3 grants Non-Point Source Pollution Grants Program. Information and material from a wide variety of sources was utilized ill creating the Guide, including the following sources: "The Baybook" (Wisconsin Department of Natural Resources, 1989); NALMS Management Guide for Lakes and Reservoirs (1987 reprint); The Lake and Reservoir Restoration Guidance Manual (EPA, 1988); "At the Water's Edge: Nature Study in Lakes, Streams and Ponds" by Alan M. Cvancara; "A Citizen's Guide to Lake Protection" (Freshwater foundation, 1985); and "Streams Sites: Buying, Building & Care" (Michigan Department of Natural Resources). Design, layout and illustrations provided by Mary C. Lynum.

Aitkin County Shoreland Stewards

We Can Work Together To Protect Your Shoreland Property

More than 350 lakes and 900 miles of streams and rivers are found in Aitkin County. We value these resources for their excellent recreational opportunities and water quality. Our many wetland areas protect ground and surface waters by filtering nutrients and pollutants.

This checklist is a tool to assist all of us in maintaining a healthy environment:

INFORMATION	WHO TO CONTACT
-wetlands are protected	SWCD
-steep slopes are fragile areas that deserve special protection	P&Z
-burning barrels are not a legal (or pleasant) means of garbage disposal	P&Z
-lawn chemicals may damage your lake	Ext.
-septic systems require approved designs and permits	P&Z

Land near lakes and rivers is especially important for wildlife habitat, filtering runoff, and providing natural scenic beauty.

INFORMATION	WHO TO CONTACT
-building setbacks are 75 feet to 150 feet depending on the lake or river	P&Z
- building permits are required for improvements & new construction	P&Z
- permits are needed before earth moving projects are started (on land)	SWCD
- permits are needed before work is started in the water	DNR
-tree and shrub removal is limited to protect shoreland areas	SWCD
-information about removal or other changes to aquatic vegetation	DNR
-recommended shoreland information will be provided by your Realtor	Realtor

P&Z	Aitkin County Planning & Zoning Office at 218-927-7342
SWCD	Aitkin Soil & Water Conservation District at 218-927-6565
Ext.	MN Extension Services at 218-927-7321
DNR MN	Department of Natural Resources at 218-828-2636

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DEVELOPMENT ON SURFACE WATERS

"I didn't want to be on the water anymore. I don't think anybody should be on the shore because of what it does to the shore. You got one house, one dock, one house, one dock, one house, one dock. Everyone wants to live on the shore, but if everyone is on the shoreline, you got no more shoreline."
"Jackpine Bob" Cary - Ely, Minnesota

Managing Lakeshore Development to Prevent Problems

Chances are that you're a shoreland dweller partly because you enjoy wildlife and the natural environment. You, like otters, mink, eagles, and many other creatures, are a land-based animal who derives some sort of benefit from living near a body of water.

Consider your role here: you're the intruder. You have the capacity to change your piece of shoreline environment so much that it can no longer support the creatures that lived there before you arrived, and whose presence you cherish. You may not even be aquatinted with the variety of living organisms you have as neighbors!

We've learned a lot about protecting our environment and how very complicated Earth's web of life really is. We know that we can't bring urban lifestyles to rural areas without exacting a big price from the environment. Let's look at a few animal groups you may enjoy.

Fish: If you enjoy fishing, remember that diverse fish populations can be supported only if water stays oxygenated and clean and if there are diverse food supplies and shelter for fish and their fry.

Removing rooted aquatic plants removes essential shelter for fish and for the tiny creatures (invertebrates) they rely on as food.

Using pesticides carelessly (herbicides on plants and insecticides for pesky insects) can kill fish -but can also kill important food sources for fish and other creatures. You probably realize that the "top predator" fish such as northerns, walleyes, bass, and muskies can exist only where energy from the sun is packed into microscopic algae, which are then eaten by a succession of invertebrates from tiny crustaceans and insect larvae to large invertebrates -and smaller fish.

Believe it or not, most insects are beneficial -not pesky! They are essential for pollinating certain flowers and trees and many of them eat noxious insects -as dragonflies eat mosquitoes. Using "bug zappers" actually kills more beneficial insects than pests, and if everyone on shorelines used them, they might even impact food sources for fish. Many insects, such as dragonflies, mayflies, caddisflies, and pesky mosquito, spend most of their lives as water creatures and live only briefly in their winged form. Some never even feed after crawling out of the water, molting, and flying away to breed and lay eggs!

Birds: In addition to popular birds such as chickadees, robins, and nuthatches who live in the vicinity of your home, there are many others who share your love of shoreland. If you're considerate, they may stay around.

Aquatic plants that rise above the water level provide shelter and protection for ducks, loons, and a variety of other birds. Be very careful not to bother nesting birds or those caring for young. Loons can be very vulnerable to disturbance and should never be approached. Human interference and habitat loss have been the most significant factors in their decline.

Kingfishers, eagles, ospreys, great crested flycatchers and other birds that prey upon insects and/or fish need perches from which they can survey their feeding areas. Leaving big old dead trees standing wherever you can will be attractive to them, especially along the shoreline. A big old dead tree becomes a fascinating "apartment house" for a variety of animals!

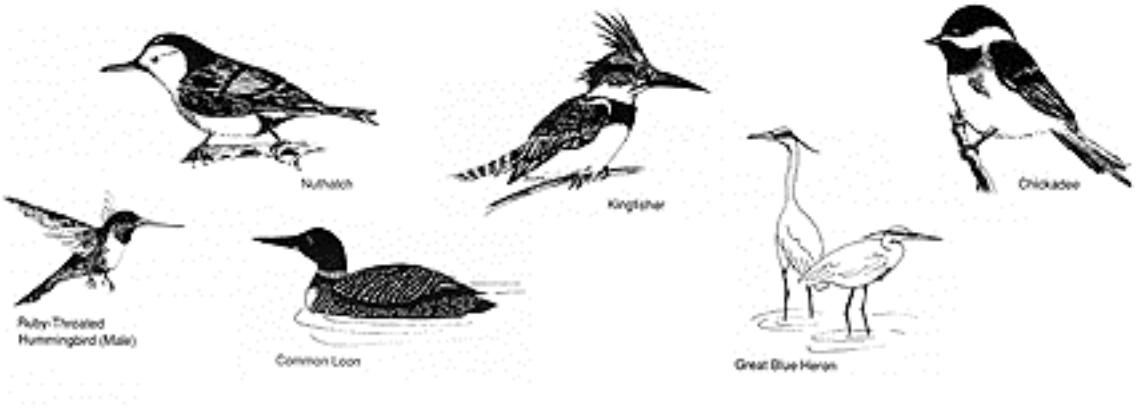
If you have property with steep banks on it, protect the banks from human misuse, as by digging or vehicular use, and you may have nesting kingfishers, swallows, and perhaps other animals move in.

Protect your tall, "supercanopy" trees (trees whose crowns rise above the rest of the forest). A variety of birds, including eagles, select such places for their nests. Eagles seem to be especially found of big old white pine trees.

Keep as much of your yard as possible in a natural state. Some smaller birds, such as the northern waterthrush, prefer to be near water. Erect different kinds of birdhouses. Large duck boxes may attract wood ducks, goldeneyes, and perhaps kestrels ("sparrow hawks") or even some mammals. Houses for martins and a number of other birds that prefer shoreland may provide you with great diversion. Make sure to clean them out each year.

Put out a variety of bird feeders and try different types of food. You may attract hummingbirds with certain flowers or with a sugar-water feeder. (You need not color the water red, especially 9 there's red on the feeder.)

Pesticides can be very hard on birds: try to avoid contaminating their food web!



Mammals: All animals need water to survive, though many of them normally get enough water in the food they eat so that they don't need to drink very often. You may have deer, bear, and a variety of creatures of all sizes use your property to get to water if you keep enough natural cover for them. Bats may also feed in your yard or over the water, especially during emergence of mayflies or other insects.

Other animals thrive on constant association with water. Raccoons and mink prefer shorelines in their food forages, but beaver, muskrats, and otters rely on water for their lifestyles. Fortunate indeed are those shoreline dwellers who can see these wonderful animals in action!

Amphibians and Reptiles: There aren't many kinds of snakes in northern Minnesota, and there are no poisonous ones. They do an important job in nature in helping to keep rodent and insect populations in check.

There are a variety of frogs and toads whose spring and summer calls add to the symphony that is provided mainly by birds. These creatures are animated insect traps and are part of the natural web that makes shoreline ecosystems work. There are cassette tapes available that can help you learn their calls.

In Summary:
1. Retain natural habitat as much as possible: keep aquatic plants, big old dead trees, brush piles, and unmowed grass. Try to keep your shoreline as wild as possible. Mow a minimal area for family activities and safety.

2. Try to avoid using chemicals, herbicides, insecticides, fungicides, and fertilizers. If you must use something, as to control poison ivy, select the product carefully and follow directions. Using insecticides to kill mosquitoes also kills the insects that would help control them. Use personal applications of repellents to avoid being bitten.

3. Respect animals' privacy: most especially, stay away from nests and animals caring for young. Teach children to respect other animals.

4. Control pets, especially at sensitive times for your wild neighbors.

5. There are many sources of information regarding birdhouses, bat houses and other structures and plantings to encourage use of your land by wild animals. (DNR Woodworking for Wildlife and Landscaping for Wildlife)

BEST MANAGEMENT PRACTICES TO PROTECT WATER QUALITY

The activities in the watershed surrounding a surface water lake affect the quality of the water of that lake or stream. A pollutant carried from land to water in runoff or seepage or through the atmosphere is known as non-point source pollution, because it has many sources and not a single source. Managing surface waters means managing land use to limit the amount of non-source pollution that can enter the surface water.

Examples of land use activities that impair water quality are:

-Urbanization of large land areas
-Use of pesticides and fertilizers
-Animal feedlots
-Agricultural land management
- Construction site practices
- Septic system installation, maintenance and operation
-Mining
-Forestry
-Use and storage of highway de-icing materials
-Activities that accelerate the erosion of roads, streambanks and lake shores
-Removal of wetlands

Control of non-point source pollutants entering surface waters can be achieved by following best management practices when engaging in any of the land uses listed above. A number of state agencies have cooperated on publication of best management practices to protect water quality. Sources available are:

"Agriculture and Water Quality: Best Management Practices for Minnesota," prepared by the Minnesota Pollution Control Agency, Division of Water Quality, with funding from the Legislative Commission on Minnesota Resources, the Soil Conservation Service, and the Environmental Protection Agency. For additional copies contact: MPCA 520 Lafayette Road St. Paul, MN 55155

"Protecting Water Quality in Urban Areas: Best Management Practices for Minnesota," prepared by the Minnesota Pollution Control Agency, Division of Water Quality, with funding from the Legislative Commission on Minnesota Resources, the Soil Conservation Service, and the Environmental Protection Agency.

"Water Quality in Forest Management: Best Management Practices in Minnesota," prepared by the Chippewa National Forest, U.S. Forest Service, Minnesota Association of County Land Commissioners, Minnesota Department of Natural Resources, Division of Forestry, Minnesota Forest Industries, Minnesota Timber Producers Association, Superior National Forest, U.S. Forest Service, University of Minnesota, with funding from the Legislative Commission on Minnesota Resources through the Minnesota Pollution Control Agency's Division of Water Quality.

Things to Consider Before You Buy or Build

People purchase take property for different reasons. Some seek a quiet retreat. An avid angler desires an excellent fishing lake. Another person wants a lake for active water recreation. Before you purchase your property, know exactly what you want and the type of lake that will satisfy your needs.

Before You Buy

The basic information you need includes:

Lot size
Zoning ordinances
Topography
Soil conditions
Vegetation

Other issues to consider are:

Land use

-What is the nature of existing adjacent or nearby development?

-Is the area generally developed around the lake? Is there agriculture or forestry management being conducted near the lake? These may affect water quality in the future.
-Are there any plans for new development? Check with the county zoning office for any current permits for that area.
-How is the area zoned? It is a good idea to become familiar with local land use regulations before you buy or build. Zoning officials are eager to help in the planning stages.
-What uses are allowed?
-Are there any easements or restrictions?
-Are the mineral rights a part of the property sale?
-What is the general trend of land values in the area?
-What are the property taxes?

Public Services

-Is electricity available?
-How is garbage collection handled?
- Are on-site sewage disposal systems allowed?
- Is the site served by emergency services?
- Where are the schools?

Lot Accessibility

-Is lot served by public or private road?
-What kind of road is it - paved or gravel? Are there plans to upgrade it?
-Is the road maintained and kept open year-round?

Site Terrain and Soils

-Is the site flat, hilly, or have steep slopes or bluffs?
-Are there swamps or low-lying areas on the site? How much of the site do they cover?
-How well do the soils drain - well or poorly?
-How deep are the top soil layers?
-Are the slope and soil types suitable for on-site waste disposal?
-Is there room for placing two on-site waste disposal systems - one for immediate use and another to replace it in 25 years or so? This is a requirement of the new DNR shoreland rules.

Site Vegetation and Views

-Is the lot forested? If so, what type of trees are on the site and what is their age and condition?
-Are there any unique plant species or communities located on the site?
-What is the nature of the shoreline - sandy, rocky, mucky bottom, presence of wetlands, and degree of vegetative cover?
-Are there any views of the lake or stream?

Site and Design Considerations

On-Site Wastewater Disposal

A typical household septic system is estimated to discharge between 50,000 to 75,000 gallons of effluent per year per household. The design life of septic systems is estimated to be 20 to 40 years, after which time deterioration in system performance is likely. Moreover, federal officials estimate those areas with densities of more than 40 septic systems per square mile are considered regions with potential for groundwater contamination. The "onsite" sewage treatment system has two parts: sewage tank and soil filter. The sewage tank separates out the large solids. The soil filter removes the fine solids and destroys accompanying bacteria. There is no "treatment" of nutrients such as phosphorus and nitrogen in an onsite sewage treatment system. Sewage systems must be maintained by regular pumping of accumulated solids from the sewage tank. Pumping should be done every one to three years for a 1,000-gallon tank serving a three-bedroom home with four residents. If you use a garbage disposal, your septic tank should be pumped at least annually. Be aware that use of a garbage disposal can clog the soil filtering system. Composting of organic garbage is a desirable alternative to garbage disposals.

Is your Septic System Up-to-Date?

Any system that is less than a sealed tank and drainfield located at a minimum setback from your lake (at least 75 feet but check with the county zoning office) should be considered for upgrading.

Choosing the Building Site

General Considerations

Lower areas on the land are generally more protected from prevailing winds. This can reduce heating costs on cold, windy days and reduce the risk to the dwelling in high winds or storms.

Below the crest of a hill or ridge, the view is more varied. Also, the dwelling will be screened from view thus preserving privacy. A building below the actual crest is generally less visible from lower elevations and helps to preserve the natural character of the area.

In rolling topography take advantage of zones behind gentle rises of earth to place new structures.

Soil Considerations

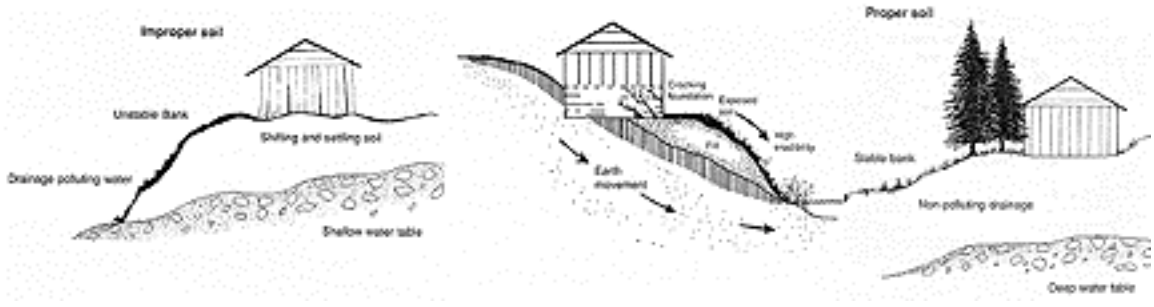
On proper soil, sewage passes through the soil at the proper rate to permit chemical reactions and bacteria in the soil to naturally purify it. Use county staff to assist you in evaluating your site for the optimum location of your septic system and well.

On proper soil left well vegetated, the building has good, stable support - shifting and settling are minimized. Again, county soil and water conservation staff can evaluate the limitations of your soils.

Slope Considerations

Though attractive as building sites, steep slopes pose many problems to the landowner. Generally speaking, buildings should not be placed on slopes in excess of 12 percent.

Steep slopes are subject to earth movement, especially where excavation and deforestation have disturbed them. Even slight movement can crack foundations, tilt basement walls, and rupture water and sewage lines. Just as importantly, construction on steep slopes will increase run-off, erosion, and sedimentation impacts on the lake.



Drainage

Paying heed to drainage patterns and not building in wet areas or swales helps avoid later problems with locating drinking water wells, placing a septic system, and structural issues.

Locate water sources so that septic system drainage does not flow into the well.

Locate septic system so that it drains away from the lake.

Direct stormwater runoff away from immediate drainage into the lake. Slow it down and allow it to be "purified" by vegetation or natural settlement basins before entering the lake.

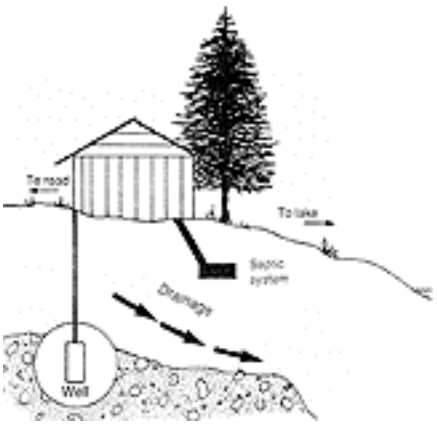
Minimize the amount of impervious surface on the site, especially that which would direct runoff to the lake.

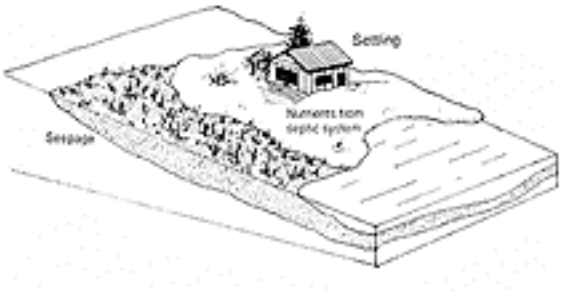
Wetlands

Perhaps no other resource is more threatened by development, yet has more potential for improving and maintaining the physical environment, then wetlands and seasonally wet areas. Filling of wetlands is strongly discouraged, and may be illegal.

Filled wetlands are unstable building sites. In addition, their soils are ineffective in removing key nutrients from septic system drainage.

Filling or dredging of wetlands destroys vital habitat for waterfowl, fish. raccoons and other creatures. These creatures and the wetlands themselves constitute an important part of the natural character of the lake and affects your use and enjoyment of the site.





Designing with Nature

General Considerations

When land is developed along a lake or stream, it can be done so that the natural values of the water body are protected. The first consideration is whether any development is appropriate near the lake or stream. If the site has no serious physical limitations, the development should not lower or ruin the quality of the shoreland site.

Natural Beauty

Build with materials and tones that blend with the natural setting: dark roof areas, muted earth-tone paints, low silhouette, simple forms.

Seek to use natural vegetation for landscaping rather than unnecessary mowed grass, exotic plants, suburban styled lawn ornaments, and harsh outdoor lights.

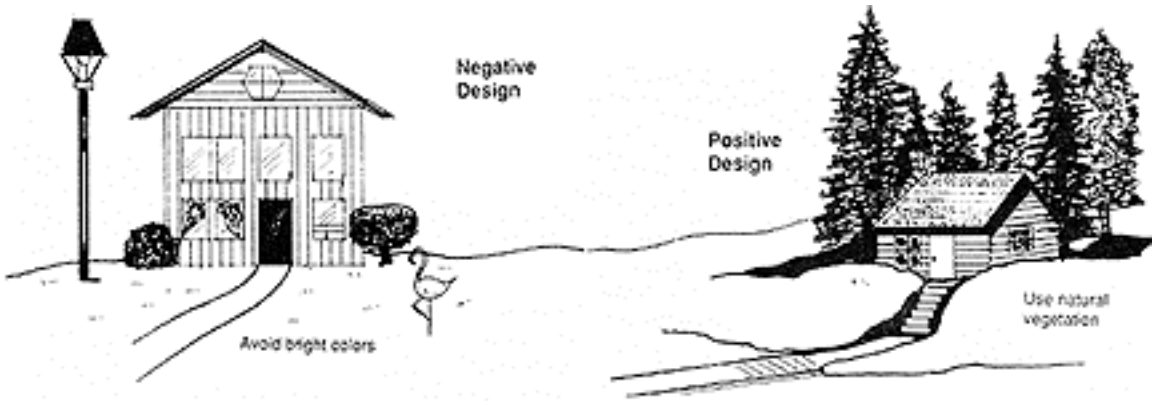
Setbacks

Most of us desire to live as close to the water as possible. However, from an environmental and developmental viewpoint it is much wiser to locate structures a considerable distance inland -from the shore. If at all possible, the location should be landward of the drainage divide.

Building on the waterside of the drainage divide directs runoff directly to the lake. These sites can also increase erosion and sedimentation.

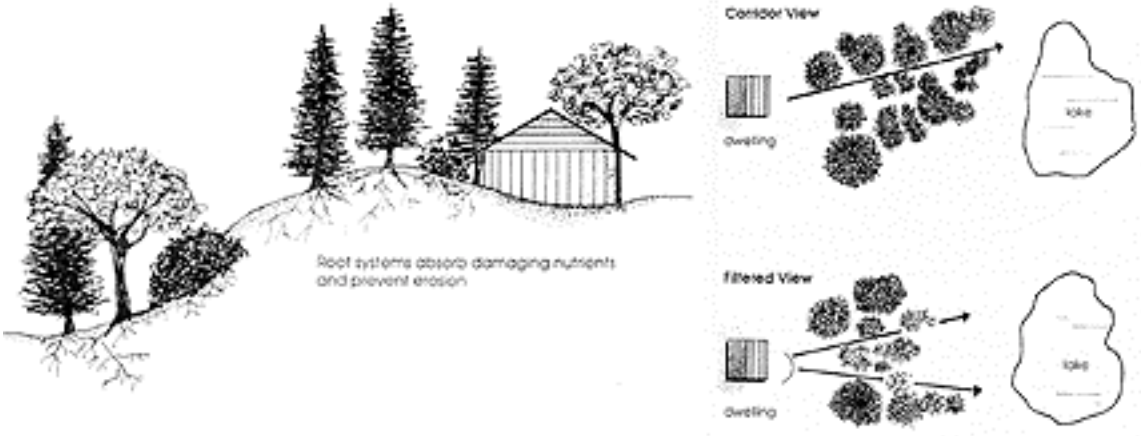
When possible, the best design is one in which the yard drainage is restricted to the landward side of the rise. With this site design, property owners can limit the influence land use activities on the lake, particularly if much of the natural vegetation is left along the shore.

Setbacks act as a partial screen from people on the lake, protect against erosion, reduce sun glare off the water, and preserve the natural assets of the shore area.



Vegetation
A natural vegetation strip along the shore provides privacy, enhances property values, and protects water resource values.

Vegetation serves many functions: winter wind protection, summer shade, lake and stream temperature control, soil stabilization, and erosion control, nutrient absorption, and shoreland habitat for wildlife and fish.



Views
When selecting your building site, consider its location in relation to existing vegetation. Many times natural openings offer the view or pathway you are seeking. If removal is necessary, consider the following two methods:

A corridor of 10 to 20 feet can be devised through selective pruning and removal of trees and shrubs. Maintaining the bulk of the vegetation will help screen structures and protect the tranquility and privacy of your site.

A filtered view can be obtained through pruning and selective removal. This technique can provide two or more irregular view corridors to the lake or river.

A view is usually better if it is framed or seen through an opening. Interesting and attractive views can be produced which preserve privacy and the natural edge of the shore.

PROJECTS FOR CHANGE

These are the little things each property owner can do to incrementally enhance the quality of your lake or stream. Do them yourself, encourage your neighbors to do them, and work with your lake association to obtain lake-wide adherence. These projects will help correct existing lake problems, prevent future ones, and reinforce the value of your lake property.

Water conservation

Conserving your use of water reduces wear and tear on your water pump, saves money, and greatly expands the lifespan of your septic system. Install low-flow showerheads and faucets - they provide the same degree of service but without adding as much

pressure on your septic system; they will also reduce your need for heating water. Low-flow toilets can also be installed to reduce the amount of water being handled by your septic system.

Water conservation extends to your garden and lawn. Once a lawn is established, water it only during very dry periods, giving it only as much water as the soil can absorb. Frequent shallow waterings on established turf will cause shallow rooting, invite crabgrass invasion, and encourage disease. Water early in the day so that your lawn will dry before sundown-, this also reduces the threat of disease. Do not water during midday - it wastes water to evaporation.

Water quality

Increase the ability of your lot to absorb rainwater before it runs off to cause erosion problems or to carry nutrients and materials into the lake or stream:

- -Install gravel trenches along driveways or patios to collect water and allow it to filter into the soil.
- -Direct roof drains and gutters away from paved surfaces and toward infiltration areas, or collect rainwater and use it to water your plants.
- -Maintain a healthy lawn utilizing natural cover and vegetation near the shore.
- -Plant shrubs and trees to promote infiltration.

If you live in an area with streets and stormwater catchbasins, see to it that the streets and gutters are kept free of debris and that catchbasins are cleaned to remove contaminants.

Yard and garden care is a major source of water contamination. The nutrients in fertilizers contribute significantly to water pollution problems. That's why it is important to apply fertilizer at the proper time and rate so that you use no more than is necessary. Avoid getting fertilizer on sidewalks and driveways where it can easily be washed directly into storm drains or the lake. Using too much fertilizer will simply result in the excess being drained directly to the lake where it will encourage excessive plant growth.

Dispose your leaves and vegetative debris in areas away from the lakeshore where runoff from the piles will not enter the lake. Better yet, compost your leaves and use it on your gardens and lawn in place of chemical products.

There is a series of strategies that can be used together to effectively control pests with minimal use of chemicals. These strategies are sometimes referred to as Integrated Pest Management. Among them are:

- -Use pest-resistant flowers, plants and vegetables when ever possible.
- -Handle minor problems by hand weeding and destroying insects and removing diseased plant parts.
- -Encourage ladybugs, praying mantises, lacewing larvae and other insects that eat garden pests.
- -Time plantings to avoid peak of insect infestations. For example, plant cabbage or broccoli early or late to avoid the peak of cabbage maggot emergence.
- -Use mulches to reduce weed problems and conserve moisture.

If you feel you must use chemicals to control garden pests, try using these two products which are less toxic than other commercially available products:

BT (Bacillus thuringiensis) - BT is a bacterium particularly effective against leaf-eating caterpillars; it kills them by paralyzing their digestive tracts.

Dormant oil sprays - Oil sprays can be used during the dormant season, which is usually early April before new growth appears. Oil sprays control scale insects, red spider mites, mealybugs, and aphids on shrubs, evergreens, woody plants, fruit trees, shade trees, azaleas, roses and other ornamentals. Timing is very important, so call your County Extension agent for details.

Other precautions to follow when using chemicals include:
Use selective products rather than products that kill a wide range of pests.

Never apply pesticides near wells, streams, ponds or marshes unless the instructions specifically allow for such use.

Never apply to bare ground or eroded areas. When it rains, many pesticides bind tightly to the soil and can be carried along with sediments to storm sewers or streams.

Choose the least toxic pesticide. The signal word warning" indicates higher toxicity than "caution." Avoid pesticides with the words "danger" and "poison" if at all possible.

Pesticide Treatment and Disposal

If a pesticide leaks or is spilled in the garage, on the driveway or on other outdoor areas, do not hose down the spill. The best way to clean a small spill is to:

Surround the contaminated area with dirt.

Sprinkle kitty litter. vermiculite, torn newspaper, or some other absorbent material over the spill.

Shovel or sweep the absorbent material into a sturdy plastic bag and put it into the trash.

Wash down the area, if it is a floor or hard surface, with water or detergent after removing as much of the pesticide as possible.

Leftover pesticides and their containers should never be buried in your yard, burned, or poured down the drain, toilet, or storm sewer. To dispose of pesticides and their containers:
Triple rinse the container. After each rinsing, spray the rinse water onto the original application area.
Dispose of empty, triple-rinsed containers as instructed on the label. Never burn or bury empty containers. Contact your local County Solid Waste Officer to determine if there is a household hazardous waste disposal program.

Household chemicals

Many of the products used at home, such as soaps and detergents, are meant to be washed down the drain. However, there are many common household products that are toxic to people and the environment. Oven cleaners, floor wax, furniture polish, drain cleaners, and spot removers are examples. Check the labels for toxic components such as lye, phenols, petroleum distillates and trichlorobenzene.

The best way to avoid disposal problems is to avoid purchasing products with toxic ingredients in the first place. Try the accompanying list of alternative methods before purchasing the toxic products they replace.

Some Alternatives to Hazardous Household Products

Instead of:	**Use this Alternative:**
Silver Polish	Soak in boiling water, baking soda, salt, and a piece of aluminum foil.
Oven Cleaner	Baking soda and water; salt; or a quarter cup of ammonia overnight.
Toilet Cleaner	Toilet brush and baking soda or mild detergent.
Disinfectants	One-half cup of borax in one gallon of water.
Drain Cleaner	Plunger, metal snake, or flush with one-fourth cup baking soda and oiling water or 2 oz. vinegar.
Floor and Furniture Polish	One part lemon oil with two parts olive or linseed oil; mineral oil with lemon oil or Carnauba wax.
Bleach Cleaners	Use powdered bleach, not liquid.
Ammonia-based Cleaners	Vinegar or salt and water mixture for surfaces; baking soda and water for the bathroom.
Powder or Abrasive Cleaners	Rub area with half a lemon dipped in borax and rinse; baking soda and mild detergent.
Garden Insecticides	Insecticidal soap; import predators such as ladybugs; weed garden and remove debris.
Herbicides	Hand weeding; keep grass mowed properly; plant desirable ground covers to smother weeds.

Home maintenance products are among the most toxic household commodities. Paints, preservatives, strippers, brush cleaners, and solvents contain a wide range of chemicals, some of which are suspected carcinogens. These products should never be put into the sewer or septic system.

To reduce disposal problems, buy only what you need and always follow the label instructions for proper use and disposal. Reuse such products as turpentine and brush cleaners. Check with your County Solid Waste Officer to determine if there is a household hazardous waste collection program.

Car care products

Motor oil, gasoline, car wax, engine cleaners, antifreeze, and radiator flushes are examples of toxic automotive products. You probably wouldn't think of dumping a quart of oil over the side of a boat, but pouring it into a storm sewer or even spreading it on your gravel driveway is exactly the same thing since they both lead to the lake or stream. One quart of oil can contaminate up to 1 million gallons of drinking water - the oil from one engine, four to six quarts, can produce an eight-acre oil slick!

Antifreeze can also be toxic in high concentrations. Never pour antifreeze into septic systems, storm drains, or on the ground. If you are served by municipal sanitary sewer, then you can dilute each gallon of antifreeze with 15-20 gallons of water; this can then be put down the toilet.

The only legal way to dispose of used oil is to recycle it through a county collection program or through gasoline stations with collection tanks. Disposal of waste motor oil on gravel roads is illegal and is a misdemeanor.

On-Site Sewage Treatment

Just about every shoreland cabin or house is served by a septic system. But how many of us know how it is supposed to work and what we should do to keep it working properly?

Maintenance of your septic system is probably the single most important action a lakeshore property owner can take to protect water quality. The following practices will keep your system running smoothly:

Know the location of all components of your septic system. Keep heavy vehicles away from the system to prevent soil compaction.

Direct water from downspouts and other drainage away from the disposal field.

Dispose of household chemicals properly - do not pour them down the toilet or drain. They can destroy the bacteria in the septic system and contaminate local groundwater.

Don't use automotive antifreeze to flush and protect your water pipes during the winter. The antifreeze can kill the bacteria in the system in the spring. Use a food grade antifreeze for recreational vehicles instead.

Don't use garbage disposals. They contribute unnecessary solids and grease to your septic system.

Don't use toilets as trashcans. Wet-strength paper towels, disposable diapers, facial tissues and other nondecomposable materials will clog the system.

Monitor your septic tank yearly and have a reputable contractor remove sludge and scum every one to two years.

Don't rely on septic tank additives. Additives do not eliminate the need for pumping -every 2-3 years. They can allow partially broken-up sludge and scum to leave the tank and clog the drain lines.

Use a good quality toilet tissue that breaks up easily when wet. The color has no effect on the septic system.
Keep a container of drinking water in the refrigerator. Then it will not be necessary to run the faucet for a period of time to obtain cold water.

Erosion Control

Berm and swale construction

Constructing a pattern of swales and berms can represent a minimal amount of earth movement for an effective system of slowing water downhill. Many lakes and streams have natural berms, or at least did until they were removed or altered for development. A berm around a lake can be an effective final barrier for slowing surface runoff. Since the shoreline area is exceptionally sensitive to erosion, this method can help reduce erosion pressures significantly.

Diversion ditches

Instead of reshaping the slope, a diversion ditch redirects the major problem caused by steep slopes water running directly downhill. The ditch can be lined with gravel, stones, concrete, masonry or wood. Water is carried across the slope rather than down it. A supplementary drainage system may be necessary to conduct water past the slope to a safe outlet.

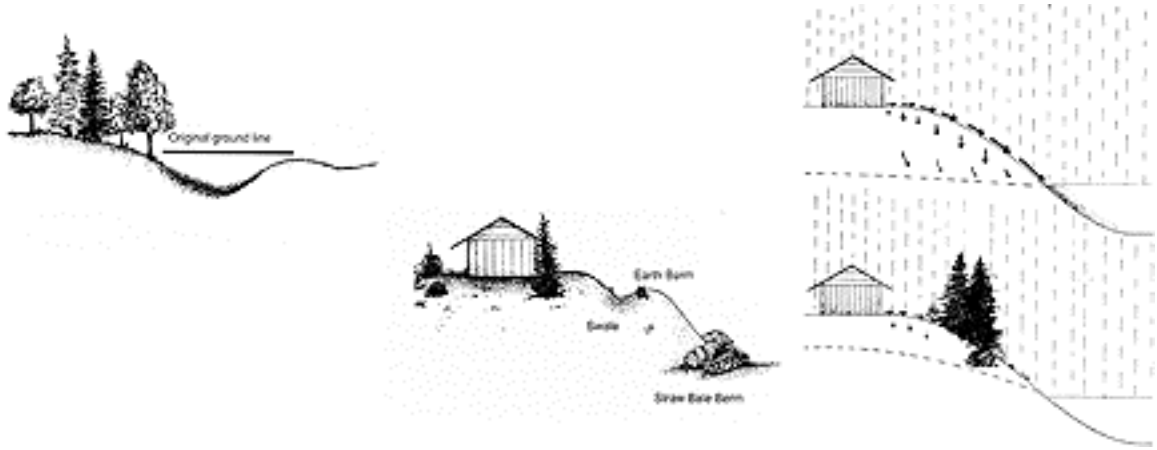
Vegetative buffer strips

A green ring around a lake has multiple benefits for lake quality. Most important, proper planting of grass, trees, and shrubs stabilize the shoreline and decrease sedimentation.

Canopies of overhanging trees can also create cool spots by shading the water. This may provide cool water refuges for fish in hot summer weather. The cooler water will also hold more oxygen.

Vegetation strips and groundcovers behind the shoreline can also aid in slope stabilization. They can strengthen the soil and substantially slow the surface flow of water.

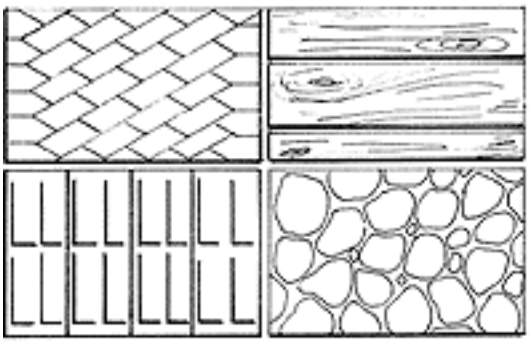
Check with your County Extension Agent for the plants most suited to your soils, lake, slope and conditions.

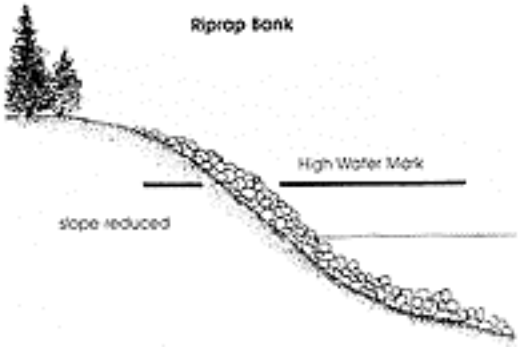


Terracing and rip rap
Severe conditions may require more extensive erosion control efforts. Before undertaking anything major, you should contact your County Extension Agent or Soil and Water Conservation Agent for advice and assistance.

Slopes that rise 2 feet for every horizontal foot (a 2: 1 or 60 degree slope) are extremely unstable regardless of soil type. At the opposite extreme a slope that rises only 1 foot for every 4 horizontal feet is quite stable; if it is well covered with vegetation, erosion may be minimal.

Reshaping the slope through terracing is a good means of controlling erosion but will likely be expensive. The terraces may be accomplished through shaping the earth or may necessitate structural supports such as retaining walls.





Rip rapping a shoreline with stones can be a good means of controlling erosion. It will likely require a permit from the DNR, so check with the local office before undertaking any actions. Although there are general guides to constructing rip rap, the specific circumstances of your case are vital to determining what should or can be done. Consult the DNR and the Soil and Water Conservation District for advice.

Use of permeable surfaces
Hard, impermeable surfaces such as concrete slabs and asphalt driveways can increase the volume and rate of surface water runoff with disastrous effects on erosion and Lake Sedimentation. There are alternatives, which you should consider.

There are many materials that provide the durability of concrete while allowing rainwater to filter into the ground. Wood decks can serve as a form of porous pavement. Decking allows rainwater to soak into the ground beneath it. As long as some air space is maintained between the deck and the ground, wood rot can be minimized.

If you are installing a new patio or rebuilding a sidewalk, consider bricks, interlocking pavers, or flat stones. If placed on well-drained soil or on a sand or gravel bed, these surfaces allow rainwater to infiltrate.
Pre-cast concrete lattice pavers also rest on a bed of sand and gravel and allow rain to soak slowly into the ground.

SUMMARY OF WATER QUALITY

Acidity and Alkalinity

This information is excerpted from Mark Mitchell and William Stapp, "Field Manual for Water Quality Monitoring," (second edition) Dexter, MI: Thomson-Shore Printers: 1986.

Dissolved Oxygen (DO);
Dissolved oxygen is an essential element for the maintenance of healthy lakes and rivers. Most aquatic plants and animals need a certain amount of oxygen dissolved in water for survival. Some aquatic organisms such as pike and trout require medium to high levels of dissolved oxygen to live. Waters of consistently high dissolved oxygen are usually considered healthy and stable aquatic ecosystems capable of supporting many different kinds of aquatic organisms. The atmosphere, algae and vascular aquatic plants are the sources of dissolved oxygen in lakes and rivers the accumulation of organic wastes depletes dissolved oxygen.

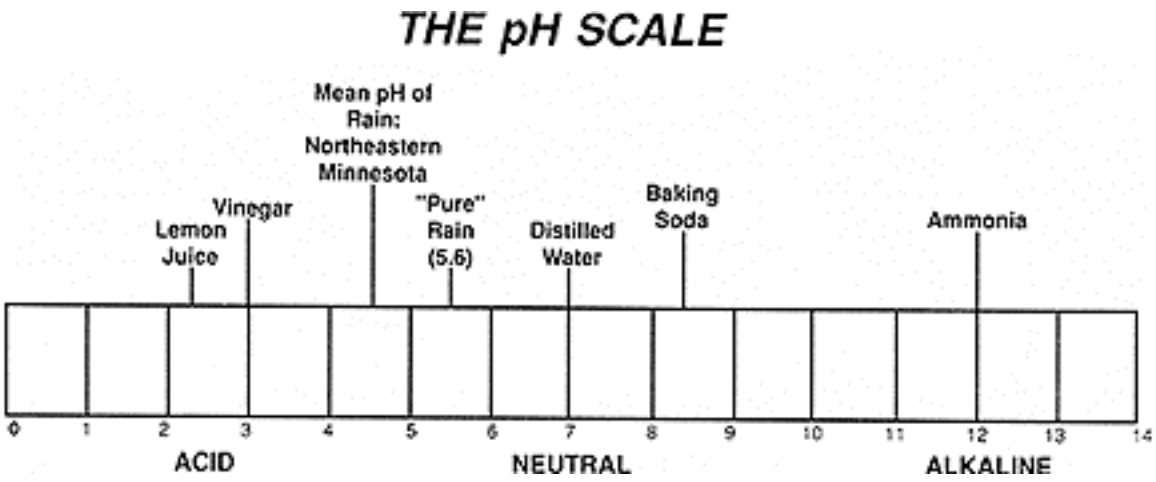
Benthic Macroinvertebrates:
Benthic macroinvertebrates are bottom dwelling organisms that live in, crawl on or attach themselves to the river bottom. These are visible with the naked eye. Macroinvertebrates are good indicators of river health because they are sensitive to pollution, they live in the water over a year, cannot easily escape pollution as a fish can, and can easily be collected.

Conductivity:
Conductivity measures the electrical conductants in the water. This is an indication of the quantity of dissolved inorganic acids, bases and salts in the water.

Biochemical Oxygen Demand (BOD):
Biochemical Oxygen Demand measures the amount of organic material in the water. Organic material is fed upon by aerobic bacteria, which require oxygen. In this process, organic matter is broken down and oxidized. Protozoa prey upon the growing population of bacteria and also require oxygen. Biochemical Oxygen Demand is a measure of the quantity of oxygen used by these microorganisms in the aerobic oxidation of organic matter.

Temperature:
Many of the physical, biological and chemical characteristics of surface water are dependent on temperature. Temperature affects the solubility of oxygen in water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms and the sensitivity of organisms to toxic wastes, parasites and diseases.

pH:
The pH value of water, on a scale of 0 to 14. measures the concentration of hydrogen ions. Pure distilled water is considered neutral, with a pH reading of 7. Water is basic if the pH is greater than 7; water with pH of less than 7 are considered acid. For every one unit change in pH there is approximately a ten-fold change in how acidic or basic the sample is. Most valuable species, such as brook trout. are sensitive to changes in pH; immature stages of aquatic insects and immature fish are extremely sensitive to low pH values. Very acidic lakes and streams cause leaching of heavy metals into the water.



Total Phosphorus (TP):
Total phosphorus includes organic phosphorus and inorganic phosphate. Organic phosphorus is a part of living plants and animals. It is attached to organic matter composed of once-living plants and animals. Inorganic phosphates include ions bonded to soil particles and phosphates present in laundry detergents.

Phosphorus is an essential element for life; it is a plant nutrient needed for growth and a fundamental element in metabolic reactions of plants and animals. In northern Minnesota, phosphorus functions as a "growth -limiting" factor because it is usually present in very low concentrations. This scarcity of phosphorus is attributed to its relationship with organic matter and soil particles. Any unattached or "free"
phosphorus, in the form of inorganic phosphates, is rapidly taken up by algae and larger aquatic plants.
Because algae only require small amounts of phosphorus to live, excess phosphorus causes extensive algal growth called algal blooms. Algal blooms color the water a pea soup green and are a classic symptom of cultural eutrophication. Sources of phosphorus are human wastes, animal wastes, industrial wastes, and
human disturbance of the land and its vegetation.

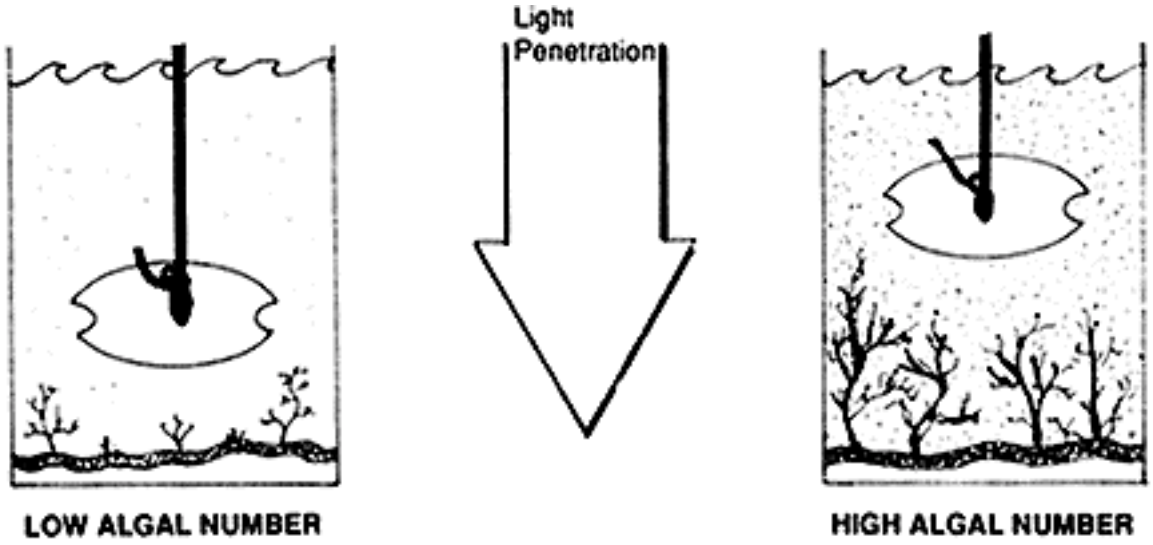
Fecal Coliform:
Fecal coliform bacteria are derived from the feces of humans and other warm-blooded animals. These organisms enter rivers through direct discharge from mammals and birds; from agricultural and storm runoff containing mammal and bird wastes; and from sewage discharge.

Even though fecal coliform bacteria are not pathogenic, they occur along with pathogenic organisms; therefore, their presence suggest the occurrence of disease-causing organisms. When fecal coliform counts are greater than 200 colonies/100 ml of water sample there is a greater chance that the disease-causing organisms are present. It is advised that water contact be avoided at this coliform level. Possible diseases and illnesses carried by such water are typhoid fever, hepatitis, gastroenteritis, dysentery, swimmer's itch, and ear infections.

Nitrates:
Nitrate and nitrite are inorganic forms of nitrogen in the aquatic environment. Nitrates along with ammonia are the forms of nitrogen used by plants. Nitrates and nitrites are formed through the oxidation of ammonia by nitrifying bacteria, a process known as nitrification. In turn they are converted to other nitrogen forms by denitrificaiton and plant uptake. Nitrogen, in its various forms is usually more abundant than phosphorus in the aquatic environment; therefore, nitrogen rarely limits plant growth as does phosphorus. Aquatic plants are not usually as sensitive to increases in ammonia and nitrate levels. Sources of nitrates are the atmosphere, inadequately treated wastewater from sewage treatment plants, agricultural runoff, storm drains, and poorly functioning septic tanks.

Turbidity:
Turbidity is the relative clarity of water. It is the result of suspended solids in the water that reduce the transmission of light. Suspended solids are varied, ranging from clay, silt and plankton to industrial wastes and sewage. When turbidity is high, water loses its ability to support a diversity of aquatic organisms. Oxygen levels decrease in turbid water as they become warmer as the result of heat absorption from the sunlight by the suspended particles and with decreased light penetration resulting in decreased photosynthesis. Suspended solids can clog fish gills, reduce growth rates and disease resistance, and prevent egg and larval development. Settled particles can accumulate and smother fish eggs and aquatic insects on the river bottom, suffocate newly-hatched insect larvae and make river bottom microhabitats unsuitable for mayfly nymphs, stonefly nymphs, caddisfly larvae and other aquatic insects.

USING A SECCHI DISK
The secchi disc is used to measure water clarity. The disc is a 9-inch white circular plate attached to a cord marked at half-foot intervals. Measurements are taken by lowering the disc over the side of a boat and noting the depth at which it is no longer visible. The secchi disc reading provides a good index of lake water quality by indirectly estimating the presence of suspended algae or other material that might interfere with water transparency.



Erosion and sedimentation

A normal part of a lake's life cycle is the gradual accumulation of silt, soil and other sediments in the lake basin.

Sedimentation creates turbidity, which is measured by the lack of water transparency and lack of light penetration. Sedimentation also reduces the open water area. Among less obvious effects of sedimentation are:

Light limitation:
Sunlight penetration is reduced and primary biological production falls. This means impaired oxygen generation and less food for species that feed on algae.

Fish diseases:
Suspended particles can irritate fish gills causing abrasions that invite parasites and disease organisms to prosper. Desirable gamefish that rely on their sight to feed become less competitive with roughfish.

Hatching areas:
Many aquatic animals lay eggs on the lake bottom. Sediment filling the voids between stones smothers the eggs and can trap young fry which die on the bottom.

Safe territories:
Rough lake bottoms give some young fish species an ideal safe nursery area. As the bottom smoothes over with sediment, fish can see farther which reduces the number of independent territories and nursery sites.

Food:
Aquatic insects and small organisms living on the bottom may be eliminated. The bottom itself can become sterile offering no food for the species that normally feed there.

Organic nutrients:
Many eroded soils include nitrogen and phosphorus. In addition, sediment particles may carry nutrients from manure, lawn fertilizer, and decayed organic material. This can lead to excessive plant growth.

The most obvious impact of excessive sedimentation is shoaling. Shoaling is the loss of lake volume and surface area due to increased sedimentation. Natural lakes in undisturbed watersheds accumulate silt comparatively slowly. Excessive shoaling can greatly alter the shape and use of a lake, necessitate dredging to maintain channels, and restrict access to parts of waterbody.

Running water is the force carrying sediments, excess nutrients and debris into a lake. The carrying capacity and, hence, destructive force of running water, is determined by speed, volume and direction of flow. Runoff increases with:

-Intensity of a rain storm
-Impermeability of the soil type
-Compaction of the soil
-Extreme dryness (until the ground is wetted enough to begin soaking freely)
-Saturation from previous rainfall or snowmelt
-Degree of slope
-Absence of growing vegetation, mulch or leaf layer.

Methods of controlling runoff range from a healthy crop of grass too much more complex systems of dikes, holding ponds, and ditches. When possible, the best runoff control program involves slopes of 5 percent around a home to 2 percent on the remaining surface with permeable soils and vegetative cover.

Exposed land is the obvious worst situation for increasing sedimentation. Examples of exposed lands that can create sedimentation to surface areas are agricultural fields on slopes, unprotected paths on banks, construction sites, gravel roads, and freshly harvested timber sites.

Aquatic Plants Make Healthy Surface Waters

Aquatic plants are essential for a healthy lake environment. Plants perform a number of functions that support the ecology of the lake. Processes supported by aquatic plants are:

Primary Production:
Plants assimilate sunlight to generate oxygen and new plant tissue.

Food Supply:
Fish, insects, or crustaceans require algae as a primary source of food. Larger aquatic herbivores may require larger plants. Many preferred gamefish are only herbivores in the early stages of their life cycle. Waterfowl and some mammals require aquatic plants for food or building materials.

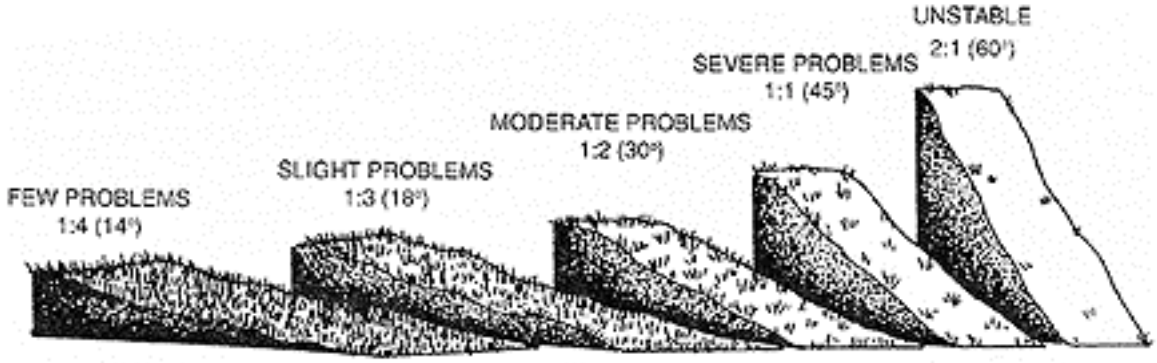
Habitat:
Aquatic plants provide valuable safe territories to protect small fish and insects from their sight-feeding predators. Plants in shallow areas can also increase water clarity by reducing the turbidity caused by particles resuspended by wave action.

Water purification:
Submerged plants absorb phosphorus, nitrates and other elements as they grow. They compete with algae for nutrients; if too many aquatic plants are destroyed, algae growth can rapidly become an unsightly “bloom.” Some kinds of aquatic plants, such as rushes, can even break down and absorb polluting chemicals.

Shoreline protection:
Aquatic plants, especially rushes and reeds, break the force of waves and help prevent shoreline erosion.

Aesthetic Values:
The look of aquatic plants is attractive, especially the flowers of the yellow lotus or any of six native waterlillies species.

Economic Values:
Wild rice is an emergent aquatic plant produces seeds, which are hand harvested. This business is worth $2 million annually to the state’s economy. Aquatic plants are the basis of state’s fish population. Fishing is a $100 million business for the state.



COMPARISON OF SLOPE ANGLES AND STABILITY

Types of aquatic plants

There are two basic types of aquatic plants. Algae are the "little" plants, which range in size from the microscopic to over two feet tall. On the other hand, macrophytes look like terrestrial plants; they are divided into three classes according to where they grow: floating, emergent, and submergent. They have leaves, stems, flowers, and roots.

Algae:

These are nature's smallest plants. Algae are easily carried by currents and wind and tend to float passively near the water surface. Some form colonies and some larger algae are not always entirely passive, but may regulate buoyancy.

Blue-green algae are especially able to position themselves vertically in the water column to find advantageous light and nutrient conditions. This enables blue-greens to dominate lake systems and quickly become noxious. In dense populations, they can emit foul odors, crowd out less harmful algae, release toxins, and seriously deplete oxygen levels at their death.

The largest algae grow from the bottom and can reach heights of two feet, but do not have root systems.

Macrophytes:

Floating plants:

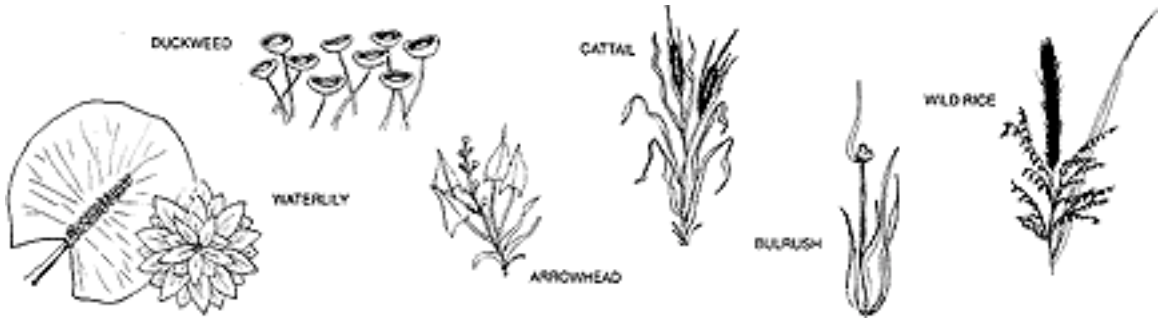
Two commonly encountered floating plants, duckweed and watermeal, can quickly reach pest levels in overnourished quiet or stagnant waters. These plants drift easily and reproduce readily. They are an important food source for ducks and other waterfowl.

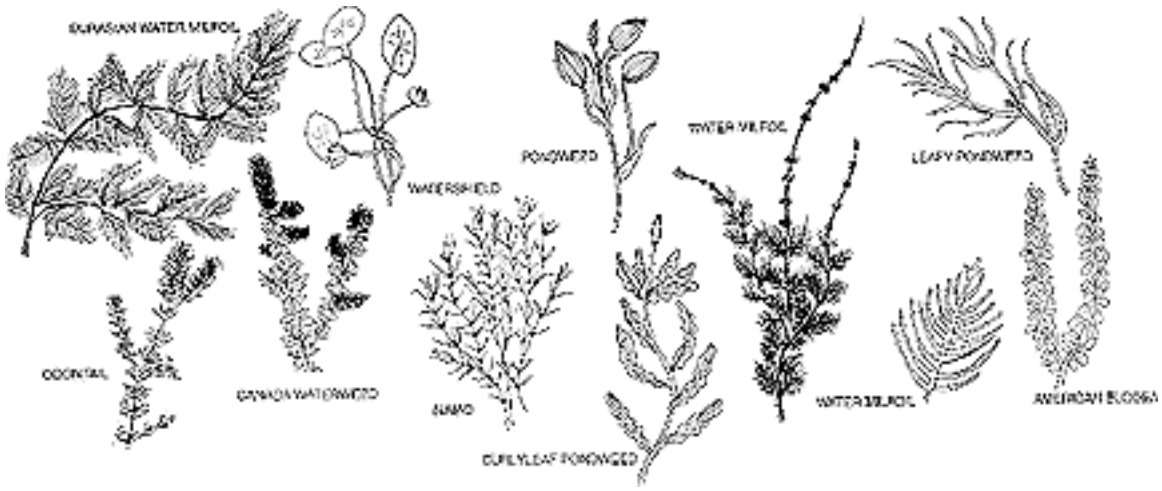
Another floating plant that can be either attractive or a nuisance is the waterlily. Many animals eat the leaves and waterfowl eat the seeds of these plants. Although they produce seeds, the principle form of reproduction is by rhizomes.

Emergent plants:

Cattail and bulrushes are the prime representatives of this class of aquatic plants. Emergents prefer the quieter, shallower, shoreline areas of lakes. They spread by rhizomes loosely attached in the soil. These plants are a valuable food source for some animals, an efficient cover for waterfowl and waterloving wildlife, and a building material for muskrat.

Emergent plants are important for their role in nutrient control and shoaling. The strong woody stems of the plants effectively trap fine sediments. This mechanism can gradually reduce lake volume as the sediments fill in. Shallow lakes have a greater problem because they offer plentiful frontier areas for plant invasion; lakes with depths that quickly drop to three feet and more are much slower to fill in.





Submergent plants:
Submerged plants are rooted in the lake or pond bottom and may be entirely underwater of barely protruding above surface. Submergents may reproduce by runners and shoots, reseeding, or rooting from plant fragments, rhizomes and tubers. They all share a need for light and are susceptible to shading.

Some submergents, such as water milfoil varieties, can grow in open lake areas up to 20 feet deep. This plant has little food value to fish but can offer excellent cover for fish and animal life. Because these tender plants are easily broken and windblown or transported on boat propellers and recreational equipment, spreading from lake to lake can be a major problem. These plants are prolific and can crowd out native aquatic plants when introduced to a new lake.

Some submergents generally do more good than harm. Naiads are among these species. They seldom reach dense populations, mix well with other plants, and are food for waterfowl; removing these plants may actually allow noxious plants to invade.

Management of Aquatic Plants

Plants require sunshine, water and nutrients in order to grow. Rooted plants need a suitable substrate or soil.

The kinds and concentrations of plant nutrients are very important in determining the abundance of aquatic plants. The nutrients needed are the same general types necessary for the growth of land plants, such as phosphate, nitrate, potassium and calcium. The source of these nutrients, under natural conditions, is the soil of the surrounding watershed. Nutrients are dissolved as water flows over or percolates through the soil and they reach a body of water in surface runoff and in the flow of ground water.

The pattern and amount of rainfall and surface runoff in a given year influence the nutrient supply to a lake or pond and the availability of stored nutrients. During periods of heavy rainfall nutrient supplies tend to be greater because of increased runoff and because nutrients may be released from flooded soils. If there is little rainfall and water levels are normal, nutrient levels are not increased and plant growth is stabilized. Conversely, continued low water levels can promote plant growth by making more shallow water areas and submerged soil available for the growth of water plants.

Human activities influence the growth of aquatic plants. Intense cultivation and fertilization of land surrounding a body of water can increase the growth of aquatic plants by providing them with more nutrients than they would normally receive. Nutrients in wastes such as effluent liquids from sewage treatment plants and drainage from septic tanks can also promote growth, as will drainage from barnyards and livestock feed lots.

Water depth and clarity have a strong influence on plant growth. All green plants require light to manufacture food. In most Minnesota lakes, vegetation does not grow at depths greater than 15 feet.

Turbidity of the water may reduce light penetration and therefore reduce plant growth.

In Minnesota, aquatic plants growing in public waters are the property of the state and may be destroyed only as authorized by the Commissioner of Natural Resources. There are about 150 kinds of larger plants in Minnesota that grow in water, along shores or on saturated soils. Of the aquatic plants, there are about 25 kinds that grow abundantly enough to interfere with recreational use such as swimming and boating.

Aquatic nuisances may be caused by excessive growths of rooted aquatic plants and algae, by large numbers of snails of kinds that carry the organism causing swimmer's itch or by leeches. Rooted aquatic plants are the greatest single source of nuisance complaints.

Aquatic nuisances usually can be controlled by methods that are compatible with maintenance of fish and wildlife populations and the protection of human health. Aquatic nuisances can be controlled by chemical or mechanical means.

The Minnesota Department of Natural Resources' Ecological Services Section of the Division of Fish and Wildlife administers the state's aquatic nuisance control program. Issuance of a permit is not automatic. Applications may be denied for the following reasons:

-Proximity of the control area to valuable fish and wildlife habitat.
-Protection of human health.
-Objections of other lakeshore property owners or lake users.
-Protection of valuable natural areas.

Good decisions about aquatic plant control should include:

1. Understanding the role of healthy plant populations in a well-balanced waterbody.
2. Understanding the effects of nuisance plant populations and the potential dangers of radical removal.
3. Identifying the plant populations and their purpose in a specific location.
4. Choosing the technique that offers the best control with the least potential for disrupting desirable balances in the lake system.

LAKE ECOLOGY AND CHARACTERISTICS

Lakes are complex and dynamic ecological systems

Lakes support a balanced web of life, including microbes, insects, plants and animals on the shoreland and in the water.

Lakes and streams have many uses for us. They provide recreational activities, from swimming to skating. They provide economic resources in the forms of fisheries, tourism and transportation. Surface waters can be engineered to generate electricity, enhance navigation, and provide water for domestic or industrial use. We are dependent on water available to us in surface waters. More importantly, perhaps, takes and streams have an aesthetic value for us. It is soothing to contemplate a placid lake and exhilarating to watch a river rush through rapids.

Surface waters are geological resources that are subject to ancient forces. A take, for example, naturally ages, progressing from a deep basin filled with clear water, to an area that gradually fills in and

is covered by vegetation. This natural process can take tens of thousands of years, although in some areas, due to natural landscape of the surrounding area, the lake ages more quickly.

Lakes and streams interact with the soils, topography and vegetation of the surrounding land. Changes in climate affect the quality of the water. The water itself is affected by the shape of the basin, the depth of the water, the rate of flow and the plant life on the shore and in the water. Understanding surface waters means understanding how each of these factors influence surface water quality. Changing a single one of these factors - the amount of rainfall, the nutrients entering the watershed, the plant life on the lake - changes the ecology of the lake system. It is important to understand the causes of water problems before initiating a discussion of treating the symptoms.

Physical, biological and chemical characteristics of lakes

Physical Processes

Water

The combination of solar heating and wind mixing of near-surface water layers warms the upper portion of most lakes. This causes the lake to stratify or to form layers of water with different temperatures and density.

Water is most dense at 39 degrees Fahrenheit. Above and below that temperature water expands and becomes less dense. A stratified lake will form three separate layers:

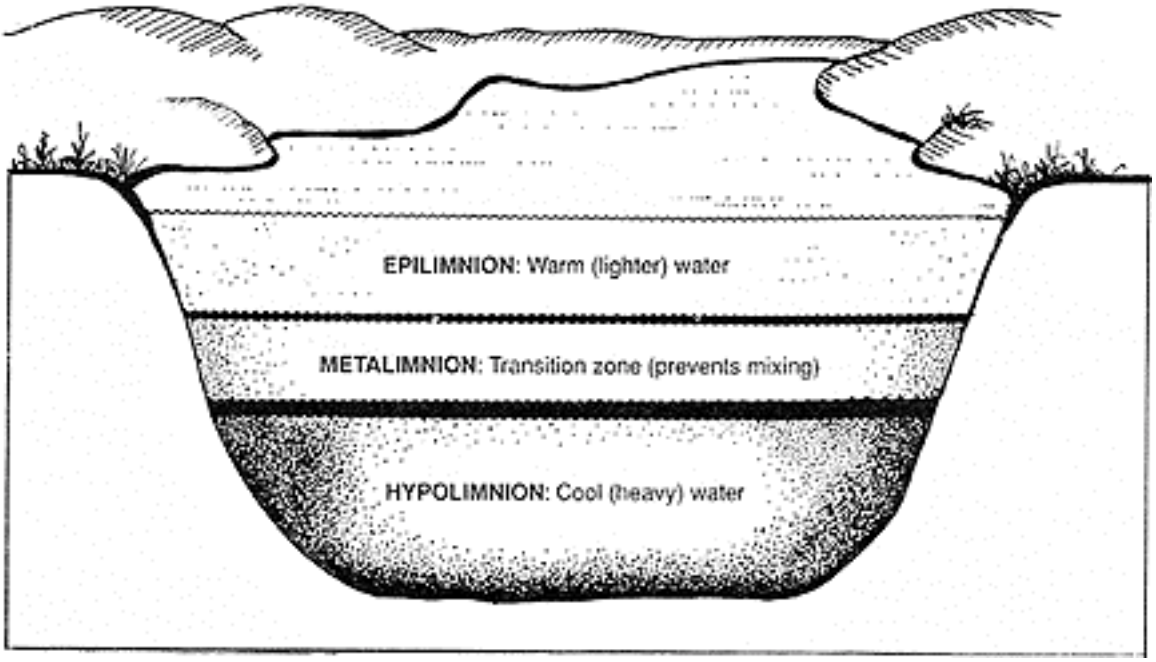
Epilimnion is the warmer upper layer of the lake. This is generally equivalent to the zone of light penetration and is where much of a lake's productivity occurs.

Metalimnion is a narrow band of transition between layers which serves to prevent mixing of the upper and lower ones. It possesses a sharp change in water temperature and density.

Hypolimnion is the coldest water lying at the bottom. It is the zone of decomposition where organic material decays or accumulates. There is often little if any oxygen available in this layer.

In the spring, melting water sinks to the bottom displacing the denser water. This is known as the spring turnover. At this time there is no stratification in the lake and water temperature is relatively uniform throughout.

In the fall, the process is reversed as cooling surface waters and wind action force a similar displacement. Again, lake temperatures are fairly uniform.



Watershed
Lake water quality is influenced as much by what goes into the lake as by what is already there. Lakes are receivers of material from the land surrounding the basin, which is known as the watershed. Because of this, soil types, forest and vegetative cover, slope, type and intensity of human development, and watershed size are all critical factors in determining water quality. Many lake in northern Minnesota are naturally "tea-" or "bog-stained" because the lakes are fed by forested wetlands. Such lakes are naturally limited in water quality and will never be crystal clear.

Surface waters receive water, dissolved materials carried in water and particulates such as soil from the watershed.

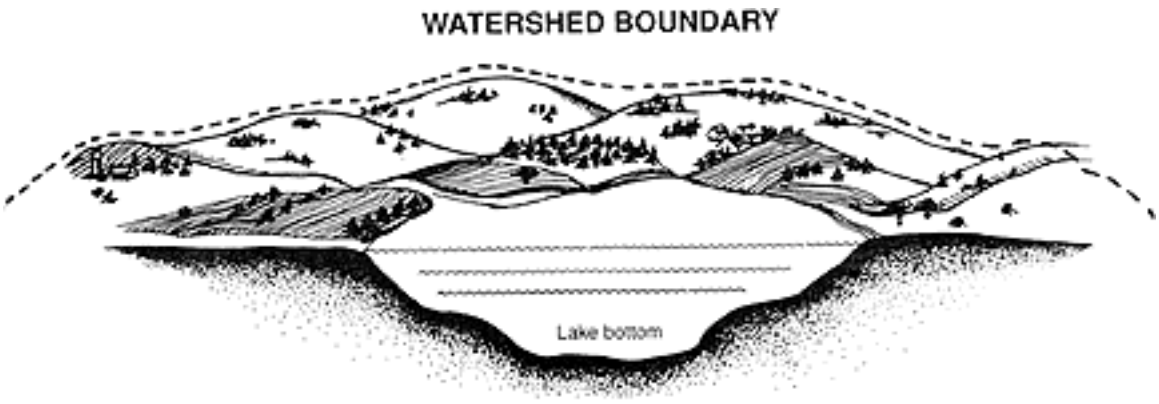
Shape and Depth
Lakes range from round, deep pothole types to long, shallow, nearly river-like waterbodies. Shape influences productivity and the aging process. A deep lake with little shallow area is likely to be less productive; shallower takes, and takes with bays, offer more habitat for rooted plants and may have impaired water quality.

Small and shallow lakes fill in with sediments more quickly than deep lakes. Small lakes with large watersheds are particularly vulnerable to sedimentation.

Flushing Rate or Hydraulic Residence Time

The average time required to completely renew a lake's water volume is called the hydraulic residence time. If the take basin volume is relatively small and the flow of water is relatively high, the hydraulic residence time can be short enough - less than 10 days or so - that algal biomass is not accumulated in the lake,

Water residence time also relates to the ability of a lake to "flush" itself of contaminated materials. Lakes with short residence times may become quickly polluted but they often quickly respond to remedial actions. Lakes with longer residence times respond more slowly to both pollution and to corrective measures.



Biological Processes

Lakes are divided into three zones or communities of plant and animal life.

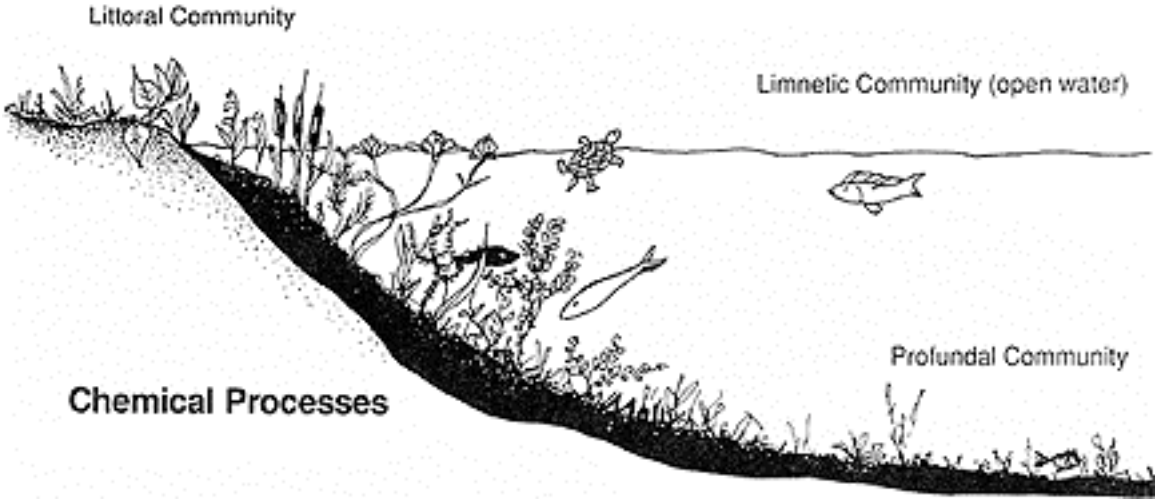
The littoral community extends out from the shoreline of the lake wherever aquatic plants dominate. Water lilies, duckweed and submerged plants grow in this zone. These plants play an important role by producing oxygen and providing food and shelter for insects, crustaceans, frogs, turtles and fish.

The limnetic community is the area of open water, the habitat of phytoplankton (algae), zooplankton (microscopic animals) and fish. The phytoplankton serve as the base of the lake's food chain and produce oxygen, The depth of light penetration in the limnetic community can be measured with a secchi disk.

A lake's primary production is the amount of plant material produced and remaining in the lake's system. The level of productivity depends on sunlight, carbon dioxide, nitrogen, phosphorus and various metals. The degree of sunlight available for biological productivity depends on water clarity.

Primary production requires light and is restricted to the lighted or photic zone of the lake. The thickness of the photic zone depends on the transparency of the water,

The profundal community corresponds with the hypolimnion. Light does not penetrate to the profundal community. This zone is dominated by bacteria and fungi, which are oxygen consuming (respirating) rather than oxygen producing organisms. These organisms decompose dead plants and animals that settle out of the upper waters and recycle many of the released nutrients to the epilemnetic zone for re-use in primary production, normally later on in the summer season.



The presence or absence of oxygen determines if and where fish and zooplankton are found in a lake. In the spring, when the water in the lake is well mixed, oxygen is usually present at all depths and thus organisms are distributed throughout the lake. By early summer when lake layers have formed, oxygen usually will not be produced in the lower, hypolimnic layer and decomposition quickly depletes available oxygen; organisms must rise to occupy the upper lake layers to find oxygen.

If these conditions persist and the upper waters become too warm, cool water species such as walleye may die. With the onset of cooler temperatures in the fall, the lake layers mix completely and turnover replenishes oxygen in the bottom layers.

The formation of ice in winter severs the atmospheric supply of oxygen to the take. If sunlight can penetrate through the snow and ice, algae and weeds will continue to produce oxygen. If the snow cover is excessive, oxygen production may fall below the rate of oxygen consumption. Winter fish kills occur in these situations.

Other factors affecting a lake's oxygen level are:

Wind: By moving water, wind increases its depth of contact with the atmosphere allowing more oxygen gas to be carried deeper into the water column. Lakes with a large wind fetch usually have a deeper thermocline.
Plant mass: Plants do not always produce oxygen. When a plant ceases photosynthesis and dies, its decomposition consumes oxygen. Thick surface mats of aquatic plants reduce oxygen production by shading lower aquatic vegetation.
Temperature: Cold water holds more oxygen than warm water. Cold water remains at the bottom in summer where decomposition strips it of oxygen while the upper, warmer layers, which hold less oxygen, are crowded with animal life.
Debris: Organic debris deposited into a lake are digested by bacteria, an oxygen-consuming process. Sediment not only carries organic matter with it, but can also block springs that sometimes supply lakes with oxygen-rich water.
Runoff and wastewater (generally, effluent from human waste treatment processes): Runoff water can contribute heavy loads of organic matter and nutrients from lawn and farm fertilizers. The nutrients permit excessive plant growth which in turn accelerate the degradation of water quality.

When light is adequate for photosynthesis, productivity is controlled by the availability of nutrients. Phosphorus and nitrogen are the least available elements and control plant production. However, if excessive phosphorus is supplied through stormwater runoff, failing septic systems, fertilizers, lawn chemicals and other sources, an overabundance of plant growth will occur. This can result in nuisance algal blooms, noxious tastes and odors, oxygen depletion in the water column, and fish kills.

Measuring Water Quality

The ecosystem of a lake is determined by a number of variables. A change in any of those variables changes the ecosystem. Increasing the nutrients in the lake occurs due to natural changes within the watershed or due to human changes. Because lakes are downstream, receiving materials from the watershed, all lakes will change due to increased nutrients. This process of increasing nutrients in the lake is known as eutrophication. Eutrophication is measured by the biological productivity of the lake. This natural process of lake succession is depicted by these trophic states:

Oligotrophy: Nutrient-poor and biologically unproductive. These lakes are clear and deep with very little algae. Typical fish populations include trout and tulibee. Fish and animals in these well-oxygenated lakes are especially sensitive to loss of oxygen.

Mesotrophy: Intermediate nutrient availability and biological productivity. Water is still clear and typical fish species include walleye and northern pike.

Eutrophy: Nutrient-rich, highly productive. These lakes have abundant algal growth, which can reach nuisance levels in late summer. These lakes are found in central Minnesota and contain perch, walleye and bass.

Hypereutrophy: Pea soup conditions, the extreme end of the eutrophic process. Algal growth is severe enough to create strong odors and discourage recreational use. Southern Minnesota has many such lakes, which usually are inhabited by roughfish species.

Eutrophication due to human intervention is known as cultural eutrophication.

STREAMS

We think of Minnesota as the Land of 10,000 Lakes. It is also the land of a variety of streams and rivers. These range from challenging white water streams to lazy, meandering streams. These rivers offer exceptional recreational opportunities, for the fisherman, the canoeist or the nature lover. These rivers are also being developed by people who want to place their home near flowing, rather than standing water.

Building on river property offers unique opportunities and challenges to the property owner. Minnesota has had a state wild and scenic river protection program for approximately 15 years; the first 400 miles of the Mississippi River have been protected by local governments for more than a decade; the state has now established regulations for building on other outstanding streams and rivers of the state.

Stream ecology and characteristics

A river system is inseparable from the land. More so than with lakes, it is easier for us to see the direct connections between a watershed and the stream that drains it. As with lakes, activities within the watershed determine the quality of its streams.

Streams may begin from springs arising from a hillside, a wetland, or as an outlet of a lake or pond. As streams increase in flow and join other streams, a branching network is formed. A numerical ordering scheme is used to describe the relative position of a stream within a river system. The beginning of the stream is defined as a first-order stream. Two first-order streams join to form a second order stream and so on, At its mouth the Mississippi River is considered a twelfth order stream.

Some of the water that precipitates on the land becomes runoff or percolates through the ground. It is this runoff and groundwater that provides the running water of streams. The gradual building of streams from rivulets, drainage ditches, and the like utilizing

surface runoff is easy to see and understand. Much of a permanent stream's water comes from groundwater seepage along channels. This water moves through the water table to feed rivers.

Permanent streams flow continuously because of stable and consistent groundwater seepage. Intermittent streams flow part of the time and groundwater contributes only periodically to flow. During dry periods a falling water table may cut off the groundwater contribution and the stream ceases to flow.

A stream ecosystem includes organisms such as bacteria, algae, protozoa, invertebrates, aquatic insects, clams and fish, who rely on non-living parts of the stream, such as rocks, gravel, sand, silt, dissolved gases and nutrients. As with lakes, sunlight is the primary source of energy for the stream as algae, aquatic plants, and streambank vegetation utilize it for photosynthesis. Algae and leaves falling into the stream become a source of food for aquatic insects; fish also eat the aquatic insects.

Stream Behavior

Stream size is generally measured in terms of discharge, or the amount of water passing a point during a period of time. Discharge relates directly to the river's cross section and the stream speed or velocity:

Discharge =	Area x	Velocity
(cubic feet/second)	(square feet)	(feet per second)

Stream velocity varies with the slope, or gradient, of the streambed. The steeper the slope, the faster the stream. It will also speed up if the cross section

of the stream is reduced and the discharge remains constant. Finally, velocity varies across the channel and with depth.

In a straight stretch, velocity is fastest at mid-channel and gradually drops off toward the banks because of friction. Where a channel curves, highest velocity occurs near the outside bend and least along the inside. Also, velocity is lower near the bottom.

Sediment and Stream Shape

Streams are actually flowing water plus sediment. They generally carry most of their sediment load in suspension. Streams will move coarser sand and gravel along the bottom by rolling and sliding, but only where velocity is sufficiently rapid.

In a sand-bed channel, sand waves are evidence of bottom movement. They're called ripples when small, velocity is low, and the stream surface appears relatively calm. With higher velocity, ripples transform to larger dunes that migrate noticeably downstream as sand grains shuffle up their backs and tumble down their cascading fronts.

Discharge increases downstream because of accumulated contribution from tributaries. The channel becomes wider and deeper. Tributaries become fewer but longer. The stream's gradient tends to flatten out. Even so, the stream becomes more efficient in carrying sediment because there is relatively less friction with the channel and the sediments are generally finer- grained.

Streams constantly adjust to irregularities in the stream profile. Most dramatic are those caused by human activities such as dams. At the dam, the gradient drops to zero; the stream drops its sediment because it cannot erode the channel. Below the dam, the gradient steepens and the stream, now without its previous sediment load, develops the ability to erode more extensively than before.

Truly straight channels are rare. Variation in flow and bottom irregularities deflect current from one bank to the other. In areas of little gradient, large meanders can form. Greater discharge produces larger and wider meanders. Faster water erodes the outer, steeper- banked part of the meander; slow water deposits sediment in arc like bars on the inner, less-steep banks. Deepest water always occurs near the outside of a meander.

Floodplains

The river's floodplain is a geologic feature, which can be defined simply as the level area bordering its channel. When the stream channel is completely full of water its surface will be level with the floodplain. When the stream is at flood stage it overflows onto the floodplain, which acts as a temporary reservoir containing the floodwaters. The waterborne sediments deposited in floodplains often create rich agricultural land. Higher level terraces may border a floodplain; these are abandoned floodplains left by the stream when it flowed at higher elevations.

The "hundred-year floodplain" is a commonly used term referring to that part of the stream valley which has a one percent (one in 100) chance of being flooded in any given year. Fifty-year, or twenty-five year floodplains can be similarly defined; they represent probabilities of flooding rather than geologic features. State and local regulations may govern management of floodplains. Check with your local zoning officer to determine if these regulations exist in your area.

Running versus Standing Water

Unlike lakes, the continual mixing in a river tends to homogenize water temperature, dissolved gases, and solid materials.

Stream water temperature, daily and seasonally, follows air temperature more closely than that of lakes. And smaller streams respond more rapidly to abrupt changes in air temperature. Streams whose discharge derives mostly from groundwater fluctuate least in temperature. Most streams do not form thermal layers, except in deep, and quiet pools.

Dissolved oxygen is generally high in streams; much of it derived from the air through natural aeration caused by flowing and agitation. Streams directly below deep reservoirs may contain little oxygen if cold, lower layer water is released to them.

Dissolved solid materials, such as those of nitrogen and phosphorus, behave in streams as in lakes. As stream discharge drops, many dissolved materials become more concentrated because more are contributed by groundwater seepage than by surface runoff. Small streams will vary more in chemical concentration and composition than large ones.

Finally, the last point of difference between lakes and streams is persistence. While lakes are geologically short-lived, streams tend to persist longer. Streams are open systems, more able to cleanse themselves, and less apt to fill with sediment or choking vegetation. Yet, streams undergo constant change, change which is inherent in their function and vitality.

Strum Channel Habitat

The riffles and pools of streams and rivers provide habitat for a variety of aquatic life, fish and mammals. The types of animals and organisms found in any place in a stream vary according to water speed and whether the river bottom is rock, gravel, sand or mud. In mud- bottomed streams, clams, burrowing mayfly nymphs and midge larvae occur. Animals and organisms adapted to life on rocks in swift currents include darters, blackfly larvae, and water pennies and stonefly nymphs. River channel vegetation is much more diverse than upland species and provides food and shelter for wildlife. Aquatic plants, grasses and shrubs have roots that bind the soil and reduce erosion. Thus, shoreline plants protect water quality by filtering and absorbing pollutants, as well as provide habitat for animals.

PROJECTS

Most of the projects previously suggested for lakeshore properties apply equally to streams and rivers. However, there are several efforts, which are specifically addressed to streams.

Management

Management of rivers and streams is more complex than is management of lakes. Lakes have easily defined boundaries, whereas streams stretch for miles through a variety of significantly different communities. Property owners need two levels of perspective. First, try to organize your own specific limited stretch of the river; use the lake association as your model for organizing, Second, work with counties and other river organizations to deal with the larger watershed issues for your stream.

Several national and state programs exist to promote wise use of our streams. The Minnesota DNR's Clean Rivers program encourages people to clean and maintain selected stretches of rivers.

Other groups with an interest in river management are:

- Izaak Walton League, which has a citizen-based water quality monitoring program, known as Save Our Streams
- American Rivers, Washington, D.C., an environmental lobbying group
- River Heritage, Minneapolis, a stewardship group for Minnesota rivers
- Mississippi Headwaters Board, Walker, an eight county river protection board
- Big Fork River Board, Arrowhead Regional Development Center, Duluth a joint power river protection board
- Project Riverbend; DNR Office of Planning

Map your watershed

Use US Geological Service topographic maps, DNR maps and county maps to define the full watershed of your stream. Everyone affects the water that flows past your property upstream. What you do affects all the property downstream. Learn about the development and land uses within your watershed and how they impact on water quality and quantity. Problems in your stretch of the river probably have its source somewhere further up the watershed.

Measure conditions

Unless you are directly behind a dam, your river will show more variation than a lake. You may want to measure flow, level, clarity and other water quality measures. Relate these to weather conditions, especially rainfall or snowmelt. A major feature of the various river watch programs is to periodically monitor water conditions along the stream.

Erosion control

As noted earlier, erosion and shifting of banks is a natural function of an active river. Dealing with erosion is best done by building well away from the erosion zones. Discuss your problems with DNR and Soil and Water Conservation District personnel before attempting any control measures. Remember, too, all work along a stream will require permits from the DNR and usually the Corps of Engineers.