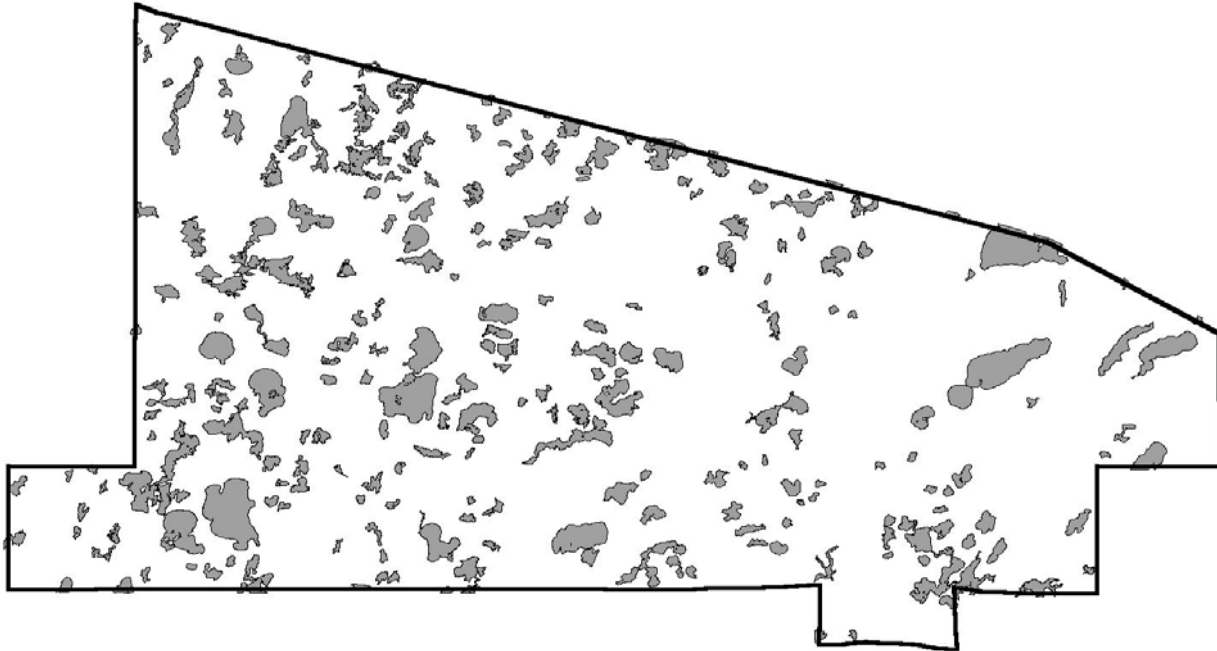


Vilas County Lake Resource Guide



Prepared by the
Vilas County Land & Water Conservation Department

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Prepared by:
Tiffany Lyden
County Conservationist
Vilas County Land & Water Conservation Department
330 Court Street
Eagle River, WI 54521
(715) 479-3648
tilyde@co.vilas.wi.us

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List of Acronyms Used:

DNR	Department of Natural Resources
GLIFWC	Great Lakes Indian Fish & Wildlife Commission
LWCD	Land and Water Conservation Department
NRCS	Natural Resources Conservation Service
USGS	United States Geological Survey
WGNHS	Wisconsin Geologic and Natural History Survey

updated 3/5/03

Purpose

This Vilas County Lake Resource Guide was produced to assist Vilas County lake organizations in the development of comprehensive lake management plans. This guide discusses the general process, factors to consider, and components to include when developing a lake management plan. It also documents specific resources that can be used by lake organizations for identifying and compiling information to include in a lake management plan.

While lake organizations from other counties may find this guide helpful, it is important to note that it has been developed specifically for lake organizations located in Vilas County and contains detailed information specific to this area.

A companion document to this guide, the North and South Twin Lakes Comprehensive Management Plan, was developed as a model lake plan and is available from the Vilas County Land and Water Conservation Department.

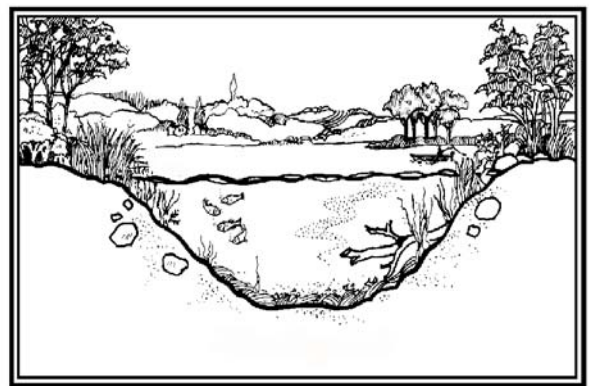
Introduction

Lake management plans assess the current condition of a lake (or lakes), including those issues and interests affecting it, and provide informed recommendations to protect, manage or improve the current condition of the lake. Lake management plans should utilize the best available information to set realistic goals, objectives and actions in order to achieve a desired condition.

One of the first steps in planning is to assess the general condition of the lake. This will determine whether the initial goal for the lake should be **protection, management, or restoration** oriented. (While your goal may change during plan development, selecting an initial goal provides important guidance early in the process.)

Protection-Oriented Plans

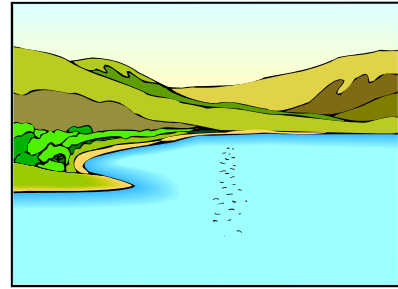
If a lake is generally considered to be in good condition, the initial goal should be to develop a protection-oriented plan. The plan should inventory existing conditions to establish a baseline, analyze the information, and make management recommendations to maintain existing conditions and prevent future degradation of the lake. (The majority of lakes in Vilas County may fit into this category). Protection-oriented plans often focus on education strategies and monitoring as inexpensive implementation strategies.



Management-Oriented Plans

If a lake is considered to be mostly in a good condition, but has one or a few areas that are in decline or need addressing, the overall goal should be to develop a management-oriented plan.

This type of plan should inventory existing conditions to establish a baseline, and do additional inventory work and analysis as needed to address a specific problem area(s). For example, the lake may be in a good condition, but there may be a specific concern with something like recreational use, pollution from an inflowing stream, low oxygen levels, or an exotic species. Additional planning, inventory work, and analysis should be conducted on each specific concern in order to develop more detailed goals and informed management recommendations to address the issue. The plan should develop a mixture of management recommendations to protect/maintain existing conditions and to remediate problem areas.

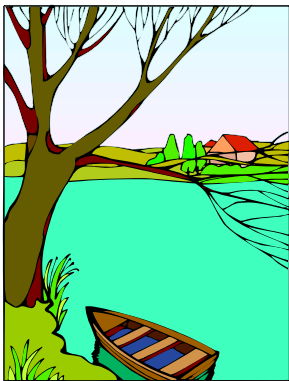


Restoration-Oriented Plans

If a lake has considerable problems, the overall goal should be to develop a restoration-oriented plan. This type of plan should inventory existing conditions to establish a baseline (if one has not been completed before) and carry out a detailed analysis of the lake's problems. The plan should contain management recommendations that are restorative in nature and that deal with in-lake processes directed at large-scale manipulations to make significant changes or improvements. These types of plans typically require considerable amounts of planning and analysis, and substantial funding for implementation.



Structuring the Plan



Once the desired type of lake management plan has been agreed upon, the lake organization can determine the level of information and analysis that will be needed and identify the appropriate party or parties to complete the different components. Most lake organizations find it helpful to establish a specific planning committee to work on the details of this effort.

Appendix A contains a worksheet for a planning committee to use in deciding what should be included in a particular plan, what information currently exists, what new information needs to be collected, and who is best suited to carry out each component. It is helpful to walk through this worksheet with DNR or Land and Water Conservation Department staff and/or a professional consultant in order to get additional input for the plan. Walking through the worksheet can also be helpful in gauging estimated costs by determining who will be responsible for each component.

Some groups choose to use volunteers from the lake organization to compile some of the needed information and then contract with an experienced consultant or utilize other professional

assistance for the remainder of the project. In these cases, it is often helpful to set up ‘teams’ or groups of volunteers who are responsible for specific components. Other lake organizations choose to hire an experienced consultant to complete the entire plan, with the planning committee providing input and review. Costs can vary a great deal depending on the scope of work and consultant selected. The plan worksheet can be very helpful for preparing a more detailed work plan and request for proposals that consultants can respond to.

Components of a Lake Management Plan

Lake management plans typically contain the following components:

- Inventory of Relevant Information
- Analysis of the Information and Development of Management Goals
- Management Recommendations and Implementation

Depending on the type of lake management plan that will be developed, varying levels of detail should be included in each section. Each of the components is discussed in this guide.

Inventory

Developing an inventory for a lake management plan involves compiling existing information about the lake and its environment, and collecting any new information needed to establish a baseline or address a particular concern. For some lake management plans, it may be necessary to collect additional data for developing more detailed analyses or lake modeling.

For many lakes in Vilas County, a comprehensive inventory of the lake has never been completed. In most cases, an inventory should include physical information about the lake and its watershed, as well as social and historical information. A lake management plan can contain all of the information that is compiled or can provide the information as a summary in the plan.

For each lake management plan, it will be important to determine what information currently exists and what data still needs to be collected.

Physical Characteristics/Background

Lake Size and Characteristics

The **Wisconsin Lakes** Book lists the *size, maximum depth, mean depth, lake type, relative abundance of various game fish species, and known exotic species* for many lakes in Wisconsin. The information is based on information collected in the 1950's and 1960's with updated information supplied periodically by the public and Department of Natural Resources (DNR) staff. (For some lakes, more recent or more accurate data may be available from various fishing guide books).

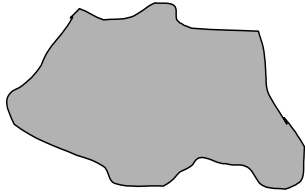


It is also helpful to include known information on any inflow or outflow streams or other information on the physical characteristics of the lake.

Source: **Wisconsin Lakes book**. Wisconsin DNR, 2001. PUB-FH-800. Free.

Available from: DNR offices: 107 Sutliff Ave, Rhinelander, (715) 365-8900
8770 Hwy J, Woodruff, (715) 358-9211
Vilas County Land & Water Conservation Department (LWCD), 330
Court Street, Eagle River, (715) 479-3648.

(Various fishing guide books and maps also contain information on the physical characteristics of many lakes.)



Shoreline Length

The Vilas County Land & Water Conservation Department (LWCD) has estimates of the length (in miles) of the shoreline for lakes in the county. This information was calculated by the Vilas County Mapping Department using aerial photos and Geographic Information System (computerized mapping). The DNR also maintains a Surface Water Inventory database from the 1960's with approximate shoreline lengths.

Sources: Vilas County LWCD, 330 Court Street, Eagle River, (715) 479-3648
DNR Lake Coordinator - Northern Region, 107 Sutliff Ave,
Rhineland, (715) 365-8937

Lake Volume

A lake's volume can be easily approximated by multiplying the lake's size by its average depth.

Lake Volume = Lake Size (acres) x Mean Depth (ft)

example: 500 acre lake x 10 ft. average depth = 5000 acre-ft of volume

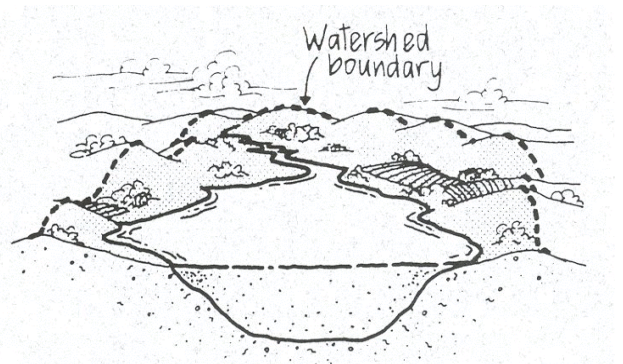
Source: **Wisconsin Lakes book**. Wisconsin DNR, 2001. PUB-FH-800. Free.

Available from: DNR offices: 107 Sutliff Ave, Rhineland, (715) 365-8900
8770 Hwy J, Woodruff, (715) 358-9211
Vilas County Land & Water Conservation Department (LWCD),
330 Court Street, Eagle River, (715) 479-3648.

Watershed

Identifying a lake's watershed boundary and the land uses and activities occurring within that watershed can be an important part of a lake management plan. This can be very helpful for understanding what affects a lake's quality and provides for more effective management.

In most cases, watershed maps for individual lakes have not been created. Watershed maps can be hand-delineated by using a U.S. Geological Survey (USGS) topographic map for the specific area. A watershed boundary can be drawn by essentially connecting the



A watershed is the land area that drains into a body of water.

highest elevation points around the lake. (Appendix B contains step by step instructions for drawing the watershed and calculating a watershed's area.) Since the actual task can be somewhat challenging, it is a good idea to have DNR or Vilas County LWCD staff provide assistance or review the completed boundary.

Source: USGS Topographic Maps

Available from: map stores
Vilas County Courthouse - County Clerk's Office, 330 Court Street, Eagle River, (715) 479-3600 (\$4 each)
www.usgs.gov (\$4 each, plus shipping).

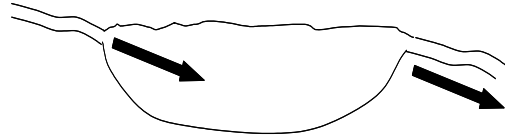
Flushing Index

Flushing measures the number of times per year that a lake's total water volume is replaced. Flushing can be approximated by dividing the lake's watershed area by the lake's volume.

$$\text{Flushing Index} = \frac{\text{Watershed Area}}{\text{Lake Volume}}$$

example: 2500 acre lake/5000

acre-ft of volume = 0.5 times per year



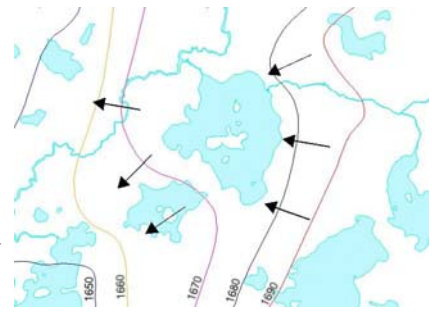
Flushing can also be expressed as residence time, the period of time it takes for water entering the lake to flow through and eventually leave the lake (i.e. a flushing rate of 0.5 times per year = a residence time of 2 years).

To calculate flushing, it is best to use a watershed area calculated by mapping the lake's watershed, however, the DNR also maintains a Surface Water Inventory database from the 1960's that contains approximate watershed areas for many lakes.

Source: see Lake Volume and Watershed sections above.

Groundwater Flow

Generalized groundwater flow direction can be determined for areas in Vilas County using a US Geologic Survey map of water table elevations. Groundwater generally flows at right angles to the elevation lines, from higher to lower elevations. Generalized groundwater flow directions can be easily drawn on a map of the lake. (It should be noted that the water table elevation lines and direction of flow are only approximate and should be identified as such in a lake management plan.)



Approximate groundwater table elevations. Arrows indicate approximate direction of groundwater flow.

More detailed, site-specific groundwater flow information can be obtained by conducting field measurements.

Source: Water Resources of Vilas County, WI. (Plate 1. Altitude and Configuration of the Water Table, Vilas County, Wisconsin) 1989. US Geological Survey, Miscellaneous Paper 89-1.
 Available from: www.uwex.edu/wgnhs cost: \$6.00, or on loan from Vilas County LWCD.

Water Budget

A water budget estimates the relative contributions by percent of all the water inputs and outputs to the lake. Knowing a lake's major sources of water can be very helpful in deciding where to best target management efforts. For example, if a water budget shows that the majority of water coming into the lake is being contributed by an inflow stream, then most of the management efforts to improve the lake's water quality should be directed at the inflow stream.

example:

<u>Water Input</u>	
<i>groundwater.....</i>	<i>30%</i>
<i>inflow stream.....</i>	<i>30%</i>
<i>surface runoff.....</i>	<i>20%</i>
<i>direct rainfall.....</i>	<i>20%</i>
<u>Water Output</u>	
<i>groundwater.....</i>	<i>10%</i>
<i>outflow stream.....</i>	<i>70%</i>
<i>evaporation.....</i>	<i>20%</i>

Surface runoff estimates, and precipitation and evaporation data from nearby areas can be easily obtained for a water budget, but actual groundwater and stream flow information may require the installation of monitoring equipment. For this reason, developing a water budget for a lake can

be a costly and time consuming exercise. If developing a water budget for a particular lake is considered important, it is probably a good idea to contract with a consultant for this.

If there is a culvert on the inflow or outflow stream, it may be fairly easy to collect information on the flow of water into and/or out of the lake. A lake volunteer can periodically measure the level of the water in the culvert, and convert that information into average flow. The DNR Lake Coordinator (715-365-8937) or Vilas County LWCD staff (715-479-3648) can provide some assistance.

Water Levels

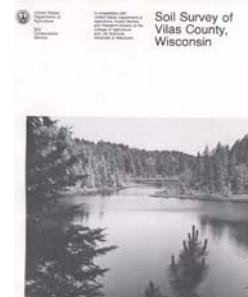
For lakes that experience a fair amount of water level fluctuation, information on water levels may be helpful to include in a lake management plan. For lakes that are controlled by a dam, the local dam operator may maintain a record of water levels. If the dam is owned by the Wisconsin Valley Improvement Company, they can provide very detailed information on water levels. For other dams, the DNR water management engineer may be able to provide some information on ownership or water levels.

Volunteers can also collect data on water level changes over time by installing a vertical staff gauge in the lake and periodically recording the level of the water. Staff gauges can be purchased from forestry or water resource type of catalogs. Where possible, a staff gauge should be installed on a permanent structure, or the elevation should be referenced with survey equipment to a specific benchmark. The DNR Water Management Specialist or other DNR staff should be able to provide assistance if needed.

Sources:	Wisconsin Valley Improvement Company, 2301 N. 3 rd St., Wausau, (715) 848-2976
	Wisconsin DNR Water Management Engineer, Northern Region, 107 Sutliff Ave, Rhinelander, (715) 365-8938
	Wisconsin DNR Water Management Specialist for Vilas County, 8770 Hwy J., Woodruff, (715) 358-9214.

Soils

Understanding soil types found in the watershed is important. Soil types influence surface water runoff - both how much gets to the lake, and its quality. All of Vilas County's soils have been mapped and classified into 40 different soil categories. Detailed maps and explanations of each soil category are included in a book called Soil Survey of Vilas County. The soil maps also show slope which is helpful to include in a lake management plan. The soil maps have been digitized and are available on Vilas County's computerized geographic information system (GIS).



Source: Soil Survey of Vilas County 1988. US Department of Agriculture, Natural Resources Conservation Service.

Available from: Natural Resources Conservation Service (NRCS) Office, 639 W. Kemp St., Rhinelander, (715) 362-5941
Vilas County UW-Extension Office, 330 Court Street, Eagle River, (715) 479-3648.

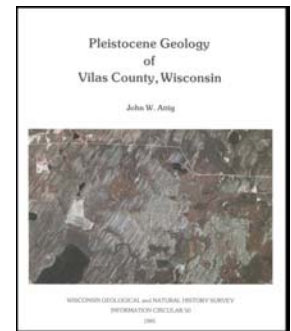
Computerized maps are also available from Vilas County Mapping Office, 330 Court Street, (715) 479-3655.

Geology

Information on the geology of the area can be found in Pleistocene Geology of Vilas County, Wisconsin. The book contains information on the glaciation of the Vilas County area and shows the resulting landforms and geology on a map.

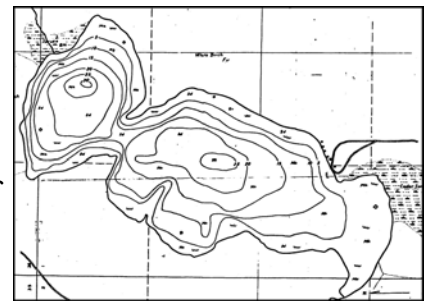
Source: Pleistocene Geology of Vilas County, Wisconsin. 1985. Wisconsin Geological and Natural History Survey, Information Circular 50.

Available from: www.uwex.edu/wgnhs cost: \$6.00, or on loan from Vilas County LWCD.



Lake Map

For many lakes in Vilas County there are lake maps which indicate lake depths and other physical features. A majority of the maps were originally developed by the Wisconsin DNR and have been reprinted in numerous fishing guides and other publications. The Woodruff DNR office can usually provide copies of lake maps.



Sources: Wisconsin DNR Woodruff Office, 8770 Hwy J, Woodruff (715-356-5211)
Fishing guide books/maps.

Lake Bottom

If an aquatic plant survey will be conducted for the lake management plan, information on the lake bottom can be collected at that time. Otherwise, many fishing guide books and maps will contain known information about the types and relative percentages of material on the lake bottom (i.e. sand, gravel, rock, muck).

Sources:	Fishing guide books and maps Aquatic plant survey work.
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Water Quality (historical and current)

Historical

It is important to include historical water quality information in a lake management plan if it is available because it can be used to compare to current water quality information. In many cases, water quality information has been collected on a lake in the 1950's or 1960's and sometimes earlier. The DNR Lake Coordinator can provide records and information that has been collected by DNR staff. Other water quality data may have been collected by the UW-Madison Center for Limnology through the Trout Lake Research Station, the Lac du Flambeau Natural Resources Department, the Wisconsin Valley Improvement Company, or by other sources.

Sediment core sampling can be another way to gain information about historical water quality and to make comparisons to current conditions. The DNR Lake Coordinator or an experienced consultant may be able to provide some assistance on determining the feasibility and costs of sediment core sampling on a particular lake.

Sources:	DNR Lake Coordinator - Northern Region, 107 Sutliff Ave, Rhinelander, (715) 365-8937 Trout Lake Research Station, UW Madison Center for Limnology, 10810 County Hwy N, Boulder Junction, 715-356-9494 Lac du Flambeau Natural Resources Department, PO Box 67, Lac du Flambeau (715) 588-9613. Wisconsin Valley Improvement Company, 2301 N. 3 rd St., Wausau, (715) 848-2976
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Current

If there is (or ever has been) a volunteer on the lake that has collected water quality data through the DNR Self Help Volunteer Monitoring Program, the DNR will have records of all of the data that has been collected since 1986. The data is available through the DNR website or directly

from the DNR Volunteer Monitor Coordinator in Rhinelander. Data may be for water clarity readings (secchi disk), or may include water chemistry, temperature, and/or dissolved oxygen information.



Some lakes conduct water quality testing on their own or through other programs offered by the UW-Stevens Point Environmental Task Force Lab, through private consulting firms, private testing labs, or other sources. It is important to collect all available water quality information for the management plan.

Depending on the amount of water quality information available, some lake organizations choose to collect additional data as part of the lake management plan in order to establish a good baseline of information or to address a specific issue. (Vilas County UW-Extension has a listing of state-certified water testing laboratories in Wisconsin.)

If there is only a small amount of water quality data for a lake, DNR or Vilas County LWCD staff can probably assist in interpreting and explaining the information. For lakes with a large amount of water quality data, however, it is recommended to contract with a consultant to help review and interpret the data.

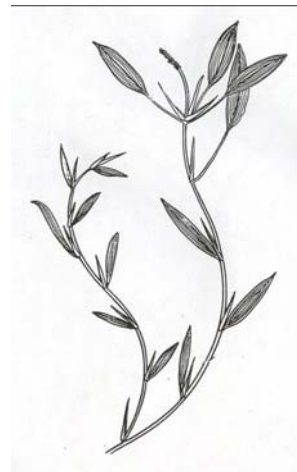
Sources:	Self-help volunteer monitoring program data: www.dnr.state.wi.us/org/water/fhp/lakes/shlmmmain.htm DNR Volunteer Monitor Coordinator - Northern Region, 107 Sutliff Ave., Rhinelander, 715-365-8984. UW-Stevens Point Environmental Task Force Lab, Stevens Point, 1-877-ETF-TEST.
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Aquatic Vegetation

For a few lakes, DNR staff may have already conducted an aquatic plant survey and can provide the information for the lake management plan. In most cases, however, very little information about the aquatic plant community exists for a lake, so conducting an aquatic plant survey is often helpful.

Some lake associations may have a volunteer who is fairly knowledgeable about aquatic plants. With a little help or training from DNR staff, that person may be able to conduct an aquatic plant survey of the lake. In many cases, however, a lake association will need to contract with a consultant for this portion.

An aquatic plant survey which sets up sampling transects around the lake and produces a generalized map of aquatic plants in the lake can be



important information to include in a lake management plan. Another option, however, is to simply list the aquatic plants that are present in the lake .

Source: DNR Aquatic Plant Management Specialist - Northern Region, 107 Sutliff Ave. Rhinelander, (715) 365-8984.

Shoreland Vegetation

Some lake management plans include an inventory of the shoreland vegetation as a way of documenting existing shoreline conditions. Establishing this baseline allows for future comparisons to be made. There are a number of ways to characterize existing shoreland conditions, some of which are listed below. The method used will depend on the information desired and the necessary level of detail.

Different methods that can be used to inventory existing shoreland vegetation:

- Photographic inventory - taking photographs or video of the entire shoreline (done from the lake)
- Estimation of the percent of natural buffer or vegetation present on each lot or section of shoreline (done from the lake)
- Short description of the existing shoreline with observed tree or plant species listed where known (done from the lake)
- Site visits to actual properties to collect detailed information on the amount and types of vegetation present on shore, in water, and on the bank. Site visits also provide the opportunity to collect additional on-site information if needed, such as: slope, soil type, bank height, bottom substrate, structures close to water, distance from septic system drainfields to lake, erosion concerns, etc. (usually done from shore)
- Aerial photography

Depending on the method used, a consultant may need to be hired to complete the shoreland vegetation survey, or it may be able to be completed by a lake volunteer, or a combination of the two.

Fisheries

It is a good idea to include fisheries information in a lake management plan such as stockings that have taken place over the years and results of fish population surveys or creel surveys that have been conducted on the lake. The DNR Fish Manager for Vilas County maintains historical and current records on fish stocking and fish surveys for lakes in Vilas County at the Woodruff DNR office. (The DNR will also have any records of surveys conducted by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), since the agencies share information.) If the lake is located within the Lac du Flambeau Indian Reservation, the



Lac du Flambeau Tribal Natural Resources Department maintain records of fish stockings and surveys that have been conducted through the tribe.

It may also be useful to include known information on any structure modifications to the lake over time, such as the installation of fish cribs, half-logs, etc. Lake association members or long-time lake residents may be the best source of information for this. The DNR Fish Manager, Lac du Flambeau Tribal Natural Resources Department staff and/or US Forest Service staff may have additional records.

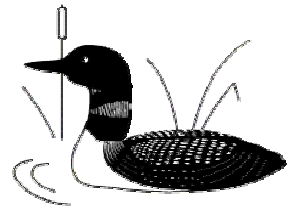
Some lake associations have chosen to contract with consultants to conduct additional fish surveys if there is little prior data on the fishery. In addition, some lake associations conduct their own informal creel surveys by asking lake property owners to keep track of the type and size of fish caught while angling.

Depending on the amount of available fishery data, the DNR Fish Manager may be able to help interpret the data and provide management recommendations, or a consultant may need to summarize and interpret the information.

Sources:	DNR Fish Manager for Vilas County, 8770 Hwy J, Woodruff, 358-9229. Lac du Flambeau Tribal Natural Resources Department, PO Box 67, Lac du Flambeau, (715) 588-9613. US Forest Service, PO Box 1809, Eagle River, (715) 479-2827
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Wildlife (including endangered, threatened or rare plants, animals or other natural communities)

Limited information often exists about the amount and types of wildlife present in and around lakes in Vilas County. The Sigurd Olson Loon Watch Program may have information on the number and nesting success of loons, particularly if there is a loon watch volunteer on the lake. The DNR Wildlife Manager for Vilas County, the US Forest Service, and/or the Lac du Flambeau Tribal Natural Resources Department may be sources of additional wildlife information such as eagle, osprey, or other wildlife in the area. In addition, the DNR maintains a listing of known endangered, threatened or rare animals, plants, or other natural communities by geographic area. Another good source of information may be wildlife sightings collected by lake residents. Lake residents can provide very useful and interesting data by keeping a log of wildlife observations over time.



Sources: Sigurd Olson Loon Watch Program, Sigurd Olson Environmental Institute, Northland College, Ashland, (715) 682-1220.
DNR Wildlife Biologist for Vilas County, DNR Office, 8770 Hwy J, Woodruff, (715) 358-9207
Lac du Flambeau Tribal Natural Resources Department, PO Box 67, Lac du Flambeau, (715) 588-9613
US Forest Service, PO Box 1809, Eagle River, (715) 479-2827
DNR Natural Heritage Inventory www.dnr.state.wi.us/org/land/er/

Exotic Species

The DNR maintains a list of known exotic species for each lake, contained in the Wisconsin Lakes book. More up-dated information should also be available from the DNR Aquatic Plant Specialist in Rhinelander.

Sources: Wisconsin Lakes Book. Wisconsin Department of Natural Resources. 2001. PUB-FH-800. Available from DNR offices and Vilas Co. LWCD, 330 Court Street, Eagle River, (715) 479-3648. Free.
DNR Aquatic Plant Management Specialist, 107 Sutliff Ave., Rhinelander, (715) 365-8984.



Eurasian Water Milfoil

History, Lake Issues, and Activities

Human History

Many lake management plans include a section on the human history of the lake. Researching and compiling information on the settlement of the lakeshore and surrounding area is often best done by a local volunteer(s). Local libraries, the Vilas County Historical Museum, and long-time residents are often sources of interesting stories, photos, and information. Tape-recording oral histories of long-time lake residents can be an outstanding project developed as part of the planning effort.

Sources: Vilas County Historical Museum, Hwy 155, Sayner, (715) 542-3388
Local libraries, museums, long-time residents

Property Owners

For some lakes it is helpful to include the number of lakefront properties that currently exist along the shoreline. The Vilas County Tax Listing Office maintains a complete listing of current properties and ownership, as do some town offices.

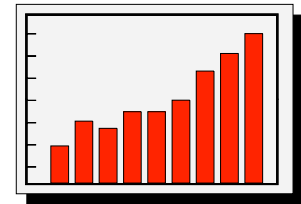


If the lake is small enough, it may be possible to determine the number of undeveloped versus developed properties, the number of residential, commercial, or other properties, and those that are seasonal versus year-round use properties. For large lakes, this information may be too difficult to currently compile, but technological changes in computerized mapping (GIS) may make it more readily available in the future.

Sources: Vilas County Tax Listing Office, 330 Court Street, Eagle River,
(715) 479-3696
Town offices

Demographics

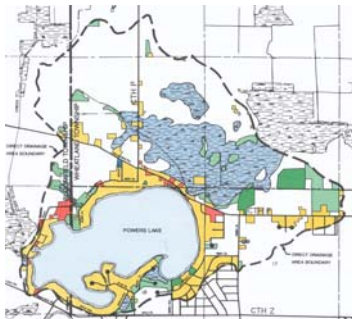
Information on historic population levels, development trends, and predictions of future population are often helpful to include in a lake management plan. Future population trends can be helpful in anticipating the expected level of development in the area. Population information is available on an individual town basis and can be found in the Vilas County Economic Indicator Report.



Source: Vilas County Economic Indicator Report www.uwex.edu/ces/cty/vilas/crd/ei/
A copy of the report is also available from the Vilas County UW-Extension Office, 330 Court Street, Eagle River, (715) 479-3648

Land Use

Identifying a lake's watershed boundary and the land uses and activities occurring within that watershed can be an important part of a lake management plan. This can be very helpful for understanding what currently affects a lake and what might affect it in the future.



Once a watershed map is drawn, the existing land uses within the watershed can be identified on the map. Local maps of existing land uses can usually be obtained from communities who have conducted local land use planning processes (Presque Isle, Winchester, Cloverland, Washington, St. Germain, Arbor Vitae, Manitowish Waters, Plum Lake, Lincoln, and the City of Eagle River). Municipal offices should have a copy of the map in their local land use plan. For other towns, generalized land uses can

probably best be identified based on local knowledge using volunteers driving the watershed area and conducting a “windshield” survey of residential, commercial, industrial, and other land uses.

If a community has completed a local land use plan, it may be possible to also include information or a map of future preferred land uses in the watershed. This can be very useful to include in a lake management plan because it can show expected changes in how land in the watershed may be used over time. A lake management plan should take these land uses into consideration and develop appropriate management recommendations to address projected changes.

Sources:	Municipal offices Vilas County Mapping Department, 330 Court Street, Eagle River, (715) 479-3655 Vilas County Planning and Zoning Department, 330 Court Street, Eagle River, (715) 479-3620.
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Lake Organization History

Compiling information on when the lake organization formed and major events or accomplishments is helpful to include in a lake management plan. Lake organization records or minutes are a good source of this information.

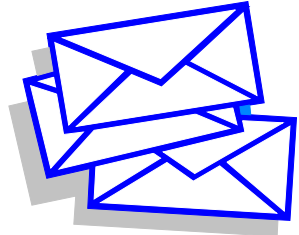
Past Lake Management Activities

Past lake management activities can include activities conducted by the lake organization, governmental agencies such as DNR, US Forest Service, or GLIFWC, tribal, town, or county governments, private groups such as sports or fish and game organizations, or individuals. Records of these activities may be included in lake organization’s records, DNR, tribal or other government files. Long-time lake property owners may also be a good source of this information.

Sources:	DNR Lake Coordinator - Northern Region, 107 Sutliff Ave, Rhinelander, (715) 365-8937 Vilas County LWCD, 330 Court Street, Eagle River, (715) 479-3648 Town offices Lac du Flambeau Tribal Natural Resources Department, PO Box 67, Lac du Flambeau, (715) 588-9613 US Forest Service, PO Box 1809, Eagle River, (715) 479-2827 Local sports or fish and game clubs
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Lake Survey

An important part of a lake management plan can be to conduct a survey of lake property owners. A survey assesses the needs and concerns of lake residents and can identify problems, values, and expectations that should be considered when developing the lake management plan. A survey helps answer the question of “what residents want from the lake” and can help in the developing more effective and appropriate management recommendations. Surveys can be cost and time intensive, so they require a strong pool of volunteers or a consultant to prepare mailings and compile results.

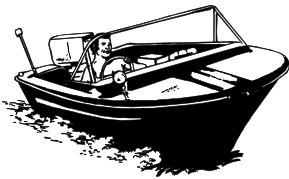


A model lake survey and examples of surveys done by local lake organizations are available from the UW-Extension Resource Agent at the Vilas County UW-Extension Office. In addition, the Resource Agent can provide assistance in reviewing draft surveys before distribution.

Source: Vilas County UW-Extension Office, Resource Agent, 330 Court Street, Eagle River, (715)479-3648.

Lake Use/Boating Activity

If lake use and boating activities are a concern on a lake, it is often helpful to quantify the amount and type of boating activity that actually takes place. In some cases, the results can be quite different from public perception. Knowing the amount and types of boating activity that actually take place on a lake can help better assess boating issues and help develop more accurate management recommendations in this area.



An easy way to quantify boating activity is to conduct random boat counts over one or more summers. This can be easily done by a lake volunteer who periodically records the number and type of each watercraft out on the lake at various days and times, and numbers of vehicles at boat landings. While the information may not be statistically representative, it can provide a relative measure of the watercraft use and a general picture of lake activity.

If a creel survey has been done on the lake, the data often includes some lake use information that can be included in the lake management plan.

Lake Access

If a lake has public access, it is helpful to include information on the ownership of the access(es). Additional information can be helpful to include, such as: who maintains the access, number of parking spaces, any erosion or other site concerns, and other relevant information.



Sources: If ownership of the lake access is unknown, contact the Vilas County Tax Listing Office, 330 Court Street, Eagle River, (715) 479-3696, for information on the parcel's ownership.

For information on boat landings owned by the State of Wisconsin, contact the Woodruff DNR Office, 8770 Hwy J, Woodruff, (715) 356-5211 or the DNR-Trout Lake Station, 4125 CTH M, Boulder Junction, (715) 385-2727.

For information on boat landings owned by the Lac du Flambeau Tribe, contact the LDF Tribal Natural Resources Department, PO Box 67, Lac du Flambeau, (715) 588-9613.

For information on boat landings owned by Vilas County, contact the Vilas County Forestry and Parks Department, 330 Court Street, Eagle River, (715) 479-5160.

For information on boat landings owned by the town, contact the individual town hall.

Pollution Sources and Loadings

If there are any direct discharges (point sources of pollution), such as municipal or industrial discharges, to the lake, its tributaries, or surrounding wetlands, information on the amount and type of discharge should be included in the lake management plan. Non-point sources of pollution within the watershed, such as runoff from residential, commercial, industrial, agricultural, transportation, and recreational land uses; construction activities, septic systems and other nonpoint pollution sources should also be included in the plan.

Lake models can be used to estimate pollutant loadings from each point and non-point source and to develop a nutrient budget for the lake showing areas within the lake's watershed that are contributing the highest pollutant loads to the lake. Once a model has been applied to a lake, hypothetical changes in land uses or pollutant loadings can easily be made to determine what effect any potential changes will have on the lake's water quality. This is a very useful technique to use in developing appropriate management recommendations for the lake.

Because some lake models can be quite technical and require detailed information, an experienced consultant, DNR Lake Coordinator, or Vilas County LWCD staff can provide guidance in determining feasibility and costs of conducting a lake modeling process.

Sources: DNR Lake Coordinator - Northern Region, 107 Sutliff Ave, Rhinelander, (715) 365-8937
Vilas County LWCD, 330 Court Street, Eagle River, (715) 479-3648
Lake Management Consulting Firms

Other Information

There may very well be other specific areas of interest for a particular lake that are important to include in a lake management plan. The DNR Lake Coordinator, Vilas County LWCD, or a consultant can provide assistance in obtaining a source for the necessary information.

Because there will always be new technologies emerging in the field of lake management, it is encouraged that lake organizations seek out the best available technologies, tools, and ideas when developing a lake management plan. The annual Wisconsin Lakes Convention is a good place to learn about new techniques and ideas, talk to lake managers, and meet with private consultants. The Lake List (PUB: FH-407, available from the Vilas County LWCD) also contains a helpful listing of consulting firms that provide lake management services.

Analysis and Management Goals

Analyzing the information that has been collected is a very important part of any lake management plan. It shows how a lake is doing and provides the framework to set management goals and meaningful recommendations for the lake.



Information collected in the plan on existing conditions is usually analyzed by comparing it to:

- historical conditions
- established standards or guidelines
- other similar lakes in the area
- expected or predicted conditions using computer lake models.

Based on the analysis of the information, meaningful goals should be developed for each aspect of the plan. The types of goals should be tailored to the type of lake management plan being developed.

Protection-oriented plans

Goals should focus on maintaining existing conditions as identified in the inventory portion of the plan. For example:

- ◆ *maintain existing water quality*
- ◆ *prevent the introduction of exotic species*
- ◆ *protect current natural shorelines*

Management-oriented plans

Goals should focus on achieving certain conditions based on the results of detailed analyses. For example:

- ◆ *raise oxygen levels to prevent winter fish kills*
- ◆ *decrease the extent of purple loosestrife*
- ◆ *increase the amount of natural shorelines on the lake*

Restoration-oriented plans

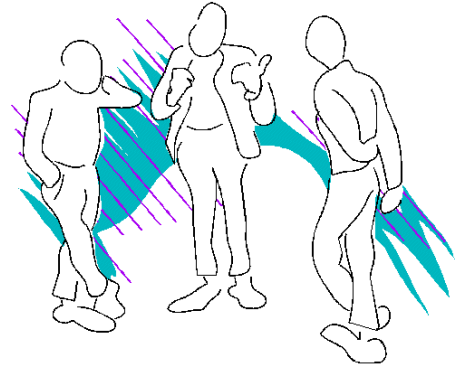
Goals should focus on large-scale changes to achieve new conditions based on the results of very detailed analyses. For example:

- ◆ *reduce in-lake phosphorus levels to a certain amount*
- ◆ *re-establish a balanced fishery in the lake*

Management Recommendations and Implementation

Management recommendations are developed in order to achieve specific goals for a lake. They should be tailored to the particular lake, they should be measurable, and they should take into consideration such things as:

- feasibility of implementation
- level of effort required
- public sentiment
- cost



Management recommendations that are specific in nature are usually easier to implement than general recommendations, and provide a good way to measure plan accomplishments over time. Some examples of specific management recommendations include:

- ✓ install an educational sign at the boat landing about exotic species
- ✓ continue to regularly monitor water clarity through the volunteer monitoring program
- ✓ conduct more-detailed water quality testing once every five years
- ✓ sponsor a demonstration site for shoreland restoration
- ✓ install hazard buoy on shallow rock bar after obtaining proper approval
- ✓ organize a work day to remove purple loosestrife from specified areas.

For Vilas County lakes, some of these management recommendations should include:

- ▶ continuation of annual secchi disk and other volunteer water quality monitoring
- ▶ long-term water quality monitoring
- ▶ annual volunteer monitoring for Eurasian Water Milfoil and other exotic species
- ▶ periodic updates of aquatic plant survey information
- ▶ participation/representation in local community planning efforts

Once management recommendations have been drafted, the lake organization may want to seek review and input on the recommendations from DNR or LWCD staff.

If multiple alternatives are developed for the management recommendations, final management recommendations will need to be selected. Some lake organizations choose to present all of the management alternatives to the full membership so the members can select the final



recommendations to include in the plan, other organizations use the planning committee to select appropriate management alternatives, and others use a consultant or other source of assistance to select the most appropriate recommendations.

After a management plan has been developed, the selected recommendations should be carried out. Where possible, the management plan should include

specific details about how to implement the selected recommendations. An implementation timeline and/or targeted dates for specific strategies should be included, and can serve as important benchmarks for the lake organization.

References

Attig, John W., 1985. **Pleistocene Geology of Vilas County, Wisconsin**. Wisconsin Geological and Natural History Survey, Information Circular 50. Available through WI Geologic and Natural History Survey (608) 263-7389. \$6.00.

Interagency Cooperating Committee, Minnesota Board of Water and Soil Resources. 1996. **Developing a Lake Management Plan**.

Patterson, G.L., 1989. **Water Resources of Vilas County, WI**. US Geologic Survey, Miscellaneous Paper 89-1. Available through WI Geologic and Natural History Survey (608) 263-7389. \$6.00.

USDA, 1988. **Soil Survey of Vilas County, Wisconsin**. Available from the Natural Resources Conservation Service (NRCS) Office (715) 362-5941, or the Vilas County UW-Extension Office (715) 479-3648.

Vilas County Land and Water Conservation Department, 2000. **North and South Twin Lakes Comprehensive Management Plan**. Available from the Vilas County Land and Water Conservation Department (715) 479-3648.

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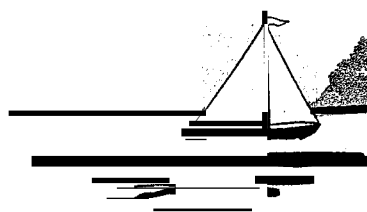
Appendix A

Lake Management Plan Worksheet

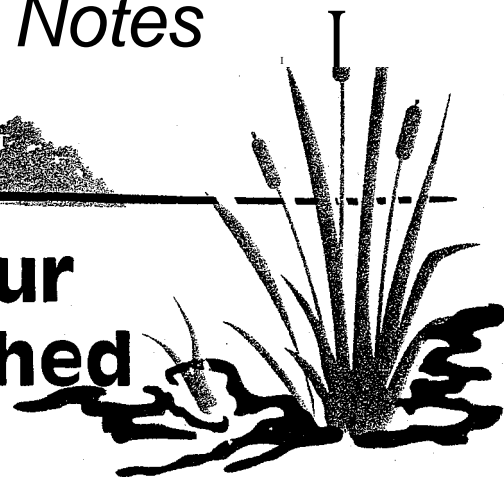
Components	What Exists	What is Needed	Who
Physical Characteristics Lake Size and Characteristics Shoreline Length Lake Volume Watershed Map Flushing Groundwater Flow Water Budget Water Levels Soils Geology Lake Map Lake Bottom			
Water Quality Historical Current			
Aquatic Vegetation Plant identification Mapping Density of growth			
Shoreland Vegetation existing vegetation, typical species			
Fisheries Fish survey data Creel census data Fish mgmt. activities (stocking, cribs, etc)			
Wildlife Wildlife populations and habitats, endangered/ threatened species, other birds, mammals, amphibians, & reptiles			

Components	What Exists	What is Needed	Who
Exotic Species			
History, Lake Issues, Activities Human History Property Owners Demographics Land Use Lake Organization History Past Lake Management Activities Property Owner/Member Survey Lake Use/Boating Activity Lake Access			
Pollution Sources and Loadings			
Other Information			
Compilation of Information/ Report Writing			

Lake Notes



Determining Your Lake's Watershed

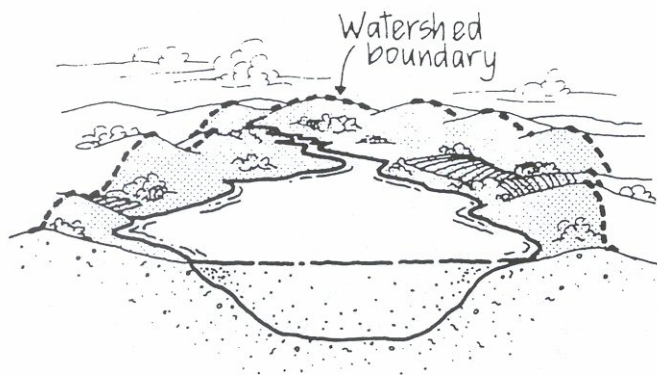


Protecting Illinois lakes requires more than shoreside diligence. Even if you don't live on a lakeshore, you may be contributing pollution to lakes-or the streams or groundwater that feed them. In essence, a lake extends beyond its shoreline. It's part of a bigger system-it's part of a *watershed*.

What is a Watershed?

A watershed is the land area that drains into a body of water. A watershed can be as small as a back yard draining into a puddle, or as large as the area that drains into the Great Lakes or the Mississippi River.

The edge or boundary of your lake's watershed is defined by the highest points and ridges of land around the lake. Rain falling or snow melting on the near side, or "inside," of the ridge flows by gravity, over the ground and in streams and groundwater, to your lake. Rainfall or snowmelt on the far side of the ridge flows away from your lake and into a different watershed. Other names you might hear for watershed are drainage basin, drainage area, or catchment.



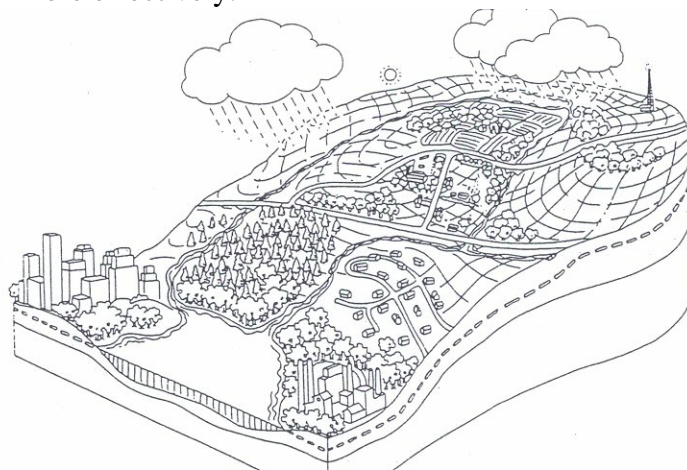
A lake's watershed often includes other waterbodies such as streams, rivers, ponds, and wetlands. Each of these waterbodies also has its own, smaller watershed called a subwatershed or subbasin.

HOW Do You Fit into a Watershed?

Wherever you are, you're in a watershed! A particular watershed may contain just one land use or a combination of land uses ... such as houses, farmland, shops, factories, and forests. Each land use and the activities associated with it can affect the quality of water within that watershed. That's because any substance that can be transported by water can eventually reach a waterbody-no matter how far away.

Just think-anything that you and all the other people do who live, work, and play in the watershed can have an effect on water quality. Common activities such as lawn care, automotive maintenance, construction, farming, and many others can contribute excess soil, nutrients, and pollutants to waterbodies in your watershed-including your lake!

This is why it's important to look beyond the lake and its shoreline and examine the entire watershed when working on lake management issues. Knowing your lake's watershed boundary and the land uses and activities going on within that boundary can help you understand your lake's quality and manage your lake more effectively.



Determining Your Lakers Watershed* Boundary

Since water naturally flows downhill, watersheds are defined by topography—the land's physical features. To draw a watershed boundary, you essentially connect high points and ridges on a topographic map. While this concept sounds simple, the actual task can be quite challenging for people who are unfamiliar with interpreting topographic maps—especially if the watershed lies in an area of varied and complex terrain, or in extremely flat areas.

Obtaining Maps

First, check to see whether a government agency has already done the work for you—such as your municipality, county planning department, regional planning commission, local soil and water conservation district (SWCD) or Natural Resource Conservation Service (NRCS) office, Illinois EPA (217/782-3362), or Illinois State Water Survey (217/333-9546). They may at least have maps showing the boundaries of major lake or river watersheds that could provide some guidance. For most lake watersheds, however, you'll likely need to draw the boundaries yourself.

To do so, you'll need to obtain one or more U.S. Geological Survey (USGS) topographic maps, called quadrangle or "quad" maps, preferably in a 1:24,000 scale (one inch on the map represents 2,000 feet on the ground). These can be ordered from the Illinois State Geological Survey (ISGS) in Champaign (217/244-2414 or 244-0933; fax: 217/244-0802), as well as from the USGS (1-800-HELP-MAP, or order on-line at <http://www.usgs.gov>). Each quad map costs \$4 plus shipping. ISGS personnel can help you figure out which quad maps to order. You also can search the USGS web site for the names of the quad maps in your area of the state. USGS quad and other topographic maps also can be purchased at some map stores, college bookstores, outdoor recreation stores, and engineering supply houses.

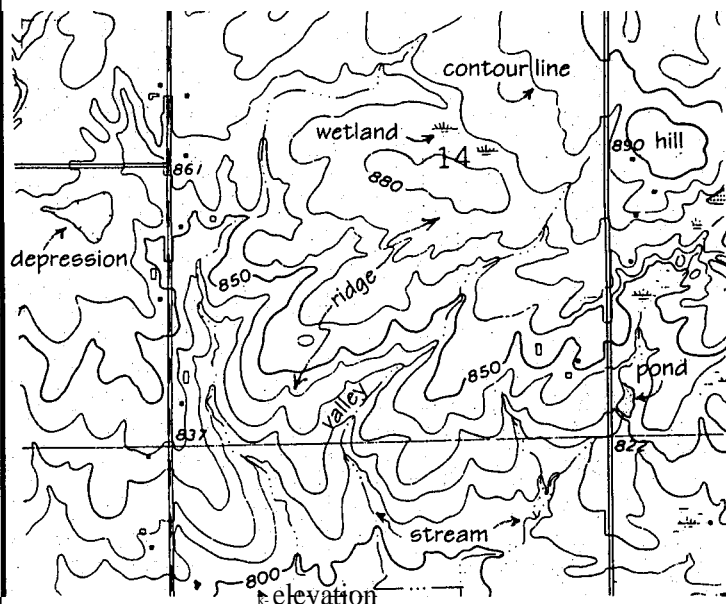
If you live in an urban/suburban area, it's also very important to review a map of the storm sewer system (contact your municipality) and adjust your watershed boundary accordingly. Storm sewers may route stormwater runoff in a different direction (i.e., either toward or away from your lake) than you would otherwise predict by looking at the ground's topography.

If you are not familiar with reading and interpreting a topographic map, see the insert "Reading a USGS Topographic Map" for some pointers.

Reading a USGS Topographic Map

Basic Terms and Conventions

- Contours represent lines of equal elevation. Contour lines never cross each other.
- Colors help to distinguish features: contour lines are brown; water features are blue; cleared areas (fields, developed areas, farmland) are white; woods, scrub, orchards, and vineyards are green; urban areas are pink; roads are red or black; buildings and other cultural features are black; and revisions are purple.
- The elevation, in feet above sea level, is usually indicated on the dark brown (thick) contours, and on certain light brown (thin) contours. Elevations of certain points also are given ("spot" elevations).
- The difference in elevation between two adjacent contours is called the contour interval. It is usually specified in the map legend. On the 1:24,000 scale USGS quads for Illinois, the contour interval is typically 5, 10, or .26 feet.



Recognizing Features on the Map

- Slopes: Contour lines that are closely spaced represent steep slopes, and those that are widely spaced represent flat areas.
- Valleys and Ridges: Contour lines that represent a valley usually are V-shaped, with the tips of the Vs pointing toward higher elevations. Contour lines that show a ridge are V- or U-shaped, but point toward lower elevations.
- Hills: Hills and mountains appear as a series of successively smaller, irregularly shaped concentric circles. The smallest circle represents the highest elevation.
- Depressions: Low areas or depressions (also called depressional areas) appear as closed contours with "tick marks" pointing inward.
- Water flow: Water flows perpendicularly to contour lines. Streams tend to form in the V-shaped contours on sideslopes, with the Vs pointing in the direction of higher ground (i.e., upstream). When two streams converge, the V formed by the point where the two come together points downstream.

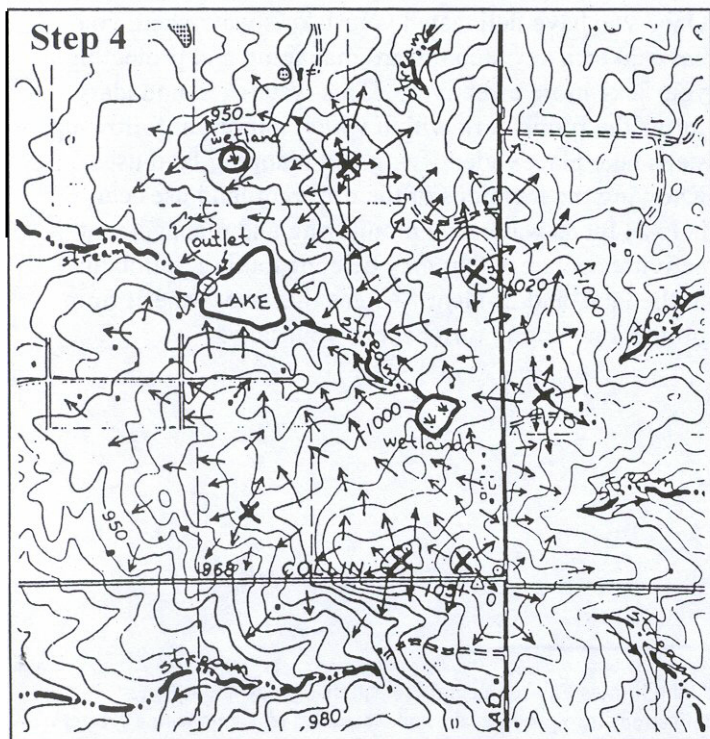
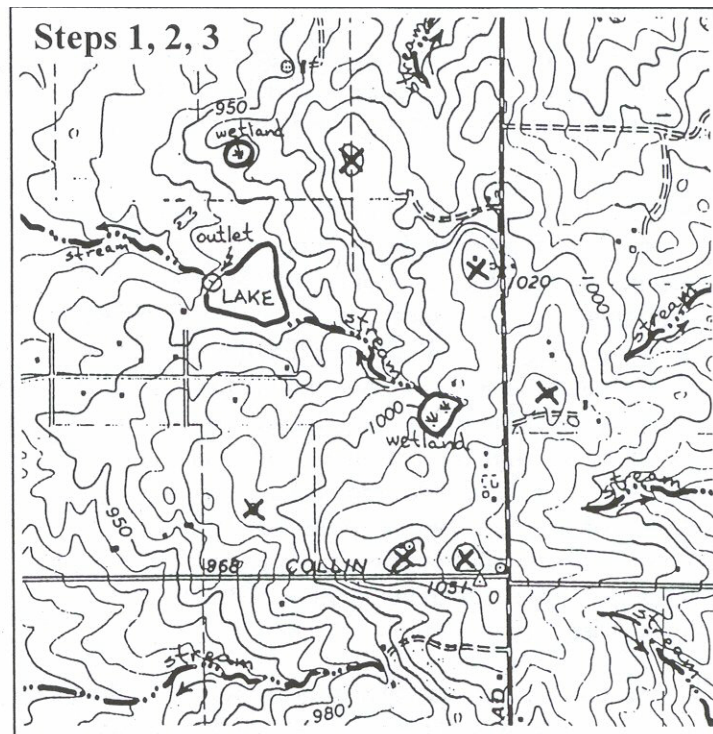
Delineating Watershed Boundaries

Once you've obtained topographic maps of your area, follow the steps below to draw-or "delineate"-your lake's watershed boundaries. Use a pencil so you can easily erase and revise your work as you go along. The accompanying figures provide an example.

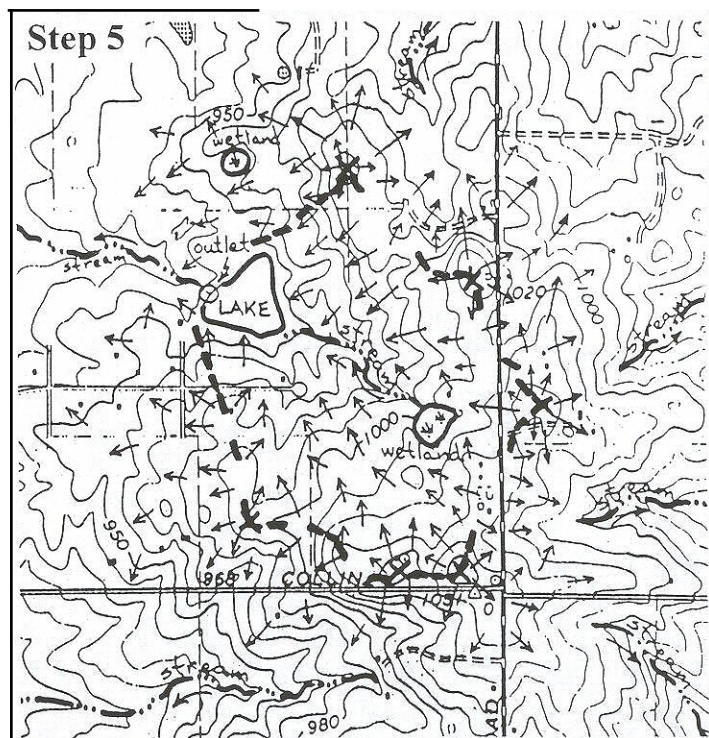
1) Locate and highlight your lake and circle the lake's outlet.

2) Locate and highlight all water features (streams, wetlands, ponds, other lakes and reservoirs) in the vicinity of your lake. Work outward from your lake, starting with streams and wetlands "tributary" (connected) to your lake, then highlighting other water features that don't appear directly connected. Use arrows to mark the direction of stream and wetland flow. To determine if a stream is flowing toward or away from another waterbody, compare the elevation of land features around the stream to that of the other waterbody. With these water features identified, this forms a general picture of where to look for the watershed boundaries.

3) Examine the contour lines surrounding the lake and the tributary waters and mark each high point (hills, ridges) with a small 'x'.



4) Determine the direction of drainage from the high points and ridges by drawing arrows perpendicular to a series of contour lines that decrease in elevation. Water running off the land seeks the shortest distance between two contour lines and thus follows a route perpendicular to those lines.



5) Mark the break point on each contour line With a dash. Each break point marks the spot where the runoff on one side of the break point would drain toward the lake, and the runoff on the other side of the break point would drain away from the lake.

6) Connect the high points and break points with a solid line following the highest elevations in the area. Remember that the watershed boundary line will always be perpendicular to each contour line it crosses. This completed line represents the boundary of the watershed.

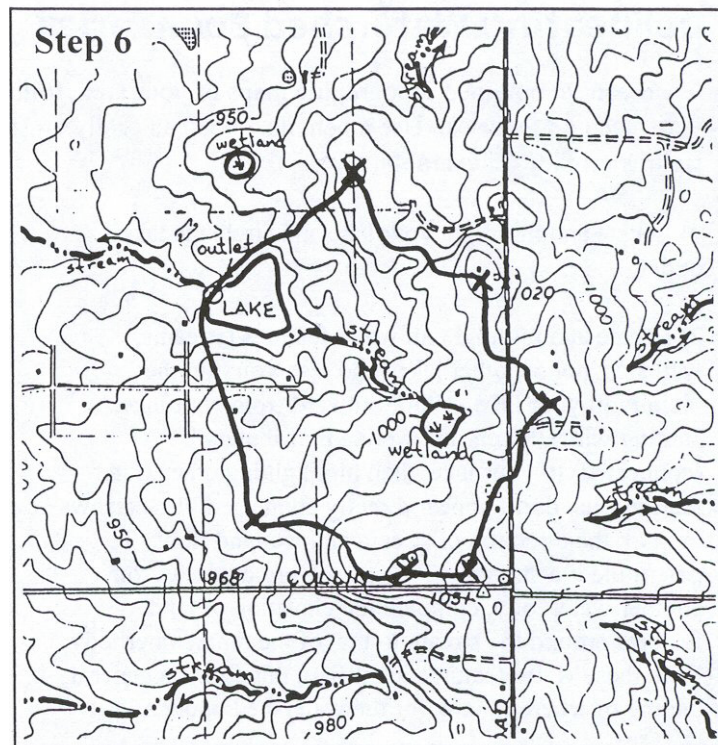
If desired, subwatersheds can be delineated by locating internal drainage divides that are bounded by ridges within the primary watershed boundary.

Some of the steps outlined above for delineating a watershed are easier said than done. For the inexperienced, expert guidance is strongly recommended. Your local SWCD or NRCS office is a source of ready help. Field checking the boundaries also is a good idea. Going out into the field allows you to identify human alterations, such as road ditches, storm sewers, and culverts, that could change the direction of water flow and thus change the watershed boundaries. Finally, bear in mind that delineating a watershed is an inexact science. Any two people, even if both are experts, will come up with slightly different boundaries.

(Note: These same steps also are used for delineating a stream or river watershed, with the outlet being the furthest downstream point you're interested in.)

Measuring Watershed Area

Now that you know your lake's watershed boundary, you can measure the watershed's area. Two methods are by using a dot grid or a small device called a planimeter. Again, your local SWCD or NRCS office can provide assistance.



Next Steps

Once you have delineated your lake's watershed, you have taken a key step toward managing and protecting your lake more effectively. This watershed boundary forms the framework within which important follow-up steps take place: identifying and mapping land uses. Knowing the locations of the different land uses can help 1) focus watershed monitoring and management activities on areas that may be contributing pollutants to the lake, and 2) identify areas that may benefit from protection-and in turn benefit your lake!

Lake Notes . . . is a series of publications produced by the Illinois Environmental Protection Agency about issues confronting Illinois' lake resources. The objective of these publications is to provide lake and watershed residents with a greater understanding of environmental cause-and-effect relationships, and actions we all can take to protect our lakes.

This *Lake Notes* publication was prepared by Holly Hudson of the Northeastern Illinois Planning Commission, Chicago, Illinois. Thanks are extended to Tom Price and Jason Novota of the Commission and Illinois EPA Headquarters staff for their review and comments.

Watershed illustrations on first page by Linda Wallis and from the Northeast Regional Agricultural Engineering Service, respectively. Topographic map figures excerpted from U.S. Geological Survey quadrangle sheets.

For more information about other publications in this series and to request copies, please contact: Illinois Environmental Protection Agency, DWPC-Lake and Watershed Unit, P.O. Box 19276, Springfield, Illinois. 62794-9276: 217/782-3362.