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*United States Environmental Protection Agency*
*Office of Water*
*Office of Environmental Information*
*Washington, DC*
*EPA###-#-##-###*

## Survey of the Nation's Lakes

# Field Operations Manual

February 2007

*DRAFT*

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**NOTICE**

The intention of the Survey of the Nation's Lakes project is to provide a comprehensive "State of the Lakes" assessment for lakes, ponds, and reservoirs across the United States. The complete documentation of overall project management, design, methods, and standards is contained in companion documents, including:

- *Survey of the Nation's Lakes: Quality Assurance Project Plan (EPA 841-B-06-_ _ _)*
- *Survey of the Nation's Lakes: Lake Evaluation Guidelines (EPA 841-B-06-003)*
- *Survey of the Nation's Lakes: Field Operations Manual (EPA 841-B-06-_ _ _)*
- *Survey of the Nation's Lakes: Laboratory Methods Manual (EPA 841-B-06-_ _ _)*

This document (*Field Operations Manual*) contains a brief introduction and procedures to follow at the base location and on-site, including methods for sampling water chemistry (grabs and *in situ*), phytoplankton, zooplankton, sediment diatoms, pathogens, algal toxins, benthic macroinvertebrates, and physical habitat. These methods are based on both the guidelines developed and followed in the Western Environmental Monitoring and Assessment Program (Peck et al. 2003) and methods employed by several key states that were involved in the planning phase of this project. Methods described in this document are to be used specifically in work relating to the Survey of the Nation's Lakes. All Project Cooperators should follow these guidelines. Mention of trade names or commercial products in this document does not constitute endorsement or recommendation for use. Details on specific methods for site evaluation and sample processing can be found in the appropriate companion document.

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# 1.0 SYNOPSIS OF THE SURVEY OF THE NATION'S LAKES

The U.S. Environmental Protection Agency (EPA) working in partnership with state and tribal organizations, has designed the Survey of the Nation's Lakes to assess the condition of the Nation's lakes. This manual contains procedures for collecting samples and measurement data on biotic and abiotic components of lakes throughout the lower 48 states. Procedures and protocols described in the Field Operations manual come from a variety of sources. Many have been tested, modified, and refined during four years of pilot and demonstration studies in the northeastern United States. Many methods are currently being used by various State water quality agencies. The purposes of this manual are to: (1) document the procedures used to collect of field data and samples for the Lakes Survey, and (2) provide these procedures for use by other groups implementing lake monitoring programs.

## 1.1 Program Goals and Objectives

Recent critiques of the water monitoring programs have claimed the EPA and states cannot make statically valid statements about the condition of the Nation's waterbody resources. They have also highlighted the lack data necessary to support management decisions. These critiques have include the General Accounting Office (2000), the National Research Council (2001), the National Academy of Public Administration (2002), the Heinz Center Report (2002) and most recently the draft Report on the Environment (2003). To address this gap, the EPA in partnership with state agencies has begun the Survey of the Nation's Lakes to answer key environmental questions about the quality of the Nation's lakes. The Lakes Survey will provide a snapshot of the condition of our Nation's lake resource on a broad geographic scale. Results from this assessment will allow water quality managers, the public, state agencies and others to say, with known statistical confidence, what proportion of the Nation's lakes are in poor ecological condition and identify key stressors affecting this resource. Data collected from the lakes will be analyzed on both a regional and national scale for the 2009 national report.

The information generated from this survey fills an important gap in meeting the requirements of the Clean Water Act. The goals of the Lakes Survey are to:

1. Report on the condition of the Nation's Lakes
    - Provide regional and national estimates of the condition of lakes in good, fair and poor condition

2. Explore the relative importance of key stressors such as nutrients and pathogens and their extent across the population.
3. Establish a baseline to compare future surveys for trends assessment
    - Evaluate trends since the 1970's National Eutrophication Survey
4. Help build state and tribal capacity for monitoring and assessment

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To answer these questions and to achieve the goals of the program, the Lakes Survey will focus on identifying and measuring relevant lake quality indicators in three basic categories – ecological integrity, trophic status, and recreational condition. Data collected on stressors will be analyzed to explore associations between stressors and ecological condition.

### 1.2 Design of the Lakes Survey

Field methods are designed to collect data on the suite of indicators being analyzed for this survey. These indicators were selected using feedback from the Lakes Survey National Meeting held in Chicago in April 2006. Limnologists and lake managers from state agencies, academics and other cooperators, participated in workgroups to help identify key lake indicators that related to ecological integrity, recreational use, or trophic status that should be sampled on a national scale. A key component to the indicators is that they be applicable on both a national and regional scale. A Steering Committee, composed of state representatives from each of the EPA regions, helped finalize indicators and identify field methods appropriate and feasible to collect data on these parameters.

For the purposes of this survey, lakes are defined as natural or man-made freshwater lakes, ponds and reservoirs in the conterminous U.S. Additional criteria includes that the lakes be greater than 10 acres (4 hectares), greater that 1 meter deep, contain greater than 1000 square meters of open water. Waters bodies that were excluded include the Great Lakes (surveyed as part of the National Coastal Condition Assessment), the Great Salt Lake, other saline systems that are affected by salt water intrusion or tidally influenced, and water treatment or disposal ponds. Lakes with a surface area of greater than 12,500 acres (5,000 hectares) are defined as Large Lakes and are assigned a slightly modified sampling approach given the increased level of effort required to sample such expansive bodies of water.

The lake sampling locations were selected using a modern survey design approach. Sample Surveys have been used in a variety of field (e.g. election polls, monthly labor estimates, forest inventory analysis) to determine the status of population or resources of interest using a representative sample of a relatively few members or sites. This approach is especially cost-effective if the population is so large that all components cannot be sampled or if it is unnecessary to obtain a complete census of the resource to reach the desired level of precision for describing its condition.

Methods described in this manual stem from discussions, input, and feedback provided by the Steering Committee. The methods are designed to be completed by a field crew over the course of one sampling day. Many of the methods are an outgrowth of the testing and refinement of the existing and developed methods and the logistical foundation constructed during the implementation of the Environmental Monitoring and Assessment Program (EMAP) studies from 1991 through 1994, from a New England pilot study conducted in 2005, from focused pilot studies for methods development, and from various State water quality agency methods currently in use. Many other documents, such as the North American Lakes Management Society (NALMS) document, Managing Lakes and Reservoirs (2001) were also consulted.

An "index" site, located above the deepest point of the lake, will be used to collect data for many of the field parameters. Index sampling at a lake must take place at appropriate locations and within the sampling window to adequately represent that waterbody within the

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larger resource population. For purposes of this study, the sampling window is the summer growing season before turn over (June through September on a national scale). Since turn over time varies from region to region, the exact time frame for sampling within this period will be developed regionally. Implementing standardized field methods, along with these aspects, will help ensure the survey is reproducible over time.

**Table 1-1.** Summary of core indicators to be used in Lakes Survey.

| Indicator Type | Indicator | Specs/Location in Lake |
|---|---|---|
| Trophic Indicators | *In Situ* measurements (D.O., Temperature, pH) | Vertical profile from deepest point (index station) |
| | Water chemistry (TP, TN [$NH_4$, $NO_3$], basic anions and cations, alkalinity [ANC], DOC, TOC, TSS, conductivity | Upper 2 m of water column at index station (depth-integrated) |
| | Turbidity/TVS | Upper 2 m of water column at index station (depth-integrated) |
| | Color | Upper 2 m of water column at index station (depth-integrated) |
| | Secchi disc transparency | From index station |
| Ecological Integrity | Diatom assemblage | Sediment cores |
| | Macrobenthos assemblage (Littoral) | Littoral margin of lake from 3 habitat types at physical habitat stations |
| | Zooplankton assemblage (composition and structure, size distribution) | Vertical tow through water column |
| | Phytoplankton | Upper 2 m of water column at index station (depth-integrated) |
| | Shoreline Physical Habitat Survey | 10 stations equidistant around lake margin |
| Recreational | Pathogen indicator organisms (Enteroccoci) | Water samples taken nearshore at (last sampling activity) final habitat station |
| | Algal toxins | Water samples taken nearshore at final habitat station |
| Other Indicators (mostly desktop, some field observations.) | Lake Area | Done at desktop, and used in target lake population selection |
| | Basin morphometry | Done at desktop |
| | Characteristics of watershed | Done at desktop using GIS and verified by state agencies |

## 1.3 Indicator Summary

Indicators were selected to represent a minimum of one of three categories: (1) ecological integrity, (2) trophic status, and (3) recreational value. Some indicators provide a basis for evaluating more than one category. For example, an assessment of phytoplankton

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allows for an examination of ecological integrity and trophic status, and to a certain extent, recreational value. Table 1-1 provides a summary of the indicators to be used in the Lakes Survey.

Each of the following subsections describes biotic assemblages, environmental measures, or attributes of indicators that will be used in the Lakes Survey to evaluate the condition of lakes, nationwide. To aid field personnel in understanding sampling procedures, these sections address the rationale for these measures and the significance of certain aspects of the methods. The indicators for this survey were selected from a wide range of possible indicators to assess lake condition. State representatives chose these indicators because of their applicability on a national scale, ability to reflect various aspects of ecological condition, and cost-effectiveness.

### 1.3.1 Ecological Integrity Indicators

Indicators of ecological condition and integrity comprise different assemblages of the aquatic community and their physical habitat. For the Lakes Survey, these indicators focus on the plankton (phytoplankton and zooplankton), benthic macroinvertebrates, diatoms, and the physical habitat of the shoreline and littoral zone. Indices of these ecological indicators will be developed as the basis for the data analyses.

#### 1.3.1.1 Phytoplankton Assemblage

The phytoplankton assemblage is an indicator selected for the national survey, because it is inexpensive to collect and highly sensitive to changes in ecosystems, two requirements of useful monitoring programs (Schindler 1987). Phytoplankton is the primary source of energy driving most lake systems (Schriver et al. 1995). A wide variety of stressors affect the phytoplankton assemblage, such as turbidity due to suspended solids, pesticides, poly-chlorinated biphenyls (PCBs), metals, and nutrient enrichment. The phytoplankton assemblage has been widely used as an indicator of nutrient condition and eutrophication in lakes. Measures such as the ratio of centric to pinnate diatoms, and a number of other ratios of phytoplankton taxa, have been used as indicators of trophic conditions.

#### 1.3.1.2 Zooplankton Assemblage

The zooplankton assemblage is an important component of the open water environment of lakes and ponds. Most taxa are microscopic and consist of crustaceans (copepods, cladocerans, and opossum shrimp), rotifers ("wheel-animals"), pelagic insect larvae (phantom midges), and aquatic mites. The zooplankton assemblage constitutes an important element of the food web, where zooplankton transfer energy from algae (primary producers) to larger invertebrate predators and fish. The zooplankton assemblage responds to environmental effects of environmental stress on zooplankton can be detected through changes in species composition, abundance, and body size distribution.

#### 1.3.1.3 Sediment Diatom Assemblage

The sediment diatom assemblage indicator is unique in that it can potentially tell us the condition of the lake at some past point in time by examining the bottom portion of the core sample. The diatom cell wall is composed of silicon dioxide and is preserved in lake sediments. Markings on the cell wall are used to distinguish species and even varieties. Dozens of different

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species occur in any lake and its drainage basin, many of which end up in the sediments at the center of the lake. Each of the species has slightly different environmental requirements; for many species, these requirements are known. By studying the diatom community, it is possible to make inferences about previous conditions in the lake and its basin. In addition, environmental variables (alkalinity, total P, conductivity, etc.) have been inferred using diatom-based predictive models.

#### 1.3.1.4 Benthic Macroinvertebrate Assemblage

Benthic invertebrates inhabit the sediment or live on the bottom substrates or in aquatic vegetation of lakes. The benthic macroinvertebrate assemblage in lakes is an important component of measuring the overall biological condition of the aquatic community. Monitoring this assemblage is useful in assessing the status of the water body and detecting trends in ecological condition. Populations in the benthic assemblage respond to a wide array of stressors in different ways so that it is often possible to determine the type of stress that has affected a macroinvertebrate assemblage (e.g., Klemm et al., 1990). Because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, the structure and function of the macroinvertebrate assemblage is a response to exposure of present or past conditions.

In the United States, benthic macroinvertabrates have primarily been used as indicators of ecological condition in streams and rivers. European biologists have used benthic macroinvertebrates for purposes of classifying lakes as to trophic status since the 1920s. Currently many states and universities are using benthic macroinvertebrates to assess biological condition on lakes. A few pilot studies, such as EMAP and New England lakes programs, have developed promising indices for lake benthic macroinvertebrates. These benthic macroinvertebrates have great potential as indicators of the biotic integrity and ecological condition of this Nation's lakes and reservoirs. It is the intent of the Lakes Survey to focus on the most promising metrics and indices for purposes of validating their use as a measure of ecological condition of lakes and reservoirs.

#### 1.3.1.5 Physical Habitat

The physical habitat shoreline and littoral surveys that the Lakes Survey field teams conduct will serve three purposes. First, this habitat information is essential to the interpretation of what lake ecological condition is expected to be like in the absence of many types of anthropogenic impacts. Second, the habitat evaluation is a reproducible, quantified estimate of habitat condition, serving as a benchmark against which to compare future habitat changes that might result from anthropogenic activities. Third, the specific selections of habitat information collected aid in the diagnosis of probable causes of ecological degradation in lakes.

In addition to information collected in the field by the shoreline and littoral surveys, the physical habitat description of each lake includes many map-derived variables such as lake surface area, shoreline length, and shoreline complexity. Furthermore, an array of information, including watershed topography and land use, supplements the physical habitat information. The shoreline and littoral surveys concentrate on information best derived "on the ground." As such, these survey results provide the linkage between large watershed-scale influences and those influences that directly affect aquatic organisms day to day. Together with water chemistry, the habitat measurements and observations describe the variety of physical and

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chemical conditions that are necessary to support biological diversity and foster long-term ecosystem stability. These characteristics of lakes and their shorelines are the very aspects that are often changed as a result of anthropogenic activities.

### 1.3.2 Trophic Status Indicators

Trophic state describes the biological condition of a lake based on algal biomass. Three variables, chlorophyll, Secchi disk depth, and total phosphorus are most often used to estimate biomass and define trophic state of a particular lake. Other variables are measured in conjunction with the trophic state variables to supplement and enhance understanding of lake processes that affect primary productivity.

The trophic state of lakes has long been of primary interest. Lakes can naturally assume different trophic states ranging from oligotrophic to eutrophic. However, nutrient enrichment will elevate the eutrophication process, causing impairment. Trophic indicators include water chemistry and associated physicochemical measurements, as well as the amount of chlorophyll-*a* present in the water.

#### 1.3.2.1 *In Situ* Temperature, pH, and Dissolved Oxygen Measurements

Depth profiles for temperature, pH and dissolved oxygen (D.O.) will be taken with a calibrated water quality meter or multi-probe sonde from the index station in each lake. This information will be used to determine the extent of stratification and the availability of the appropriate temperature regime and level of dissolved oxygen necessary to support aquatic life. Different types of instruments are available to take these measurements. However, rigorous quality control procedures for instrument calibration and maintenance will ensure adequate quality data for the depth profiles of temperature, dissolved oxygen, and pH.

#### 1.3.2.2 Water Chemistry and Associated Measurements

The primary functions of lake water samples collected from the depth-integrated sampler and *in situ* water column measurements (described above) are to determine acidic conditions, trophic state and nutrient enrichment, and classification of water chemistry type. Water chemistry data collected for this survey will help identify stressed lakes due to high levels of nutrient, acidification, salinity, etc.

#### 1.3.2.3 Chlorophyll-*a*

Chlorophyll-*a* is a commonly used indicator to estimate trophic status of lakes. Much literature exists on evaluating the results of chlorophyll-*a* and how this indicator is used for algal biomass and trophic status. The chlorophyll-*a* sample is collected with the depth-integrated sampler at the index station of the lake.

#### 1.3.2.4 Secchi Transparency

The Secchi disk is very old limnological instrument used to measure water transparency. The rate at which light levels decrease while moving down the water column is primarily dependent on the amount of light-adsorbing dissolved substances as well as suspended materials which cause light absorption and scattering. These factors play the major role in determining transparency. Because the euphotic zone is associated with water transparency,

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the Secchi disk measurement can be used to help make an estimate of the euphotic zone depth in the field.

### 1.3.3 Recreational Value Indicators

Indicators of recreational value vary from accessibility to a lake and boat traffic to human health concerns. For the Lakes Survey, indicators of human health will be emphasized. Both the extent of pathogens and algal toxins will serve as the primary indicators of recreational value.

#### 1.3.3.1 Pathogens (*Enterococci*)

Typically in lakes, fecal coliform and/or Enterococci measurements from samples collected near bathing beaches serve as the main indicator for presence of pathogens. For the Lakes Survey, a representative (rather than targeted habitat) sample of pathogens within a lake is needed to ensure comparable samples are collected from all lakes. Note that the objective is not to determine whether or not a single lake passes or fails a water quality standard based on a single sample, but to provide a description of conditions in the population of lakes that can be assessed on its own merits. A water sample will be collected from within the last shoreline station, which provides a random selection process rather than a targeted sampling nearest the highest concentration of human activity and shortens the holding time for the sample.

#### 1.3.3.2 Algal toxins (microcystins)

Toxic blooms of *Microcystis, Anabaena,* and *Amphanizomenon* can occur in lakes causing both ecological and human health concerns. *Microcystis* produces a liver toxin, microcystin, while the other two produce neurotoxins, including saxitoxin, the compound responsible for paralytic shellfish poisoning in the marine environment (Carmichael 1997). These taxa can produce compounds responsible for taste and odor problems in water supplies (Jones and Korth 1995) and off-flavors in fish (Persson 1980). Microcystins will be measured as the primary algal toxin for the Lakes Survey.

### 1.3.4 Lake Characteristics

Observations and impressions about the lake and its surrounding catchment by the field teams are extremely useful for ecological value assessment, development of associations and stressor indicators, and data verification and validation. Thus, it is important that observations of the field teams about lake characteristics be recorded for future data interpretation and validation. The form provided for this purpose is designed as a guide for recording pertinent field observations. It is by no means comprehensive and any additional observations should be recorded in the "Comments" section. Field team members will complete the form at the end of the lake sampling, taking into account all observations made while on site.

## 1.4 Supplemental Material to the Field Operations Manual

The field operations manual describes field protocols and daily operations for crews to use in the Lakes Survey. Following these detailed guides will ensure consistency across regions and reproducibility for future surveys. Before beginning sampling on a lake, crews should prepare a packet for each lake containing pertinent information to successfully conduct sampling. This includes a road map and set of directions to the lake, topographic or bathymetric

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maps, land owner access forms, site evaluation forms and other information necessary to ensure an efficient sampling day.

Field crews will also receive a quick-reference handbook that contains tables and figures summarizing field activities and protocols from the Field Operations Manual for Lakes. This waterproof handbook will be the primary field reference used by field teams after a completing a required field training session. The field teams are also required to keep the field operations manual available in the field for reference and for possible protocol clarification.

Large-scale and/or long-term monitoring programs such as those envisioned for national surveys and assessments require a rigorous QA program that can be implemented consistently by all participants throughout the duration of the monitoring period. Quality assurance is a required element of all EPA-sponsored studies that involve the collection of environmental data (USEPA 2000a, 2000b). Field teams will be provided a copy of the integrated Quality Assurance and Project Plan (QAPP). The QAPP contains more detailed information regarding QA/QC activities and procedures associated with general field operations, sample collection, measurement data collection for specific indicators, and data reporting activities.

# 2.0 DAILY OPERATIONS SUMMARY

This section presents a general overview of the activities that a 2 person field team conducts during a typical 1-day sampling visit to a lake. General guidelines for recording data and using standardized field data forms and sample labels are also presented. Finally, safety and health considerations and guidelines related to field operations are described.

## 2.1 Sampling Scenario

Field methods for the Lakes Survey are designed to be completed in one field day for most lakes. Depending on the time needed for both the sampling and traveling for that day, an additional day may be needed for pre-departure and post-sampling activities (e.g., cleaning equipment, repairing gear, shipping samples, and traveling to the next lake). Remote lakes with lengthy or difficult approaches may require more time to gain access to the lake, and field teams will need to plan accordingly.

A field team will typically be composed of two people. Additional field members and boats can be used to reduce overall sampling time on the lake. Two people are always in the boat together to execute the sampling activities and to ensure safety. Any additional team members may either remain on shore to provide logistical support or are deployed in a second boat to assist in data collection. A daily field sampling scenario showing how the work load may be split between team members is presented in Figures 2-1 and 2-2. Each field team should define roles and responsibilities for each team member to organize field activities efficiently. Minor modifications to the sampling scenario may be made by crews, however the sequence of sampling event presented in Figure 2-1 is based on the need to protect some types of samples from potential contamination and to minimize holding times once samples are collected. For example, secchi disk reading needs to be taken first before other sampling procedures disturb water clarity. On the other side of the boat *in situ* measurements and D.O. profiles can be measured and recorded. Pathogen samples need to be the last sample collected to minimize holding time.

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The sequence of sampling events presented in Figure 2-1 cannot be changed, with exception to Large Lakes, which omit the physical habitat and benthic macroinvertebrate sampling efforts altogether and algal toxin and pathogen samples are collected at the launch site. The sequence is based partially on the need to protect some types of samples from potential contamination and to minimize holding times once samples are collected. The following sections further define the sampling sequence and the protocols for sampling activities.

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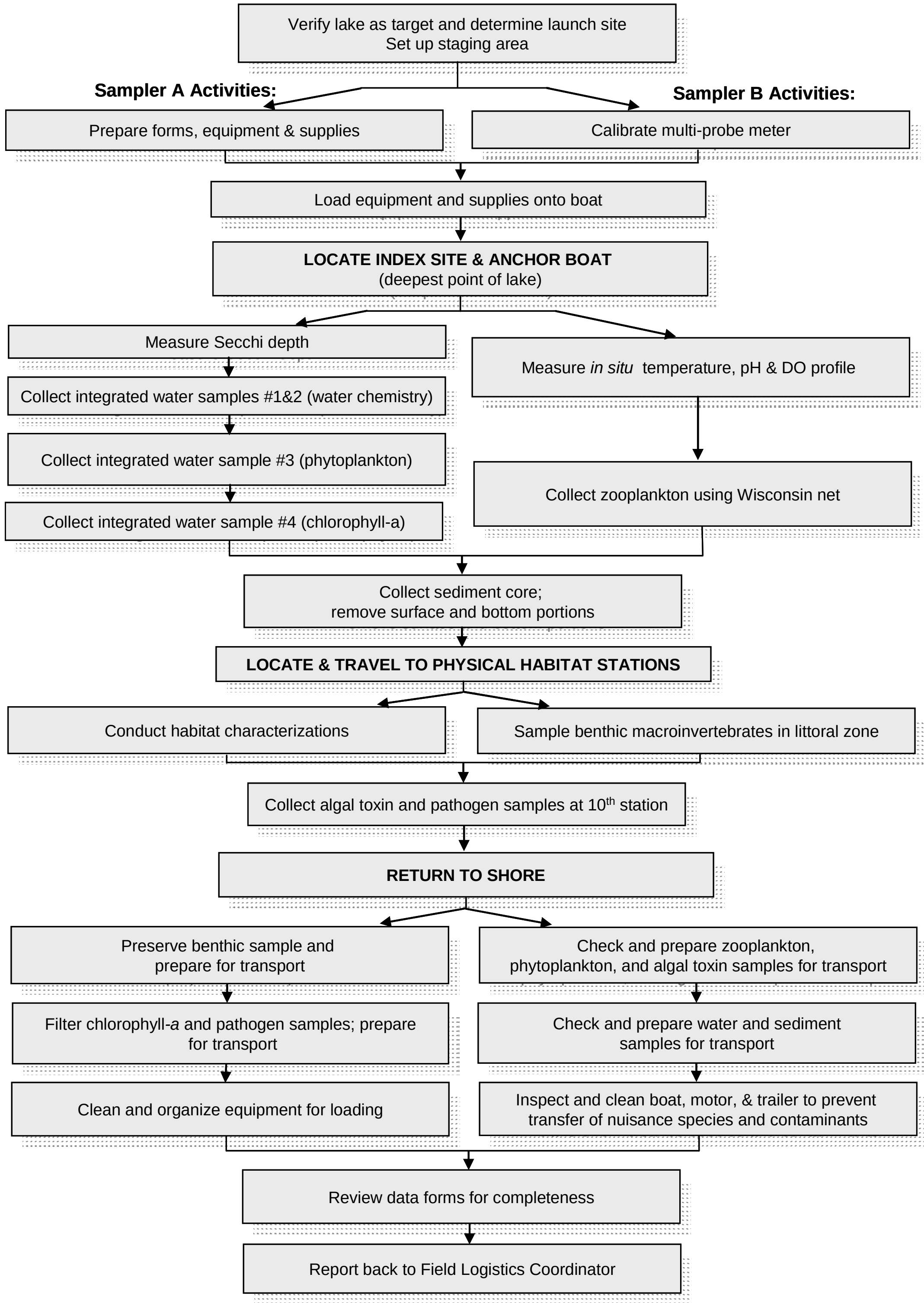


Figure 2-1. Field sampling scenario.

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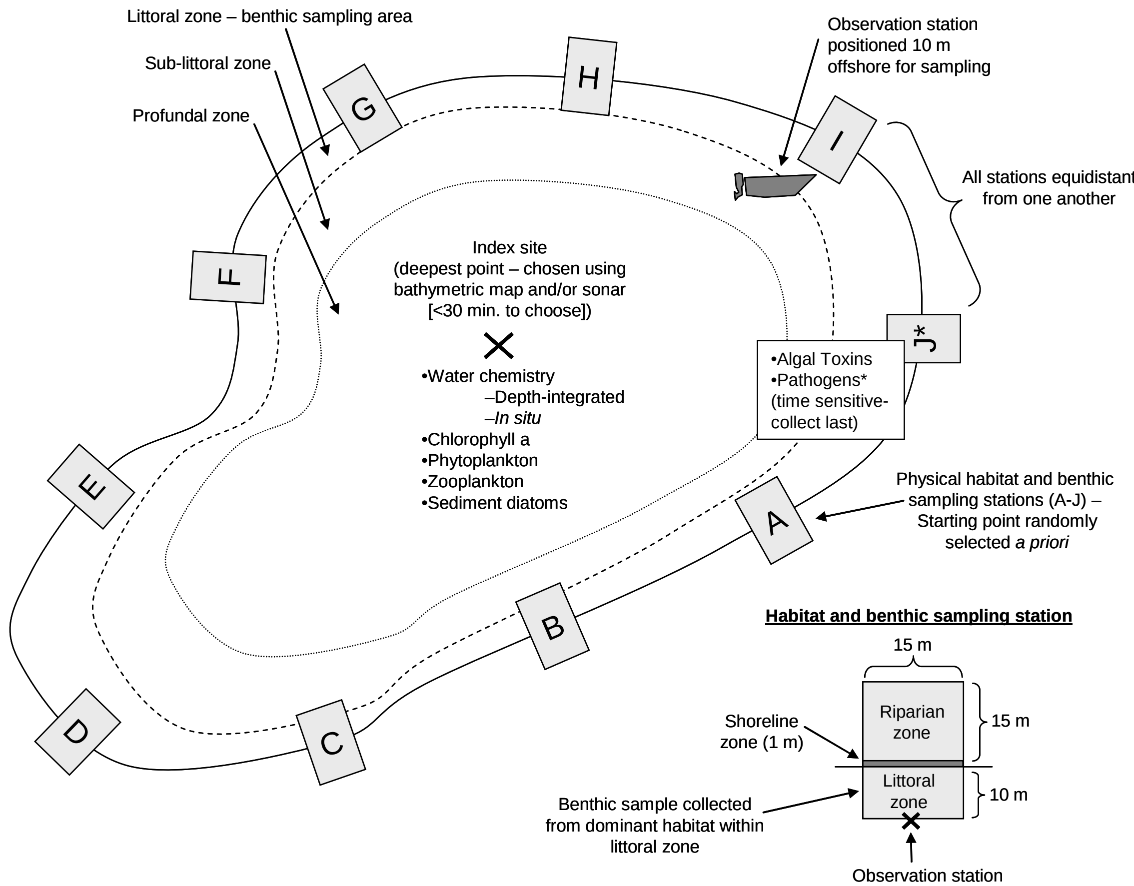


Figure 2-2. Location of sample collection points and shoreline stations.

The field team should arrive at the lake in the early morning to complete the sampling in a single day. The sampling sequence is to:

- verify lake and locate index site,
- conduct depth profile measurements of dissolved oxygen and temperature,
- take Secchi disk transparency depth measurement,
- use the integrated sampler to collect water chemistry, chlorophyll-*a*, and phytoplankton samples
- collect zooplankton samples,
- collect sediment core samples,
- conduct physical habitat characterization,
- collect benthic samples,
- collect algal toxin sample,
- collect pathogen sample,
- filter chlorophyll-*a* and pathogen samples,
- preserve and prepare all samples for shipment,
- review field forms,
- report sampling event, and
- ship time-sensitive samples.

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## 2.2 Recording Data and Other Information

During the sampling visit to a lake, the field crew is required to obtain and record a substantial amount of data and other information for all of the various ecological indicators described in Section 1. In addition, all the various samples collected need to be identified and tracked, and associated information for each sample must be recorded. To assist with sample identification and tracking, labels are preprinted with sample ID numbers and bar codes (Figure 2-3).

It is imperative that field and sample information be recorded accurately, consistently, and legibly. Measurement data that cannot be accurately interpreted by others besides the field crews and samples with incorrect or illegible information associated with them is lost to the program. The cost of a sampling visit coupled with the short index period severely limits the ability to resample a lake if the initial information recorded was inaccurate or illegible. Some guidelines to assist field personnel with information recording are presented in Table 2-1. These include a list of flags or qualifiers for data and samples and guidance for completing forms and labels while in the field and before shipping.

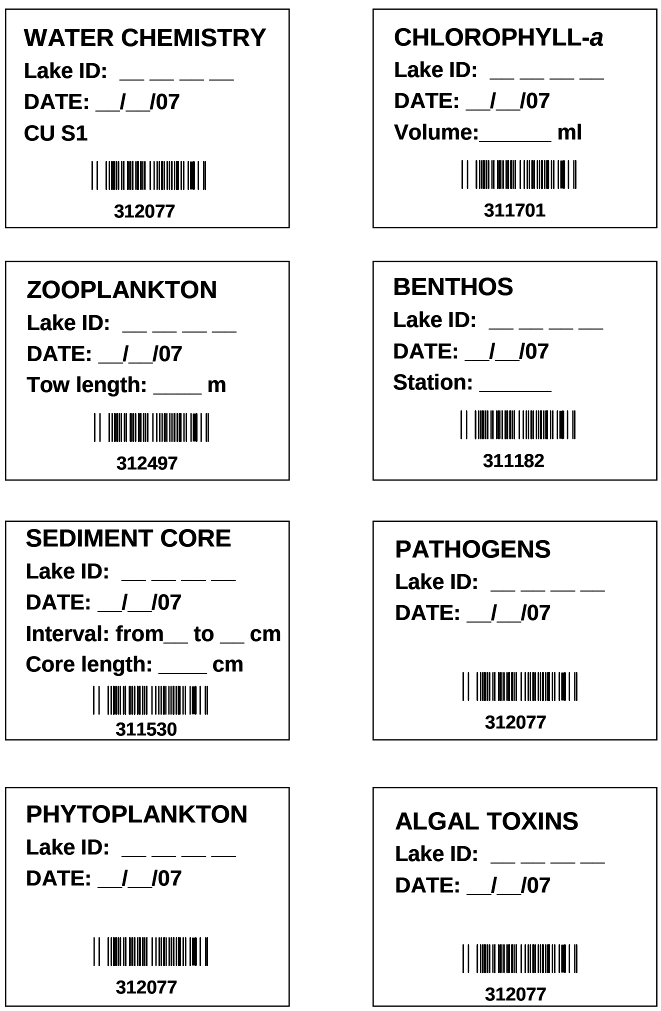


Figure 2-3. Bar-coded sample labels for sample tracking and identification.

Table 2-1. Guidelines for recording field data and other information.

| ACTIVITY | GUIDELINES |
|---|---|
| **Field Measurements** | |
| **Data Recording** | Record measurement values and observations on data forms preprinted on water-resistant paper.<br>Use No. 2 pencil only (fine-point indelible markers can be used if necessary) to record information on forms.<br>Record data and information using correct format as provided on data forms.<br>Print legibly (and as large as possible). Clearly distinguish letters from numbers (e.g., 0 versus O, 2 versus Z, 7 versus T or F, etc.), but do not use slashes.<br>In cases where information is to be recorded repeatedly on a series of lines (e.g., physical habitat characteristics), do not use "ditto marks" (") or a straight vertical line. Record the information that is repeated on the first and last lines, and then connect these using a wavy vertical line.<br>When recording comments, print or write **legibly**. Make notations in comments field only; avoid marginal notes. Be concise, but avoid using abbreviations or "shorthand" notations. If you run out of space, attach a sheet of paper with the additional information, rather than trying to squeeze everything into the space provided on the form. |
| **Data Qualifiers (Flags)** | Use only defined flag codes and record on data form in appropriate field.<br><br>K = Measurement not attempted or not recorded.<br>Q = Failed quality control check; remeasurement not possible.<br>U = Suspect measurement; remeasurement not possible.<br>F*n* = Miscellaneous flags (*n*=1, 2, etc.) assigned by a field crew during a particular sampling visit (also used for qualifying samples).<br><br>Explain reason for using each flag in comments section on data form. |
| **Review of Data Forms** | Review data forms for accuracy, completeness, and legibility before leaving lake.<br>The Field Team Leader must review all data forms for consistency, correctness, and legibility before transfer to the Information Management Center. |

*(continued)*

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Table 2-1 (continued). Guidelines for recording field data and other information.

| ACTIVITY | GUIDELINES |
|---|---|
| **Sample Collection and Tracking** | |
| **Sample Labels** | Use adhesive labels with preprinted ID numbers and follow the standard recording format for each type of sample.<br>Use a pencil to record information on labels. Cover completed labels with clear tape. |
| **Sample Collection Information** | Record sample ID number from label and associated collection information on sample collection form preprinted on water-resistant paper.<br>Use a No. 2 pencil only (fine-point indelible fine-tipped markers can be used if necessary to record information on forms).<br>Record collection information using correct format as provided on the sample collection form. |
| **Sample Qualifiers (Flags)** | Use only defined flag codes and record on sample collection form in appropriate field.<br><br>K = Sample not collected or lost before shipment; resampling not possible.<br>U = Suspect sample (e.g., possible contamination, does not meet minimum acceptability requirements, or collected by non-standard procedure).<br>F*n* = Miscellaneous flags (*n*=1, 2, etc.) assigned by a field crew during a particular sampling visit (also used for field measurements).<br><br>Explain reason for using each flag in comments section on sample collection form. |
| **Review of Labels and Collection Forms** | Compare information recorded on labels and sample collection form for accuracy before leaving lake.<br>Review labels and sample collection form for accuracy, completeness, and legibility before leaving lake.<br>The Field Team Leader must review sample collection forms for consistency, correctness, and legibility before transfer to the Information Management Center. |

Protocols for these activities are described in Sections 4 through 7.

## 2.3 Safety and Health

Collection and analysis of samples (e.g., benthic invertebrates, water chemistry, and sediment) can involve significant risks to personal safety and health (drowning, pathogen exposure, etc.). While safety is often not considered an integral part of field sampling routines, personnel must be aware of unsafe working conditions, hazards connected with the operation of sampling gear, boats, environmental surroundings, and other risks (Berry et al., 1983). Personnel safety and health are of the highest priority for all investigative activities and must be

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emphasized in safety and health plans for field, laboratory, and materials handling operations. Preventative safety measures and emergency actions must also be emphasized. Individual states and other grantees should assign health and safety responsibilities and have an established program for training in safety, accident reporting, and medical and first aid treatment. Safety documents and standard operating procedures (SOPs) containing necessary and specific safety precautions should be available to all field personnel. Additional sources of information regarding field laboratory safety related to biomonitoring studies include Berry et al. (1983), USEPA (1986), and (1990).

### 2.3.1 General Considerations

Important considerations related to field safety are presented in Table 2-3. It is the responsibility of the group safety officer or project leader to ensure that the necessary safety courses are taken by all field personnel and that all safety policies and procedures are followed. Sources of information regarding safety-related training include the American Red Cross (1979), the National Institute for Occupational Safety and Health (1981), U.S. Coast Guard (1987) and Ohio EPA (1990).

Persons using sampling devices should become familiar with the hazards involved and establish appropriate safety practices prior to using them. If boats are used to access sampling sites, personnel must consider and prepare for hazards associated with the operation of motor vehicles, boats, winches, tools, and other incidental equipment. Boat operators should be familiar with U.S. Coast Guard rules and regulations for safe boating contained in a pamphlet, "*Federal Requirements for Recreational Boats*, " available from a local U.S. Coast Guard Director or Auxiliary or State Boating Official (U.S. Coast Guard, 1987). All boats with motors must have fire extinguishers, boat horns, life jackets or flotation cushions, and flares or communication devices.

A communications plan to address safety and emergency situations is essential. All field personnel need to be fully aware of all lines of communication. Field personnel should have a daily check-in procedure for safety. An emergency communications plan should include contacts for police, ambulance, fire departments, hospitals, and search and rescue personnel.

Proper field clothing should be worn to prevent hypothermia, heat exhaustion, sunstroke, drowning, or other dangers. Field personnel should be able to swim. Chest waders made of rubberized or neoprene material and suitable footwear must always be worn with a belt to prevent them from filling with water in case of a fall. If a member of the field sampling team is not a strong swimmer or feels uncomfortable in deep, fast flowing water, a personal flotation device may be used.

Many hazards lie out of sight in the bottoms of lakes, rivers and streams. Broken glass or sharp pieces of metal embedded in the substrate can cause serious injury if care is not exercised when walking or working with the hands in such environments. Infectious agents and toxic substances that can be absorbed through the skin or inhaled may also be present in the water or sediment. Personnel who may be exposed to water known or suspected to contain human or animal wastes that carry causative agents or pathogens must be immunized against tetanus, hepatitis, typhoid fever, and polio. Biological wastes can also be a threat in the form of viruses, bacteria, rickettsia, fungi, or parasites.

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Prior to a sampling trip, personnel should determine that all necessary equipment is in safe working condition. Good housekeeping practice should be followed in the field. These practices protect staff from injury, prevent or reduce exposure to hazardous or toxic substances, and prevent damage to equipment and subsequent down time and/or loss of valid data.

Table 2-2. General health and safety considerations. **CAPTION SHOULD CONTINUE ON NEXT PAGE**

**Recommended Training:**

- First aid
- Cardiopulmonary resuscitation (CPR)
- Vehicle safety (e.g., operation of 4-wheel drive vehicles)
- Boating and water safety (if boats are required to access sites)
- Field safety (e.g., weather conditions, personal safety, orienteering, reconnaissance of sites prior to sampling
- Equipment design, operation, and maintenance
- Handling of chemicals and other hazardous materials

**Communications**

- Check-in schedule
- Sampling itinerary (vehicle used and its description, time of departure, travel route, estimated time of return)
- Contacts for police, ambulance, hospitals, fire departments, search and rescue personnel
- Emergency services available near each sampling site and base location
- Cell (or satellite) phone, if possible

**Personal Safety**

- Field clothing and other protective gear including lifejackets for all crew members
- Medical and personal information (allergies, personal health conditions)
- Personal contacts (family, telephone numbers, etc.)
- Physical exams and immunizations

### 2.3.2 Safety Equipment and Facilities

Appropriate safety apparel such as waders, lab coats, gloves, safety glasses, etc. must be available and used when necessary. Bright colored caps (e.g., orange) should be worn during field activities. First aid kits, fire extinguishers, and blankets must be readily available in the field. A properly installed and operating fume hood must be provided in the laboratory for use when working with chemicals that may produce dangerous fumes. Cellular or satellite telephones and/or portable radios should be provided to field teams working in remote areas for use in case of an emergency. Facilities and supplies must be available for cleaning of exposed body parts that may have been contaminated by pollutants in the water. Anti-bacterial soap and

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an adequate supply of clean water or ethyl alcohol, or equivalent, should be suitable for this purpose.

### 2.3.3 Safety Guidelines for Field Operations

General safety guidelines for field operations are presented in Table 2-3. Personnel participating in field activities on a regular or infrequent basis should be in sound physical condition and have a physical examination annually or in accordance with Regional, State, or organizational requirements. All surface waters and sediments should be considered potential health hazards due to toxic substances or pathogens. Persons must become familiar with the health hazards associated with using chemical fixing and/or preserving agents. Chemical wastes can cause various hazards due to flammability, explosiveness, toxicity, causticity, or chemical reactivity. All chemical wastes must be discarded according to standardized health and hazards procedures (e.g., National Institute for Occupational Safety and Health [1981]; U.S. EPA [1986]).

During the course of field research activities, field teams may observe violations of environmental regulations, may discover improperly disposed hazardous materials, or may observe or be involved with an accidental spill or release of hazardous materials. In such cases it is important that the proper actions be taken and that field personnel do not expose themselves to something harmful. The following guidelines should be applied:

- First and foremost during any environmental incident, it is extremely important to protect the health and safety of all personnel. Take any necessary steps to avoid injury or exposure to hazardous materials. If you have been trained to take action such as cleaning up a minor fuel spill during fueling of a boat, do it. However, you should always error on the side of personal safety

- Field personnel should never disturb, or even worse, retrieve improperly disposed hazardous materials from the field and bring them back to a facility for "disposal". To do so may worsen the impact to the area of the incident, may incur personal liability, may incur liability for the team members and their respective organizations, may cause personal injury, or my cause unbudgeted expenditure of time and money for proper treatment and disposal of the material. However, it is important not to ignore environmental incidents. There is a requirement to notify the proper authorities of any incident of this type. The appropriate authorities may then take the necessary actions to properly respond to the incident.

- For most environmental incidents, the following emergency telephone numbers should be provided to all field teams: State or Tribal department of environmental quality or protection, U.S. Coast Guard, and the U.S. EPA regional office. In the event of a major environmental incident, the National Response Center may need to be notified at 1-800-424-8802.

Table 2-3. General safety guidelines for field operations.

- Two persons must be present during all sample collection activities, and no one should be left alone while in the field.

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- Exposure to lake water and sediments should be minimized as much as possible. Use gloves if necessary, and clean exposed body parts as soon as possible after contact.
- All electrical equipment must bear the approval seal of Underwriters Laboratories and must be properly grounded to protect against electric shock.
- Use heavy gloves when hands are used to agitate the substrate during collection of benthic macroinvertebrate samples.
- Use appropriate protective equipment (e.g., gloves, safety glasses) when handling and using hazardous chemicals
- Persons working in areas where poisonous snakes may be encountered must check with the local Drug and Poison Control Center for recommendations on what should be done in case of a bite from a poisonous snake.
- Any person allergic to bee stings, other insect bites, or plants (i.e., poison ivy, oak, sumac, etc.) must take proper precautions and have any needed medications handy.
- Field personnel should also protect themselves against the bite of deer or wood ticks because of the potential risk of acquiring pathogens that cause Rocky Mountain spotted fever and Lyme disease.
- All field personnel should be familiar with the symptoms of hypothermia and know what to do in case symptoms occur. Hypothermia can kill a person at temperatures much above freezing (up to 10$^{o}$C or 50$^{o}$F) if he or she is exposed to wind or becomes wet.
- Field personnel should be familiar with the symptoms of heat/sun stroke and be prepared to move a suffering individual into cooler surroundings and hydrate immediately.
- Handle and dispose of chemical wastes properly. Do not dispose any chemicals in the field.

## 3.0 BASE SITE ACTIVITIES

Field teams conduct a number of activities at their base site (i.e., office or laboratory, camping site, or motel). These include tasks that must be completed both before departure to the lake site and after return from the field (Figure 3-1). Close attention to these activities is required to ensure that the field teams know (1) where they are going, (2) that access is permissible and possible, (3) that equipment and supplies are available and in good working order to complete the sampling effort, and (4) that samples are packed and shipped appropriately.

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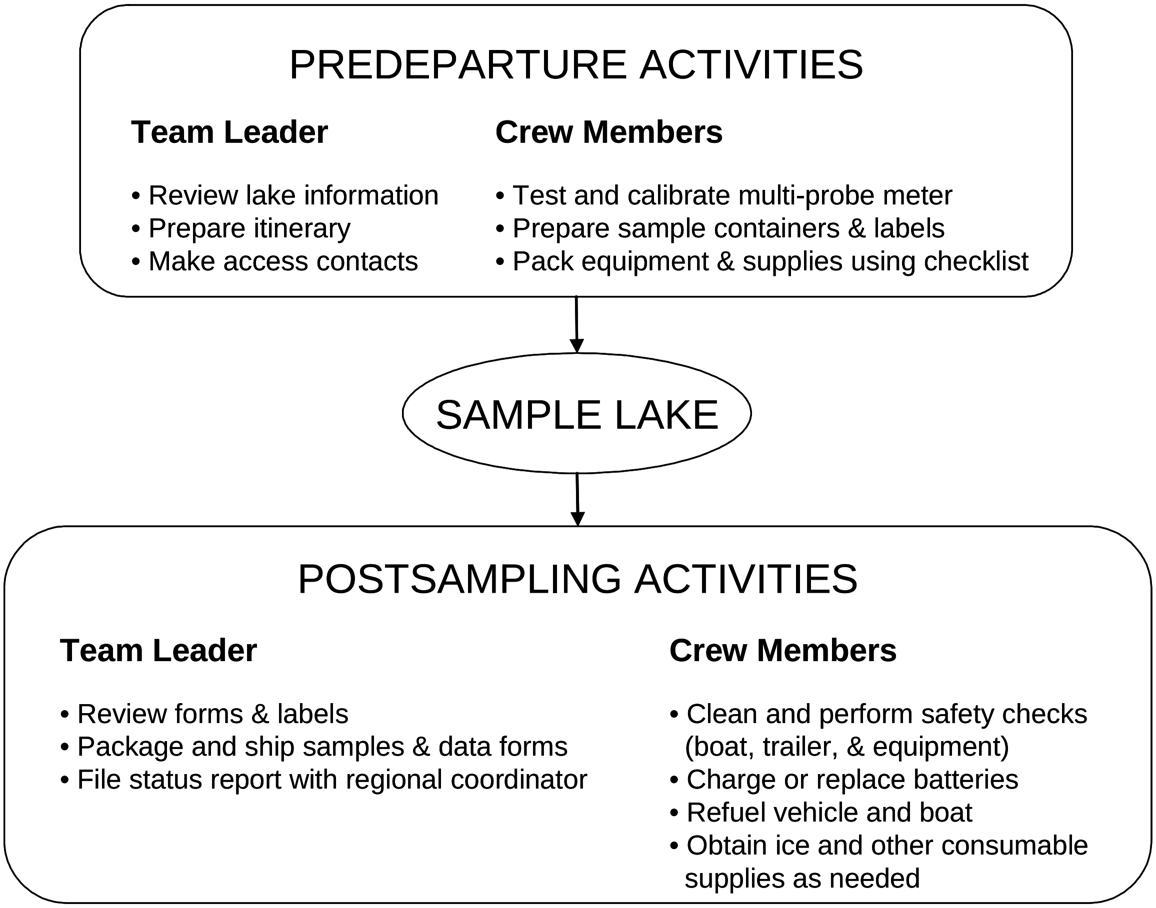


Figure 3-1. Overview of base site activities.

### 3.1 Predeparture Activities

Predeparture activities include development of daily itineraries, instrument calibration, equipment checks and repair, supply inventories, and sample container preparation. Procedures for these activities are described in the following sections.

#### 3.1.1 Daily Itineraries

The Field Team Leaders are responsible for developing daily itineraries. The Field Team Leader is responsible for assembling the appropriate field equipment along with maps, contacts, copies of permission letters, and access instructions. Additional activities include confirming the best access routes, calling the landowners or local contacts, confirming lodging plans, and coordinating rendezvous locations with individuals who must meet with field teams prior to accessing a site. This information is used to develop an itinerary. Changes in the itinerary during the week, such as cancelling a sampling day, must be relayed by the Field Team Leader to the Field Logistics Coordinator as soon as possible. The Field Logistics Coordinator will track progress of all sampling crews participating in the Lakes Survey (see section 3.3.3 for additional information). Miscommunications can result in the initiation of expensive search and rescue procedures and disruption of carefully planned schedules.

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### 3.1.2 Instrument Checks and Calibration

Each field team must test and calibrate instruments prior to sampling. Calibration can be conducted prior to departure for the lake site or at the lake, with the exception of dissolved oxygen (DO) calibration. Because of the potential influence of altitude, dissolved oxygen calibration should be performed only at the lake site. Field instruments include a multiprobe unit for measuring temperature, DO, and pH and a Global Positioning System (GPS) receiver. The procedures described here are designed for these instruments. Field teams should have access to backup instruments if any instruments fail the manufacturer performance tests or calibrations.

#### 3.1.2.1 Multi-probe Meter Performance Test

Test and precalibrate the multi-probe meter prior to departure from the base. Each field crew should have a copy of the manufacturer's calibration and maintenance procedures. All dissolved oxygen meters should be calibrated according to manufacturer specifications provided along with the meter.

#### 3.1.2.2 Global Positioning System Battery Check

Turn on the GPS receiver and check the batteries prior to departure. Replace batteries immediately if a battery warning is displayed.

### 3.1.3 Equipment Preparation

To ensure that all sampling activities at the lake are conducted completely and efficiently, field teams must check all equipment and supplies before traveling to the lake site. In addition, they should prepare labels and assemble packets of sample containers.

Check the inventory of supplies and equipment prior to departure using the equipment and supplies checklists provided in Appendix A. Use these checklists to ensure that all needed materials are taken to each lake; use of the lists is mandatory. Pack meters, probes, and sampling gear in such a way as to minimize physical shock and vibration during transport. If necessary, prepare stock preservation solutions as described in Table 3-1. Follow the regulations of the Occupational Safety and Health Administration (OSHA).

Table 3-1. Stock solutions, uses, and methods for preparation.

| Solution | Use | Preparation |
|---|---|---|
| Bleach (10%) | Clean nets, other gear, and inside of boat. | Add 400 mL bleach to 3,600 mL distilled water. |
| Lugol's | Preservative for phytoplankton samples. | Dissolve 100 g KI in 1 L of distilled water. Dissolve 50 g iodine (crystalline) in 100 ml glacial acetic acid. Mix these two solutions. Remove any precipitates. Store in the dark. |
| 95% Ethanol | Preservative for benthic invertebrate samples and zooplankton samples. | |

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In addition, inspect the vehicles, boats, and trailers every morning before departure. Pay particular attention to the trailer hitch, electrical connections, tiedowns, air pressure in the tires, and the overall condition of the boats. Refuel vehicles and conduct maintenance activities the night before a sampling trip. Check trailer lights, turn signals, and brake lights before departure.

Label sample containers before departing from the base site. Label and package the sample containers into sample kits prior to departure. Container labels should not be covered with clear tape until all information is completed during sampling at the lake. Store an extra kit of sampling supplies (cubitainers, bottles, chlorophyll-*a* filters, pathogen filters, foil, gloves, and labels) in the vehicles. Inventory these extra supply kits prior to each lake visit.

## 3.2 Lake Verification

Sampling the correct lake and locating the index site (deepest point on the lake) are critical to the sampling design and to making regional lake population estimates about condition. Data collected from the wrong lake are of no value to the Lakes Survey monitoring and assessment efforts. On arriving at a lake, the GPS is a valuable tool to verify the identity and location of a lake, however, lake verification must be supported by all available information (e.g., maps, road signs, and GPS). Do not sample the lake if there is reason to believe it is the wrong lake. Contact the Field Logistics Coordinator to resolve discrepancies.

Rigorous quality assurance practices are observed in the field. To assure accuracy, completeness, and legibility in recording, field forms are completed by one individual and checked by another to verify that all pertinent information is included.

### 3.2.1 Lake Verification at the Launch Site

The field team must verify that the lake is correctly identified and located. Lake verification is based on map coordinates, locational data from the GPS when possible, and any other evidence such as signs or conversations with local residents. Record locational coordinates for the lake on the Lake Verification Form, Side 1 (Figure 3-2(a)). If GPS coordinates are obtained, check the GPS box and record the latitude, longitude, and the type of satellite fix (2D or 3D) for the launch site. Compare the map coordinates given on the lake spreadsheet for the lake with the GPS coordinates displayed for the launch site, and check to see if the two sets of coordinates are within ±15 seconds of latitude and longitude. This distance is approximately equal to the precision of the GPS receiver (±100 m) without differential correction of the position fix. This is the desired level of precision but is not required if it can be confirmed via other methods (e.g., map, landowner confirmation) that the correct sample lake has been located. If GPS coordinates are not available, do not record any information but try to obtain the information at a later time during the visit. A fix may be taken at any time during a lake visit and recorded on the form. Mark the location of the launch site with an "L" on the lake outline sketch on the Lake Verification Form, Side 1 (Figure 3-2(a)).

Record directions to the lake and a description of the launch site on the Lake Verification Form, Side 1 (Figure 3-2(a)). regardless of whether the site is sampled or not. This information is very important and will be used in the future if the lake is revisited by another sampling team. Provide information about signs, road numbers, gates, landmarks, and any additional

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information you feel will be useful to another sampling team in relocating this lake. It is also helpful to describe the distance traveled (miles) between turns. Also describe the launch site on the same form. For example: Can the boat be launched with a trailer? Are there fees? Is the launch paved or does it consist of soft sand? What landmarks are at the launch?

In addition to or in the absence of an accurate GPS reading, use as many of the following methods as possible to verify the site:

- Obtain confirmation from a local person familiar with the area.
- Identify confirming roads and signs.
- Compare lake shape to that shown on a topographic map (USGS 7.5 minute map or equivalent).
- Determine lake position relative to identifiable topographic features shown on the map.

If the lake shape on the USGS topographic map does not correspond with the actual lake shape (which should be sketched on the Lake Verification Form, Side 2 [Figure 3-2(b)]), and you cannot verify the lake by any other means, check "Not Verified" and provide comments on the Lake Verification Form. At each lake, evaluate whether or not the lake meets the study's operational definition of a "lake":

- $\geq$ 4 ha in total surface area
- $\geq$ 1000 square meters of open water
- $\geq$ 1 meter in depth
- Not saline (due to salt water intrusion or tidal influence)
- Not used for aquaculture, disposal-tailings, mine-tailings, sewage treatment, evaporation, or other unspecified disposal use

If the lake does not fit this definition, check "Non-target" in the lake sampled section on the middle of the Lake Verification Form, Side 1 (Figure 3-2(a)) and provide an explanation for not sampling the lake. Add any additional explanation as required. An overview of the lake verification activities is shown in Figure 3-3. (For complete details on the Lake Evaluation process, refer to the companion document *Lake Evaluation Guidelines* [EPA 841-B-06-003]).

Field crew personnel and duties performed at each particular lake should also be recorded. Record the names of each crew member and check off the duties performed by each individual at the bottom of the Lake Verification Form, Side 2 (Figure 3-2(b)).

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Reviewed by (initial): ______

## LAKE VERIFICATION FORM

SITE ID: ____________ DATE: ___/___/______ VISIT: 1 2

SITE NAME: ____________ MODE OF ACCESS: ☐ Vehicle ☐ Hike-In ☐ Aircraft TEAM: ____

### LAKE VERIFICATION INFORMATION

Lake shape compares with map? ☐ YES ☐ NO

Lake verified by (X all that apply): ☐ GPS ☐ Local Contact ☐ Signs ☐ Roads ☐ Topo. Map

☐ Other (Describe Here): ☐ Not Verified (Explain In Comments)

| Coordinates | | Latitude North | Longitude West | Type of GPS Fix |
|---|---|---|---|---|
| MAP | Degrees, Minutes, and Seconds OR Decimal Degrees | | | |
| LAUNCH SITE | Degrees, Minutes, and Seconds OR Decimal Degrees | | | ☐ 2D ☐ 3D |
| INDEX SITE | Degrees, Minutes, and Seconds OR Decimal Degrees | | | ☐ 2D ☐ 3D |

### DID YOU SAMPLE THIS SITE?

☐ YES ☐ NO

If NO, check one reason below and provide explanation:

☐ Not Visited ☐ Inaccessible
☐ Non-target ☐ Other

Explanation if lake not sampled:

### GENERAL COMMENTS:

### DIRECTIONS TO LAKE & LAUNCH SITE (from nearest main road or town):

### LAUNCH SITE DESCRIPTION:

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Figure 3-2(a). Lake Verification Form, Side 1.

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## LAKE VERIFICATION FORM (cont.)

Reviewed by (initial): ______

SITE ID: ____________________ DATE: ___ / ___ / ______

**SKETCH MAP - Arrow Indicates North; Mark site L=Launch X=Index**

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**PERSONNEL**

| NAME | DUTIES Index Site | DUTIES Shoreline | DUTIES Forms |
|---|---|---|---|
| ____________________ | ☐ | ☐ | ☐ |
| ____________________ | ☐ | ☐ | ☐ |
| ____________________ | ☐ | ☐ | ☐ |
| ____________________ | ☐ | ☐ | ☐ |
| ____________________ | ☐ | ☐ | ☐ |
| ____________________ | ☐ | ☐ | ☐ |
| ____________________ | ☐ | ☐ | ☐ |

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Figure 3-2(b). Lake Verification Form, Side 2.

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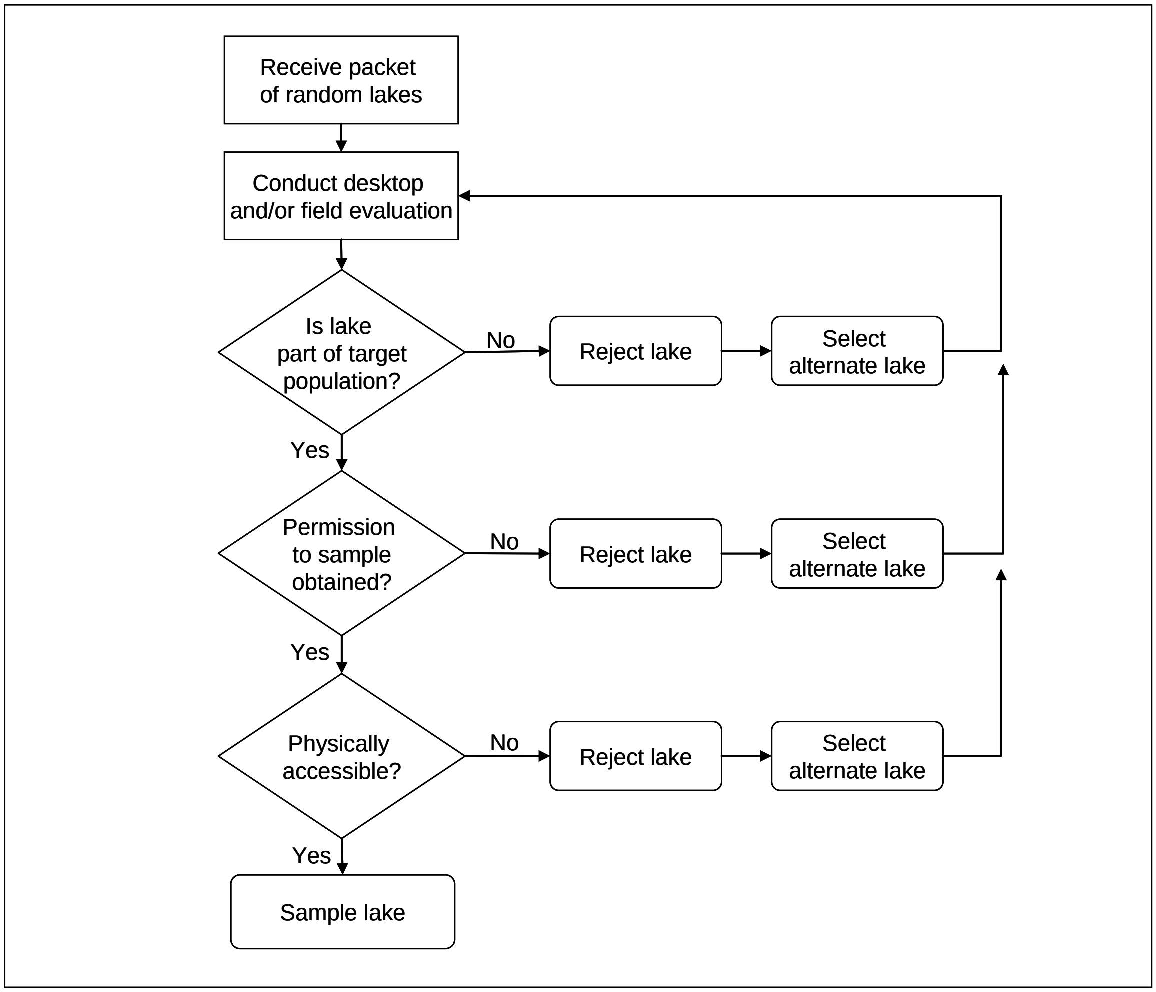


Figure 3-3. Lake verification activities.

### 3.2.2 Lake Verification at the Index Site Location

Estimate the deepest point in the lake (designated as the "index site") by using sonar and a bathymetric map and by observing the lake shape and surrounding topography. Note that for large lake systems (i.e. >5000 ha.), the index site will be the deepest point in the lake nearest to the midpoint of the lake. Table 3-2 outlines sonar operation and procedures for finding the index site. Once in the general area, use the sonar unit to locate the deepest point. When an acceptable site is located, anchor the boat. Lower the anchor slowly to minimize disturbance to the water column and sediment. Determine the coordinates of the index site by GPS (if satellite coverage is available) and record on the Lake Verification Form, Side 1 (Figure 3-2(a)). In addition, check the GPS fix box to indicate the type of satellite fix (2D or 3D) for the index site coordinates. If satellite coverage is not available at that time, try again before leaving the index site. Identify the index site on the sketch map with an "X" on the Lake Verification Form, Side 2 (Figure 3-2(b)).

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Table 3-2. Locating the index site.

| |
|---|
| 1. Operate Sonar unit according to manufacturer's specific operating procedures. If possible, depth readings should be made and recorded in metric units (be sure to specify units on the Lake Profile Form). |
| 2. Use the sonar in the area expected to be the deepest. Spend no more than **30 minutes** searching for the deepest point. Mentally note the location of maximum depth. For Large Lakes (>5000 ha.), the deepest point **nearest to the midpoint** of the lake should be chosen. |
| 3. Return to the location of maximum depth. Anchor the boat. |
| 4. Determine the coordinates using GPS. Record GPS coordinates on Side 1 of the Lake Verification Form. |

Compare the spreadsheet coordinates with those GPS coordinates recorded for the index site. If coordinates at the launch site or the index site are not within ±15 seconds of the map coordinates listed in the spreadsheet, question whether or not you are at the correct lake. Information collected through the other methods described in the previous subsection should always be considered before deciding whether or not the identity of a lake can be verified. If the lake is sampled and coordinates are not within criteria or the lake shape does not match, provide comments justifying your actions on the Lake Verification Form, Side 1 (Figure 3-2(a)).

### 3.2.3 Equipment and Supply List

Table 3-3 is the checklist for equipment and supplies required to conduct protocols described in this section. It is similar to but may be different somewhat from the checklist in Appendix A that is used at a base site to assure that all equipment and supplies are taken to and available at the lake. Field teams should use the checklist presented in this section to assure that the equipment and supplies are organized and available on the boat in order to conduct protocols correctly and efficiently.

Table 3-3. Lake Verification Checklist.

| Equipment and Supplies | Number Needed Each Lake |
|---|---|
| Clipboard | 1 |
| Lake Verification Form | 1 |
| Field notebook | 1 |
| Field Operations Manual and Field Handbook | 1 |
| Survey of the Nation's Lakes Fact Sheets | 20 |
| Sampling permit (if required) | 1 |
| Hand-held Sonar | 1 |
| GPS unit with manual, reference card, extra battery pack | 1 |
| Anchor with 50 m line | 1-2 |
| Float to attach to anchor | 1 |

## 3.3 Post Sampling Activities

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Upon return to the launching location after sampling, the team reviews all labels and completed data forms for accuracy, completeness, and legibility and makes a final inspection of samples. If information is missing from the forms or labels, the Field Team Leader attempts to fill in the information accurately. The Field Team Leader will initial all data forms after review. If obtainable samples are missing, the lake should be rescheduled for complete sampling. Other post sampling activities include: inspection and cleaning of sampling equipment, inventory and sample preparation, sample shipment, and communications.

#### 3.3.1 Equipment Cleanup and Check

Table 3-4 describes the equipment cleaning procedures. Inspect all equipment, including nets, boat, and trailer, and clean off any plant and animal material. This effort ensures that introductions of nuisance species such as Eurasian watermilfoil (*Myriophyllum spicatum*) and zebra mussels (*Dreissena polymorpha*) do not occur between lakes. Prior to leaving a lake, drain all bilge water or live wells in the boat. Inspect, clean, and handpick plant and animal remains from vehicle, boat, motor, and trailer that contact lake water. Inspect and remove any remnants of vegetation or animal life. Before moving to the next lake, if a commercial car wash facility is available, wash vehicle, boat, and trailer and thoroughly clean (hot water pressurized rinse--no soap).

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Table 3-4. Postsampling equipment care.

**1. Clean for biological contaminants (e.g., Eurasian water milfoil, zebra mussels, and alewife).**

-Prior to departing from a lake, drain all bilge water from the boat.

-At the lake, inspect motors, boat, and the trailer for evidence of plant fragments especially in or near the propeller and water intakes. Remove all plant fragments.

-At the lake or base site, dry out nets and buckets and inspect and remove any remnant vegetation or animal life. If an additional set of gear is not available, disinfect gear with 10 percent bleach solution.

-If a commercial car wash facility is available, take vehicle, boat, and thoroughly clean (hot water pressurized rinse--no soap).

**2. Clean and dry other equipment prior to storage.**

-Rinse chlorophyll-*a* and pathogen filtration chambers three times with distilled water after each use.

-Briefly soak zooplankton nets in a dilute bleach solution (10 percent) and dry after each use. Do not dry in sunlight because the mesh is photosensitive.

-Rinse core sampler, sectioning apparatus, and siphon with tap water at the base site.

-Rinse coolers with water to clean off any dirt or debris on the outside and inside.

**3. Inventory equipment and supply needs and relay orders to the Field Logistics Coordinator.**

**4. Remove multi-probe meter and GPS from carrying cases and set up for predeparture checks and calibration. Examine the oxygen membranes for cracks, wrinkles, or bubbles. Replace if necessary.**

**5. Recharge/replace batteries as necessary.**

**6. Recheck field forms from the day's sampling activities. Make corrections and completions where possible, and initial each form after review.**

**7. Replenish fuel and oil.**

### 3.3.2 Shipment of Samples and Forms

The field team ships or delivers time-sensitive samples (i.e., water chemistry, chlorophyll-*a*, pathogens) to the appropriate analytical laboratories as soon as possible after collection. Other samples (i.e., phytoplankton, zooplankton, sediment diatoms, algal toxins, benthic macroinvertebrates) may be shipped or delivered in batches provided they can be adequately preserved. For example, algal toxin samples need to remain completely frozen and cannot be allowed to thaw prior to shipping. Make sure to report all sample shipments to the Information Management Coordinator as soon as possible so that the analytical labs can be notified to receive samples and they can be tracked if they do not arrive when expected.

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One sample tracking form should be filled out for each sample shipment. As mentioned previously, some samples will be sent individually to analytical labs, while others will be sent in batches. On each sample tracking form (Figure 3-4) the following information must be recorded:

- Airbill or package tracking number
- Date sample(s) were sent
- Site ID where each sample was collected
- Sample type code:
    - ALTX – Algal toxin
    - CHEM – Chemistry
    - CHLA – Chlorophyll-*a*
    - PATH – Pathogen
    - SEDI – Sediment core
    - BENT – Benthos
    - PHYT– Phytoplankton
    - ZOOP – Zooplankton
- Date when the sample(s) was collected
- Site visit number (e.g., 1 for first visit, 2 for re-visit)
- Sample ID number encoded on label
- Number of containers for each sample
- Any additional comments

Packaging and shipping guidelines for each type of sample are summarized in Figure 3-5. More detailed sample shipping instructions are presented in Appendix C.

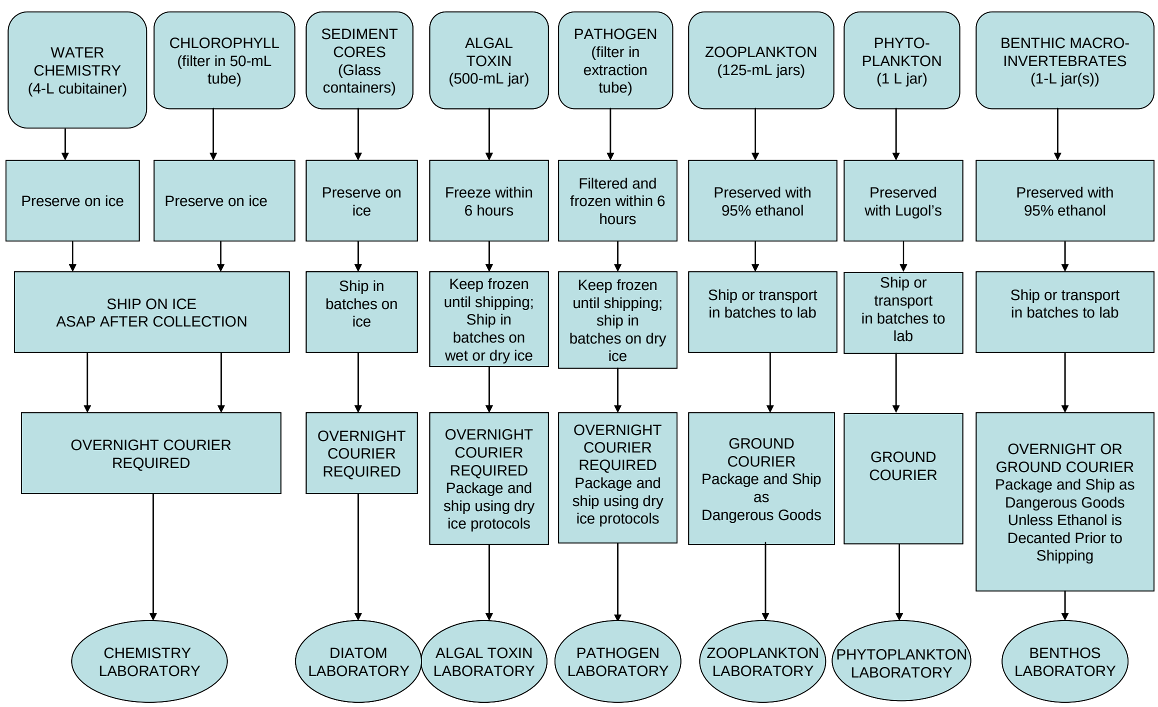


Figure 3-5. Sample packaging and shipping procedures.

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**LAKES - TRACKING**

AIRBILL NUMBER: ____________ DATE SENT: ___/___/______ TEAM: ______

| Site ID | Date Sample Collected MM/DD/YYYY | Visit | Sample ID | Sample Type | # of Containers | Comments | Cond. Code |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
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| Contact Information | Chain of Custody | Sample Types | Condition Codes |
|---|---|---|---|
| PLACE LAB LABEL HERE<br><br>Tracking<br>Marlys Cappaert<br>p) 541-754-4467 | Date Received:<br>___/___/______<br>Received by:<br>______________<br><br>Filled in at lab | UNPRESERVED (ship ASAP)<br>ALTX - Algal toxin<br>CHEM - Chemistry<br>CHLA - Chlorophyll<br>PATH - Pathogen<br>SEDI - Sediment core (Diatoms)<br><br>PRESERVED (ship in batches)<br>BENT - Benthos<br>PHYT - Phytoplankton<br>ZOOP - Zooplankton | C = Cracked jar<br>F = Frozen<br>L = Leaking<br>ML = Missing label<br>NP = Not preserved<br>W = Warm<br>OK = Sample OK<br><br>Filled in at lab |

FAX TRACKING FORM TO 541-754-4637 OR CALL 541-754-4663

Figure 3-4. Lakes Sample Tracking Form.

### 3.3.3 Communications

The Field Logistics Coordinator will be a contractor and will serve as the central point of contact for information exchange among field teams, the management and QA staffs, the information management team, analytical laboratories, and the public (Figure 3-6). The Field Logistics Coordinator also monitors all aspects of field sampling activities and responds to supply replenishment requests. Requests to replenish EPA-provided supplies can be made weekly but are not restricted to that frequency. When possible, teams should inventory their supplies after each lake visit and submit requests well in advance of exhausting on-hand stocks.

Each Field Team Leader must call the Field Logistics Coordinator and provide a brief description of activities during the previous week including lakes visited and sampled, problems encountered, and requests for information. Contact information for the Field Logistics Coordinator is as follows:

- Ms. Jennifer Pitt, EPA Lakes Survey Field Logistics Coordinator (410-356-8993)

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The Field Logistics Coordinator will contact the EPA Headquarters Coordinator to provide regional updates throughout the sampling period. The EPA Headquarters Coordinator will maintain a database of all sampling activities and reconnaissance information.

The Information Management Coordinator monitors all aspects of data form and shipping activities, including coordinating and tracking field sample shipments to the various analytical laboratories. The Field Team Leader must review all data forms for consistency, correctness, and legibility before transfer to the Information Management Center. The Field Team Leader must also provide sample tracking information as soon as possible following sample shipment to the analytical labs. The information can be relayed either by faxing a copy of the sample tracking form to the Information Management Center or by calling in the information recorded on the tracking form. Contact information for the Information Management Center is listed on the bottom of the Lakes Sample Tracking Form (Figure 3-4) and is as follows:

- Sample Tracking (Fax): 541-754-4637
- Sample Tracking (Phone): 541-754-4663
- Ms. Marlys Cappaert, EPA Lakes Survey Information Management Coordinator (541-754-4467)

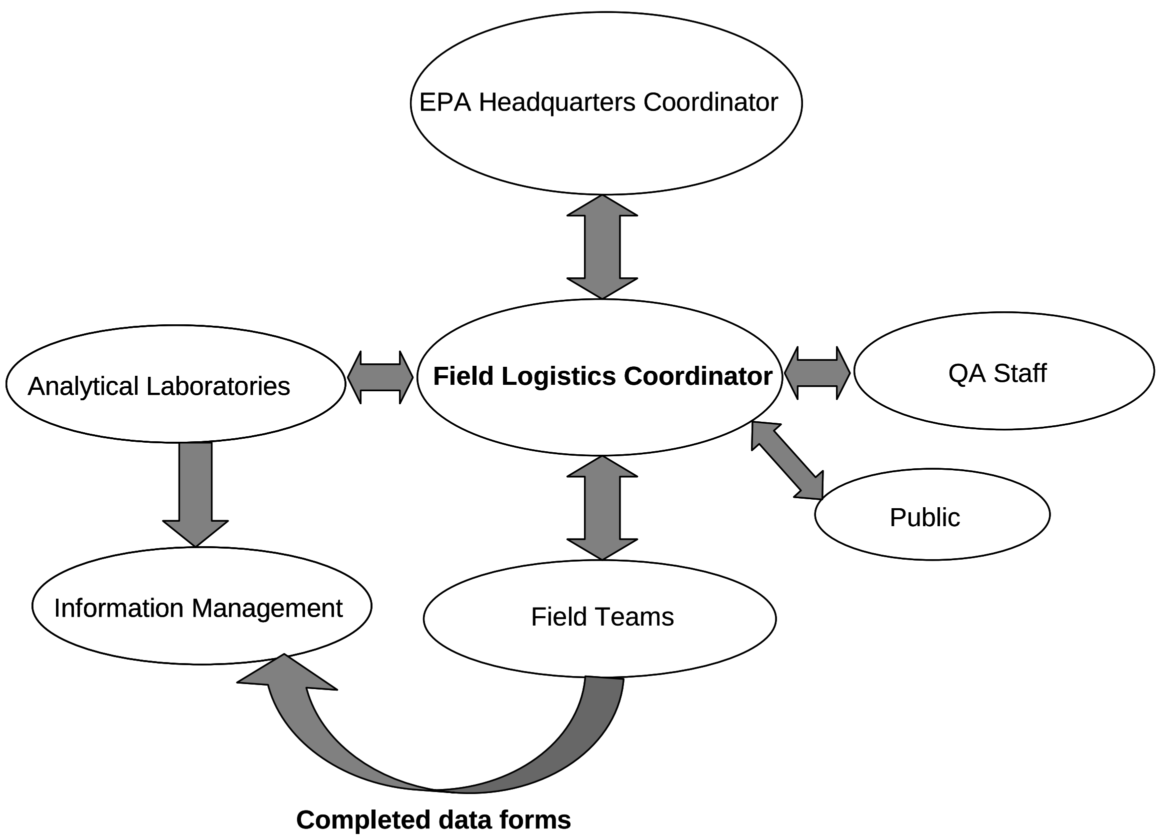


Figure 3-6 Communications flowchart for the Lakes Survey.

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# 4.0 DEEPEST POINT (INDEX SITE) SAMPLING

A variety of measurements and indicators will be taken from the index site of the lake. A detailed description of the individual elements is included here.

## 4.1 Temperature, Oxygen, and pH Profiles

### 4.1.1 Introduction

A temperature, dissolved oxygen (DO), and pH profile is created by lowering a multi-parameter water quality meter (or sonde) by a calibrated cable through the water column and taking readings at predefined depth intervals. The first measurement is just below the lake surface (actually at about 0.3 m depth) and the last measurement is recorded at 0.5 meter from the bottom, or at a maximum depth of 50 m.

The instruments are delicate, and care should be taken to avoid touching the bottom sediments. Therefore, the site depth must be accurately measured before taking the temperature, DO, and pH profile measurements. An accurate depth measurement is also needed to determine the number of measurements needed and entering the depth intervals on the Lake Profile Form.

To make the profile measurement procedure most efficient, use of a multi-probe sonde is recommended. This instrument allows temperature, DO, and pH measurements to be measured simultaneously at each depth interval. There are many models of multi-parameter water quality meters equipped to measure temperature, DO, pH and most will provide reliable data provided they are maintained, calibrated, and operated according to the manufacturer's instructions.

Table 4-1 provides a summary of equipment and supplies needed for field operations to measure temperature, pH, and dissolved oxygen profiles at the index site.

Table 4-1. Equipment and supplies - temperature and dissolved oxygen profiles.

| | |
|---|---|
| For determining water column depth | • Hand-held sonar unit (or a calibrated sounding line, or a calibrated pole for very shallow lakes) |
| For taking profile measurements and calibrating the water quality meter | • Multi-parameter water quality meter with temperature, pH, and DO probes.<br>• 50 m sonde communication cable with length marked in 0.5 m intervals<br>• Extra batteries<br>• Deionized and tap water<br>• Calibration cups<br>• Calibration standards<br>• Barometer or elevation chart to use for calibration |
| For recording profile measurements | • Lake Profile Form<br>• Pencils (for data forms) and permanent markers (for labels) |

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#### 4.1.1.1 Sonde

The multi-probe sonde must be heavy enough, or weighted in some manner, to minimize wobbling as it is lowered and raised in the water column. It is important that the instrument stabilizes in the water when readings are made. The Lakes Survey field team needs to experiment with the sonde prior to sampling and add weight to the cable if needed.

Some state or tribal agencies might want to attach additional probes to the sonde and collect profile data on other parameters. Specific conductance is commonly profiled in lakes through the use of multi-parameter sondes. While not required for the Lakes Survey Program, including this data is not discouraged, and the Lake Profile form is designed to capture these additional data.

#### 4.1.1.2 Temperature Meter

The temperature sensor in most sonde instruments is fairly robust. At a minimum, however, the sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards (NIST) at least once per sampling season. The entire temperature range encountered in the Lakes Survey should be incorporated in the testing procedure and a record of test results kept on file.

#### 4.1.1.3 Dissolved Oxygen Meter

The DO meter must be calibrated prior to each sampling event. It is recommended that the probe be calibrated in the field against an atmospheric standard (ambient air saturated with water) prior to launching the boat. In addition, manufacturers typically recommend periodic comparisons with a DO chemical analysis procedure (e.g., Winkler titration) to check accuracy and linearity. It is important for each field team to develop their own calibration procedures to match the instructions and recommendations for the instruments used in their program.

#### 4.1.1.4 pH Meter

The pH meter must be calibrated prior to each sampling event. It is recommended that a two point calibration be performed using certified calibration standards. If it is known that the lake is acidic, pH 4 and pH 7 standards should be used for calibration; if the lake is known to be basic, pH 7 and pH 10 standards should be used. If the pH trend is not known, a three point calibration is recommended (pH 4, 7, 10) to ensure that the instrument is calibrated within the full range of expected measurements. It is also recommended that quality control check samples (QCCS) be prepared to periodically evaluate instrument precision.

#### 4.1.1.5 Lake Profile Form

The 2-page Lake Profile Form is shown in Figures 4-1(a) and (b). Field team members use the Lake Profile Form to record the following:

- The top portion of page 1 of the Lake Profile Form is used to record environmental conditions observed at the site and overall depth.
- The remaining portion of page 1 is used to record calibration information.. Documentation includes the instrument's manufacturer and model number, identification

number, QCCS values (for pH and conductivity), and the instrument readings. The instrument manufacturer and model should be recorded (e.g., YSI 600XL with 650 display) as well as the instrument's ID number. The purpose of the ID number is to track which instrument provided the data, in the event it is later discovered that the unit was operating in error and will likely be an internal reference number or code supplied by the entity conducting the field sampling.

- The profile table is on page 2. It includes columns to record depth, DO, pH and temperature (as well as optional conductivity) and a column to indicate the location of the metalimnion. It also contains a "Flag" column to note a problem or other conditions of interest.

- The comment section is used to report on "Flagged" measurements or other conditions of note.

### 4.1.2 Procedures for Taking the Temperature, DO and pH Profile

Table 4-2 presents step by step procedures for completing the task associated with taking a temperature, DO, and pH profile at the Index Site.

## 4.2 Secchi Disk Transparency Depth

### 4.2.1 Introduction

The Secchi disk, which has alternating black and white quadrants (Figure 4-2), is a visual contrast device that requires the observer to determine when it disappears and appears against an ambient background. This procedure is typically conducted on the shaded side of the boat without the aid of polarized sunglasses. A team member lowers the disk into the water with a measured line until he/she loses sight of it. The disk is then raised until it reappears. The two depths are recorded and averaged to determine the Secchi disk transparency for the lake.

The Secchi disk should be 20 cm in diameter with alternating black and white quadrants (Figure 4-2). Disks should have a smooth matte (not glossy surface) in order to more equally distribute reflected light in all directions (i.e., making the disk reading less sensitive to sun angle). The disk itself can be made of any material but it must be heavy enough, or weighted in some manner, to minimize wobbling as it is lowered and raised in the water column. It is important that the disk stabilizes in the water when readings are made.

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**LAKE PROFILE FORM**

Reviewed by (initial): ____

SITE ID: ____________ DATE: ___/___/______ TEAM: ____

Precipitation: ☐ NONE ☐ LIGHT ☐ HEAVY Surface Conditions: ☐ FLAT ☐ RIPPLES ☐ CHOPPY ☐ WHITECAPS

Odor: ☐ YES ☐ NO Description:

Scum: ☐ YES ☐ NO Description:

Index Site Depth: (m) ___ . ___

Method Used: ☐ SONAR ☐ POLE ☐ ESTIMATE

Comments:

**CALIBRATION INFORMATION**

Instrument manufacturer and model: ____________

Instrument ID number: ____________ Operator: ____________

**TEMPERATURE**

Thermometer Reading: ___ . ___ (°C)

Sensor Reading: ___ . ___ (°C)

TEMP FLAG

**DO**

Elevation: (m) ___ 0 0 OR Barometric Pressure: (mm Hg) ______

Calibration Value: ___ . ___ (mg/L)

OR: ___ . ___ (%)

Displayed Value: ___ . ___ (mg/L)

OR: ___ . ___ (%)

DO FLAG

**pH**

QCCS Description: ____________

QCCS True: ___ . ___

QCCS Measured: ___ . ___

pH FLAG

**CONDUCTIVITY**

QCCS Description: ____________

QCCS True: ___ . ___ (µS/cm @25°C)

QCCS Measured: ___ . ___ (µS/cm @25°C)

COND. FLAG

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; Q = Unacceptable QC check associated with measurement; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comments section.

| Flag | Comments |
| --- | --- |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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Figure 4-1(a). Lake Profile Form, Page 1.

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LAKE PROFILE FORM (continued)

Reviewed by (initial): ____

SITE ID: ____ DATE: __ / __ / ____ TEAM: ____

**DISSOLVED OXYGEN AND TEMPERATURE PROFILE**

Depth Units: ☐ m ☐ ft

Intervals (m): Surface to 20 m = every 1 m; 20-50 m = every 2 m; last reading 0.5 m above bottom

Intervals (ft): Surface to 66 ft, every 3 ft; 66-164 ft every 6.5 ft; last reading 1.5 ft above bottom

| Depth XX.X | $O_2$ (mg/L) XX.X | Temp. (°C) XX.X | pH XX.X | Cond. (µS/cm@ 25°C) XX.X | Meta-limnion (T, B) | Flag | Depth XX.X | $O_2$ (mg/L) XX.X | Temp. (°C) XX.X | pH XX.X | Cond. (µS/cm@ 25°C) XX.X | Meta-limnion (T, B) | Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| | | | | | | | Dup Surface | | | | | | |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; Q = Unacceptable QC check associated with measurement; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

Is the Duplicate $O_2$ reading within ±0.5 mg/L of the initial surface reading? ☐ YES ☐ NO

| Flag | Comments |
|---|---|
| | |
| | |
| | |
| | |
| | |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

a If the site depth is <3 m, take readings at the surface, every 0.5 m, and 1 m above bottom.
b METALIMNION = The region of the profile where the temperature changes at the rate of 1 °C or greater per meter of depth. Indicate the depth of the top of the metalimnion with a 'T', and the bottom of the metalimnion (when the rate change becomes less than 1 °C per meter) with a 'B'. After i encountered, take readings every 1 m until bottom of the metalimnion is reached.
Record the depth of the top of the metalimnion on the Shoreline Sample Collection Form.

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Figure 4-1(b). Lake Profile Form, Page 2.

Table 4-2. Procedure for measuring the temperature, DO, and pH profile.

| | |
|---|---|
| Calibrate Instrument | Check meter and probes and calibrate according to manufacturers specifications. Enter pertinent calibration information on Page 1 of the Lake Profile Form. |
| Record Site Conditions | Observe site conditions and fill out the "Site Conditions" portion of the Lake Profile Form. Conditions to be reported on include:<br><br>• Precipitation (Choice of "None, "Light," or "Heavy.")<br>• Surface conditions (Choice of "Flat," "Ripples," "Choppy," or "Whitecaps.")<br>• Presence or absence of odor or scum. (Choice of "Yes" or "No" plus space to describe the odor or scum if present.) |
| Determination of Site Depth | Use sonar or other means to determine the depth of the site and record the depth on the Lake Profile Form. Indicate on the form if sonar was not used to determine depth. |
| Determination of Measurement Intervals | The number of readings and the depth intervals taken will depend on the depth at the index site. Below is a list of rules for determining the intervals.<br><br>• The profile will always begin with a measurement just below the surface.<br>• The deepest measurements will always be at 0.5 m above the bottom, or at 50 m if the depth >50 m.<br>• If the site is less than 3.0 meters deep, measurements should be recorded just below the surface and at 0.5 m intervals, until 0.5 m above the bottom.<br>• If the depth is between 3.0-20 m, measurements should be recorded just below the surface, then at 1.0 m, intervals through 20 m (or until reaching 0.5 m above the bottom).<br>• If the depth exceeds 20 m, record at 1.0 m, intervals through 20 m, then record measurements every 2 m starting at 22 m (until 0.5 m above the bottom or the maximum depth of 50 m is reached).<br><br>Using the above rules, record the intervals for the profile in Depth column of the Lake Profile Form. |
| Measure Temperature, DO, and pH | • Lower the sonde in the water and measure the vertical profile of temperature, dissolved oxygen and pH at the predetermined depth intervals.<br>• Record the measurements on the Lake Profile Form.<br>• Flag any measurements that the team feels needs further comment or when a measurement cannot be |

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Table 4-2. Procedure for measuring the temperature, DO, and pH profile.

| | |
|---|---|
| | made.<br>• Use the flag codes on the form and the comment box found on the second page. |
| Repeat Surface DO Measurement | When the profile is completed, take another measurement at the surface, record it, and compare it to the initial surface reading. Mark Yes or No on the form if the second DO reading is within 0.5 mg/L of the initial surface reading. This provides information regarding measurement precision and possible calibration drift during the profile. |
| Determine the Metalimnion | If the lake is thermally stratified, note the top and bottom of the metalimnion in the Metalimnion column. The metalimnion is typically the region of the profile where the temperature changes at a rate of 1 °C or greater per meter of depth. For standardization purposes the metalimnion has been defined in the protocol as an area where water temperature changes at least 1 degree per meter. If an individual has a suspicion that the metalimnion exists but does change at the specified rate they can flag the data form and explain. |

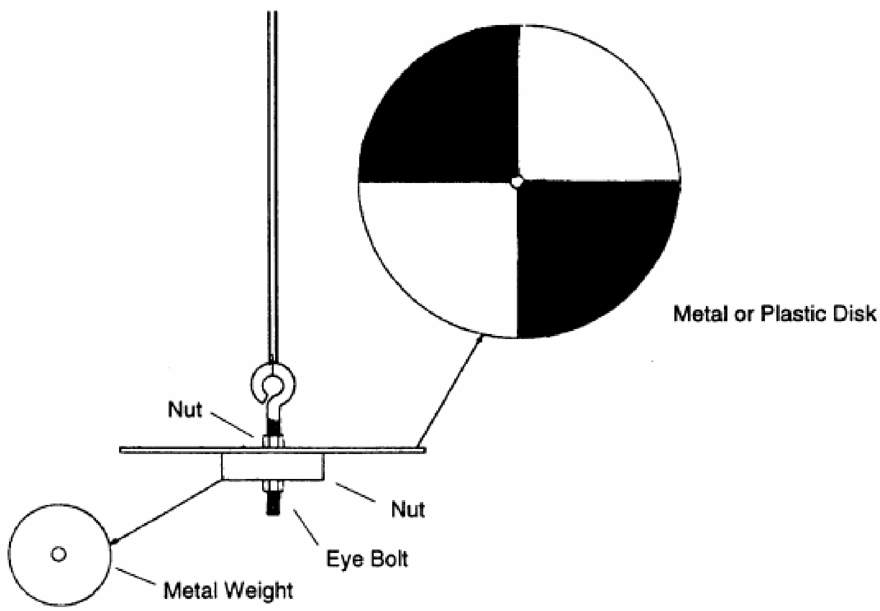


Figure 4-2. Secchi disk diagram (EPA, 1991).

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### 4.2.2 Secchi Disk Lowering Line

The Secchi disk line doubles as a lowering line and a depth measuring device. The line itself should be marked at 0.5 meter intervals and made of a material that does not shrink with repeated wetting and drying (e.g., dacryon, polypropylene, or metal chain).

The equipment and supplies needed for field operations to make the Secchi disk measurement at the index site are listed in Table 4-3.

**Table 4-3.** Equipment and supplies - Secchi transparency

| | |
|---|---|
| For determining Secchi disk depth | • Secchi disk and calibrated sounding line, marked in 0.5 m intervals<br>• Tape measure (cm) |
| For recording profile measurements | • Sample Collection Form<br>• Pencils and permanent markers |

### 4.2.3 Determination of Secchi Transparency

Unlike other parameter measurements, the human observer is an integral part of measurement process. He/she must look down into the water and discern the difference between the disk and its ambient background. Not surprisingly, different people taking a Secchi disk reading at the same site will usually come up with different measurement results. This phenomenon is primarily due to differences in visual acuity and interpretations of disk disappearance/reappearance. Consequently, it is best if one team member is designated as the "official" Secchi disk reader for all the lakes sampled by the team.

Other factors that can affect Secchi disk readings include glare on the water surface, time of day, the nature of the water (e.g., color, suspended material), and shadows created by the boat.

In order to standardize at least some of the environmental conditions, Secchi disk measurements should be made according to the following rules.

- Reading must be made before taking other samples from index point. This prevents disturbance to the water column due to sampling effort before reading is made.
- Take readings on the shady side of the boat (to reduce surface glare).
- Take off sunglasses and **do not** use view scopes or other visual aids. If wearing prescription sunglasses, temporarily replace them with regular clear lens prescription glasses.

States that wish to take additional measurements for comparisons using a viewscope are encouraged to do so **after** completing the Secchi disk measurements following the previously described protocols.

## LAKE INDEX SITE SAMPLE COLLECTION FORM

Reviewed by (initial): ______

SITE ID: ____________________ DATE: ___/___/______

| SECCHI DISK TRANSPARENCY | | | |
|---|---|---|---|
| Depth Disk Disappears (m) | Depth Disk Reappears (m) | Clear to Bottom | Comments |
| ___.___ | ___.___ | ☐ | |

DEPTH OF INTEGRATED SAMPLE FOR WATER CHEM, CHLOROPHYLL, AND PHYTOPLANKTON (TYPICALLY 2 M) ______ m

**WATER CHEMISTRY** (4-L CUBITAINER)

| Sample ID | Sample Type * | Comments |
|---|---|---|
| | R1 | |
| | | |

**CHLOROPHYLL** (Target Volume = 1000 mL; max vol = 2000 mL)

| Sample ID | Sample Type * | Volume Filtered (mL) | Comments |
|---|---|---|---|
| | R1 | | |
| | | | |

**PHYTOPLANKTON** (Target Volume = 1000 mL)

| Sample ID | Sample Type * | Volume Filtered (mL) | Pre-served (ETOH | Comments |
|---|---|---|---|---|
| | R1 | | ☐ | |
| | | | ☐ | |

* Sample Types: R1 = First replicates (index sample), R2 = Field duplicate

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Figure 4-3(a). Lake Index Site Sample Collection Form, Page 1.

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## LAKE INDEX SITE SAMPLE COLLECTION FORM (cont.)

Reviewed by (initial): ____

SITE ID: ______________________ DATE: ___/___/______

| ZOOPLANKTON (Fill to Mark on Bottle = 80 mL) | | | | | | |
|---|---|---|---|---|---|---|
| | Sample ID | Sample Type * | Length of Tow (m) | No. of Jars | Pre-served (ETOH) | Comments |
| COARSE | | R1 | | | ☐ | |
| FINE | | R1 | | | ☐ | |
| | | | | | ☐ | |
| | | | | | ☐ | |

| SEDIMENT CORE SAMPLES (Target Core Length = 35 to 45 cm) | | | | |
|---|---|---|---|---|
| Collected at: | ☐ INDEX<br>☐ OTHER | If OTHER, record GPS coordinates: | Latitude North<br>___ ___ ___<br>___ . ______ | Longitude West<br>___ ___ ___<br>___ . ______ |

| Sample Class | Sample ID | Sample Type * | Length of Core (cm) | No. of Jars | INTERVAL (cm) From | INTERVAL (cm) To | Comments |
|---|---|---|---|---|---|---|---|
| TOP | | R1 | | | | | |
| BOTTOM | | R1 | | | | | |
| | | | | | | | |
| | | | | | | | |

* Sample Types: R1 = First replicates (Index sample), R2 = Field duplicate

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Figure 4-3(b). Lake Index Site Sample Collection Form, Page 2.

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#### 4.2.4 Sample Collection Form

Data from the Secchi disk readings will be recorded on page 1 of the Lake Index Site Sample Collection Form, as seen in Figure 4-3(a). This form will also be used to record data related to the collection of the water chemistry sample, phytoplankton sample, and chlorophyll-*a* sample.

A Field Team member records the following in the Secchi disk portion of the Lake Index Site Sample Collection Form:

- The depth that the Secchi disk disappears.
- The depth that the Secchi disk reappears.
- If the Secchi disk is still visible at the bottom of the lake, mark a check box.
- Any comments concerning the measurements.

#### 4.2.5 Procedures for Taking the Secchi Disk Reading

Step by step procedures for taking the Secchi disk reading are presented in Table 4-4

Table 4-4. Procedure for measuring Secchi transparency.

1. Confirm the lowering line is firmly attached to the Secchi disk.
2. Remove sunglasses.
3. Lower the Secchi disk over the shaded side of the boat until it disappears.
4. Read the depth indicated on the lowering line. If the disappearance depth is <1.0 m, determine the depth to the nearest 0.05 m by marking the line at the nearest depth marker and measuring the remaining length with a tape measure. Otherwise, estimate the disappearance depth to the nearest 0.1 m. Record the disappearance depth on the Sample Collection Form.
5. Lower the disk a bit farther and then slowly raise the disk until it reappears and record the reappearance depth on the Sample Collection Form.
6. Note any conditions that might affect the accuracy of the measurement in the comments field.

If the lake is shallow and the water clear, the Secchi disk might reach the bottom and still be visible. If this is potentially the case, it is important to not stir up the bottom sediments while anchoring the boat. Be sure and move the boat away from the anchor before taking the reading. If indeed the disk is visible at the bottom of the lake, indicate this on the form.

### 4.3 Water Sample Collection and Preservation

#### 4.3.1 Introduction

Lakes Survey team members will draw four 2-L samples of water from the upper two meters of the water column (within the euphotic zone) at the index site using a 2 m long integrated sampler device. The samples are analyzed in the laboratory for several water chemistry and biological parameters (see Table 1-1). For most lakes the euphotic zone will

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easily extend two meters or more into the water column (i.e., the Secchi disk reading is 1 m or more) and taking a vertical sample is appropriate. If a lake is especially murky, however, the euphotic zone might not extend to 2 m depth. In this case, the same volume of water will be collected, but it will be drawn obliquely (i.e., an angle < 90° from water surface), not vertically, and only to the estimated depth of the euphotic zone (2x Secchi depth).

Below is a list of equipment and supplies needed for field operations to collect water samples at the index site.

Table 4-5. Equipment and supplies - water samples.

| | |
|---|---|
| For collecting water samples | • Integrated sampler (MPCA design)<br>• Surgical gloves (non-powdered) |
| For storing and preserving water samples | • One 4L cubitainer<br>• HDPE sample bottles (one 1L and two 2 L sample bottles)<br>• Wet ice<br>• Dry ice<br>• Lugol's solution<br>• Coolers |
| For filtering chlorophyll-*a* sample | • Whatman GF/F or equivalent 0.7 µm glass fiber filter<br>• Filtration apparatus with graduated filter holder<br>• Hand pump<br>• 50-mL screw-top centrifuge tube<br>• DI water<br>• Aluminum foil |
| For documenting the collection of water samples | • Sample Collection Form<br>• Pencils and permanent markers |

### 4.3.2 Integrated Sampler

The sampler used in the Lakes Survey Program is based on an integrated sampler device developed by the Minnesota Pollution Control Agency (MPCA). It is constructed using a 2 meter long and 3.2 cm diameter PVC pipe with stopper plugs fitted for both ends (Figure 4-4). When used properly, it draws a 2 L sample volume from the surface to 2 m depth. The collected water is then composited as a single depth-integrated sample (when emptied into a 4 L cubitainer).

To take a sample, a team member lowers the sampler fully into the water column, plugs the top end and then lifts the sampler out of the water. If the top end is well-sealed the water column sample will remain in the sampler intact. Once out of the water, a container is positioned at the lower end, the top end is unplugged, and the water pours into the container. The operation takes practice but once mastered it can be done efficiently and without sample spillage.

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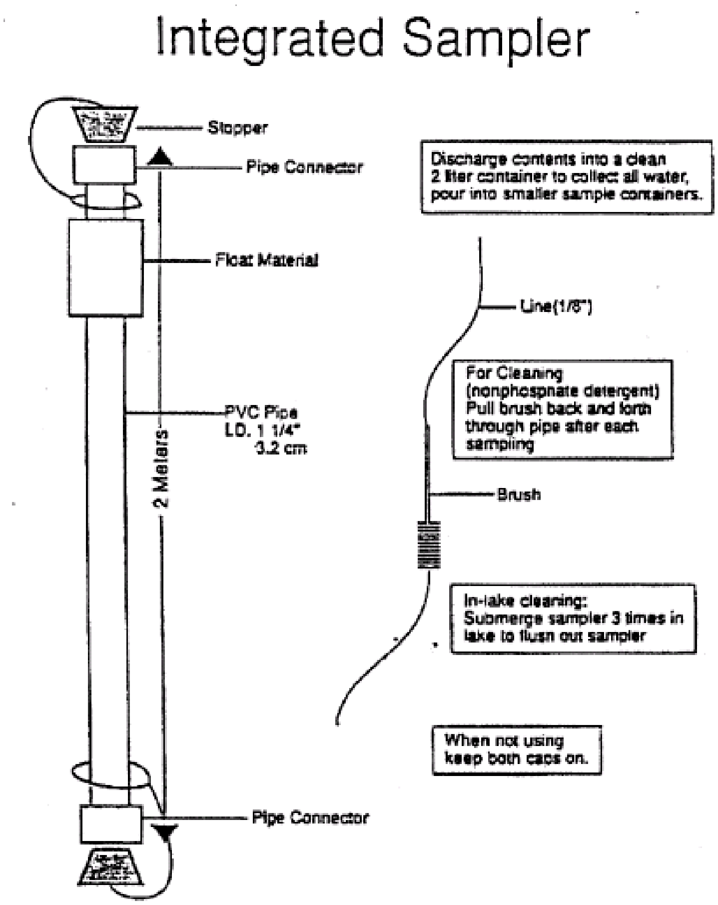


Figure 4-4. Integrated water sampler device (MPCA).

### 4.3.3 Sample Collection Form

The 2-page Lake Index Site Sample Collection Form is shown in Figures 4-3 (a) and (b). The form is used to record and document: (a) Secchi disk transparency depth measurement, (b) water sample collection, (c) sediment core sampling, (d) zooplankton collection, e) phytoplankton collection and (e) chlorophyll-*a* sample processing.

### 4.3.4 Procedures for Taking Water Samples

The field team collects a total of four integrated samples from the lake (Figure 4-5). The water samples are transferred from the sampler and collected in (a) one 4 L cubitainer (samples #1 and #2), (b) one 2 L sample bottle for chlorophyll-*a* filtering, and (c) .one 2 L sample, which is mixed thoroughly and poured into a 1 L bottle for phytoplankton processing (Sample #3).

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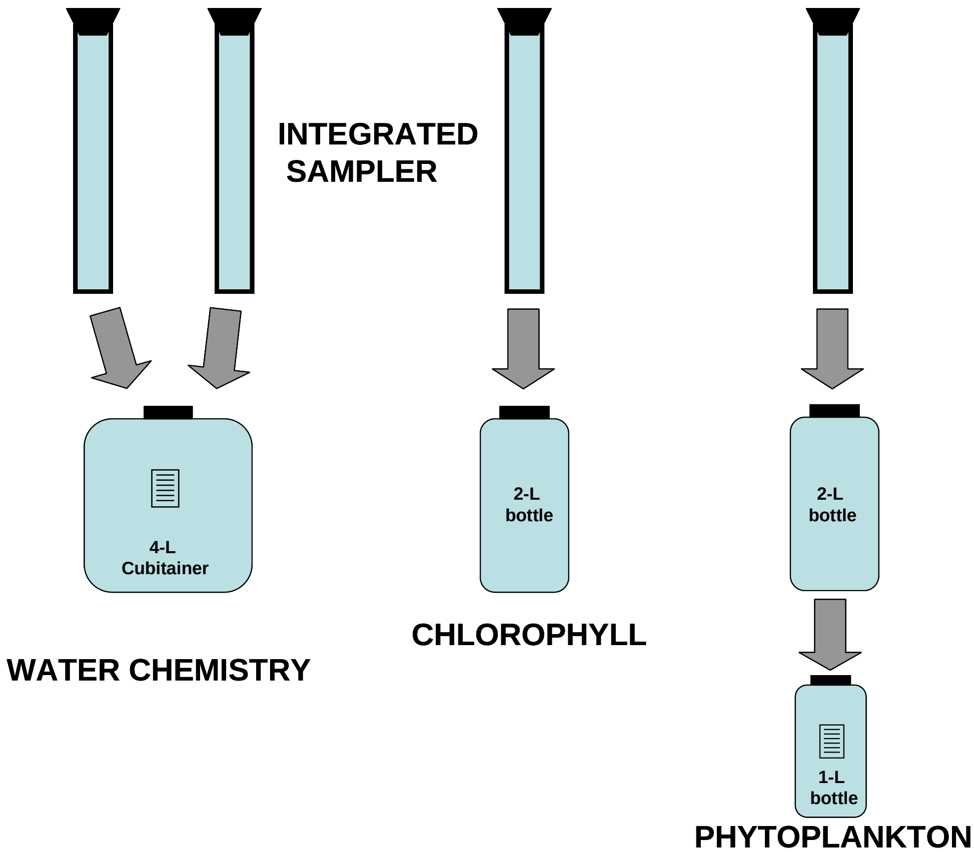


Figure 4-5. Procedure for using the integrated sampler device to collect depth-integrated samples

#### 4.3.4.1 Collecting the Integrated Water Samples

Detailed step-by-step procedures for collected integrated water samples are presented in Table 4-6.

Table 4-6. Procedure for collecting the integrated water samples.

1. Make sure all the water sample containers have the same bar code and the labels are completely covered with clear tape.
2. Put on surgical gloves (non-powdered). Do not handle any food, drink, sunscreen, or insect repellant until after the water chemistry sample has been collected.
3. Remove the rubber stopper caps on both ends of the sampler and field rinse by submerging it three times in the lake and draining. Do this on the opposite side of the boat you plan to sample from.
4. Slowly lower the sampler into the lake as vertically as possible. Stop when the upper end is just below the surface.
5. Cap the upper end with the rubber stopper firmly and slowly raise the sampler.
6. When the bottom of the sampler is near the surface, another team member reaches underneath and caps the bottom end.

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Table 4-6. Procedure for collecting the integrated water samples.

7. Lift the sampler in the boat, keeping it as vertical as possible.
8. For Pull #1, pour the contents into the 4 L cubitainer to use for rinsing (3 small portions of lake water that are discarded).
9. Take Pull #2 and also pour the collected water into the 4 L cubitainer. Seal the cap tightly and wrap electrical tape clockwise around the cap. Place the cubitainer in a cooler with sealed 1-gal plastic bags of ice.
10. Take Pull #3 and pour the water sample into the 2 L bottle. This is the chlorophyll sample, which will be filtered on shore (see Section 4.3.4.2). Immediately after the sample is collected, wrap bottle in aluminum foil to minimize exposure to light and place on ice until filtration can be initiated.
11. Take Pull #4 and pour the water sample into a 2 L bottle. Cap the bottle and mix thoroughly. Then uncap the bottle and fill one 1 L sample bottle (labeled for phytoplankton) allowing enough headspace to add ~20-25 mL of preservative.
12. Add a small amount of Lugol's solution (~20-25 mL) until the sample resembles the color of weak tea, shake well, and place the bottle in the cooler with sealed 1-gal plastic bags of ice.

#### 4.3.4.2 Process the Chlorophyll-*a* Sample

Procedures for processing chlorophyll-*a* samples are presented in Table 4-7. Whenever possible, sample processing should be done in subdued light, out of direct sunlight.

Table 4-7. Procedure for processing Chlorophyll-a sample.

1. Put on surgical gloves.
2. Place a glass fiber filter (Whatman GF/F or equivalent 0.7 µm filter) in the graduated filter holder apparatus. Do not handle the filter with bare hands; use clean forceps.
3. Pour the 250 mL of water into the top of the filter holder, replace the cap, and pump the sample through the filter using the hand pump. If 250 mL of lake water will not pass through the filter, change the filter, rinse all apparatus with DI water, and repeat the procedures using 100-mL of lake water measured in a 100-mL graduated cylinder. Filtration pressure should not exceed 7 psi to avoid rupture of fragile algal cells. (Occasionally, the pump dials have a systematic offset from 0 psi with no pressure applied. In this case, add 7 psi to the at rest value to obtain the maximum value. Example: If the value at rest = 5 psi (rather than 0 psi) then, 5 + 7 = 12 psi = the maximum apparent pressure allowed on the pressure gauge during filtration).

   NOTE: IF the water is green or turbid, use a smaller volume to start with. IF the filter clogs before all of the sample in the upper chamber has passed through the filter, you must discard the filer and sample and start again with a smaller volume.
4. Remove the bottom portion of the apparatus and pour off the water from the bottom.
5. Replace the plugs. Pour and pump a second 250-mL portion (or less if you think the filter might clog) of the sample through the same filter. The total sample volume after this portion is filtered is 500 mL. Skip this step if the first 250 mL of

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Table 4-7. Procedure for processing Chlorophyll-a sample.

water would not pass through the filter. If the filter clogs before all of the second 250-mL portion is filtered, discard the filter and prepare a new sample using a smaller volume (100 mL). Record the total volume filtered on the Sample Collection Form and on the sample label.

6. Rinse the upper portion of the filtration apparatus thoroughly with DI water to include any remaining cells adhering to the sides and pump through the filter. Monitor the level of water in the lower chamber to ensure that it does not contact the filter or flow into the pump.
7. Observe the filter for visible color. If there is visible color, proceed; if not, repeat steps 3 through 5 until color is visible on the filter or until a maximum of 2,000 mL have been filtered. Record the actual sample volume filtered on the Sample Collection Form and on the sample label.
8. Remove the filter from the holder with clean forceps. Avoid touching the colored portion of the filter. Fold the filter in half, with the colored side folded in on itself.
9. Place the folded filter into a 50-mL screw-top centrifuge tube and cap. Record the sample volume filtered on a chlorophyll label and attach it to the centrifuge tube (do not cover the volume markings on the tube with the label). Ensure that all written information is complete and legible. Cover with a strip of clear tape. Double check that the amount for the total volume of water filtered that is recorded on the Sample Collection Form matches the total volume recorded on the sample label. Wrap the tube in aluminum foil to keep the light out and then place in a self-sealing plastic bag. Place this bag between two small bags of ice in a cooler.
10. Rinse graduated cylinders and filter chambers with de-ionized (DI) water.

## 4.4 Sediment Diatom Collection

### 4.4.1 Introduction

Lakes Survey team members will use a corer to extract a sediment sample at the index site and then slice off the top and bottom of the core for analysis in the laboratory. The results will be used to compare current conditions with past conditions based on the diatom frustule abundance and composition. The bottom core sample collected from natural lakes will not be dated (using radioisotopes or other means) so it will be impossible to pinpoint the age of the bottom of the core. Nonetheless, this investigation will provide a general indication of how the lake has changed over time.

Table 4-8 lists equipment and supplies needed for field operations to collect a sediment core sample.

Table 4-8. Equipment and supplies - sediment core sample.

| | |
|---|---|
| For collecting sediment core sample | • Modified KB corer<br>• Plexiglas sectioning apparatus<br>• Core tubes<br>• Siphon tube with a bent plastic tip |

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| | |
|---|---|
| For storing and preserving sediment core sample | • Natural Lakes: two small glass containers with Teflon coated lids<br>• Reservoirs: one small glass container with a Teflon coated lid |
| For documenting the collection of sediment core sample | • Sample Collection Form<br>• Pencils and permanent markers |

### 4.4.2 Modified KB Corer and Sectioning Apparatus

Figure 4-6 is an illustration of the modified KB corer used in the Lakes Survey Program. Core tubes will be marked at 45cm.

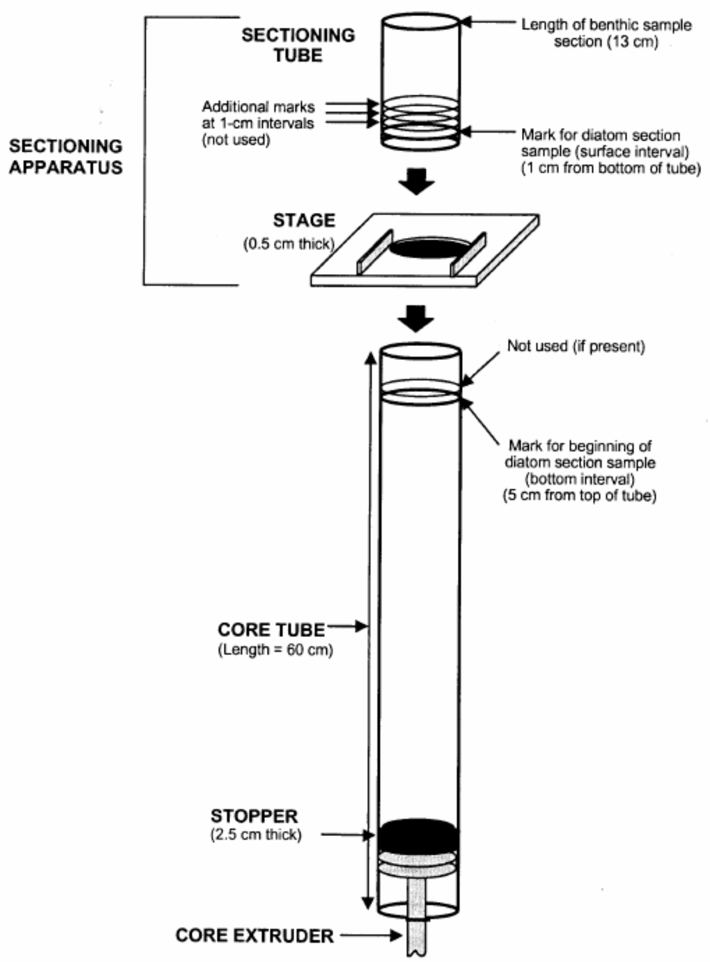


Figure 4-6. Modified KB corer diagram (EMAP).

### 4.4.3 Sample Collection Form

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Record on page 2 of the Lake Index Site Sample Collection Form (Figure 4-3[b]) pertinent information for sample ID, core length, measured interval of the core used for top and bottom, location collected, and associated comments. If collected from a location other than the index site, GPS coordinates for the collection location should also be recorded.

### 4.4.4 Procedures for Collecting and Processing a Sediment Core

The goal of Lakes Survey Program's sediment diatom sampling is to collect a 45 cm long sediment core from undisturbed sediments, and section off 1 cm of sediment from the top and bottom (for natural lakes) of the core for analysis. In natural lakes, the composition and texture of the bottom will vary from lake to lake and, in some lakes, it will be impossible to get a 45 cm core because the bottom is too rocky, the sediments too dense, or, if it a shallow lake, there are macrophytes covering the bottom. In deep lakes (>50 m), it may be necessary to shift the collection location to a shallower (<50 m) area of the lake so that a core sample may be obtained. In this case, a location as close to the index site as possible should be selected (while avoiding any potential bias). It is essential that the GPS coordinates be recorded and the collection location be marked on the Lake Verification Form, Side 2 (Figure 3-2(b)).

If the team collects a core less than 45 cm on the first try they should try moving to another location near the index site with the intent of finding an area with a softer bottom. In addition the team can experiment with getting improved penetration by releasing the corer further above the sediments. If a 45 cm core sample cannot be collected from these natural lakes waterbodies, the longest core that the team can obtain should be processed.

Detailed procedures for collecting and processing sediment cores are presented in Table 4-9.

Table 4-9. Procedure for Collecting a Sediment Core.

*Collect the Sediment Core from Natural Lake*

1. Record the lake ID and the date on two sample labels. Mark one label for the top interval and the second for the bottom. Attach the labels to two small glass containers. Record the bar code number on the collection form.
2. If the bottom has been disturbed during the initial depth determination or for any other reason, move at least 5 m to take the core. It is critical that the corer strikes undisturbed surface sediments.
3. Put on surgical gloves. They must be worn during sample collection because the sediments may contain contaminants.
4. Insert the core tube into the sampling housing apparatus and tighten the hose clamp screws to secure the tube.
5. Attach the messenger to the sampler line and slowly lower the corer through the water column until the bottom of the core tube is 0.5 m above the sediment surface. While maintaining a slight tension on the line, let the line slip through the hands and allow the corer to settle into the bottom sediments. Immediately after the corer drops into the sediments, maintain line tension to prevent the corer from tilting and disturbing the core sample. (Keep in mind that the goal is to obtain a core 45 cm in length. If this core length is not obtained the first time, the

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Table 4-9. Procedure for Collecting a Sediment Core.

operation might need to be repeated at a new site using a greater release height in order to improve penetration and attain a longer core.)

6. Trip the corer by releasing the messenger weight so that it slides down the line.
7. Slowly raise the corer back to the surface, until the core tube and rubber seal are just under the water.
8. While keeping the seal under water, slowly tilt the corer until you can reach under the surface and plug the bottom of the corer with a rubber stopper. To do this without disturbing the water-sediment interface, you cannot tilt the corer more than 45 degrees. (This is a fairly difficult operation and stoppers are easily lost. Be sure to have spares available at all times.)
9. Raise the corer into the boat in a vertical position. Stand the corer in a large tub to prevent contaminating the boat with sediment material.

*Process the Sediment Core from a Natural Lake*

1. Detach the core tube from the corer. One team member should hold the sampler in a vertical position while the second person dismantles the unit.
2. Remove the water above the sediment core by using a siphon tube with a bent plastic tip so that the surface sediments are not disturbed.
3. Measure the length of the core to the nearest 0.1 cm and record the interval on the Sample Collection Form and on the two sample labels.
4. Slowly extrude the sample. To do this, position the extruder under the stopper at the base of the coring tube. Supporting both the core tube and the extruder in a vertical position, slowly lower the coring tube until the sediment is approximately 1 cm below the top of the tube. Place the Plexiglas sectioning apparatus (marked with a line 1 cm from the bottom) on the stage directly over the coring tube. Slowly lower the tube and attached sectioning apparatus until the top of the sediment reaches the 1-cm line on the sectioning tube. Slide the top 1 cm section of sediment into the glass container labeled for the top interval. Record this interval on the Sample Collection Form and on the sample label for the top core.
5. Before collecting the bottom section, remove the sectioning apparatus and rinse in lake water. This procedure prevents contamination of the bottom sediment layer with diatoms from the upper portion of the core. This step is critical as a small amount of sediment contains millions of diatoms which would destroy the population structure needed to compare environmental conditions depicted by top and bottom core samples.
6. Continue extruding the sample, discarding the central portion in the tube, until the bottom of the stopper is approximately 5 cm (3 inches) from the top of the coring tube. Affix the sectioning apparatus to the top of the tube. Extrude the sample until the bottom of the stopper reaches the lower black line at the top of the tube (approximately 5 cm from the top of the tube). Section the extruded sediment and discard. Rinse the sectioning tube with lake water. Without removing the sectioning apparatus from the coring tube, slightly tilt the tube and wash the sectioning stage with a small amount of water from a squirt bottle. Make sure the rinse water runs off the stage and not into the coring tube with sediment. Lower the tube until the top of the sediment is at the 1-cm mark on the sectioning tube. Collect the 1-cm section of core material in the second glass container labeled for the bottom interval. Record this interval on the Sample Collection Form and on the sample label for the bottom core.

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Table 4-9. Procedure for Collecting a Sediment Core.

7. Cover the labels on each glass container completely with clear tape. Place containers in a cooler with bags of ice.
8. Rinse the corer, collection apparatus, and sectioning apparatus thoroughly with lake water. Rinse with tap water at the base site.

*Collect the Sediment Core from a Reservoir*

1. Record the lake ID and the date sample label. Mark the label for the top interval. Attach the label to the small glass container with Teflon coated lid. Record the bar code number on the collection form.
2. Put on surgical gloves. They must be worn during sample collection because the sediments may contain contaminants.
3. Insert the core tube into the sampling housing apparatus and tighten the hose clamp screws to secure the tube.
4. Attach the messenger to the sampler line and slowly lower the corer through the water column until the bottom of the core tube is 0.5 m above the sediment surface. While maintaining a slight tension on the line, let the line slip through the hands and allow the corer to settle into the bottom sediments. Immediately after the corer drops into the sediments, maintain line tension to prevent the corer from tilting and disturbing the core sample.
5. Trip the corer by releasing the messenger weight so that it slides down the line.
6. Slowly raise the corer back to the surface, until the core tube and rubber seal are just under the water.
7. While keeping the seal under water, slowly tilt the corer until you can reach under the surface and plug the bottom of the corer with a rubber stopper. To do this without disturbing the water-sediment interface, you cannot tilt the corer more than 45 degrees. (This is a fairly difficult operation and stoppers are easily lost. Be sure to have spares available at all times.)
8. Raise the corer into the boat in a vertical position. Stand the corer in a large tub to prevent contaminating the boat with sediment material.

*Process the Sediment Core from a Reservoir*

1. Detach the core tube from the corer. One team member should hold the sampler in a vertical position while the second person dismantles the unit.
2. Remove the water above the sediment core by using a siphon tube with a bent plastic tip so that the surface sediments are not disturbed.
3. Measure the length of the core to the nearest 0.1 cm and record the interval on the Sample Collection Form and on the sample label.
4. Slowly extrude the sample. To do this, position the extruder under the stopper at the base of the coring tube. Supporting both the core tube and the extruder in a vertical position, slowly lower the coring tube until the sediment is approximately 1 cm below the top of the tube. Place the Plexiglas sectioning apparatus (marked with a line 1 cm from the bottom) on the stage directly over the coring tube. Slowly lower the tube and attached sectioning apparatus until the top of the sediment reaches the 1-cm line on the sectioning tube. Slide the top 1 cm section of sediment into the glass container labeled for the top interval. Record this interval on the Sample

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Table 4-9. Procedure for Collecting a Sediment Core.

| |
|---|
| Collection Form and on the sample label for the top core.<br>5. Cover the label on the glass container completely with clear tape. Place container in a cooler with bags of ice.<br>6. Rinse the corer, collection apparatus, and sectioning apparatus thoroughly with lake water. Rinse with tap water at the base site. |

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## 4.5 Zooplankton Collection

### 4.5.1 Introduction

Zooplankton are primary consumers. They feed on algae, bacteria, and detritus. In freshwater they mainly consist of three groups; rotifers, cladocerans, and copepods. Often passed over in limnological investigations they are nonetheless a critical part of the food web. By looking a species composition and abundance scientists can infer in much about food web dynamics including fish ecology, as well as water quality conditions.

The field team will collect two zooplankton samples from the water column, by performing two separate vertical tows 0.5 meters from the bottom (or to a maximum depth of 50 m) to the surface using a fine mesh (80 μm) Wisconsin nets and a coarse mesh (250 μm) net (Figure 4-7). If the depth of the index site is less than 2 m and the Secchi disk could be seen at the bottom, a second 1.5 m tow is made and the samples combined (total tow length=3 m).

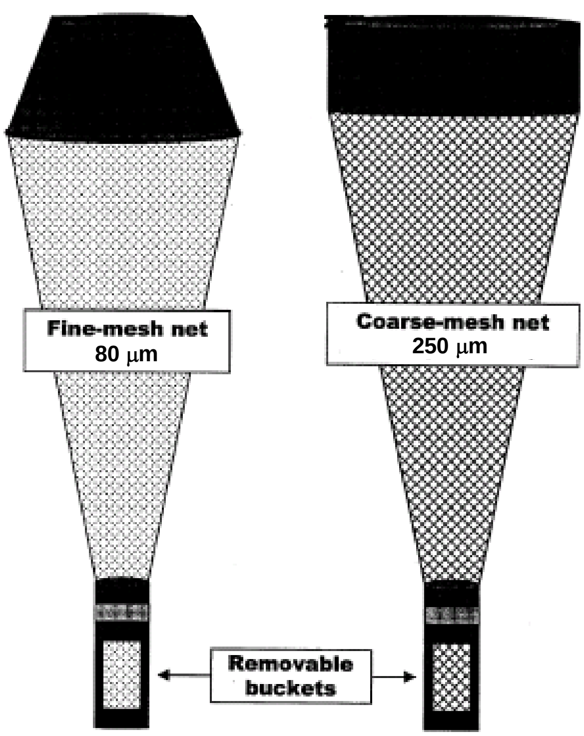


Figure 4-7. Wisconsin net and collection bucket diagram

### 4.5.2 Equipment and Supplies

Table 4-10 lists equipment and supplies needed for field operations to collect the zooplankton sample.

Table 4-10. Equipment and supplies - zooplankton sample.

| | |
|---|---|
| For collecting zooplankton sample | • Wisconsin net (80 m mesh)and collection bucket Squirt bottle with DI water<br>• Wisconsin net (250 µm mesh)and collection bucket<br>• calibrated line, marked in 0.5 m increments |
| For storing and preserving zooplankton sample | • 125 ml sample bottles<br>• Squirt bottle with DI water<br>• 95% ethanol<br>• Alka-seltzer or club soda<br>• 500 mL container<br>• Self-sealing plastic bag |
| For documenting the collection of zooplankton sample | • Sample Collection Form<br>• Pencils and permanent markers |

### 4.5.3 Procedures for Collecting and Processing the Zooplankton Sample

Step-by-step procedures for collecting and processing zooplankton samples are shown in Table 4-11

Table 4-11. Procedure for Zooplankton Collection.

*Collect the Zooplankton Samples*

1. Record the lake ID on the sample label.
2. Prior to each use, carefully clean and thoroughly rinse the interior of the plankton nets and buckets with DI water.
3. Carefully inspect the nets and buckets for holes or tears.
4. Attach the collection buckets to the "cod" end of the nets and secure.
5. Attach the bridled end of the plankton net to a ¼" calibrated line with markings every 0.5 m (you could use the line for the Secchi disk if necessary).
6. Carefully and slowly, lower the first net in a constant upright position over the side of the boat.
7. Continue lowering the net until the mouth of the net is 0.5 meters above the lake bottom. If the lake is deeper than 50 m, lower the net to a depth of 50 m and proceed.
8. Retrieve the net by pulling back to the surface at a steady constant rate without stopping (0.3 m or 1 ft per second).
9. Once at the surface, slowly dip the net up and down in the water without submersing the net mouth and help rinse contents into the collection bucket.

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Table 4-11. Procedure for Zooplankton Collection.

10. Complete the rinsing of the net contents by spraying water against the outside of the net with a squirt bottle or similar tool.
11. Holding the collection bucket in a vertical position, carefully remove the bucket from the net.
12. Concentrate the contents of the collection bucket by swirling the bucket without spilling the contents. Excess lake water will filter out of the bucket from the screened sides.
13. Repeat steps 6-12 with the second net on the opposite side (or end) of the boat.

*Process the Zooplankton Samples*

1. Carefully remove the mesh bucket from its net. Set the bucket in a 500-mL container filled three-fourths full with lake water to which an Alka-Seltzer tablet has been added. Alternatively, club soda may also be used. The $CO_2$ narcotizes the zooplankton to relax their external structure prior to preservation in 95% ethanol. This facilitates taxonomic identification. Wait until zooplankton movement has stopped (usually about 1 minute).
2. Record the sample ID number and check on the Sample Collection Form that it is preserved.
3. Use small volumes of DI water from a squirt bottle to rinse the contents of the mesh net bucket into the polyethylene jar. Rinse bucket with DI water three to four times or until the majority of zooplankton have been removed. Drain the remaining filtrate into the sample container. Fill the jar of zooplankton to the mark (~80 mL or a little more than half full) with 95% ethanol.
4. In some cases, the volume of zooplankton collected in bucket may exceed 125 mL. Do not try to force all of the sample into a single bottle or the preservative will not function properly and the sample may be lost. In such cases, use a second bottle to preserve the additional amount of sample. Use an "extra jar" label (i.e., one with no bar code printed on it). Complete the label, and print in the bar code assigned to the first container on the label of the second container. On the Sample Collection Form, record a "2" in the "No. Containers" field.
5. Record the length of the tow and net mesh size on the Sample Collection Form and on the sample labels. Verify that all information on the labels and the form is complete and correctly recorded. Cover each label completely with a strip of clear tape.
6. Seal the lids of the jars by wrapping electrical tape in a clockwise direction so that the lid is pulled tight as the tape is stretched around it. Place jars in a self-sealing plastic bag.
7. Repeat steps 1-6 for the second sample collected.

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## 5.0 LITTORAL AND SHORELINE ACTIVITIES

To better understand the character of near-shore habitats and conditions, the Lakes Survey team will travel to 10 evenly spaced stations around the lake and document conditions and characteristics observed within a defined plot area. It should be noted, however, that for lakes with a surface area of greater that 5,000 ha (defined as Large Lakes) the Lakes Survey team will not be required to travel to the shoreline stations and perform physical habitat assessments or benthic macroinvertebrate sampling due to the increased level of effort required to complete such large areas. Additionally, such lakes will require modified procedures for collecting pathogen and algal toxin samples (see Sections 5.3 and 5.4, respectively).

Figure 2-2 displays the placement and distribution of stations around the lake. The plot area itself measures 25 m by 15 m and include portions of the riparian zone (shoreline and uplands) and the littoral zone. Figure 5-1 displays the plot dimensions of a shorezone station used in the Lakes Survey.

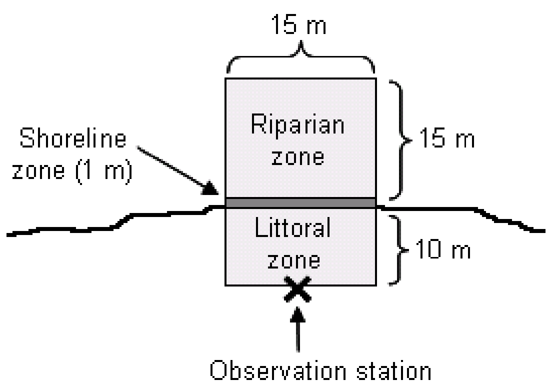


Figure 5-1. Dimensions and layout of a shorezone station.

The approximate locations of the 10 stations are determined prior to the sampling visit and marked on the Lake Verification Form, side 2 (Figure 3-2(b)). Once on the water, the Lakes Survey field team travels to a station site and establishes the dimensions of the survey plot. The survey begins by measuring a perpendicular line 10m from the shoreline. This spot is marked with a buoy and will be the vantage point that the team will record riparian observations. It is also the point that bisects the open water end of rectangular plot. The remaining dimensions of the plot are visually estimated.

The riparian portion of the plot is 15 m deep into the upland (beginning at the shoreline) and 15m across (15 m is about 3 standard canoe lengths). In this zone the team records information about the vegetation type and the height and aerial coverage of trees, shrubs, and grasses. Observing the shoreline they record information about the material makeup of the shoreline (e.g., gravel, sand), the high-water mark, and bank slope. Cultural landmarks and other features (e.g., land use, docks will also be noted).

The littoral region of the lake is that portion of the shoreward profile susceptible to the habitation of autotrophic plants, and is the region of fluctuating water level between the high and low water marks (Ruttner 1969). The littoral portion of the plot will measure 10 m distance from buoy to shoreline and 15 m across (7.5 m on either side of the boat). At the buoy, the field team will measure the water depth. The team notes any surface film or algae growth in the zone and probes the sediments to determine the type (e.g., gravel, sand) and areal extent of the bottom substrate. In addition they observe and estimate the aerial extent of macrophytes and habitat/cover and use a simple coding system to characterize habitat and cover within the littoral plot. All the observations are recorded on a 2-page Physical Habitat Characterization Form (Figures 5-2 a and b).

Lake physical habitat and shoreline disturbances are characterized based on observations of the lake riparian and littoral habitat at 10 physical habitat (P-Hab) stations spaced evenly around the lake. The full array of measurements and sampling described in this chapter include:

- measures or observations of littoral and riparian physical habitat structure at 10 P-Hab stations;
- collection of water samples for pathogen analysis;
- collection of water samples for algal toxin analysis; and
- sampling of benthic macroinvertebrates at each of the 10 stations and composited as a single sample.

## 5.1 Locating the Physical Habitat Stations and Defining the Shoreline Boundary

The initial P-Hab station (i.e., Station A) is randomly selected before arriving at the lake. A photocopy of each lake outline should be made (1:100:000 topographic map) and then magnified to fit on an 8.5" x 11" paper (suitable magnifications are available from Topozone - http://www.topozone.com/). A random starting point (i.e., Station A) on the lake outline should then be assigned prior to beginning sampling activities (i.e., in the office before beginning field work). Any reasonable method may be used to randomly select the starting point (e.g. tossing a coin on the map, place a compass on the map in the center of the lake and find due north). It is important that the remaining nine stations be located at equal distances around the lake going in a clockwise direction (see Figure 2-2). This can be done using a string to trace the perimeter of the lake, which can then be straightened and marked in equal intervals, or by using a planimeter wheel to measure the perimeter and dividing by 10.

The 10 P-Hab stations locations (marked A through J) are shown on a preprinted lake outline map provided as part of the dossier compiled for each lake.

The outline with the assigned stations is then included as part of the site dossier for the lake. Starting at the nearest boat access point, proceed by boat around the lake near the shore, observing bank, shoreline, emergent, and subsurface characteristics. Using the preprinted lake map and a topographic map or GPS unit, locate and stop at each of the 10 P-Hab stations. Mark each station with flagging, then position the boat at a distance of 10 m (~30 ft, offshore), anchor if necessary, and make the semi-quantitative measurements on the Physical Habitat Characterization Form, (Figure 5-2(a)). A separate Physical Habitat Characterization Form will be completed for each station. Make every reasonable attempt to record physical habitat observations and measurements for all 10 P-Hab stations. Where this is impossible, record a "K" flag in each field to clearly indicate on the form that no observations could be made at that particular station.

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Reviewed by (Initials): ________

## SHORELINE RIPARIAN HABITAT FORM - LAKES

SITE ID: ____________ DATE: __ __ / __ __ / __ __ __ __

STATION: ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H ☐ I ☐ J ☐ K

### LITTORAL ZONE

Surface Film Type:
☐ Scum ☐ Algal Mat ☐ Oily ☐ None/Other

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%)
3 = Heavy (40-75%) 4 = Very Heavy (>75%)

| BOTTOM SUBSTRATE | | | | | | Flag |
|---|---|---|---|---|---|---|
| Bedrock (>4000mm; larger than a car) | 0 | 1 | 2 | 3 | 4 | |
| Boulders (250-4000mm; basketball-car) | 0 | 1 | 2 | 3 | 4 | |
| Cobble (64-250mm; tennis ball-basketball) | 0 | 1 | 2 | 3 | 4 | |
| Gravel (2-64mm; ladybug to tennis ball size) | 0 | 1 | 2 | 3 | 4 | |
| Sand (0.06 - 2mm; gritty between fingers) | 0 | 1 | 2 | 3 | 4 | |
| Silt, Clay, or Muck (<0.06mm; not gritty) | 0 | 1 | 2 | 3 | 4 | |
| Woody Debris | 0 | 1 | 2 | 3 | 4 | |

Color:
☐ Black ☐ Gray ☐ Brown ☐ Red ☐ None or Other

Odor:
☐ $H_2S$ ☐ Anoxic ☐ Oil ☐ Chemical ☐ None

| MACROPHYTES | | | | | | Flag |
|---|---|---|---|---|---|---|
| Submergent | 0 | 1 | 2 | 3 | 4 | |
| Emergent | 0 | 1 | 2 | 3 | 4 | |
| Floating | 0 | 1 | 2 | 3 | 4 | |
| Total Weed Cover | 0 | 1 | 2 | 3 | 4 | |

Do macrophytes extend lakeward? ☐ Yes ☐ No

| FISH COVER | | | | | | Flag |
|---|---|---|---|---|---|---|
| Aquatic Weeds | 0 | 1 | 2 | 3 | 4 | |
| Snags > 0.3 M Dia. | 0 | 1 | 2 | 3 | 4 | |
| Brush/Woody Debris <0.3 m dia. | 0 | 1 | 2 | 3 | 4 | |
| Inundated Live Trees >0.3 m dia | 0 | 1 | 2 | 3 | 4 | |
| Overhanging Veg. =<1 m of Surface | 0 | 1 | 2 | 3 | 4 | |
| Ledges or Sharp Dropoffs | 0 | 1 | 2 | 3 | 4 | |
| Boulders | 0 | 1 | 2 | 3 | 4 | |
| Human Structures-Docks, Landings, etc | 0 | 1 | 2 | 3 | 4 | |

#### LITTORAL FISH HABITAT CLASSIFICATION

Disturbance: ☐ Human ☐ Natural ☐ Mixed

Cover Class: ☐ Cover ☐ Open ☐ Mixed

Cover Type: ☐ Artificial ☐ Fill ☐ Veg. ☐ Woody ☐ Boulders ☐ Mixed ☐ None

Substrate: ☐ Mud/Muck ☐ Sand/Gravel ☐ Cobble/Boulder ☐ Bedrock

### RIPARIAN ZONE

Vegetation Type:
☐ Deciduous ☐ Coniferous ☐ Mixed ☐ None

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%)
3 = Heavy (40-75%) 4 = Very Heavy (>75%)

| CANOPY (>5 m high) | | | | | | Flag |
|---|---|---|---|---|---|---|
| Big Trees (Trunk >0.3 m dBH) | 0 | 1 | 2 | 3 | 4 | |
| Small Trees (Trunk <0.3 m dBH) | 0 | 1 | 2 | 3 | 4 | |

| UNDERSTORY (0.5 TO 5m high) | | | | | | Flag |
|---|---|---|---|---|---|---|
| Woody Shrubs & Saplings | 0 | 1 | 2 | 3 | 4 | |
| Tall Herbs, Grasses, & Forbs | 0 | 1 | 2 | 3 | 4 | |

| GROUND COVER (<0.5 high) | | | | | | Flag |
|---|---|---|---|---|---|---|
| Woody Shrubs & Saplings | 0 | 1 | 2 | 3 | 4 | |
| Herbs, Grasses and Forbs | 0 | 1 | 2 | 3 | 4 | |
| Standing Water or Inundated Vegetation | 0 | 1 | 2 | 3 | 4 | |
| Barren, Bare Dirt or Buildings | 0 | 1 | 2 | 3 | 4 | |

| SHORELINE SUBSTRATE ZONE | | | | | | Flag |
|---|---|---|---|---|---|---|
| Bedrock (>4000mm; larger than a car) | 0 | 1 | 2 | 3 | 4 | |
| Boulders (250-4000mm; basketball-car size) | 0 | 1 | 2 | 3 | 4 | |
| Cobble/Gravel (64-250mm; ladybug ball-basketball size) | 0 | 1 | 2 | 3 | 4 | |
| Sand (0.06 - 2mm; gritty between fingers) | 0 | 1 | 2 | 3 | 4 | |
| Silt, Clay, or Muck (<0.06mm; not gritty) | 0 | 1 | 2 | 3 | 4 | |
| Woody Debris | 0 | 1 | 2 | 3 | 4 | |

#### HUMAN INFLUENCE (Flag)

0 = Not Present
C =Present within plot
P = Observed adjacent to or behind plot

| | | | | Flag |
|---|---|---|---|---|
| Buildings | 0 | C | P | |
| Commercial | 0 | C | P | |
| Park Facilities | 0 | C | P | |
| Docks/Boats | 0 | C | P | |
| Walls, dikes or revetments | 0 | C | P | |
| Landfill/Trash | 0 | C | P | |
| Roads or Railroad | 0 | C | P | |
| Row Crops | 0 | C | P | |
| Pasture/Range/Hay Field | 0 | C | P | |
| Orchard | 0 | C | P | |
| Lawn | 0 | C | P | |

#### BANK FEATURES (within plot)

Angle: ☐ Near Vertical/Undercut ☐ 30-75° ☐ <30° ☐ >75°

Vertical distance from waterline to high water mark: ___ ___ ___ . ___ (m)

Horizontal distance from waterline to high water mark: ___ ___ ___ . ___ (m)

Flag codes: K = No measurement or observation made;
U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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Figure 5-2(a). Example Physical Habitat Characterization Form, Side 1.

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PHYSICAL HABITAT CHARACTERIZATION - LAKES (continued)

SITE ID: ______________ DATE: ___ / ___ / ______

**INVASIVE PLANTS AND INVERTEBRATES**

| Littoral Plot | | | Shoreline/Riparian Plot | | |
|---|---|---|---|---|---|
| SPECIES | X if observed | FLAG | SPECIES | X if observed | FLAG |
| NONE OBSERVED | ☐ | | NONE OBSERVED | ☐ | |
| Zebra or Quagga Mussel | ☐ | | Purple loosestrife | ☐ | |
| Eurasian watermilfoil | ☐ | | Knotweeds | ☐ | |
| Hydrilla | ☐ | | Hairy willow herb | ☐ | |
| Curly pondweed | ☐ | | Yellow floating heart | ☐ | |
| African waterweed | ☐ | | Giant salvinia | ☐ | |
| European water chestnut | ☐ | | Flowering rush | ☐ | |
| Water hyacinth | ☐ | | | ☐ | |
| Parrot feather | ☐ | | | ☐ | |
| | ☐ | | | ☐ | |
| | ☐ | | | ☐ | |
| | ☐ | | | ☐ | |

| Flag | Comments |
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Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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2007 Physical Habitat Characterization Form - Lakes 02/14/2007

Figure 5-2(b). Example Physical Habitat Characterization Form, Side 2.

### 5.1.1 Shoreline Adjustments

Once in the field, the field team might run into conditions for problems that will require modifications to the shoreline and/or station location(s) as drawn on the sketch map. If this occurs, the field team makes the corrections and adjustments on the Lake Verification Form and the Physical Habitat Characterization Form and notes reasons on the comments section of the form. The general guidelines for locating or modifying the location of the littoral and shoreline stations are summarized in Table 5-1.

Table 5-1. General guidelines for locating or modifying the location of littoral and shoreline stations.

| **At Each Physical Habitat (P-Hab) Sampling Station:** | |
|---|---|
| 1. | Locate station using maps or GPS units, and mark with flagging. |
| 2. | Define shore as either the current waterline OR the boundary between open water and the edge of dense vegetation (terrestrial, wetland, or emergent vegetation) or extensive very shallow water. |
| 3. | If the shoreline observed in the field differs from the mapped shoreline, enter a comment on the Physical Habitat Characterization Form (Side 2) stating the apparent reason (e.g., drought, flooding, dredging). |
| 4. | If a P-Hab station is lost because of shoreline changes, position one or more new stations at approximately equal intervals. Add an X to the station letter at the top of the Physical Habitat Characterization Form. |
| 5. | If a station is eliminated, enter "K" flags on the Physical Habitat Characterization Form to indicate no observations. |
| 7. | If the shoreline observed in the field differs radically from the mapped shoreline and you are sure you are at the correct lake, draw a new map on the same page as the original lake. Use a string to measure the new outline, divide it into 10 equal parts, and lay out the 10 station locations. |
| 9. | At each of the 10 P-Hab stations, position the boat at an observation point 10 m from shore. Drop buoy at observation point. |
| 10. | Limit shoreline and riparian observations to an area 15 m (50 ft) wide by 15 m (50 ft) inland from shore, and littoral observations to an area 15 m wide (50 ft) by 10 m (30 ft) from shore to the boat. |
| 11. | Record littoral and riparian characteristics on side 1 of the Physical Habitat Characterization Form. Record any observed invasive plants and invertebrates, as well as any additional comments on side 2 of the Physical Habitat Characterization Form. |
| ** For most categories, multiple items may have very heavy (4), heavy (3), moderate (2), sparse (1) or absent (0) cover ratings.* | |

The shoreline is defined as the interface between "lake-like" conditions and riparian or wetland conditions. In most cases the shoreline will be easily identified as the current waterline. In some instances, however, the shoreline might not be obvious. Listed below are some general situations and rules that should be applied.

- If there has been a big drop in lake level due to drought, dam repair, or other reasons, shallow areas may be exposed that are usually covered with water. In this case,

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consider the current waterline as shoreline for the purposes of this survey, not the normal waterline.

- If there are extensive very shallow areas, or shoal-type areas, consider the shoreline to be the boundary between the shallow area and deeper open water.
- If access to the true shoreline is prevented by an area of dense aquatic or terrestrial vegetation, consider the shoreline to be the boundary between the vegetation and deeper open water.

All adjustments to the shoreline based on field observations should be drawn directly on the Sketch Map and noted on the comments page of the Physical Habitat Characterization Form. It will hopefully be a very rare instance that the preprinted lake map will not in any way match the lake shoreline. If this occurs, the field team will need to survey the lake, draw a new sketch map, and establish the 10 P-Hab stations. A quick way to locate 10 evenly-spaced P-Hab stations is to: (a) lay a piece of string on the lake perimeter, (b) pick up the string, measure it, and mark out 10 equal parts, and (c) lay the string back on the perimeter and use the marks to locate the 10 sites on the map.

### 5.1.2 Relocating, Adding, and Eliminating Stations

The goal of the physical habitat characterization survey is to observe conditions at 10 evenly spaced P-Hab sites around the lake. Adjustments to station locations might be needed if the field team runs into unusual conditions or problems. Below are some rules concerning modifications to the station location(s).

<u>Actual shoreline is different than appears on the map</u>

- If only a small portion of the shoreline differs and it does not affect, or only slightly affects, a P-Hab site location, sketch the lake shoreline on the Sketch Map and reposition the station (if needed).
- If the difference causes a contraction of the shoreline and a P-Hab station location is lost, the field team should sketch the lake shoreline on the Sketch Map and make a decision to (a) keep the station, relocate it on the revised shoreline map and adjust some or all other stations in order to keep stations evenly spaced around the lake (i.e., keep 10 stations), or (b) eliminate the station altogether (i.e., reduce the number of stations).
- If the difference causes an expansion of the shoreline the team should sketch the lake shoreline on the Sketch Map and make a decision to (a) add one or more stations, mark them on the revised shoreline map and adjust some or all other stations if needed so they are evenly spaced around the lake (i.e., designate more than 10 stations), or (b) adjust the stations so they are evenly spaced around the lake (i.e., keep 10 stations). On larger lakes the field team should try to maintain the goal of 10 stations.

<u>P-Hab Station is inaccessible</u>

- If a P-Hab station is inaccessible the field team must make a decision to (a) relocate the station and adjust some or all other stations so they are evenly spaced around the lake (i.e., keep 10 stations), or (b) eliminate the station altogether (i.e., reduce the number of stations). The size of the lake will help drive this decision. On larger lakes the field team should try to maintain the goal of 10 stations.

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### 5.1.3 Identifying Relocated and New Stations on the Form

The field team should use the following notations when recording station location modifications.

- If a station is relocated, note the new location on the Sketch Map, and label the station with the original letter with an added "X." For example, if station "C" is moved, the new station name is "CX." The team also must cross check the box for Station "C" and also the box for "X" on the Physical Habitat Characterization Form to indicate that the station is "CX."
- If a station is lost and cannot be replaced, cross out the original station location on the pre-printed lake map and fill in each of the data boxes with "K" to indicate that no observations were made at the designated station and note the reason in the comments.
- If one or more stations are added, note the locations on the Sketch Map, and label the new stations as "X". Use a blank Physical Habitat Characterization Form and label the new stations appropriately.

At each P-Hab station, make observations and measurements of the shoreline from the boat which is 10 m offshore (estimated by eye). It is important to be at the proper distance from shore, and to limit bank and shoreline observations at each station to the area that is within your field of vision. The littoral and riparian observation plots have fixed dimensions (Figure 5-1) that are estimated by eye. Littoral measurements pertain to the water and lake bottom in the 10 m (30 ft) distance between the boat and the shoreline and extending 15 m (50 ft) along the shore. Riparian observations at each station pertain to the adjacent land or wetland area that is 15 m wide and extends 15 m back onto land. The bank angle and shoreline substrate observations refer to a narrower shoreline zone that extends 1 m landward from the waterline.

The shoreline boundary is defined as the approximate interface between "lake-like" conditions and riparian or wetland conditions. In cases where the lake shoreline is not obvious (e.g., where there is evidence of large seasonal change in lake level) define the shoreline as the current waterline. In cases where the lake shoreline is not visible, define the lake shoreline as the approximate boundary between open water and swamp or marsh conditions into which your boat could not easily move.

## 5.2 Physical Habitat Characterization Form and Instructions

Use the ranking system based on areal coverage in evaluations of riparian vegetation, shoreline substrate, littoral bottom substrate, and aquatic macrophytes. The five entry choices range from 0 (absent) to 4 (>75% cover) and are defined in Table 5-2, which lists steps required to complete the Physical Habitat Characterization Form (Figures 5-2 (a) and (b)). The second page of the form is left for comments. When ranking cover or substrate type, mixtures of more than one class might all be given sparse (1), moderate (2), or heavy (3) rankings. One dominant class with no clear subdominant class might be ranked 4 with all the remaining classes either sparse (1) or absent (0). Two dominant classes with more than 40 percent cover can both be ranked 3.

Table 5-2. Completing the physical habitat characterization form.

| | |
|---|---|
| **General** | 1. **Fill in a Physical Habitat Characterization Form at each of the 10 P-Hab stations, clearly indicating from which station the observations have been** |

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Table 5-2. Completing the physical habitat characterization form.

| | |
|---|---|
| | **made**.<br>**2. Survey plot dimensions:**<br>• Riparian Vegetation – 15 m along shoreline and 15 m back onto land.<br>• Shoreline Substrate and Bank Angle – 15 m along shore and 1 m back.<br>• Littoral (in lake) – 15 m along shoreline and 1 m out into lake<br>3. Use **semi-quantitative ranking** for vegetation, substrate, aquatic macrophytes & fish cover:<br>• Very heavy (greater than 75% coverage) = 4<br>• Heavy (40 to 75% coverage) = 3<br>• Moderate (10 to 40% coverage) = 2<br>• Sparse (present, but less than 10% coverage) = 1<br>• Absent = 0 |
| **Riparian Habitat** | **1. Divide shoreline vegetation into 3 categories:**<br>• Greater than 5 m high = canopy layer<br>• 0.5 to 5 m high = understory layer<br>• Less than 0.5 m high = ground cover layer<br>*(Grasses or woody shrubs and tree branches can occur in >1 layer. The ground cover layer may be vegetation, water, barren ground, or duff.)*<br>2. **Record the type of vegetation** in the two tallest shoreline vegetation layers (canopy & understory) as none, deciduous, coniferous, or mixed. Define mixed as a segment where at least 10% of the areal coverage is made up of the alternate vegetation type.<br>3. **Estimate the areal cover of the shoreline vegetation**, recording the % of each coverage type within 3 vegetation classes (canopy, understory, and ground cover):<br>4. **Rate the shoreline substrate** 1 m into the riparian plot for areal coverage in particle size classes shown on the Physical Habitat Characterization Form.<br>5. **Describe the angle of the shoreline bank** back 1 m from the edge of the water<br>**6.** Estimate the **vertical and horizontal distances between the present lake level and the high water line.**<br>7. Record presence of each **human influence** type<br>8. **Record invasive plant or invertebrate species** observed. |
| **Littoral Habitat** | 1. **Measure lake depth** 10 m from shore at each P-Hab station, noting new location if the point has to be relocated for some reason.<br>2. **Note the presence or absence of water surface scums, algal mats, or oil slicks**.<br>3. **Determine the lake bottom substrate** visible from the boat. If the bottom is not visible, attempt to collect a sample or characterize by remote sensing with a sounding tube (e.g., PVC tubing).<br>4. **Rank the littoral substrate sediment particle size**, making multiple probes if the bottom is not visible. If the bottom is covered with logs, sticks, or other organic debris, choose "woody debris." If the substrate is concealed and remote sampling is not possible, use "Not observed" flag (K).<br>5. **Note sediment color and odor** if a sample can be seen or collected.<br>6. **Estimate the areal coverage of the 3 aquatic macrophyte types**: submerged, emergent, and floating within the 10 x 15 m swath between the boat and shoreline. If you cannot see or probe the bottom with tube or anchor, move closer to shore and note your new location in the white space in the "Bottom Substrate" section.<br>7. **Record fish habitat cover** observed from the shore to the boat and 15 m along shore.<br>8. **Record fish habitat microhabitat classification** for 10 m by 15 m littoral area.<br>9. **Record invasive plant or invertebrate species** observed. |

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For the fish habitat cover entry fields, circle 0 for absence of listed habitat features, 1 if they are present but sparse, 2 if they are moderate, 3 if they are abundant, or 4 if they are very abundant. On the human influence entry fields, circle "C" if present within the shoreline plot. Record a "P" if visible but adjacent or behind (outside) the plot, or "0" for absence of listed features. If, for some reason, you cannot make measurements at a station, record a "K" flag in all data fields for that station. This entry is very important, as there is no other way of determining whether your intent is to record the absence of features or to denote a missed station.

Entering data qualifiers ("flags") on the Physical Habitat Characterization Form is slightly different than for the other data forms. As there is no defined "FLAG" field for each variable, flags are entered into the data field itself. For any particular measurement variable, if no effort is made to collect data, or if you make an effort but for some reason are unable to obtain data, enter a "K" flag in the data field. Explain on the Physical Habitat Characterization Form (side 2) in the section designed for comments why data could not be obtained. If you collect data for a variable but have reason to believe it is suspect (or it was collected using a nonstandard protocol), enter a "U" flag in the data field. In the comments section, record the data value itself and explain why you think it is suspect (or describe what nonstandard procedure was used and why).

### 5.2.1 Riparian Zone Habitat Characterization

The riparian habitat characterization includes riparian vegetation cover, shoreline substrate, bank features, and human influences. Record all measures or observations for these categories on the Physical Habitat Characterization Form (Figures 5-2 a and b).

#### 5.2.1.1 Riparian Vegetation Cover

To characterize riparian vegetation, observe the visible area from the shoreline back a distance of 15 m (50 ft) from the shore. If the high water mark is more than 15 m away from shore, this area includes parts of the shore that are sometimes inundated. If the "shoreline" boundary (defined as the approximate interface between "lake-like" conditions and riparian or wetland conditions) is an inundated wetland, then this area includes the wetland vegetation. Conceptually divide the shoreline vegetation into three layers:

- Canopy (>5 m high)
- Understory Layer (0.5 to 5 m high)
- Ground Cover Layer (<0.5 m high).

Note that several vegetation types (e.g., grasses or woody shrubs) can potentially occur in more than one layer. Similarly note that some things other than vegetation are possible entries for the "Ground Cover" layer (e.g., water or barren ground), as indicated in Table 5-2. Before estimating the areal coverage of the vegetation layers, record the type of vegetation

- deciduous,
- coniferous,
- mixed, or
- none

in each of the two taller layers (Canopy and Understory). Consider the layer "Mixed" if >10% of the areal coverage is made up of the alternate vegetation type.

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#### 5.2.1.2 Shoreline Substrate

Rank, by areal coverage (very heavy, heavy, moderate, sparse, and absent) particle size classes of the substrate that are visible in the 1-m wide strip nearest to the lake shoreline. These size estimates are made by eye from the boat, using the size classes defined on Side 1 of the Physical Habitat Characterization Form. If the inorganic substrate is obscured by vegetation, choose "Vegetated"; if there is another type (e.g., organic flotsam), record its coverage rank in the "other" category and then identify the category in the comments section.

#### 5.2.1.3 Bank Type and Evidence of Lake Level Changes

Choose the bank angle description that best reflects the current shoreline that is dominant within your field of vision and 1 m into the riparian plot: Near vertical/undercut (>75 degrees, steep (>30 to 75 degrees), or gradual, (0 to 30 degrees). Estimate the vertical difference between the present level and the high water line; similarly, estimate the horizontal distance up the bank between current lake level and evidence of higher level.

#### 5.2.1.4 Human influences

Select "C" for any and all of the human activities and influences that you observe within the defined lake and riparian observation areas. If present adjacent to the plot or within your field of vision behind (outside) the defined observation area, choose "P." Select "0" if human activity is not present in either lake or riparian areas.

### 5.2.2 Littoral Zone Habitat Characterization

Lake depth at the observation point of each littoral station is taken using the sonar, calibrated Secchi disk line, or the marked PVC sounding rod. Measure depth at each of the P-Hab stations, 10 m (30 feet) offshore. Note the presence or absence of water surface scums, algal mats, or oil slicks; on the form. All measurements or observations in the following categories are recorded on the Physical Habitat Characterization Form.

#### 5.2.2.1 Bottom substrate

To characterize littoral bottom substrate, restrict observations to the substrate you can detect from the boat. If you can't see the bottom, collect a sediment sample using a long tube (e.g., the 3-m PVC sounding rod). Probe the bottom beneath the boat with the sounding rod (you may have to move closer to shore). Soft sediment can be brought to the surface for examination. Hard sediments can be "felt" with the sounding rod. Sandy substrate can be "felt" or "heard" by twisting the sounding rod and detecting grittiness. If you had to move into shallow water to observe sediment characteristics, flag the observation and record (on the Physical Habitat Characterization Form comments section) the depth where you observed the sediment. Rate the cover of substrate sediment particle sizes that have very heavy, heavy, moderate, sparse, and absent areal coverage. Base these ratings on visual observations and judgments using the size classes defined on the form. If the bottom is covered with logs, sticks, or other organic debris, choose "woody debris." If the substrate is obscured by vegetation and you cannot obtain a PVC sounding rod sample, enter a "K" flag to denote "no observation made." However, probing with the sediment tube usually makes it possible to determine if the sediment is soft (therefore either Sand or Silt/Clay/Muck).

Sediment color and odor are subjective observations to be noted on the form, whenever possible. Select "None/Other" if sediment color does not match one of the categories. For sediment odor, the choices are "$H_2S$" (sulfurous, rotten egg), "Anoxic" (sewage odor), "Chemical" (strong odor like turpentine, paint, etc.), "Oil/petroleum", or "None/Other" (including musty, no odor, organic, and fishy odors). If "Other" is noted, explain the observation on the comment form.

#### 5.2.2.2 Aquatic Macrophytes

To characterize aquatic macrophytes, separately estimate the areal coverage (as defined in Table 5-2) within the lake area between your boat and the shoreline for each of the three aquatic macrophyte types:

- submerged,
- emergent (has erect portions above the water surface), and
- floating (either rooted or non-rooted vegetation)

Count any plant as being in only one of these types. Then estimate the coverage of all combined types of aquatic macrophytes in the same area. You may have to probe the bottom with the PVC sounding tube or your anchor if the water is turbid. Indicate ("yes" or "no") if the aquatic macrophytes extend further out into the lake than the area included in your observation area (i.e., more than 10 m [or 30 ft] from shore).

#### 5.2.2.3 Fish Habitat Cover

Evaluate the presence and abundance of the listed types of fish habitat and cover features that are in the water and shoreline within the 10-m by 15-m littoral portion of the field of vision at each P-Hab station (Table 5-2). Select "0" for cover types that are absent, "1" for those present but sparse, and "2" for those that are present in moderate to heavy amounts. These features are within or partially within the water and conceal fish from aquatic and terrestrial predators such as larger fish, otters, kingfishers, and ospreys.

- Aquatic Weeds -- submerged, floating, or emergent forms
- Snags -- inundated or partially inundated dead trees, branches, or rootwads with diameter >0.3 m (1 ft)
- Woody debris or brush -- inundated dead or living woody vegetation <0.3 m diameter.
- Inundated Live Trees -- inundated portions of trees >0.3 m in diameter
- Overhanging Vegetation -- <1 m from the water surface (do not include higher overhanging vegetation, which might provide perches for birds such as kingfishers)
- Rock Ledges or Sharp Dropoffs -- overhanging banks, submerged rock shelves, and steep sloping rock walls
- Boulders -- >basketball size
- Human Structures -- docks, barges, houseboats, swimming platforms, tires, car bodies, and habitat enhancement structures (e.g., log rafts)

#### 5.2.2.4 Littoral Fish Habitat Classification

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At each physical habitat station, classify the fish microhabitat within the littoral zone. The hierarchical classification system defined in Table 5-3 consists of four levels. The first classification level refers to disturbance: is there major human influence in the littoral zone (not the shore) or is this area in a more or less natural state (including largely recovered areas)? The second level refers to the presence of cover: is there cover for fish or open water or a mixture of the two? The third level defines the kind of cover: human influence includes "structures" (e.g., docks, boats, floating platforms) and "fill" (e.g., revetment boulders, trash); natural areas include in-lake vegetation, boulders, or woody materials or a mixture. The fourth level describes substrate. Check the appropriate box for each category on the Physical Habitat Characterization Form.

Table 5-3. Littoral microhabitat characteristics.

| | |
|---|---|
| **Littoral Fish Microhabitat Classification** | Classify the habitat for fish into the following categories for each respective level:<br><br>**1st level (in-lake disturbance)**<br>Human, Natural, or Mixed.<br>**2nd level (in-lake cover)**<br>Cover (major fish cover), Open, or Mixed (patchy).<br>**3rd level (cover type)**<br>Artificial Structure (docks, boats), Fill (revetment, boulders, etc.), Vegetated, Woody, Boulders, Mixed (a combination), or None.<br>**4th level (main substrate)**<br>Mud/Muck, Sand/gravel, Cobble/Boulder, or Bedrock. |

### 5.2.3 Invasive Plants and Invertebrates

Record if any invasive plant and invertebrate species listed in Table 5-4 have been observed within the habitat plot. Check the boxes on the side 2 of the Physical Habitat Characterization Form (Figure 5-2(b)) for any species observed within either the littoral or shoreline/riparian plots.

Table 5-4. Invasive plants and invertebrates.

| | |
|---|---|
| **Littoral Species** | • Zebra (or Quagga) mussel<br>• Eurasian watermilfoil<br>• Hydrilla<br>• Curly pondweed<br>• African waterweed<br>• European waterchestnut<br>• Water hyacinth<br>• Parrot feather |
| **Shoreline/Riparian Species** | • Purple loosestrife<br>• Knotweed<br>• Hairy willow herb<br>• Yellow floating heart<br>• Giant salvinia<br>• Flowering rush |

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## 5.3 Pathogens PLACEHOLDER, SUBJECT TO REVISION

### 5.3.1 Introduction

For the Lakes Survey, enterococci will be the pathogen indicator collected. A single water sample for this indicator will be collected offshore of the final P-hab station. Samples are collected in pre-sterlized, 500 ml bottles at a depth of approximately 6 to 12 inches below the water surface. Following collection, samples are placed in coolers and maintained on ice prior to filtration. Samples must be filtered within 6 hours of collection.

The equipment and supplies needed to collect an algal toxin sample from the lake shoreline are listed in Table 5-9.

### 5.3.2 Sample Collection and Processing

The pathogen sample should be collected within the littoral zone of the final habitat station (station J) from a location where the water depth is approximately waist-deep water. The process for selecting the P-hab stations is described in the Physical Habitat Assessment Section 5.2. For lakes designated as Large Lakes, there will be no shoreline stations, therefore, the sample should be collected from an area nearby the launch site. The sample collection and processing procedures are described in Table 5-5.

Table 5-5. Procedure for Pathogen sample collection. **PLACEHOLDER-SUBJECT TO REVISION**

*Collect the Pathogen Sample*

13. Put on surgical gloves (non-powdered).
14. Make sure the lid of the sample container is tightly secured.
15. Lower the container to a depth of 6-12 inches below the water surface. Position the container so that the mouth is pointed away from the sampler and remove the lid. Allow bottle to fill completely and replace lid.
16. After removing the container from the water, discard a small portion of the sample to allow for proper mixing before analyses.
17. Store the sample in a cooler on ice at a temperature of <10° C until commencement of filtration. Do not freeze the samples. Do not hold samples longer than 6 hours between collection and initiation of filtration.

*Process the Pathogen Sample*

18. Place a sterile polycarbonate filter on the filter base, and attach the funnel to the base so that the membrane filter is now held between the funnel and the base.
19. Shake the sample bottle vigorously 25 times to distribute the bacteria uniformly, and measure 50 mL of sample into the funnel.
20. Filter the sample. If entire sample volume passes readily through the filter (within several minutes), add another 50 mL and continue filtration. After filtering samples, rinse the sides of the funnel at least twice with 20-30 mL of sterile PBS (Section 7.4). Turn off the vacuum and remove the funnel from the filter base.
21. Label an extraction tube with glass beads (Section 7.20) appropriately. Remove

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filter from filtration unit base and fold into a cylinder with the sample side facing inward, being careful to handle the filter only on the edges, where the filter has not been exposed to the sample. Insert the rolled filter into the labeled extraction tube with glass beads. Prepare one filter for each sample filtered in this manner.

### 5.3.3 Sample Collection Form

Figure 5-3 is a sample of the Lake Shoreline Sample Collection Form. The form is used to record and document: (a) Pathogens, (b) Algal Toxins, and (c) Benthic Macroinvertebrate samples. Record the sample ID number, station where the sample was collected, depth collected, and sample volume collected.

## 5.4 Algal Toxins

### 5.4.1 Introduction

The field team will collect a single subsurface water grab approximately 6 inches (15 cm) below the surface for algal toxin analysis. The grab will be collected from within the final shoreline station (station J) where the water depth is approximately waist-deep. The equipment and supplies needed to collect an algal toxin sample from the lake shoreline are listed in Table 5-9.

### 5.4.2 Sample Collection Form

On the Lake Shoreline Sample Collection Form (Figure 5-3), record the sample ID number, station where the sample was collected, depth collected, and sample volume collected.

### 5.4.3 Sample Collection and Processing

The field team collects algal toxin samples from the same location as the pathogen samples are collected (waist-deep water within the final shoreline station; Section 5.3). For lakes designated as Large Lakes, the sample should be collected from an area nearby the launch site. Detailed step-by-step procedures for collecting algal toxin samples are presented in Table 5-6.

Table 5-6. Procedure for algal toxin samples.

1. Fill out the Algal Toxins label completely, attach to 500-ml sample container and cover completely with clear tape.
2. Put on surgical gloves (non-powdered).
3. Slowly submerge the container, opening first, into the water.
4. When the bottle is approximately 6 inches (15 cm) below the surface, invert the bottle so the opening is upright. Allow water to enter the container until the bottle is full.
5. Return the filled container quickly to the surface.

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6. Pour off approximately 100 ml of water (or until the 400 ml mark is reached if using pre-marked bottles), providing sufficient headspace for the sample to expand upon freezing.
7. Quickly cap the container and tighten securely.
8. Place the sample bottle in a cooler on dry ice and allow sample to freeze completely.

## 5.5 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates inhabit the sediment or live on the bottom substrates or in aquatic vegetation of lakes. The benthic macroinvertebrate assemblage in lakes is an important component of measuring the overall biological condition of the aquatic community. Monitoring this assemblage is useful in assessing the status of the water body and detecting trends in ecological condition. Populations in the benthic assemblage respond to a wide array of stressors in different ways so that it is often possible to determine the type of stress that has affected a macroinvertebrate assemblage (e.g., Klemm et al., 1990). Because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, the structure and function of the macroinvertebrate assemblage is a response to exposure of present or past conditions.

The collection method used here is patterned after the technique in the document entitled *"Development of Biocriteria for Vermont and New Hampshire Lakes, Criteria Development for Phytoplankton and Macroinvertebrate Assemblages for Three Lake Classes"*, prepared by the Vermont Department of Environmental Conservation (Kamman 2005 Draft). Benthos are collected using a semi-quantitative sampling of multiple habitats in the littoral zone of lakes using a D-frame dip net (Figure 5-4). The lake littoral zone is made up of many microhabitat types which have a strong influence on the macroinvertebrate species composition present. Therefore, sample collection is stratified on the following three specific habitat types: rocky/cobble/large woody debris; macrophyte beds; and organic fine muds or sand. Target macroinvertebrate communities for these habitat types are rocky-littoral epibenthos, macrophytic epibenthos, and muddy-littoral epi- and infaunal benthos, respectively.

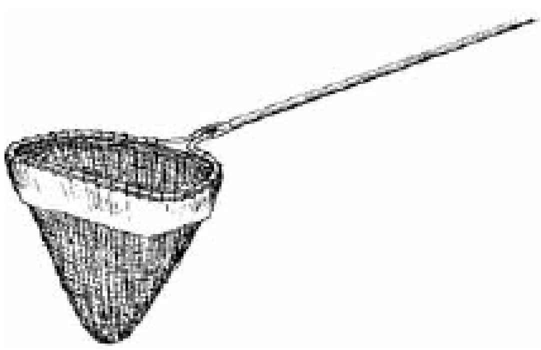

Figure 5-4. D-frame net used for collecting benthic macroinvertebrates.

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## LAKE SHORELINE SAMPLE COLLECTION FORM

Reviewed by (initial): ______

SITE ID: ____________________ DATE: ___ / ___ / ______

| ALGAL TOXIN (Target Volume = 1000 mL) | | | | | |
|---|---|---|---|---|---|
| Sample ID | Sample Type | Station | Surface to Depth Collected (m) | Sample Volume (mL) | Comments |
| | | | | | |
| | | | | | |

| PATHOGEN (Target Volume = 1000 mL) | | | | | |
|---|---|---|---|---|---|
| Sample ID | Sample Type | Station | Surface to Depth Collected (m) | Sample Volume (mL) | Comments |
| | R1 | | | | |
| | | | | | |

| BENTHOS | Sample ID | No. of Jars | Flag |
|---|---|---|---|
| | | | |

| STATION | | A | | B | | C | | D | | E | | F | | G | | H | | I | | J | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTRATE | CHAN. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. | Sub. | Chan. |
| Rocky/Cobble/ Woody debris | Boat | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B |
| Macrophyte beds | Wading | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W |
| Organic fine muds | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | |
| Other: Note in Comments | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | |
| FLAG | | | | | | | | | | | | | | | | | | | | | |

| COMMENTS | |
|---|---|
| | |
| | |
| | |
| | |
| | |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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Figure 5-3. Lake Shoreline Sample Collection Form.

### 5.5.1 Site Selection and Sample Collection

The process for selecting the sample sites is described in the Physical Habitat Assessment Section 5.2. The equipment and supplies needed to collect the benthic macroinvertebrate sample from the littoral zone are listed in Table 5-9. All benthic samples should be collected from the dominant habitat type within the 10 m x 15 m littoral zone component of each of the 10 sampling stations (Figure 5-5). The sampling process is described in Table 5-7.

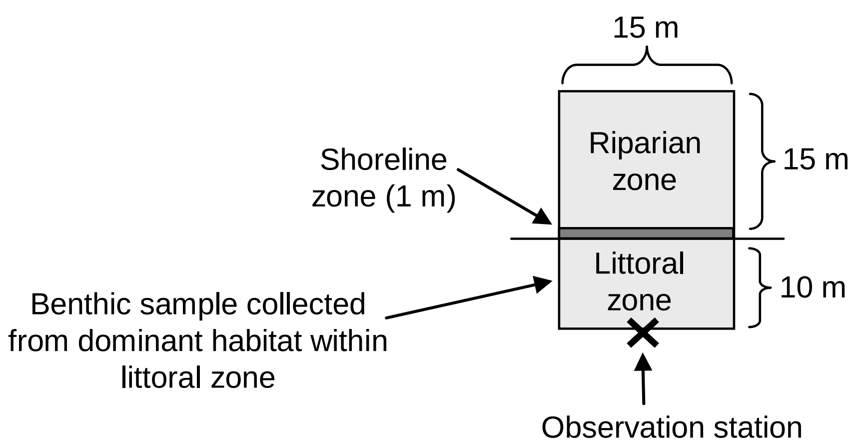


Figure 5-5. Benthic and habitat sampling station diagram.

### 5.5.2 Sample Processing in the Field

Use a 500 μm mesh sieve bucket placed inside a larger bucket full of lake water while sampling to carry the composite sample as you travel around the lake. Once the composite sample from the collections from the 10 stations is sieved and reduced in volume, store in a 1-liter jar and preserve with 95% ethanol. Multiple jars may be required if detritus is heavy (Table 5-8). Record tracking information for each composite sample on the Sample Collection Form as shown in Figure 5-3. Do not fill out the collection form until you have collected (or confirmed at the site that you will collect) samples. If forms are filled out before you arrive at the site, and then no samples are collected, a lot of time is wasted by others later trying to find samples that do not exist.

A set of completed sample labels, including the label that is used if more than one jar is required for a single composite sample, is shown in Figure 5-8. The ID number is also recorded with a lead pencil (No. 2) on a waterproof label that is placed inside each jar (Figure 5-6, lower right). If more than one jar is used for a composite sample, a special label (Figure 5-6, lower left) is used to record the ID number assigned to the sample. DO NOT use two different barcode numbers on two jars containing one single sample. Blank labels for use inside of sample jars are presented in Figure 5-7. These can be copied onto waterproof paper. If a sample requires more than one jar, make sure the correct number of jars for the sample is recorded on the Sample Collection Form. Again, accurate record keeping in the field saves substantial amounts of time later.

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Table 5-7. Collection protocol for benthic macroinvertebrate sampling

1. Prior to launching the boat, ensure that all sample containers and forms are filled out for lake ID, date, and sample type where required. To ensure completeness, one individual completes the field forms and a second team member checks to verify that all pertinent information is included.

2. After locating the sample site according to procedures described in the physical habitat section, identify the dominant habitat type within the plot:
   - Rocky/cobble/large woody debris;
   - Shorezone vegetation and/or submerged aquatic vegetation;
   - or organic fine muds or sand.

3. After identifying the dominant habitat type, use the D-frame dip net (equipped with 500 µm mesh) to sweep through 1 linear meter of the dominant habitat type at a single location within the 10m x 15m littoral zone sampling area, making sure to disturb the substrate enough to dislodge organisms.

   - If the dominant habitat is rocky/cobble/large woody debris it may be necessary to exit the boat and disturb the substrate (e.g., overturn rocks, logs) using your feet while sweeping the net through the disturbed area.
   - Because a dip-net is being used for sampling, the maximum depth for sampling will be approximately 0.5 m (the length of the dip-net staff); therefore, in cases in which the depth of the lake quickly drops off it may be necessary to sample in the nearest several meters to the shore.

4. After completing the 1-meter sweep, remove all organisms and debris from net and place them in a bucket following sample processing procedures described in the following section.

5. Proceed to the next sampling station and repeat steps 1-5. The organisms and detritus collected at each station on the lake should be combined in a single bucket to create a single composite sample for the lake. After sampling at all 10 stations is completed, process the composite sample in the bucket according to procedures described in the following section.

Table 5-8. Procedure for preparing composite samples for benthic macroinvertebrates

1. Pour the entire contents of the bucket through a sieve (or into a sieve bucket) with 500 µm mesh size. Remove any large objects and wash off any clinging organisms back into the sieve before discarding.

2. Using a wash bottle filled with lake water, rinse all the organisms from the bucket into the sieve. This is the composite sample for the lake.

3. Estimate the total volume of the sample in the sieve and determine how large a jar will be needed for the sample (500-mL or 1-L) and how many jars will be required.

4. Fill in a sample label with the Lake ID and date of collection. Attach the completed label to the jar and cover it with a strip of clear tape. Record the sample ID number for the composite sample on the Sample Collection Form. For each composite sample, make sure the number on the form matches the number on the label. **Please do not record an ID number on the form until you have collected the sample!**

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Table 5-8. Procedure for preparing composite samples for benthic macroinvertebrates

5. Wash the contents of the sieve to one side by gently agitating the sieve in the water. Wash the sample into a jar using as little water from the wash bottle as possible. Use a large-bore funnel if necessary. If the jar is too full pour off some water through the sieve until the jar is not more than ¼ to ½ full, or use a second jar if a larger one is not available. Carefully examine the sieve for any remaining organisms and use watchmakers' forceps to place them into the sample jar.
   - If a second jar is needed, fill in a sample label that does not have a pre-printed ID number on it. Record the ID number from the pre-printed label prepared in Step 4 in the "SAMPLE ID" field of the label. Attach the label to the second jar and cover it with a strip of clear tape. Record the number of jars required for the sample on the Sample Collection Form. **Make sure the number you record matches the actual number of jars used.** Write "Jar *N* of *X*" on each sample label using a waterproof marker ("*N*" is the individual jar number, and "*X*" is the total number of jars for the sample).

6. Place a waterproof label inside each jar with the following information written with a number 2 lead pencil:
   - Lake ID
   - Type of sampler and mesh size used
   - Name of lake
   - Date of collection
   - Collectors initials
   - Number of stations sampled
   - Jar N of X

7. Completely fill the jar with 95% ethanol (no headspace). It is very important that sufficient ethanol be used, or the organisms will not be properly preserved. Existing water in the jar should not dilute the concentration of ethanol below 70%.
   - NOTE: Prepared composite samples can be transported back to the vehicle before adding ethanol if necessary. In this case, fill the jar with lake water, which is then drained using the net (or sieve) across the opening to prevent loss of organisms, and replaced with ethanol at the vehicle.

8. Replace the cap on each jar. Slowly tip the jar to a horizontal position, then gently rotate the jar to mix the preservative. Do not invert or shake the jar. After mixing, seal each jar with plastic tape.

Store labeled composite samples in a container with absorbent material that is suitable for use with 70% ethanol until transport or shipment to the laboratory.

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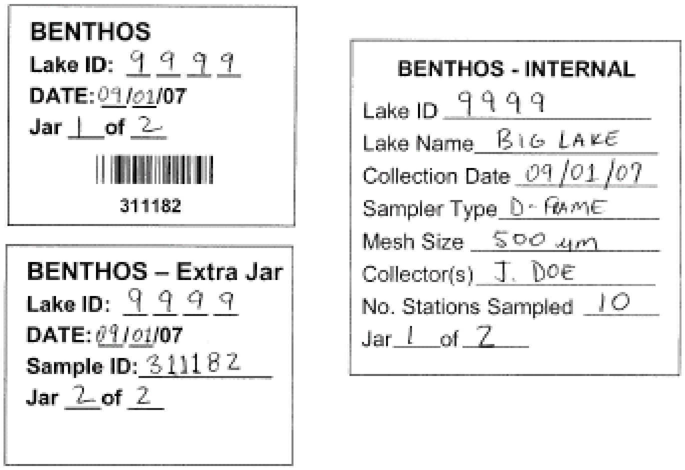

**BENTHOS**
**Lake ID:** 9 9 9 9
**DATE:** 09/01/07
**Jar** 1 **of** 2
311182

**BENTHOS – Extra Jar**
**Lake ID:** 9 9 9 9
**DATE:** 09/01/07
**Sample ID:** 311182
**Jar** 2 **of** 2

**BENTHOS - INTERNAL**
Lake ID 9999
Lake Name BIG LAKE
Collection Date 09/01/07
Sampler Type D-FRAME
Mesh Size 500 µm
Collector(s) J. DOE
No. Stations Sampled 10
Jar 1 of 2

Figure 5-6. Example completed labels for benthic macroinvertebrate samples. The label at lower left is used if more than one jar is required for a composite sample. The label at right is an internal label to be placed inside the sample container.

**BENTHOS - INTERNAL**

Lake ID ________________
Lake Name ______________
Collection Date ___________
Sampler Type ____________
Mesh Size ______________
Collector(s) _____________
No. Stations Sampled ______
Jar ____of _____

Figure 5-7. Blank internal label for benthic invertebrate samples.

Check to be sure that the pre-numbered adhesive label is on the jar and covered with clear tape, and that the waterproof label is in the jar and filled in properly. Be sure the inside label and outside label describe the same sample. Replace the cap on each jar. Place the samples in a cooler or other secure container for transporting and/or shipping the laboratory (see Appendix C). Check to see that all equipment is in the vehicle.

## 5.6 Equipment and Supply List for Littoral and Shoreline Survey

A checklist of equipment and supplies required to conduct protocols described in this

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section is shown in Table 5-9. This checklist is similar to but may be different somewhat from the checklists in Appendix A, which are used at a base site to assure that all equipment and supplies are brought to and are available at the lake. The field teams are required to use the checklist presented in this section to assure that equipment and supplies are organized and available on the boat in order to conduct the protocols efficiently.

Table 5-9. Equipment and supplies list for littoral and shoreline stations.

| Item | Quantity |
|---|---|
| **Physical Habitat Assessment** | |
| Sonar | 1 |
| GPS unit with manual, reference card, extra battery pack | 1 |
| Anchor with 50-m line | 1 |
| Float to attach to anchor | 1 |
| Surveyor's tape | 1 roll |
| Habitat Sketch Map Form | 2 |
| Physical Habitat Characterization Forms | 10 |
| Field notebook | 1 |
| Quick reference field operations handbook | 1 |
| PVC sounding rod, 3-m length, marked in 0.1 m increments | 1 |
| Buoy for marking observation point | 1 |
| **Benthic Macroinvertebrate** | |
| Modified kick net (D-frame with 500 µm mesh) and 4-ft handle | 1 |
| Spare net(s) and/or spare bucket assembly for end of net | |
| Buckets, plastic, 8- to 10-qt capacity | 2 |
| Sieve-bucket or soil sieve with 500 µm mesh openings (U.S. std No. 35) | 1 |
| Watchmakers' forceps | 2 pr. |
| Wash bottle, 1-L capacity labeled "LAKE WATER" | 1 |
| Small spatula, spoon, or scoop to transfer sample | 1 |
| Funnel, with large bore spout (optional) | 1 |
| Sample jars, HDPE plastic with leakproof screw caps, 500-mL and 1-L capacity, suitable for use with ethanol | 4 to 6 each sample |
| 95% ethanol, in a properly labeled container | 2 gal |
| Rubber gloves | 2 pr. |
| Cooler (with suitable absorbent material) for transporting ethanol and samples | 1 |

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Table 5-9. Equipment and supplies list for littoral and shoreline stations.

| | |
|---|---|
| Benthic sample labels, with preprinted ID numbers (barcodes) | 2 |
| Benthic sample labels without preprinted ID numbers | 4 |
| Internal benthic sample labels on waterproof paper | 6 |
| Lake Shoreline Sample Collection Form | 1 |
| Soft (#2) lead pencils | |
| Fine-tip indelible markers | |
| Clear tape strips | 1 pkg. |
| Plastic electrical tape | 4 rolls |
| Scissors | 1 |
| Pocket-sized field notebook (optional) | 1 |
| Field operations and methods manual | 1 copy |
| **Pathogens** | |
| Sterilized sample bottle, HDPE plastic, 500-mL | 1 |
| Sterile filter holder, Nalgene 145/147 | 1 |
| Osmonics 47 mm polycarbonate sterile filters | 1 pkg |
| Sterile disposable forceps | |
| Sterile microcentrifuge tubes containing sterile glass beads | 3 |
| Pathogen sample label | |
| Dry ice | |
| Cooler | 1 |
| **Algal Toxins** | |
| Sample bottle, HDPE plastic, 500-mL | 1 |
| Surgical gloves (non-powdered) | 1 pair |
| Dry ice | |
| Cooler | 1 |
| Lake Shoreline Sample Collection Form | 1 |
| Pencils and permanent markers | |
| Algal toxin sample label | 1 |

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## 6.0 FINAL LAKE ACTIVITIES

Prior to leaving the lake, the field team makes a general visual assessment of the lake and its surrounding catchment and makes a final check of the data forms and samples. The objective of the lake assessment is to record field team observations of catchment and lake characteristics that are useful for future data interpretation, ecological value assessment, development of associations, and verification of stressor data. The observations and impressions of field teams are extremely valuable. The purpose of the second check of data forms and samples is to assure completeness of all sampling activities. Activities described in this section are summarized in Figure 6-1.

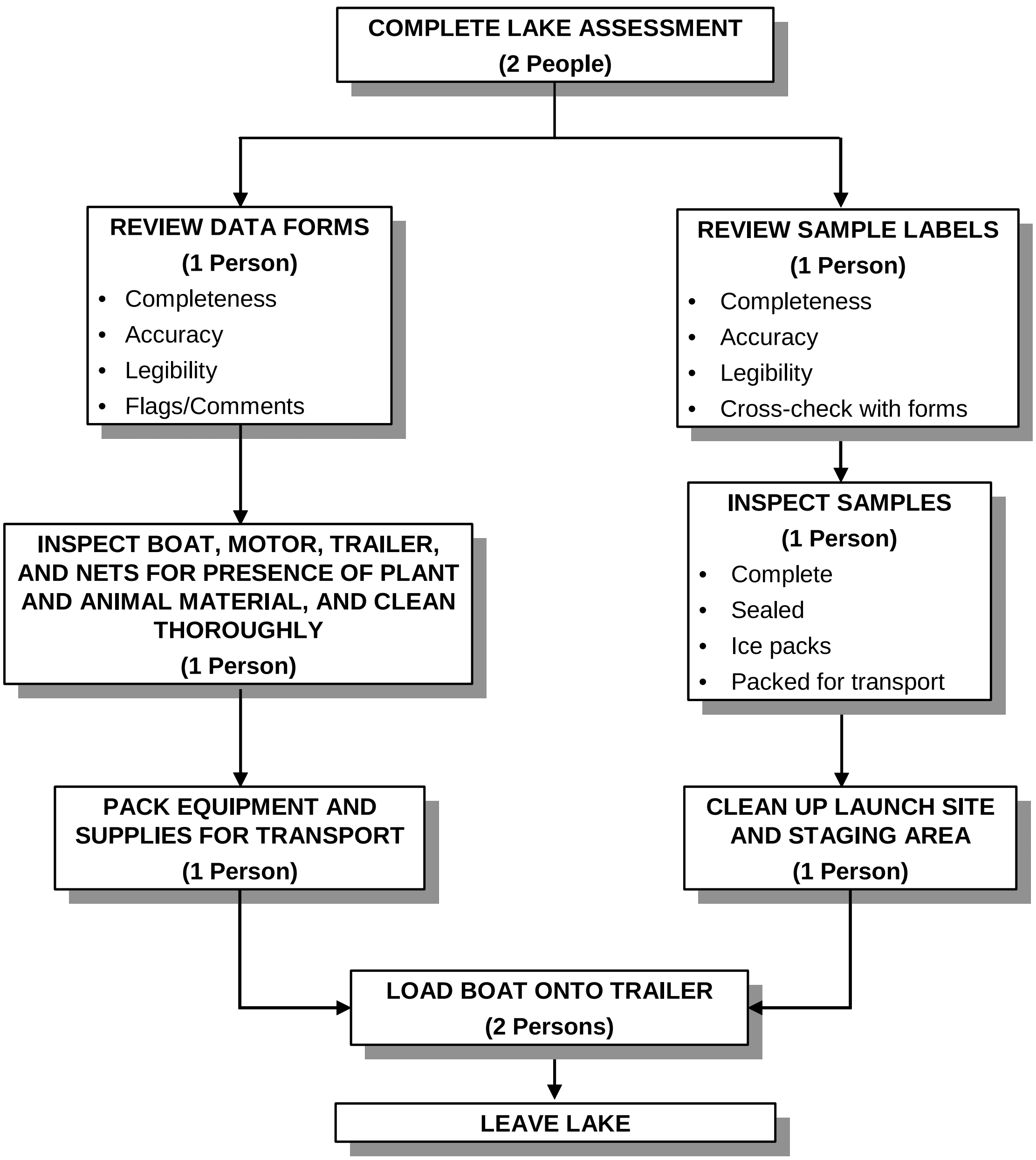


Figure 6-1. Final lake activities summary.

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## 6.1 General Lake Assessment

The team members complete the Lake Assessment Form (Figures 6-2 a and b) at the end of lake sampling, recording all observations from the lake that were noted during the course of the visit. This Lake Assessment Form is designed as a template for recording pertinent field observations. It is by no means comprehensive, and any additional observations should be recorded in the comments section. The form consists of five major sections: 1) Lake Site Activities and Disturbances, 2) General Lake Information, 3) Shoreline Characteristics, 4) Qualitative Macrophyte Survey, and 5) Qualitative Assessment of Environmental Values.

### 6.1.1 Lake Site Activities and Disturbances

Record any of the sources of potential stressors listed in Table 6-1 on the Lake Assessment Form, Side 1 (Figure 6-2(a)), that were observed while on the lake, while driving or walking through the lake catchment, or while flying over the lake and catchment. For activities and stressors that you observe, rate their abundance or influence as low (L), moderate (M), or heavy (H) on the line next to the listed disturbance. Leave the line blank for any disturbance not observed. The distinction between low, moderate, and heavy will be subjective. For example, if there are two to three houses on a lake, circle "L" for low next to "Houses." If the lake is ringed with houses, rate it as heavy (H). Similarly, a small patch of clear-cut logging on a hill overlooking the lake would rate a low ranking. Logging activity right on the lake shore, however, would get a heavy disturbance ranking. The section for "Lake Site Activities and Disturbances Observed" includes residential, recreational, agricultural, industrial, and lake management categories.

### 6.1.2 General Lake Information

Observations regarding the general characteristics of the lake are described in Table 6-2, and are recorded on Side 1 of the Lake Assessment Form (Figure 6-2(a)). The hydrologic lake type is a very important variable for defining subpopulations for acidic deposition effects. Note any flight hazards that might interfere with either low-altitude fly-overs by aircraft (for future aerial photography or videography) or landing on the lake for sampling purposes (either by float plane or helicopter). When estimating the intensity of motor boat usage, in addition to the actual number of boats observed on the lake during the visit, use other observations such as the presence of boat houses, docks, and idle craft.

### 6.1.3 Shoreline Characteristics

Shoreline characteristics of interest during the final lake assessment are described in Table 6-3. Observations related to this portion of the assessment are recorded on the Lake Assessment Form, Side 1 (Figure 6-2(a)). To estimate the extent of major vegetation types, limit the assessment to the immediate lake shoreline (i.e., within 20 m of the water). Also estimate the percentage of the immediate shoreline that has been developed or modified by humans.

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LAKE ASSESSMENT FORM

Reviewed by (initial): ______

SITE ID: ____________________ DATE: __ __ / __ __ / __ __ __ __

**LAKE SITE ACTIVITIES AND DISTURBANCES OBSERVED** (Intensity: Blank=Not observed, L=Low, M=Moderate, H=Heavy)

| Residential | Recreational | Agricultural | Industrial | Lake Management |
|---|---|---|---|---|
| L M H Residences | L M H Hiking Trails | L M H Cropland | L M H Industrial Plants | L M H Liming |
| L M H Maintained Lawns | L M H Parks, Campgrounds | L M H Pasture | L M H Mines/Quarries | L M H Chemical Treatment |
| L M H Construction | L M H Primitive Parks, Camping | L M H Livestock Use | L M H Oil/Gas Wells | L M H Angling Pressure |
| L M H Pipes, Drains | L M H Resorts | L M H Orchards | L M H Power Plants | L M H Drinking Water Treatment |
| L M H Dumping | L M H Marinas | L M H Poultry | L M H Logging | L M H Macrophyte Control |
| L M H Roads | L M H Trash/Litter | L M H CAFOs | L M H Evidence of Fire | L M H Water Level Fluctuations |
| L M H Bridges/Causeways | L M H Surface Films, Scums, or Slicks | L M H Water Withdrawal | L M H Odors | L M H Fish Stocking |
| L M H Sewage Treatment | | | L M H Commercial | |

**GENERAL LAKE INFORMATION**

Hydrologic Lake Type: ☐ Reservoir ☐ Drainage (outlets present) ☐ Seepage (no outlets observed)

Outlet Dams: ☐ None ☐ Artificial ☐ Natural

Low Elevation Flight Hazards: ☐ Yes ☐ No

Motor Boat Density: ☐ High ☐ Low ☐ Restricted ☐ Banned

General Aesthetics: ☐ Pleasant ☐ Somewhat pleasant ☐ Unpleasant

Swimability: ☐ Good ☐ Fair ☐ Not Swimmable

Lake Level Changes: ☐ Zero ☐ Elevation Change = ________ m

**SHORELINE CHARACTERISITCS (% of shoreline)**

| | | | | |
|---|---|---|---|---|
| Forest | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Grass | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Shrub | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Wetland | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Bare Ground | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Agriculture | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Shoreline Mods (docks, riprap) | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Development (Residential & Urban) | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |

**QUALITATIVE MACROPHYTE SURVEY**

| | | | | |
|---|---|---|---|---|
| Macrophyte Density | ☐ Absent | ☐ Sparse | ☐ Moderate | ☐ Extensive |
| Emergent/Floating Coverage (% Lake Area) | ☐ <5% | ☐ 5 to 25% | ☐ 25 to 75% | ☐ >75% |
| Submergent Coverage (% Lake Area) | ☐ <5% | ☐ 5 to 25% | ☐ 25 to 75% | ☐ >75% |

**WATERBODY CHARACTER**

| | | | | | | |
|---|---|---|---|---|---|---|
| Pristine | ☐ 5 | ☐ 4 | ☐ 3 | ☐ 2 | ☐ 1 | Highly Disturbed |
| Appealing | ☐ 5 | ☐ 4 | ☐ 3 | ☐ 2 | ☐ 1 | Unappealing |

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Figure 6-2(a). Lake Assessment Form, Side 1.

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## LAKE ASSESSMENT FORM (cont.)

Reviewed by (initial): ____

SITE ID: ______________________ DATE: ___/___/______

| QUALITATIVE ASSESSMENT OF ENVIRONMENTAL VALUES | |
|---|---|
| Ecological Integrity: | ☐ Excellent ☐ Good ☐ Fair ☐ Poor |
| General Assessment: | |
| Wildlife Observed: | |
| Trophic State: | ☐ Oligotrophic ☐ Mesotrophic ☐ Eutrophic ☐ Hypereutrophic |
| Visual Assessment: | |
| Algal Abundance & Type: | |
| Nutrient Status: | |
| Other: | |
| Recreational Value: | ☐ Excellent ☐ Good ☐ Fair ☐ Poor |
| Conditions and Local Contacts: | |
| Observations (e.g. accessibility, boating, fishing, swimming, health concerns): | |

**Comments:**

DRAFT

2007 Lake Assessment 02/13/2007

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Figure 6-2(b). Lake Assessment Form, Side 2.

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Table 6-1. Lake site activities and disturbances.

| **Observe any lake activities or disturbances listed below and record as L (low), M (moderate), or H (heavy) intensity on Side 1 of the Lake Assessment Form (except as noted below):** | |
|---|---|
| **Residences** | Presence of any houses and residential buildings around the lake. |
| **Maintained Lawns** | Presence of any maintained lawns around the lake. |
| **Construction** | Presence of any recent construction in the immediate area around the lake or signs of recent sedimentation events (depositional fans). |
| **Pipes/Drain** | Presence of any pipes or drains feeding into or out of the lake. If known, write down what type of activity the pipe is associated with (e.g., storm sewer, plant intake) in the "Comments" section on Side 2. |
| **Sewage Treatment** | Presence of sewage treatment facility. |
| **Dumping** | Any evidence of landfill or dumping around the lake, including garbage pits and informal dumping of large amounts of trash or cars and appliances along roads or lakeshore. This does not include small amounts of litter. If informal dumping areas exist, note that they are informal sites in the "Comments" section on Side 2. |
| **Roads** | Presence of any maintained roads in the immediate area around the lake. |
| **Bridges/Causeways** | Presence of any bridges or causeways across or in the immediate vicinity of the lake. |
| **Hiking Trails** | Presence of formal hiking trails around the lake. |
| **Parks, Campgrounds** | Presence of organized public or private parks, campgrounds, beaches or other recreational areas around the lake. |
| **Primitive Parks, Camping** | Presence of informal or primitive parks, camping areas, beaches or other recreational areas (e.g., swimming holes) around the lake. |
| **Resorts** | Level of resort activity; this could include motels, resorts, golf courses, and stores. |
| **Marinas** | Presence of any marinas. |
| **Trash/Litter** | Relative abundance of trash or litter around the lake. |
| **Surface Films, Scum or Slicks** | Relative abundance of surface films, scum, or slicks on the lake. |
| **Cropland** | Presence of cropland. |
| **Pasture** | Presence of pastures. |
| **Orchards** | Presence of orchards. |
| **Livestock Use** | Presence of livestock use. |
| **Poultry** | Presence of poultry operations. |
| **CAFOs** | Presence of concentrated animal feeding operations. |
| **Water Withdrawl** | Any evidence of water withdrawl from the lake. |
| **Industrial Plants** | Any industrial activity (e.g., canning, chemical, pulp) around the lake or in the catchment. Describe the type of industry in the "Comments" section on Side 2. |

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Table 6-1. Lake site activities and disturbances.

| | |
|---|---|
| **Mines/Quarries** | Any evidence of mining or quarrying activity in the catchment or around the lake. |
| **Oil/Gas Wells** | Any evidence of oil or gas wells in the catchment or around the lake. |
| **Power Lines** | Presence of any power generating facilities or heavy duty transmission lines around or across the lake (not ordinary telephone or electric wires). |
| **Power Plants** | Presence of any power plants. |
| **Logging** | Any evidence of logging or fire removal of trees in the lake area. |
| **Evidence of Fire** | Any evidence of forest fires in the lake area. |
| **Odors** | Presence of any strong odors. |
| **Commercial** | Any commercial activity (e.g., convenient stores, shopping centers, restaurants) around the lake or in the catchment. |
| **Macrophyte Control** | Any evidence of dredging or other activities to control macrophyte growth; describe these in the "Comments" section on Side 2. |
| **Liming** | Any evidence of liming activities. |
| **Chemical Treatment** | Presence of any chemical treatment facilities. |
| **Drinking Water Treatment** | Presence of any drinking water treatment facilities. |
| **Angling Pressure** | Estimate of the intensity of fishing activity in the lake. |
| **Water Level Fluctuations** | Any evidence of water level fluctuations due to lake management. |
| **Fish Stocking** | Any evidence of fish stocking in the lake. |
| **Record any other oddities observed or additional information for any specific activity in the "Comments" section on Side 2.** | |

Table 6-2. General lake information noted during lake assessment.

| | |
|---|---|
| **Hydrologic Lake Type** | Note if there are any stream outlets from the lake, even if they are not flowing. If no lake outlets were observed, record the lake as a seepage lake. If the lake was created by a man-made dam (not that a dam is present just to raise the water level), record the lake as a reservoir. Otherwise record the lake as a drainage lake. |
| **Outlet Dams** | Note the presence of any dams (or other flow control structures) on the lake outlet(s). Differentiate between artificial (manmade) structures and natural structures (beaver dams). |
| **Flight Hazards** | If there are any hazards (above tree level) that would interfere with low elevation aircraft flights or landing on the lake, check "Yes"; otherwise check "No." Examples include radio towers or power lines. |
| **Motor Boats** | Record your impression of the density of motor boat usage on this lake (high or low). If there is a restriction on the size of motor boat engines, check "Restricted." If motor boats are banned, check "Banned." Consider the day |

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Table 6-2. General lake information noted during lake assessment.

| | |
|---|---|
| | of the week and weather in your assessment as well as the number of boathouses, idle craft. Count jet skis and any other motorized craft, which could stir up the lake, as motor boats. |
| **General Aesthetics** | Record your impression of the general aesthetic atmosphere of the lake. |
| **Swimmability** | Record a subjective impression about the aesthetics of swimming in this lake (swimmability) along the range of "good" to "not swimmable." |
| **Lake Level** | Examine the lake shoreline for evidence of lake level changes (e.g., bathtub ring). If there are none, check "zero"; otherwise try to estimate the extent of vertical changes in lake level from the present conditions based on other shoreline signs. |

Table 6-3. Shoreline characteristics observed during final lake assessment.

| **Check percent of shoreline characteristics:** | |
|---|---|
| Forest/Shrub | Deciduous, coniferous, or mixed forest, including shrub and sapling vegetation. |
| Agriculture | Cropland, orchard, feedlot, pastureland, or other horticultural activity. |
| Open Grass | Meadows, lawns, or other open vegetation. |
| Wetland | Forested and non-forested wetlands (submerged terrestrial vegetation). |
| Barren | Non-vegetated areas such as beaches, sandy areas, paved areas, and exposed rock. |
| Developed | Immediate shoreline area developed by human activity; this includes lawns, houses, stores, malls, marinas, golf courses, or any other human-built land use. |
| Shoreline Modifications | Actual shoreline that has been modified by the installation of riprap,revetments, piers, or other human modifications. |

### 6.1.4 Qualitative Macrophyte Survey

Macrophytes (aquatic plants large enough to be seen without magnification) are important indicators of lake trophic status. The most important indicator for this survey is the percentage of the lake area covered with macrophytes, as perceived by observers. For both "emergent/floating" and "submergent" coverage, choose one of the four percentage groupings (0-25%, 25-50%, 50-75%, 75-100%), on Side 1 of the Lake Assessment Form. In some cases, it will be fairly easy to estimate the percentage from observations made during sampling. In other cases, it will be an educated guess, especially if the water is turbid. After recording the areal percentage of macrophyte coverage, record the density of the plants in the observed macrophyte beds as dense, moderate, or sparse. Finally, provide any qualitative description (genera present, dominant type [floating, emergent, or submergent]) of the macrophyte beds that would be useful for interpreting the trophic status of the lake. All activities described in this subsection are recorded on Side 1 of the Lake Assessment Form (Figure 6-2(a)).

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### 6.1.5 Qualitative Assessment of Environmental Values

The primary goal of this study is to assess three major ecological values with respect to lakes: trophic state, ecological integrity, and recreation. Based on your field experience, record your own assessment of these values on the Lake Assessment Form, Side 2 (Figure 6-3). Write comments on these values in this section. The key words on the left side of each value section are there to stimulate thought and are not comprehensive. It is not necessary to address each of these key words.

- ***Trophic state*** is the rate or amount of phytoplankton and macrophytes produced or present in a lake. List any observed potential nutrient sources to the lake (e.g., septic tanks and agricultural runoff). Give your visual impression of the trophic status as oligotrophic (little or no biomass in the lake water), mesotrophic (intermediate amounts of biomass in the lake water), eutrophic (large amounts of biomass in the lake water), or hypereutrophic (choked lake, with more biomass than water).

- ***Ecological integrity*** is the ability to support and maintain a balanced, integrated, adaptive community with a biological diversity, composition, and functional organization comparable to natural lakes of the region. Record your overall impression of the "health" of the biota in the lake. Note any possible causes of impairment. The presence of higher order consumers (fish-eating birds and mammals) is an indication of a healthy food web and should be noted here. Similarly, the absence of an organism that you might expect to see is an important observation.

- Suitability for ***Recreation*** is the ability to support recreational uses such as swimming, fishing, and boating. Record your overall impression of the lake as a site for recreation. Note any possible causes of impairment. Note the presence or absence of people using the lake for recreational activities.

In addition, rate the ***water body character*** which is the physical habitat integrity of the water body and is largely a function of riparian and littoral habitat structure, volume change, trash, turbidity, slicks, scums, color, and odor. The Lakes Survey attempts to define water body character through two attributes: **degree of human development** and **aesthetics**. Rate each of these attributes on a scale of 1 to 5. For development, give the lake a "5" if it is pristine, with no signs of any human development. A "1" would indicate a lake is totally developed; for example, the entire lake is ringed with houses, seawalls, docks, etc. For aesthetics (whether the lake is appealing or not) base the decision on any factors about the lake that disturb you (trash, algal growth, weed abundance, overcrowding). Circle the number that best describes your opinion about how suitable the lake water is for recreation and aesthetic enjoyment today:

1. Enjoyment is nearly impossible.
2. Level of enjoyment is substantially reduced.
3. Enjoyment is slightly impaired.
4. There are very minor aesthetic problems; it is otherwise excellent for swimming, boating, and enjoyment.
5. It is beautiful and could not be any nicer.

Use the comments section on Side 2 (Figure 6-2(b)) to note any other pertinent information about the lake or its catchment. Here the field team can record any observations that may be useful for future data interpretation.

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### 6.2 Data Forms and Sample Inspection

After the Lake Assessment Form is completed, one team member reviews all of the data forms and sample labels for accuracy, completeness, and legibility. The other team member inspects all sample containers and packages them in preparation for transport, storage, or shipment. Both team members load the boat on the trailer, pick up the equipment and supplies for transport, and clean up the launch site area as described in Section 6.3.

Ensure that all required data forms for the lake have been completed. Confirm that the LAKE-ID is correct on all forms, as well as the date of the visit. On each form, verify that all information has been recorded accurately, the recorded information is legible, and any flags are explained in the comments section. Ensure that written comments are legible and use no "shorthand" or abbreviations. After reviewing each form initial the lower right corner of each page of the form.

Ensure that all samples are labeled, all labels are completely filled in, and each label is covered with clear plastic tape. Make sure that all sample containers are properly sealed.

### 6.3 Launch Site Cleanup

Load the boat on the trailer and inspect the boat, motor, and trailer for evidence of weeds and other macrophytes. Clean the boat, motor, and trailer as completely as possible before leaving the launch site. Inspect all nets for pieces of macrophyte or other organisms and remove as much as possible before packing the nets for transport. Pack all equipment and supplies in the vehicle and trailer for transport; keep them organized as presented in the equipment checklists (Appendix A). Lastly, be sure to clean up all waste material at the launch site and dispose of or transport it out of the site if a trash can is not available.

## 7.0 FIELD QUALITY CONTROL

Standardized training and data forms will provide the foundation to help assure that data quality standards for field sampling are met. These Standard Operating Procedures for field sampling and data collection will be the primary guidelines for all cooperators and field crews. In addition, repeat sampling and field evaluation and assistance visits will address specific aspects of the data quality standards for the Survey of the Nation's Lakes.

### 7.1 Repeat Sampling

A total of 10% of the target sites visited will be revisited during the same field season by the same field crew that initially sampled the lake. The field crews will need to conduct repeat sampling at the first 10% of the sites visited. For example, if a state is assigned 20 primary sites, the first two sites on the list should be revisited. If one of these first two sites is dropped, then the alternate assigned to replace it should be revisited. The primary purpose of this "revisit" set of sites is to provide variance estimates that would provide information on the extent to which the population estimates might vary, and can be used to evaluate the survey design for its potential to estimate status and detect trends in the target population of lakes. The revisit will include the full set of indicators and associated parameters. The time period between the initial and repeat visit to a lake should be as long as possible.

## 7.2 Field Evaluation and Assistance Visits

A rigorous program of field and laboratory evaluation and assistance visits has been developed to support the Survey of the Nation's Lakes Program. These evaluation and assistance visits are explained in detail in the Quality Assurance Project Plan (QAPP) for the Lakes Survey. The following sections will focus only on the field evaluation and assistance visits.

These visits provide a basis for the uniform evaluation of the data collection methods, and an opportunity to conduct procedural reviews as required to minimize data loss due to improper technique or interpretation of field procedures and guidance. Through uniform training of field crews and review cycles conducted early in the data collection process, sampling variability associated with specific implementation or interpretation of the protocols will be significantly reduced. The field evaluations will be based on the uniform training along with the evaluation plan and checklists. This evaluation will be conducted for each unique crew collecting and contributing data under this program (EPA will make a concerted effort to audit every crew, but will rely on the data review and validation process to identify unacceptable data that will not be included in the final database).

### 7.2.1 Specifications for QC Assurance

Field evaluation and assistance personnel are trained to the specific data collection methods detailed in this Lakes Survey Field Operations Manual. A plan and checklist for field evaluation and assistance visits have been developed to detail the methods and procedures. The plan and checklist are included in the QAPP. Table 7-1 summarizes the plan, the checklist, and corrective action procedures.

Table 6-2. General lake information noted during lake assessment.

| | |
|---|---|
| **Field Evaluation Plan** | • Regional Lake Coordinators will arrange the field evaluation visit with each Field Team, ideally within the first two weeks of beginning sampling operation.<br>• The Evaluator will view the performance of a team through one complete set of sampling activities.<br>• If the Team misses or incorrectly performs a procedure, the Evaluator will note this on the checklist and immediately point this out so the mistake can be corrected on the spot.<br>• The Evaluator will review the results of the evaluation with the Field Team before leaving the site, noting positive practices and problems. |
| **Field Evaluation Checklist** | • The Evaluator observes all pre-sampling activities and verifies that equipment is properly calibrated and in good working order, and Lakes Survey protocols are followed.<br>• The Evaluator checks the sample containers to verify that they are the correct type and size, and checks the labels to be sure they are correctly and completely filled out.<br>• The Evaluator confirms that the Field Team has followed Lakes Survey |

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Table 6-2. General lake information noted during lake assessment.

| | |
|---|---|
| | protocols for locating the lake and determining the index site on the lake.<br>• The Evaluator observes the index site sampling, confirming that all protocols are followed.<br>• The Evaluator observes the littoral sampling and habitat characterization, confirming that all protocols are followed.<br>• The Evaluator will record responses or concerns, if any, on the Field Evaluation and Assistance Check List. |
| **Corrective Action Procedures** | • If the Evaluator's findings indicate that the Field Team is not performing the procedures correctly, safely, or thoroughly, the Evaluator must continue working with this Field Team until certain of the Team's ability to conduct the sampling properly so that data quality is not adversely affected.<br>• If the Evaluator finds major deficiencies in the Field Team operations the Evaluator must contact an Lakes Survey QA official. |

It is anticipated that evaluation and assistance visits will be conducted with each Field Team early in the sampling and data collection process, and that corrective actions will be conducted in real time. If the Field Team misses or incorrectly performs a procedure, the Evaluator will note this on the checklist and immediately point this out so the mistake can be corrected on the spot. The role of the Evaluator is to provide additional training and guidance so that the procedures are being performed consistent with the Field Operations Manual, all data are recorded correctly, and paperwork is properly completed at the site.

### 7.2.2 Reporting

When the sampling operation has been completed, the Evaluator will review the results of the evaluation with the Field Team before leaving the site (if practicable), noting positive practices and problems (i.e., weaknesses [might affect data quality] or deficiencies [would adversely affect data quality]). The Evaluator will ensure that the Team understands the findings and will be able to perform the procedures properly in the future. The Evaluator will record responses or concerns, if any, on the Field Evaluation and Assistance Check List. After the Evaluator completes the Field Evaluation and Assistance Check List, including a brief summary of findings, all Field Team members must read and sign off on the evaluation.

If the Evaluator's findings indicate that the Field Team is not performing the procedures correctly, safely, or thoroughly, the Evaluator must continue working with this Field Team until certain of the Team's ability to conduct the sampling properly so that data quality is not adversely affected. If the Evaluator finds major deficiencies in the Field Team operations (e.g., less than three members, equipment or performance problems) the Evaluator must contact the following QA official:

- Mr. Otto Gutenson, EPA Lakes Survey Project QA Officer (202-566-1183)

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The QA official will contact the Project Manager or Project Technical Advisor to determine the appropriate course of action. Data records from sampling sites previously visited by this Field Team will be checked to determine whether any sampling sites must be redone.

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# APPENDIX A

# LIST OF EQUIPMENT AND SUPPLIES

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***EPA Survey of the Nation's Lakes Equipment & Supply List***

| **General Equipment** |
|---|
| 50 m sonde cable with length marked in 0.5 m intervals |
| Anchor with 50 m line |
| Barometer or elevation chart to use for calibration |
| Batteries |
| Bleach |
| Access instructions |
| 1-L wash bottle with deionized water |
| Buoy for marking observation point |
| Calibration cups |
| Calibration standards |
| Clear tape strips |
| Clipboards |
| Contact info |
| Dossier for lake to be sampled |
| Electrical tape |
| Extra batteries |
| Field forms |
| Field notebook |
| Field operations and methods manual |
| Filtration apparatus with graduated filter holder |
| Fine-tip indelible markers |
| Float to attach to anchor |
| GPS unit with manual and reference card |
| Maps |
| Hand-held sonar unit |
| Pencils and permanent markers |
| Permission letters |
| Plastic storage tub |
| Pocket-sized field notebook (optional) |
| PVC sounding rod, 3-m length, marked in 0.1 m increments |
| Quick reference field operations handbook |
| Rubber gloves |
| Sampling permit (if required) |
| Scissors |
| Spare water quality meter (optional) |
| Survey of the Nation's Lakes Fact Sheets |
| Surveyor's tape |
| Tape measure (cm) |
| Watchmakers' forceps |
| 1-L wash bottle labeled "LAKE WATER" |
| Sample labels |

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**Sample/Data Collection**
Modified KB corer
Modified kick net (D-frame with 500 µm mesh) and 4-ft handle
Core tubes
rubber stoppers
Multi-parameter water quality meter with pH, temperature, and DO probes
Secchi disk and calibrated sounding line, marked in 0.5 m intervals
Integrated sampler device (MPCA design)
Sterilized sample bottle, HDPE plastic, 500-mL
Spare net(s) and/or spare bucket assembly for end of net
Wisconsin net (250 m mesh) and collection bucket
Wisconsin net (80 m mesh) and collection bucket

**Sample Processing/Preservation**
95% ethanol
Alka-seltzer or club soda
Narcotization chamber
Lugol's solution
Hand pump
Osmonics 47 mm polycarbonate sterile filters
Plexiglas sectioning apparatus
Siphon tube with a bent plastic tip
Sterile disposable forceps
Sterile filter holder, Nalgene 145/147
Funnel, with large bore spout (optional)
Buckets, plastic, 8- to 10-qt capacity
Sieve-bucket or soil sieve with 500 µm mesh openings (U.S. std No. 35)
Small spatula, spoon, or scoop to transfer sample
Whatman GF/F or equivalent 0.7 µm glass fiber filter

**Sample Storage**
125 ml sample bottles for zooplankton
1-L polypropylene bottles for phytoplankton
500 mL sample bottle for algal toxins
50-mL screw-top centrifuge tube
4 L cubitainer
small glass containers with Teflon coated lids
Sterile microcentrifuge tubes containing sterile glass beads
Aluminum foil

**Packaging/Shipping**
Coolers
Cooler liners (30-gal garbage bags)
Dry ice
Wet ice
Self-sealing plastic bags
1-gallon self-sealing bags
Shipping tape

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# APPENDIX B
# SAMPLE FORMS

Sample Forms are being finalized and will be provided for review once completed.

# APPENDIX C

# SHIPPING GUIDELINES

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# SHIPPING GUIDELINES

Before shipping, it is very important to preserve each sample as directed in the sample collection portion of this Field Operations Manual.

- Preserve the samples as specified for each indicator before shipping (Fig. C-1).
- Be aware of the holding times for each type of sample (Table C-1):
  - **Water chemistry samples must be shipped the same day as collection.**
  - Chlorophyll-*a* samples have a longer holding time, but should be sent with the water chemistry samples since they are going to the same laboratory.
  - The **remaining samples must be preserved immediately** upon collection; they may then be sent in batches to the appropriate laboratory.

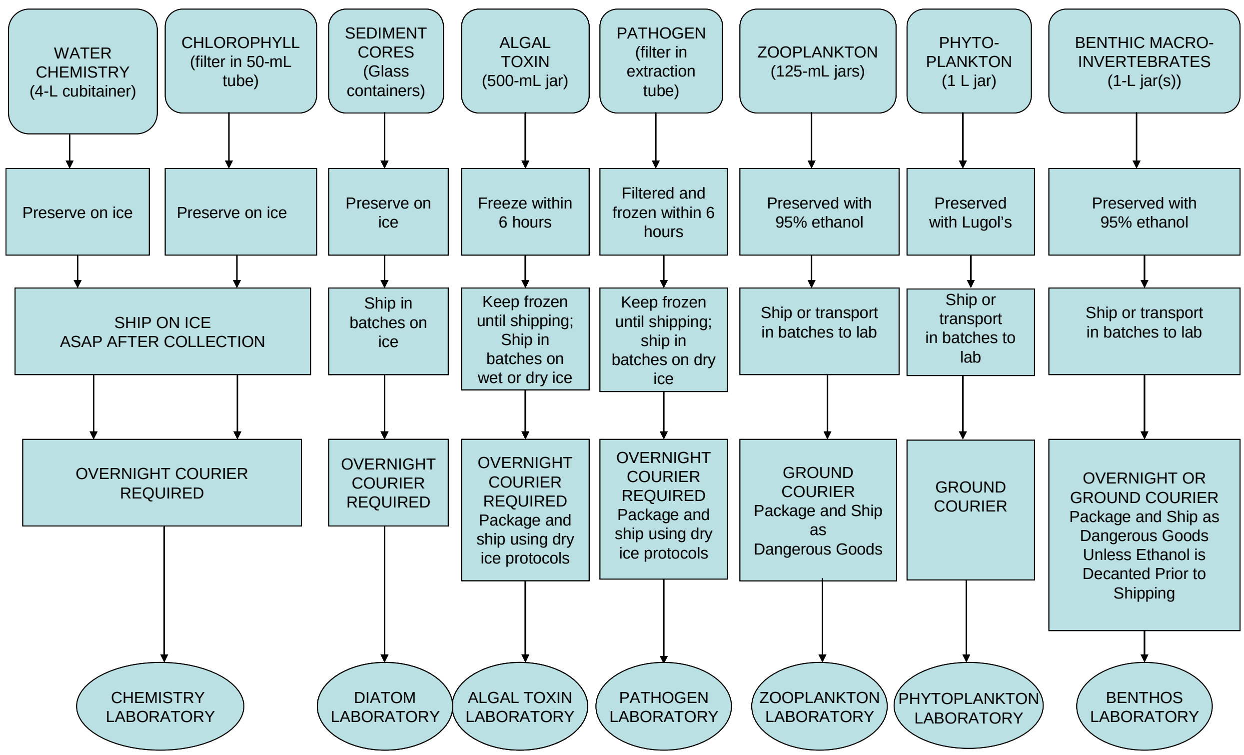


Figure C-1. Sample packaging and shipping summary.

Table C-1. Sample preservation, packaging, and holding times.

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| SAMPLE | PRESERVATIVE | PACKAGING FOR SHIPMENT | HOLDING TIME |
|---|---|---|---|
| Water Chemistry | Ice | Ship in cooler with ice | 24 hours |
| Chlorophyll-*a* | Ice | Ship in cooler with ice | Shipped with Water sample |
| Sediment Cores | Ice | Ship in cooler with ice | Batch |
| Algal Toxins | Dry Ice | Ship in cooler with wet or dry ice | Batch |
| Pathogens | Dry ice | Ship in cooler with dry ice | MUST be filtered and frozen within 6 hours of collection |
| Zooplankton | 95% Ethanol | Ship in cooler or other sturdy container; no additional preservative needed for shipping. | Batch |
| Macrobenthos | 95% Ethanol | | Batch |
| Phytoplankton | Lugol's | | Batch |

**When ice is used for shipment** (water chemistry, chlorophyll-a, and sediment cores):

- Ensure that the ice is fresh before shipment.
- Line the cooler with a large, 30-gallon plastic bag.
- Contain the ice separately within numerous (as many as possible) 1-gallon self-sealing plastic bags.
- White or clear bags will allow for labeling with a dark indelible marker. Label all bags of ice as "ICE" with an indelible marker to prevent misidentification by couriers of any leakage of water as a possible hazardous material spill.
- Place samples and bags of ice inside the cooler liner and seal the cooler liner.
- Secure the cooler with strapping tape.
- Package and label the cooler for shipping to the appropriate lab

**When dry ice is used for shipping** (algal toxin and pathogen samples):

- Indicate dry ice on shipping airbill.
- Label cooler with a Class 9 Dangerous Goods label.
- Securely tape the cooler drainage open to prevent pressure build-up in the cooler.
- Secure the cooler with strapping tape
- See "Dry Ice Shipping Protocols" at the end of this Appendix.

**WATER CHEMISTRY and CHLOROPHYLL-*a* SAMPLES**

- **Water Chemistry**
  - Place another garbage bag inside the cooler liner.
  - Confirm that the Cubitainer is labeled and covered with clear plastic tape.
  - Place the Cubitainer in the second bag.

- **Chlorophyll-*a***
  Stored in a 50-mL screw-top centrifuge tube
  - Confirm that the label with bar code is completed and covered with clear tape.
  - Place the centrifuge tube in a 1-qt self-sealing plastic bag.

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- Place the bag in a1-gal self-sealing plastic bag.
- Close the second bag containing all samples.
- Surround the bag with bags of fresh ice. It is important to keep the samples as cold as possible.
- Ship the water chemistry and chlorophyll-*a* samples on the day of collection whenever possible. If shipping on the day of collection is not possible, the samples must be shipped the next day with fresh ice.

**SEDIMENT CORE SAMPLES**
Stored in glass containers with Teflon coated lids

- Place another garbage bag inside the cooler liner.
- Confirm that the labels with bar codes attached to each of the glass containers containing sediment (top and bottom) are complete and covered with clear plastic tape.
- Place the containers in the bag.
- Close the bag containing all samples.
- Surround the bag with bags of fresh ice. It is important to keep the samples as cold as possible.

**ALGAL TOXIN SAMPLES**
The sample needs to be frozen as soon as possible after collection (within 6 hours).

- Confirm that the 500ml sample container is labeled and properly sealed.
- Place the sample container in the cooler and close.
- Pack the cooler with at least 20 kg of dry ice.
- Refer to the DRY ICE SHIPPING PROTOCOLS at the end of this Appendix.
- Alternatively, once the samples are completely frozen, they can be shipped on wet ice and begin the first thawing cycle.

**PATHOGEN SAMPLES - PLACEHOLDER, SUBJECT TO CHANGE**
The sample needs to be filtered and frozen as soon as possible after collection (within 6 hours).

- Confirm that the container is labeled and properly sealed.
- Place the container in the cooler and close.
- Pack the cooler with at least 20 kg of dry ice.
- Refer to the DRY ICE SHIPPING PROTOCOLS at the end of this Appendix.

**ZOOPLANKTON SAMPLES**
Preserved in 95% ethanol and sealed at the lake.

- Confirm that each jar is labeled with the appropriate bar code and covered with clear plastic tape. If a sample requires an additional jar, confirm that the bar code number of the corresponding labeled sample is recorded on the supplemental label.
- Verify that each jar is sealed with electrical tape and sealed in a quart-size self-sealing plastic bag.
- Place the quart-size self-sealing plastic bags in a gallon-size self-sealing plastic bag.
- Place the bags in the appropriate shipping container.
- Samples can be held for a short period before shipment but should be transported as soon as possible to the laboratory for analysis.

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NOTE: If shipped, these samples must be shipped as "DANGEROUS GOODS" and should be packaged and labeled in accordance with the requirements of the chosen courier.

**PHYTOPLANKTON SAMPLES**

Preserved with Lugol's solution and sealed at the lake.

- Confirm that the bottle is labeled with the appropriate bar code and covered with clear plastic tape.
- Verify that the bottle is sealed with electrical tape.
- Place the sealed bottles in a gallon-size self-sealing plastic bag.
- Place the bagged samples in the appropriate shipping container.
- Samples can be held for a short period before shipment but should be transported as soon as possible to the laboratory for analysis.

**BENTHIC INVERTEBRATE SAMPLES**

Preserved in 95% ethanol and sealed at the lake.

- Check to make sure jars are sealed with electrical tape.
- Place up to twenty 500-mL or ten 1-L jars in each cooler.
- Surround the jars with crumpled newspaper, vermiculite, or other absorbent material.
- Samples can be held for a short period before shipment but should be transported as soon as possible to the laboratory for analysis.

NOTE: If shipped, these samples must be shipped as "DANGEROUS GOODS" and should be packaged and labeled in accordance with the requirements of the chosen courier.

*Alternatively, the ethanol may be decanted from the benthic invertebrate samples so that they may be shipped using standard overnight shipping:*

- Allow the samples to sit for at least 1 week to adequately preserve the organisms.
- Immediately before shipping, decant the ethanol from the samples jars, leaving enough liquid to keep the samples moist.
- Make sure to use an overnight delivery so that the lab can immediately restore the ethanol to the sample jars.

**DRY ICE SHIPPING PROTOCOLS**

1. Indicate dry ice on shipping airbill

    - Fill out Section 1 and Section 3 of the Fed Ex airbill with your Sender and Recipient address and phone number.
    - In Section 4, check "FedEx Priority Overnight."
    - In Section 5, check "Other."
    - In Section 6, under "Does this shipment contain dangerous goods?":
        - Check "Yes/Shipper's Declaration not required."
        - Check "Dry Ice," and fill out "_1_ x _*(amt. of dry ice in kg)*_ kg"
    - In Section 7, fill out weight and declared value of package.

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2. Label cooler with a Class 9 Dangerous Goods label (Fig. A-1).

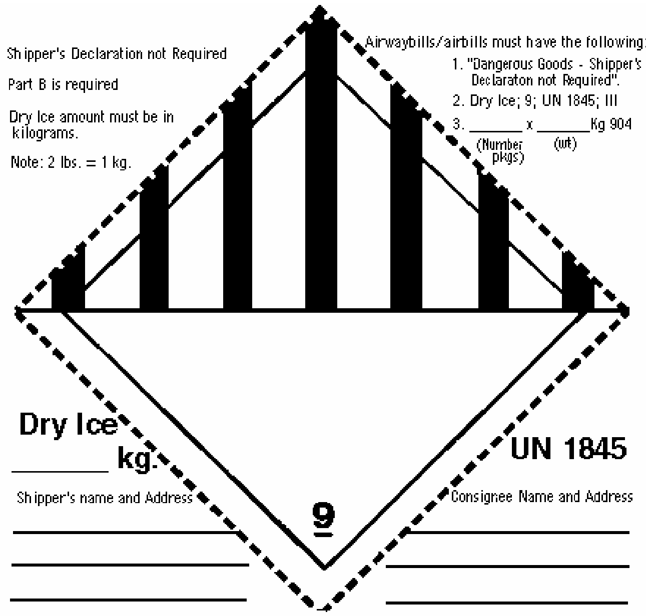


Figure C-2. Class 9 Dangerous Goods label.

- Place the label on the front side of the cooler, not the top of the cooler.
- Fill out #3 in the top right hand corner of the label with the same information as in Section 6 of the FedEx airbill.
- Declare the weight of the dry ice again in the lower left hand corner.
- Fill out the Sender ("Shipper") and Recipient ("Consignee") address on the bottom of the label.

3. Securely tape the cooler drainage open to prevent pressure build-up in the cooler. This is critical to ensure proper venting of the dry ice.

4. Secure the cooler with strapping tape.

5. Place the completed airbill on the top of the cooler.

**NOTE:** Not all FedEx locations will accept shipments containing dry ice. Please be sure to call in advance to ensure your location will accept the package for shipment.

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## LAKES - TRACKING

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AIRBILL NUMBER: ______________ DATE SENT: ___/___/______ TEAM: ______

| Site ID | Date Sample Collected MM/DD/YYYY | Visit | Sample ID | Sample Type | # of Containers | Comments | Cond. Code |
|---|---|---|---|---|---|---|---|
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| Contact Information | Chain of Custody | Sample Types | Condition Codes |
|---|---|---|---|
| PLACE LAB LABEL HERE<br><br>Tracking<br>Marlys Cappaert<br>p) 541-754-4467 | Date Received:<br>___/___/______<br>Received by:<br>______________<br><br>Filled in at lab | UNPRESERVED<br>ALTX - Algal toxin<br>CHEM - Chemistry<br>CHLA - Chlorophyll<br>PATH - Pathogen<br>SEDI - Sediment core (Diatoms)<br><br>PRESERVED<br>BENT - Benthos<br>PHYT - Phytoplankton<br>ZOOP - Zooplankton | C = Cracked jar<br>F = Frozen<br>L = Leaking<br>ML = Missing label<br>NP = Not preserved<br>W = Warm<br>OK = Sample OK<br>T = Thawed<br><br>Filled in at lab |

FAX TRACKING FORM TO 541-754-4637 OR CALL 541-754-4663

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Reviewed by (initial): ______

## LAKE VERIFICATION FORM

SITE ID: ____________ DATE: __ / __ / ____ VISIT: 1 2

SITE NAME: ____________ MODE OF ACCESS: ☐ Vehicle ☐ Hike-In ☐ Aircraft TEAM: ____

### LAKE VERIFICATION INFORMATION

Lake shape compares with map? ☐ YES ☐ NO

Lake verified by (X all that apply): ☐ GPS ☐ Local Contact ☐ Signs ☐ Roads ☐ Topo. Map

☐ Other (Describe Here): ☐ Not Verified (Explain in Comments)

| Coordinates | | Latitude North | Longitude West | Type of GPS Fix |
|---|---|---|---|---|
| MAP | Degrees, Minutes, and Seconds OR Decimal Degrees | | | |
| LAUNCH SITE | Degrees, Minutes, and Seconds OR Decimal Degrees | | | ☐ 2D ☐ 3D |
| INDEX SITE | Degrees, Minutes, and Seconds OR Decimal Degrees | | | ☐ 2D ☐ 3D |

### DID YOU SAMPLE THIS SITE?

☐ YES ☐ NO

If NO, check one reason below and provide explanation:

☐ Not Visited ☐ Inaccessible

☐ Non-target ☐ Other

Explanation if lake not sampled:

GENERAL COMMENTS:

DIRECTIONS TO LAKE & LAUNCH SITE (from nearest main road or town):

LAUNCH SITE DESCRIPTION:

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## LAKE VERIFICATION FORM (cont.)

Reviewed by (initial): ______

SITE ID: ____________________ DATE: ___/___/______

**SKETCH MAP - Arrow Indicates North; Mark site L=Launch X=Index**

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**PERSONNEL**

| NAME | DUTIES: Index Site | Shoreline | Forms |
|---|---|---|---|
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |
| | ☐ | ☐ | ☐ |



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## LAKE PROFILE FORM

Reviewed by (initial): ____

SITE ID: ____________ DATE: ___/___/______ TEAM: ____

Precipitation: ☐ NONE ☐ LIGHT ☐ HEAVY Surface Conditions: ☐ FLAT ☐ RIPPLES ☐ CHOPPY ☐ WHITECAPS

Odor: ☐ YES ☐ NO Description:

Scum: ☐ YES ☐ NO Description:

Index Site Depth: (m) ___ . _

Method Used: ☐ SONAR ☐ POLE ☐ ESTIMATE

Comments:

### CALIBRATION INFORMATION

Instrument manufacturer and model: ____________

Instrument ID number: ____________ Operator: ____________

| TEMPERATURE | DO |
|---|---|
| Thermometer Reading: ___ . _ (°C)<br>Sensor Reading: ___ . _ (°C)<br>TEMP FLAG ☐ | Elevation: (ft) ______ 0 0 OR Barometric Pressure: (mm Hg) ______<br>Calibration Value: ___ . _ (mg/L)<br>OR: ___ . _ (%)<br>Displayed Value: ___ . _ (mg/L)<br>OR: ___ . _ (%)<br>DO FLAG ☐ |

| pH | CONDUCTIVITY |
|---|---|
| QCCS Description: ____________<br>QCCS True: ___ . _<br>QCCS Measured: ___ . _<br>pH FLAG ☐ | QCCS Description: ____________<br>QCCS True: ___ . _ (µS/cm @25°C)<br>QCCS Measured: ___ . _ (µS/cm @25°C)<br>COND. FLAG ☐ |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; Q = Unacceptable QC check associated with measurement; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comments section.

| Flag | Comments |
|---|---|
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Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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Reviewed by (initial): ______

## LAKE PROFILE FORM (continued)

**SITE ID:** ______________ **DATE:** ___/___/______ **TEAM:** ____

### DISSOLVED OXYGEN AND TEMPERATURE PROFILE

**Depth Units:** ☐ m ☐ ft

**Intervals (m): Surface to 20 m = every 1 m; 20-50 m = every 2 m; last reading 0.5 m above bottom**

**Intervals (ft): Surface to 66 ft, every 3 ft; 66-164 ft every 6.5 ft; last reading 1.5 ft above bottom**

| Depth XX.X | $O_2$ (mg/L) XX.X | Temp. (°C) XX.X | pH XX.X | Cond. (µS/cm@ 25°C) XX.X | Meta-limnion (T, B) | Flag | Depth XX.X | $O_2$ (mg/L) XX.X | Temp. (°C) XX.X | pH XX.X | Cond. (µS/cm@ 25°C) XX.X | Meta-limnion (T, B) | Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface | | | | | | | | | | | | | |
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| | | | | | | | Dup Surface | | | | | | |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; Q = Unacceptable QC check associated with measurement; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

**Is the Duplicate $O_2$ reading within ±0.5 mg/L of the initial surface reading?** ☐ **YES** ☐ **NO**

| Flag | Comments |
|---|---|
| | |
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Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

a If the site depth is <3 m, take readings at the surface, every 0.5 m, and 0.5 m above bottom.
b METALIMNION = The region of the profile where the temperature changes at the rate of 1 °C or greater per meter of depth. Indicate the depth of the top of the metalimnion with a 'T', and the bottom of the metalimnion (when the rate change becomes less than 1 °C per meter) with a 'B'. After t encountered, take readings every 1 m until bottom of the metalimnion is reached.
Record the depth of the top of the metalimnion on the Shoreline Sample Collection Form.

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Reviewed by (initial): ____

## LAKE INDEX SITE SAMPLE COLLECTION FORM

SITE ID: ______________ DATE: ___/___/______

### SECCHI DISK TRANSPARENCY

| Depth Disk Disappears (m) | Depth Disk Reappears (m) | Clear to Bottom | Comments |
|---|---|---|---|
| __ . __ | __ . __ | ☐ | |

DEPTH OF INTEGRATED SAMPLE FOR WATER CHEM, CHLOROPHYLL, AND PHYTOPLANKTON (TYPICALLY 2 M) ____ m

### WATER CHEMISTRY (4-L CUBITAINER)

| Sample ID | Sample Type * | Comments |
|---|---|---|
| | R1 | |
| | | |

### CHLOROPHYLL (Target Volume = 1000 mL; max vol = 2000 mL)

| Sample ID | Sample Type * | Volume Filtered (mL) | Comments |
|---|---|---|---|
| | R1 | | |
| | | | |

### PHYTOPLANKTON (Target Volume = 1000 mL)

| Sample ID | Sample Type * | Pre-served Lugol's | Comments |
|---|---|---|---|
| | R1 | ☐ | |
| | | ☐ | |

* Sample Types: R1 = First replicates (Index sample), R2 = Field duplicate

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## LAKE INDEX SITE SAMPLE COLLECTION FORM (cont.)

Reviewed by (initial): ____

SITE ID: ____________ DATE: __ / __ / ____

| ZOOPLANKTON (Fill to Mark on Bottle = 80 mL) | | | | | | |
|---|---|---|---|---|---|---|
| | Sample ID | Sample Type * | Length of Tow (m) | No. of Jars | Pre-served (ETOH) | Comments |
| COARSE | | R1 | | | ☐ | |
| FINE | | R1 | | | ☐ | |
| | | | | | ☐ | |
| | | | | | ☐ | |

**SEDIMENT CORE SAMPLES** (Target Core Length = 35 to 45 cm)

| Collected at: | ☐ INDEX ☐ OTHER | If OTHER, record GPS coordinates: | Latitude North | Longitude West |
|---|---|---|---|---|
| | | | ___ ___ ___ / ___ . ______ | ___ ___ ___ / ___ . ______ |

| Sample Class | Sample ID | Sample Type * | Length of Core (cm) | No. of Jars | INTERVAL (cm) From | INTERVAL (cm) To | Comments |
|---|---|---|---|---|---|---|---|
| TOP | | R1 | | | | | |
| BOTTOM | | R1 | | | | | |
| | | | | | | | |
| | | | | | | | |

* Sample Types: R1 = First replicates (Index sample), R2 = Field duplicate

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Reviewed by (initial): ______

# PHYSICAL HABITAT CHARACTERIZATION - LAKES

SITE ID: ____________ DATE: ___ / ___ / ______

STATION: ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H ☐ I ☐ J    DEPTH AT STATION ____ . __ ☐ ft ☐ m

IF STATION WAS RELOCATED, INDICATE HERE: ☐

## LITTORAL ZONE

Surface Film Type: ☐ Scum ☐ Algal Mat ☐ Oily ☐ None/Other

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

| BOTTOM SUBSTRATE | | | | | | Flag |
|---|---|---|---|---|---|---|
| Bedrock (>4000mm; larger than a car) | 0 | 1 | 2 | 3 | 4 | |
| Boulders (250-4000mm; basketball-car) | 0 | 1 | 2 | 3 | 4 | |
| Cobble (64-250mm; tennis ball-basketball) | 0 | 1 | 2 | 3 | 4 | |
| Gravel (2-64mm; ladybug to tennis ball size) | 0 | 1 | 2 | 3 | 4 | |
| Sand (0.06 - 2mm; gritty between fingers) | 0 | 1 | 2 | 3 | 4 | |
| Silt, Clay, or Muck (<0.06mm; not gritty) | 0 | 1 | 2 | 3 | 4 | |
| Woody Debris | 0 | 1 | 2 | 3 | 4 | |
| Color | ☐ None ☐ Black ☐ Gray ☐ Brown ☐ Red ☐ Other | | | | | |
| Odor | ☐ None ☐ $H_2S$ ☐ Anoxic ☐ Oil ☐ Chemical ☐ Other | | | | | |

| MACROPHYTES | | | | | | Flag |
|---|---|---|---|---|---|---|
| Submergent | 0 | 1 | 2 | 3 | 4 | |
| Emergent | 0 | 1 | 2 | 3 | 4 | |
| Floating | 0 | 1 | 2 | 3 | 4 | |
| Total Weed Cover | 0 | 1 | 2 | 3 | 4 | |

Do macrophytes extend lakeward? ☐ Yes ☐ No

| FISH COVER<br>0 = None 1 = Sparse 2 = Moderate - Very Heavy | | | | Flag |
|---|---|---|---|---|
| Aquatic Weeds | 0 | 1 | 2 | |
| Snags > 0.3 m Dia. | 0 | 1 | 2 | |
| Brush/Woody Debris <0.3 m dia. | 0 | 1 | 2 | |
| Inundated Live Trees >0.3 m dia | 0 | 1 | 2 | |
| Overhanging Veg. within 1 m of Surface | 0 | 1 | 2 | |
| Ledges or Sharp Dropoffs | 0 | 1 | 2 | |
| Boulders | 0 | 1 | 2 | |
| Human Structures- Docks, Landings, etc | 0 | 1 | 2 | |

### LITTORAL FISH HABITAT CLASSIFICATION

Disturbance: ☐ Human ☐ Natural ☐ Mixed

Cover Class: ☐ Cover ☐ Open ☐ Mixed

Cover Type: ☐ Artificial ☐ Fill ☐ Veg. ☐ Woody ☐ Boulders ☐ Mixed ☐ None

Substrate: ☐ Mud/Muck ☐ Sand/Gravel ☐ Cobble/Boulder ☐ Bedrock

## RIPARIAN ZONE

Vegetation Type: ☐ Deciduous ☐ Coniferous ☐ Mixed ☐ None

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

| CANOPY (>5 m high) | | | | | | Flag |
|---|---|---|---|---|---|---|
| Big Trees (Trunk >0.3 m dBH) | 0 | 1 | 2 | 3 | 4 | |
| Small Trees (Trunk <0.3 m dBH) | 0 | 1 | 2 | 3 | 4 | |
| **UNDERSTORY (0.5 TO 5m high)** | | | | | | **Flag** |
| Woody Shrubs & Saplings | 0 | 1 | 2 | 3 | 4 | |
| Tall Herbs, Grasses, & Forbs | 0 | 1 | 2 | 3 | 4 | |
| **GROUND COVER (<0.5 high)** | | | | | | **Flag** |
| Woody Shrubs & Saplings | 0 | 1 | 2 | 3 | 4 | |
| Herbs, Grasses and Forbs | 0 | 1 | 2 | 3 | 4 | |
| Standing Water or Inundated Vegetation | 0 | 1 | 2 | 3 | 4 | |
| Barren, Bare Dirt or Buildings | 0 | 1 | 2 | 3 | 4 | |
| **SHORELINE SUBSTRATE ZONE** | | | | | | **Flag** |
| Bedrock (>4000mm; larger than a car) | 0 | 1 | 2 | 3 | 4 | |
| Boulders (250-4000mm; basketball-car size) | 0 | 1 | 2 | 3 | 4 | |
| Cobble/Gravel (64-250mm; ladybug ball-basketball size) | 0 | 1 | 2 | 3 | 4 | |
| Sand (0.06 - 2mm; gritty between fingers) | 0 | 1 | 2 | 3 | 4 | |
| Silt, Clay, or Muck (<0.06mm; not gritty) | 0 | 1 | 2 | 3 | 4 | |
| Woody Debris | 0 | 1 | 2 | 3 | 4 | |

| HUMAN INFLUENCE<br>0 = Not Present C =Present within plot P = Present behind plot B = At shoreline/bank or in lake | | | | Flag |
|---|---|---|---|---|
| Buildings | 0 | P | C | |
| Commercial | 0 | P | C | |
| Park Facilities | 0 | P | C | |
| Docks/Boats | 0 | P | C | |
| Walls, dikes or revetments | 0 | P | C | |
| Landfill/Trash | 0 | P | C | |
| Roads or Railroad | 0 | P | C | |
| Row Crops | 0 | P | C | |
| Pasture/Range/Hay Field | 0 | P | C | |
| Orchard | 0 | P | C | |
| Lawn | 0 | P | C | |

### BANK FEATURES (within plot)

Angle: ☐ <30° ☐ 30-75° ☐ >75°

Vertical distance from waterline to high water mark: ______ . __ (m)

Horizontal distance from waterline to high water mark: ______ . __ (m)

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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## PHYSICAL HABITAT CHARACTERIZATION - LAKES (continued)

SITE ID: ____________________ DATE: __ __ / __ __ / __ __ __ __

| INVASIVE PLANTS AND INVERTEBRATES | | | | | |
|---|---|---|---|---|---|
| **Littoral Plot** | | | **Shoreline/Riparian Plot** | | |
| SPECIES | X if observed | FLAG | SPECIES | X if observed | FLAG |
| NONE OBSERVED | ☐ | | NONE OBSERVED | ☐ | |
| Zebra or Quagga Mussel | ☐ | | Purple loosestrife | ☐ | |
| Eurasian watermilfoil | ☐ | | Knotweeds | ☐ | |
| Hydrilla | ☐ | | Hairy willow herb | ☐ | |
| Curly pondweed | ☐ | | Yellow floating heart | ☐ | |
| African waterweed | ☐ | | Giant salvinia | ☐ | |
| European water chestnut | ☐ | | Flowering rush | ☐ | |
| Water hyacinth | ☐ | | | ☐ | |
| Parrot feather | ☐ | | | ☐ | |
| | ☐ | | | ☐ | |
| | ☐ | | | ☐ | |
| | ☐ | | | ☐ | |

| Flag | Comments |
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Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

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# LAKE SHORELINE SAMPLE COLLECTION FORM

Reviewed by (initial): ______

**SITE ID:** ______________________ **DATE:** ___/___/______

**ALGAL TOXIN** (Target Volume = 1000 mL)

| Sample ID | Sample Type | Station | Surface to Depth Collected (m) | Sample Volume (mL) | Comments |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

**PATHOGEN** (Target Volume = ??? mL)

| Sample ID | Sample Type | Station | Depth Collected (m) | Sample Volume (mL) | Comments |
|---|---|---|---|---|---|
| | R1 | | | | |
| | | | | | |

**BENTHOS**

| Sample ID | No. of Jars | Flag |
|---|---|---|
| | | |

| STATION | | A | | B | | C | | D | | E | | F | | G | | H | | I | | J | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTRATE | COLL. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. | Sub. | Coll. |
| Rocky/Cobble/ Woody debris | Boat | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B | ☐ R | ☐ B |
| Macrophyte beds | Wading | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W | ☐ M | ☐ W |
| Organic fine muds | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | | ☐ F | |
| Other: Note in Comments | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | | ☐ O | |
| FLAG | | | | | | | | | | | | | | | | | | | | | |

**COMMENTS**

| | |
|---|---|
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| | |

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew.
Explain all flags in comment sections.

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# LAKE ASSESSMENT FORM

Reviewed by (initial): ______

SITE ID: ______________________ DATE: ___/___/______

## LAKE SITE ACTIVITIES AND DISTURBANCES OBSERVED (Intensity: Blank=Not observed, L=Low, M=Moderate, H=Heavy)

| Residential | Recreational | Agricultural | Industrial | Lake Management |
|---|---|---|---|---|
| L M H Residences | L M H Hiking Trails | L M H Cropland | L M H Industrial Plants | L M H Liming |
| L M H Maintained Lawns | L M H Parks, Campgrounds | L M H Pasture | L M H Mines/Quarries | L M H Chemical Treatment |
| L M H Construction | L M H Primitive Parks, Camping | L M H Livestock Use | L M H Oil/Gas Wells | L M H Angling Pressure |
| L M H Pipes, Drains | L M H Resorts | L M H Orchards | L M H Power Plants | L M H Drinking Water Treatment |
| L M H Dumping | L M H Marinas | L M H Poultry | L M H Logging | L M H Macrophyte Control |
| L M H Roads | L M H Trash/Litter | L M H CAFOs | L M H Evidence of Fire | L M H Water Level Fluctuations |
| L M H Bridges/Causeways | L M H Surface Films, Scums, or Slicks | L M H Water Withdrawal | L M H Odors | L M H Fish Stocking |
| L M H Sewage Treatment | | | L M H Commercial | |

## GENERAL LAKE INFORMATION

| | | | | |
|---|---|---|---|---|
| Hydrologic Lake Type: | ☐ Reservoir | ☐ Drainage (outlets present) | ☐ Seepage (no outlets observed) | |
| Outlet Dams: | ☐ None | ☐ Artificial | ☐ Natural | |
| Low Elevation Flight Hazards: | ☐ Yes | ☐ No | | |
| Motor Boat Density: | ☐ High | ☐ Low | ☐ Restricted | ☐ Banned |
| General Aesthetics: | ☐ Pleasant | ☐ Somewhat pleasant | ☐ Unpleasant | |
| Swimability: | ☐ Good | ☐ Fair | ☐ Not Swimmable | |
| Lake Level Changes: | ☐ Zero | ☐ Elevation Change = ______ m | | |

## SHORELINE CHARACTERISITCS (% of shoreline)

| | | | | |
|---|---|---|---|---|
| Forest | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Grass | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Shrub | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Wetland | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Bare Ground | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Agriculture | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Shoreline Mods (docks, riprap) | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |
| Development (Residential & Urban) | ☐ Rare (<5%) | ☐ Sparse (5 to 25%) | ☐ Moderate (25 to 75%) | ☐ Extensive (>75%) |

## QUALITATIVE MACROPHYTE SURVEY

| | | | | |
|---|---|---|---|---|
| Macrophyte Density | ☐ Absent | ☐ Sparse | ☐ Moderate | ☐ Extensive |
| Emergent/Floating Coverage (% Lake Area) | ☐ <5% | ☐ 5 to 25% | ☐ 25 to 75% | ☐ >75% |
| Submergent Coverage (% Lake Area) | ☐ <5% | ☐ 5 to 25% | ☐ 25 to 75% | ☐ >75% |

## WATERBODY CHARACTER

| | | | | | | |
|---|---|---|---|---|---|---|
| Pristine | ☐ 5 | ☐ 4 | ☐ 3 | ☐ 2 | ☐ 1 | Highly Disturbed |
| Appealing | ☐ 5 | ☐ 4 | ☐ 3 | ☐ 2 | ☐ 1 | Unappealing |

US EPA ARCHIVE DOCUMENT

## LAKE ASSESSMENT FORM (cont.)

Reviewed by (initial): ____

SITE ID: ______________________ DATE: __ __ / __ __ / __ __ __ __

| QUALITATIVE ASSESSMENT OF ENVIRONMENTAL VALUES | |
|---|---|
| **Ecological Integrity:** | ☐ Excellent ☐ Good ☐ Fair ☐ Poor |
| General Assessment: | |
| Wildlife Observed: | |
| **Trophic State:** | ☐ Oligotrophic ☐ Mesotrophic ☐ Eutrophic ☐ Hypereutrophic |
| Visual Assessment: | |
| Algal Abundance & Type: | |
| Nutrient Status: | |
| Other: | |
| **Recreational Value:** | ☐ Excellent ☐ Good ☐ Fair ☐ Poor |
| Conditions and Local Contacts: | |
| Observations (e.g. accessibility, boating, fishing, swimming, health concerns): | |

**Comments:**

DRAFT