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Field Operations Manual for Lakes

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ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM SURFACE WATERS

FIELD OPERATIONS MANUAL FOR LAKES

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ABSTRACT

The methods and instructions for field operations presented in this manual for lake surveys were developed and tested through 4 years of pilot and demonstration projects from 1991 through 1994. These projects were conducted under the sponsorship of the U.S. Environmental Protection Agency and its collaborators through the Environmental Monitoring and Assessment Program (EMAP). This program focuses on evaluating ecological conditions on regional and national scales. This document describes procedures for collecting data, samples, and information about biotic assemblages, environmental measures, or attributes of indicators of lake ecosystem condition. The procedures presented in this manual were developed based on standard or accepted methods, modified as necessary to adapt them to EMAP sampling requirements. In addition to methodology, additional information on data management and other logistical aspects is integrated into the procedures and overall operational scenario. Procedures are described for collecting chlorophyl *a*, water, sedimentary diatoms, and zooplankton data in conjunction with the development of standard methods to obtain acceptable index samples for macrobenthos, fish assemblage, fish tissue contaminants, riparian birds, and physical habitat structure. The manual describes field implementation of these methods and the logistical foundation constructed during field projects. The manual includes flow charts with overall summaries of specific field activities required to visit a lake site and collect data for these indicators. Tables give step-by-step protocol instructions. These figures and tables can be extracted and bound separately to make a convenient quick field reference for field teams. The manual also includes example field data forms for recording measurements and observations made in the field and sample tracking information. Checklists of all supplies and equipment needed for each field task are included to help ensure that these materials are available when required.

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In any undertaking with a scope as broad as that of EMAP-Surface Waters, many individuals contribute in important ways not reflected by authorship on documents such as this. This is especially true of the contents of this manual which are the product of tests and lessons learned over a period of 5 years of field work. Rather than attempt to list all of these contributors, and risk omitting some, we will identify the organizations whose staff members participated in the development of the material presented in this manual:

- EMAP-Surface Waters and associated laboratory staff in Corvallis, Las Vegas, and Cincinnati, including EPA and on-site contractor personnel (ManTech Environmental Technology, Inc., Lockheed Environmental Systems & Technologies Company, and Technology Applications, Inc.).
- Environmental Services Division of EPA Regions 1 and 2.
- Personnel on cooperative agreements with Oregon State University, Queens University, Dartmouth College, University of Maine, the University of Nevada at Las Vegas, and the Aquatic Resources Center.
- Members of the lake sampling crews of miscellaneous origin.
- Members of the peer review panel and reviewers of this manual.

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ACRONYMS AND ABBREVIATIONS

BPJ	Best Professional Judgment
DLGs	Digital Line Graphs
DO	dissolved oxygen
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
GQ	geometric quality
ID	identification
ORD	Office of Research and Development
OSHA	Occupational Safety and Health Administration
P-Hab	physical habitat
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
SQ	signal quality
STARS	Sample Tracking and Reporting System
T	Top
TIME	Temporally Integrated Monitoring of Ecosystems
USGS	United States Geological Survey
YOY	young of year
YSI	Yellow Springs Instrument system

Measurement Units

ha	hectare
m	meter
ppm	parts per million

SECTION 1
INTRODUCTION

by
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Wesley L. Kinney, Richard Stemberger, Donna W. Sutton,
Thomas R. Whittier, and Roger B. Yeardley

The U.S. Environmental Protection Agency (EPA), in cooperation with other federal and state organizations, has designed the Environmental Monitoring and Assessment Program (EMAP) to periodically assess the condition of the Nation's ecological resources. This document provides background and procedures for field personnel working with the EMAP Surface Waters Resource Group, one of seven EMAP ecological resource groups. The Surface Waters Group focuses on monitoring and assessment of the condition of lakes and streams. This manual covers field operations for lakes. The procedures and protocols described in this manual have been tested, modified, and refined during 4 years of pilot and demonstration studies in the northeastern United States.

1.1 OVERVIEW OF EMAP SURFACE WATERS

The intent of EMAP is to assist decision makers, both within and outside the Agency, to evaluate the cumulative effectiveness of current environmental regulations in protecting the Nation's natural resources, prioritize issues of concern and regions in which action is needed, and set environmental policy. This Program is a strategy to identify and bound the extent, magnitude, and location of degradation or improvement in the environment. In the long-term, the Program intends to contribute to answering the following critical questions:

- What is the current extent of our ecological resources (e.g., estuaries, lakes, streams, forests, and grasslands) and how are they distributed geographically?
- What percentage of resources appears to be adversely affected by pollutants or other anthropogenic environmental stresses?
- Which resources are degrading or improving, where, and at what rate?
- What are the relative magnitudes of the most likely causes of adverse effects?
- Are adversely affected ecosystems improving as expected in response to cumulative effects of control and mitigation programs?

To answer these questions, the various, integrated monitoring networks within EMAP focus on the following objectives:

- Estimate the current status, extent, changes, and trends in indicators of the condition of the Nation's ecological resources on a regional basis with known confidence.
- Monitor indicators of pollutant exposure and habitat condition and seek associations between human-induced stresses and ecological condition that identify possible causes of adverse effects.
- Provide periodic statistical summaries and interpretive reports on ecological status and trends to the EPA Administrator and to the public.

The EMAP Surface Waters resource group plans to estimate the condition of lakes, reservoirs, streams, and rivers on relatively broad, regional scales. The design of the program uses an integrated, probability-based monitoring framework based on a systematic grid and is explained in detail by Paulsen et al. (1991), Larsen and Christie (1993), and Larsen et al. (1994). Figure 1-1 summarizes the probability-based selection process. Lake, reservoir, stream, and wetlands resource information is initially derived from hydrologic information which is part of U.S. Geological Survey (USGS) 1:100,000 scale Digital Line Graphs (DLGs). Specific spatial information associated with surface water bodies (e.g., geographic coordinates and surface area or stream "blue line" length) extracted from the DLGs into a data base file. After accuracy and completeness checks, missing surface water bodies are added to the spatial file.

The first stage (Tier I) of the probability sample is developed by intersecting the spatial file of surface water body information with a second file containing spatial information related to the EMAP systematic sampling grid. The Tier I sample represents all surface water bodies whose digitized labeling points are located within the boundaries of one of the hexagons.

The second stage of site selection involves selecting a subset of the Tier I sample. This subset (Tier II) represents sites that are expected to be visited by field sampling crews. The Tier II sample is selected through a process that incorporates the desired Tier II sample size and any Tier I stratification needed (e.g., lake area). Sites are selected randomly from the Tier I sample, with the constraint that the spatial distribution of sites be preserved. Each Tier II site has an associated inclusion probability with which any measured attribute can be related to the target population of sites.

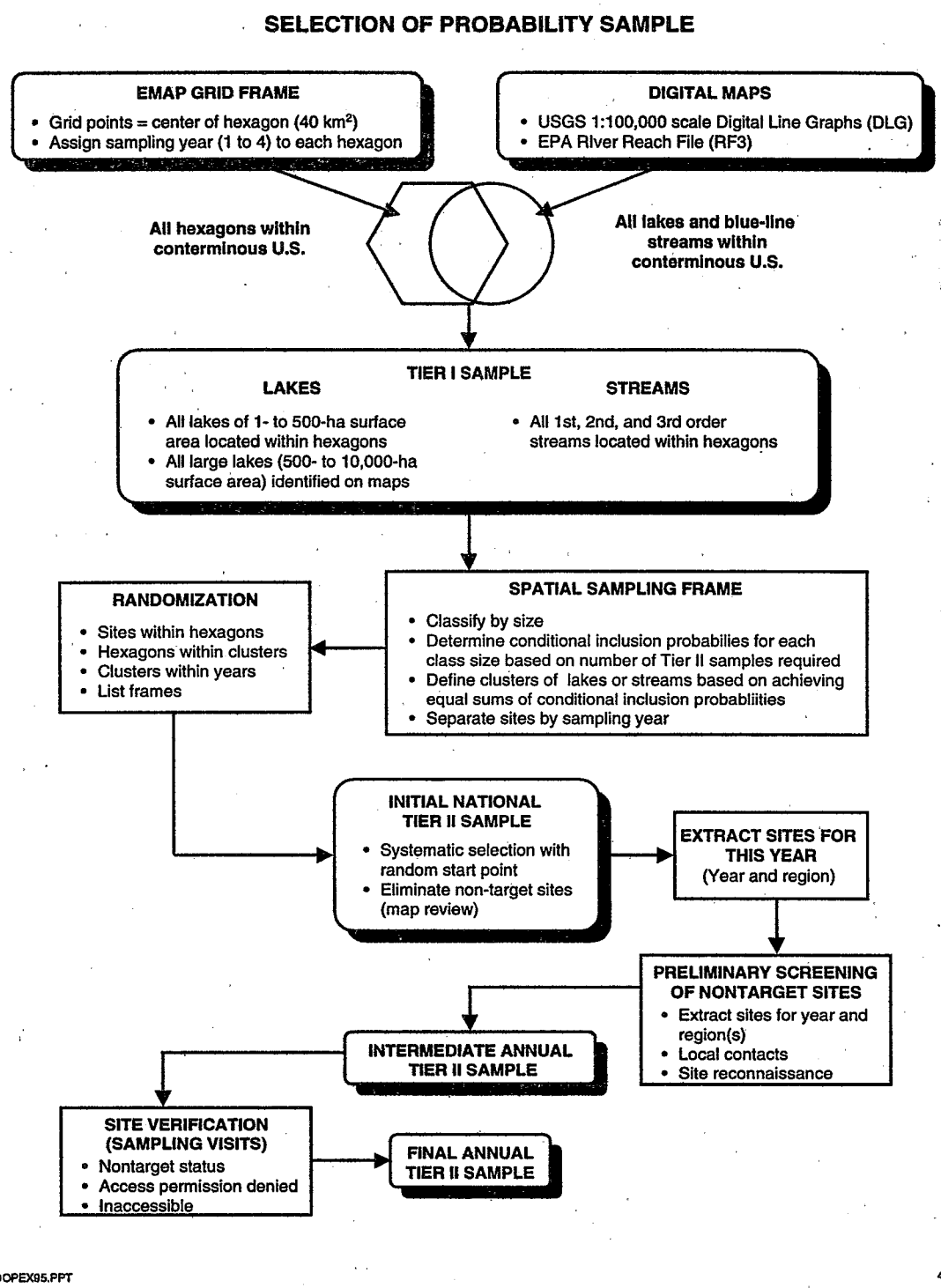

Figure 1-1. Selection of probability sample.

A sample size of at least 30 to 50 is necessary for making statements about the condition of a regional subpopulation with reasonable precision. Larger total sample sizes are necessary if the condition of numerous subpopulations are to be described. Overselection should protect against a reduction in sample size due to: (1) landscape-related errors not portrayed by the DLGs, (2) the inability to visit a site due to weather conditions or lack of access permission, or (3) the reclassification of a site to nontarget status when it is visited.

Data obtained from Surface Waters projects allow estimation of the spatial extent and geographical distribution of various classes of surface waters. Additionally, investigators can use the data to estimate the current status of, and changes or trends in, indicators of lake ecological condition.

1.2 SYNOPSIS OF THE LAKE SAMPLING COMPONENT OF EMAP SURFACE WATERS

Field activities conducted by the EMAP Surface Waters resource group for lake monitoring and assessment from 1991 through 1994 consisted of pilot and demonstration projects in the Northeast. The pilot projects were designed to answer questions related to development of proposed "indicators" of the condition of surface waters. Various aspects of each indicator were evaluated during the pilot projects, including plot design, sensitivity to various stressors, magnitude of spatial and measurement variance components, evaluation of methods and other logistical constraints. The 1994 demonstration project was designed to evaluate the capability of indicators to be implemented on a regional scale and their ability to estimate the condition of regional populations of lakes.

Ecological indicators are measurements, metrics, or indices that quantify physical, chemical or biological condition, habitat, or stress (Larsen and Christie, 1993). Measurements of a biological assemblage (e.g., fish or diatoms) or other ecosystem attribute are converted into numerical metric or index scores. The distribution of indicator values is presented and used to determine the status of the resource populations of interest.

Because it is not possible to measure all attributes in all parts of all waterbodies at all times, an "index" sample is collected. To be valid, index sampling at a lake must take place at appropriate times and locations. Index samples must adequately represent the waterbody character. In addition, the lakes and streams selected for sampling must represent the population of waters from which they are drawn--the survey must be conducted on a spatially balanced, probabilistic selection of lakes and streams.

Selection of the appropriate measurements for each indicator is necessary to begin development of a diagnostic plan that guides the search for associations between indicators

of condition (response indicators) and indicators of stress induced by both humans and nature (diagnostic indicators). Response indicators are developed based on field data collected for chlorophyll *a*, macrophytes, fish, riparian birds, zooplankton, benthos, and sedimentary diatoms. Diagnostic indicators are developed using exposure, habitat, and available stressor data to allow testing hypotheses that poor biological conditions are associated with hydrological, physical habitat, chemical, or biological modifications.

Acceptable index sampling approaches for chlorophyll-*a*, water quality, sedimentary diatoms, and zooplankton had already been determined before the 1991 pilot. These methods were used as a regional probability sample of lakes to answer questions about the logistics of conducting regional surveys and to begin to collect data on important components of variance. Standard methods for obtaining an acceptable index sample for macrobenthos, fish assemblage, fish tissue contaminants, riparian birds, and physical habitat structure were not available in the literature or in methodologies of the monitoring community. For these indicators, focused pilot studies helped to develop efficient indexing protocols appropriate for a single visit by a small field team. These protocols were then applied to the regional probability sample for further evaluation. The protocols and instructions for field operations presented in this manual are an outgrowth of the testing and refinement of the existing and developed methods and the logistical foundation constructed during their implementation in the field from 1991 through 1994.

Field operations and training were planned and conducted by representatives from several organizations. These include the EPA (involving EPA personnel from several laboratories [Las Vegas, Nevada; Corvallis, Oregon; and Cincinnati, Ohio], EPA Regions 1 and 2, and EPA cooperators and contractors) and the U.S. Fish and Wildlife Service (involving personnel representing Region 5 and a cooperative agreement); state agencies; cooperators; and contractors. Training prepared six to eight field teams of three or four members each to collect samples and data from 80 to 100 lakes annually in the Northeast. Field work also included collecting samples from approximately two to four dozen lakes by helicopter for the Temporally Integrated Monitoring of Ecosystems (TIME) project. Field operations usually began the first week in July and continued through August, sometimes continuing into early September. In addition to actual sampling tools and supplies, other equipment provided to each team included two 4-wheel-drive vehicles, a boat and trailer, and a portable computer. Field Coordinators provided support for the teams and a Communications Center served as a central point of contact for exchange of information and requests for supplies or assistance.

1.3 INDICATOR SUMMARY

Each of the following subsections describes biotic assemblages, environmental measures, or attributes of indicators used by EMAP-Surface Waters to evaluate the condition of lakes. To aid field personnel in understanding sampling procedures, these sections address the rationale for these measures and the significance of certain aspects of the methodologies. These indicators do not represent all possibilities, but were selected based on an evaluation approach using criteria deemed appropriate to meet EMAP requirements. Additional information regarding this evaluation can be found in Paulsen et al. (1991).

1.3.1 Physical Habitat

The magnitude of aquatic ecosystem degradation and loss due to physical habitat alterations in the United States may exceed degradation due to other human activities. The physical habitat shoreline and littoral surveys that the Surface Waters field teams conduct serve three purposes. First, this habitat information is absolutely essential to the interpretation of what lake biological assemblages "should" 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 impairment 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 all-important linkage between large watershed-scale influences and those forces that directly affect aquatic organisms day to day. Together with water chemistry, the habitat measurements and observations describe the variety of physical and 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.

The shoreline and littoral habitat surveys employ a randomized, systematic design with 10 equally spaced observation stations located around the shore of each sample lake. Teams go to the field with premarked lake outlines showing these stations. The

observations at each station include quantitative and semiquantitative observations of vegetation structure, anthropogenic disturbances, and bank substrate onshore. In-lake littoral measurements and observations deal with littoral water depth, bottom substrate, nearshore fish cover, and aquatic macrophyte cover. With quantifiable confidence, investigators condense these observations into descriptions applicable to the whole lakeshore and littoral zone. For example, team observations lead to quantitative descriptions such as the mean canopy or aquatic macrophyte cover along the lakeshore, the extent of shoreline disturbed by various human activities, and the dominant littoral substrate in the lake.

1.3.2 Fish Assemblage

Major objectives for the fish assemblage indicator work are to collect an index sample of the fish assemblage at each lake and to use the data derived from these samples to develop metrics of biological integrity. Biological integrity is a measure of the ability of the biotic components of an ecosystem to maintain a level of diversity and functional organization that is comparable to natural systems unimpacted by human disturbance (Karr and Dudley, 1981; Karr et al., 1986; Noss, 1990). Following the approach of Karr (1986) for use in streams, metrics are developed from numerical measures of various attributes of lake fish assemblage structure and composition. Responses of individual metrics are then compared to expected conditions in lake fish assemblages if human disturbance is absent or minimal. High biological integrity should be reflective of good lake water quality and lake habitat conditions.

For EMAP an index sample of lake fish is collected by catching (a) all except rare species; (b) enough individuals to indicate relative proportions of abundant and common species, which species are uncommon or rare, and the general population structure of abundant and common species; and © nonadults of naturally reproducing species.

Because of the various habitats in lakes, the habitat preferences of different species, and habitat specificity of sampling gear, there is no single method to index fish assemblages in all lakes. Therefore, EMAP Surface Waters uses a combination of gear types in a variety of habitats. The challenge is to index fish assemblages in large numbers of lakes of varying sizes, physical structures, and accessibility using multiple teams to collect samples and data. At each lake a team assesses the presence and proportion of major fish habitats. All habitats are sampled regardless of their expected productivity (gear are not placed to maximize catch), using a stratified random protocol. Littoral habitats are classified by presence and type of cover and by substrate type. Areas of extensive human modification are considered to be a habitat type. Samples are collected in as many as five of the most

extensive littoral habitats at each lake, as close as possible to randomly chosen physical habitat stations.

Fish are collected with passive gear--gill nets set overnight in oxygenated midlake areas, trap nets set overnight in littoral habitats, and minnow traps placed in shallow water with cover near the trap nets. After sunset, appropriate locations are seined. The fish are identified to species and examined for external gross pathology. Long-lived species are measured for length (short-lived species are recorded by size class). Specimens of all small fishes are preserved for archival storage in a museum. At most lakes a sample consisting of five large fish is collected for tissue contaminant analysis (Section 1.3.3).

Data collected in the lake surveys are used to evaluate several metrics of lake fish assemblages as indicators of biological integrity including (1) species richness as a measure of assemblage diversity, (2) numbers of introduced species and individuals relative to native species as a measure of biological stress and resiliency of the native fauna, and (3) proportion of individuals sensitive to human perturbation relative to proportion of tolerant species. In addition, the EMAP Surface Waters team will evaluate combining several metrics into an overall index of biological integrity reflecting changes in the species structure related to individual stressors, combinations of stresses, or reductions in impacts.

1.3.3 Fish Tissue Contaminants

As an indicator of accumulation of toxic chemicals in a lake, levels of contaminants in fish tissue can be used to estimate regional hazards to predators of fish, either wildlife or human. The EMAP Surface Waters group proposes to track how these hazards change with time. The fish tissue contaminants indicator has characteristics of both response and diagnostic indicators (Paulsen et al. 1991). As a response indicator tissue contaminant levels can be used to infer effects on piscivorous populations in and around lakes. When response indicators identify lake degradation, the fish tissue contaminants indicator can also be used in conjunction with other diagnostic indicators (physical habitat, water chemistry, land use, population density, and other records of relevant anthropogenic stresses) to discover the probable causes. Analyses of fish tissue detect contaminants such as a number of organochlorinated pesticides, PCB congeners, and heavy metals, including mercury.

It would be optimal, in representing fish bioaccumulation of contaminants, to collect samples of both top predators and bottom feeders from each lake. However, for Surface Waters lakes surveys, priority is given to top predators primarily because of their ecological significance as likely prey of the consumers of main concern--piscivorous birds (including

endangered raptors), mammals (e.g., mink and otter), and man. Bottom feeders are considered secondary target fish (lowest in the ranking order).

Various studies of fish tissue contaminants have focused on different parts of the fish, such as fillets or livers, or on the whole fish. The EMAP Surface Waters group will focus on whole fish because of the Program focus on the ecological health of the whole lake (as opposed to a focus solely on human health concerns). Whole fish are a reliable ecological indicator and a better indicator of risk to piscivorous wildlife than fillets, as wildlife (and some human consumers, i.e., subsistence fishermen) are likely to consume more parts of the fish than just the fillets. Results derived from analyzing whole fish also provide information about risks to human health. In addition, whole fish present fewer logistical problems for field crews (no gutting is required in the field, and use of dry ice for preserving and shipping is not necessary) and the analytical laboratory (no filleting is necessary).

Repeated lake sampling within the index period for fish tissue will answer two questions: "Will repeat visits yield the same types and numbers of fish?" and, most importantly, "Will the five-fish composite from each of two visits yield a similar value for level of contaminants in that lake?" In trying to answer these questions and provide reproducible (useful) data, the efforts of field teams to apply the protocol for sampling, handling, and shipping, in a consistent manner are very important.

1.3.4 Water Chemistry and Associated Measurements

The primary functions of lake water samples collected from the Van Dorn sampler and in situ water column measurements are to determine acid-base status, trophic state, and classification of water chemistry type. Lake water collected in Cubitainers is used to measure major cations and anions, nutrients, turbidity, and color. Water samples, collected in sealed syringes to minimize contact with the atmosphere, are analyzed for pH, dissolved inorganic carbon, and monomeric aluminum species (believed to be toxic to fish under acidic conditions). The concentration of each of these analytes will change if the lake water sample equilibrates with atmospheric carbon dioxide. Both the Cubitainers and the syringes must be shipped as soon as possible by overnight courier service because the syringe samples need to be analyzed and the Cubitainer samples need to be stabilized (filtration and/or acidification) within a short period of time (72 hours).

The filter paper from the lake water filtration is used to determine chlorophyll concentration, an indicator of algal biomass in the lake. The filtration (and filter paper) should be shielded from light as much as possible because light breaks down chlorophyll.

Throughout the water chemistry sampling process it is important to take precautions to avoid contaminating the sample. Many lakes in some regions (e.g., the Northeast) have a very low ionic strength (i.e., very low levels of chemical constituents) and samples can be contaminated quite easily by perspiration from hands, sneezing, smoking, suntan lotion, insect repellent, fumes from gasoline engines or chemicals used during sample collection (e.g., the narcotizing agent used for zooplankton or formalin).

1.3.5 Zooplankton

Zooplankton are important components of the open water environment of lakes and ponds. Most species are microscopic and consist of crustaceans (copepods, cladocerans, and opossum shrimp), rotifers ("wheel-animals"), pelagic insect larvae (phantom midge), and aquatic mites. In lakes of the northeastern United States, more than 200 species have been recorded. Zooplankton are important elements of the food chain where they transfer energy from algae (primary producers) to larger invertebrate predators and fish. The zooplankton species assemblage responds to environmental stressors such as nutrient enrichment, acidification, and fish stocks. The effects of environmental stress can be detected through changes in species composition and abundance, body size distribution, and food web structure.

Body size (0.05 to 15 mm long) and swimming abilities vary greatly among zooplankton species. Some species can swim fast enough to avoid being caught by the net. Therefore, we use two kinds of nets to optimize capture of size-based fractions--a coarse mesh net for fast swimming macrozooplankton ($\geq$600 µm long) and a fine mesh net for the microzooplankton (<600 µm long). The net is hauled from about 0.5 m off the bottom to the surface in the deepest part of the lake. It is important to avoid bottom sediments which clog the net pores and make the sample unusable. If bottom sediments occur in the sample, the net must be washed out and the procedure repeated. The net should be towed slowly (about 0.5m/sec) to reduce the pressure wave at the "bow" of the net. Some species can detect this frontal wave and swim out of the path of the net. The reducing collar on the fine mesh net decreases the volume of water passing through the net, thus increasing the filtration efficiency of the net and reducing the pressure wave problem. Because the net phytoplankton and debris are collected primarily in the fine mesh sample, laboratory preparation and processing is greatly facilitated for the macrozooplankton fraction. Finally, it is important to thoroughly rinse the nets to avoid contaminating later samples with species that may adhere to the inner sides of the net. Placing the nets into a mild bleach solution will help alleviate this problem and reduce the possibility of spreading resistant stages of exotic species to other lakes.

As the summer progresses, wind-driven mixing enlarges the warm water epilimnion and reduces the cold water hypolimnion. This mixing becomes increasingly important in small, shallow (10 to 15 m deep) lakes where the later summer, cold water hypolimnion may be only 1 to 3 meters thick. Therefore, when sampling such lakes, it is very important to take the tow at the deepest spot. Missing the deep spot by 1 or 2 meters of depth can miss such a cold water stratum and greatly confound interpretation of the true species assemblage in such lakes. This possibility is a concern for fish as well as zooplankton samples.

1.3.6 Sediment Diatoms

The diatom indicator is unique in that it can potentially tell us the "original" or pristine condition of the lake. None of the other indicators can provide this information. Thus, sampling the sediments in a precise and consistent manner is particularly critical. To assess the original condition, sediments dating from that time need to be collected. A general understanding of the diatom indicator and the sampling and analysis process will enhance sample collection.

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 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.

To study the microscopic cells, the sediments are cleaned of organic matter with strong oxidizing agents and slides are made. The analysis is made by identifying and counting 500 individual cells. Any contamination of the samples can produce significant errors in the resulting interpretation. Samplers must be careful not to contaminate the bottom sample with higher levels of the core or with lake water or with the tools used to collect the sample (i.e., the corer, core tube, and spatulas) and not to mix the top layer with the deeper sediments, thus obscuring small changes in community structure which are critical to monitoring trends.

Results from the 1991 Surface Waters pilot study indicated that some productive lakes were not sampled at a deep enough level to get a sample of sediments representing the preindustrial condition. Samplers should make an effort to get at least a 45-cm core from all lakes that have a Secchi disk reading of 2.5 m or less. Some judgment is necessary. For example, if the lake is artificial, there is no point in sampling through its sediments into the soil profile below. For most other lakes, a core 35 cm in length is adequate.

Since an undisturbed sediment sample is needed, outboard motors should not be used in shallow lakes near the sampling site nor should there be vigorous use of paddles or oars. If for some reason the first core is not satisfactory, a second try should be made in another spot. If the boat is well-anchored, the second try could simply be on the other side of the boat. If a corer begins to malfunction frequently, another should be acquired. The team should keep good notes--for example, if it is not possible to get a 45-cm core in a lake that seems to be very productive, the notes should explain the situation.

Data on diatom abundance and species composition is obtained from the cell counts. These data are combined with environmental data (e.g., chemical concentrations) and analyzed using multivariate statistical techniques. From this analysis, the expected abundance of individual taxa as a function of one or more environmental variables is determined. These expected abundance distributions are then used to infer historical conditions based on cell counts obtained from the bottom of the core samples.

1.3.7 Benthic Invertebrate Assemblages

Bottom dwelling invertebrates have long been used as indicators of water quality throughout this country and abroad. In the United States their use as living monitors of environmental conditions has principally been applied in environmental assessments of rivers and streams. However, European biologists have used benthic invertebrates for purposes of classifying lakes as to trophic status since the 1920s. Although their use for this purpose has not been as widespread in North America as it has been in Europe, these organisms show great potential as indicators of the biotic integrity and ecological condition of this Nation's lakes and reservoirs.

Freshwater benthic invertebrates are those organisms that spend at least part of their life cycles in or upon the substrates of aquatic systems. They are represented by forms that cling to, burrow in, or crawl over the sediments or other substrata of waterways and waterbodies. The larger forms that can be seen with the unaided eye and retained by a U.S. Standard No. 30 mesh sieve (28 meshes per inch and openings of 595 μm) are the benthic macrofauna or macroinvertebrates. It has become customary within the EPA to focus on these larger forms because they are relatively easy to separate from debris and to identify. This bias toward the larger animals undoubtedly can be traced back to the days when invertebrates were sampled principally to provide an estimate of the forage available for fish, since most of the animal biomass within and upon a unit area of substrate is contained within the larger animals. Secondly, the very early instars of insect larvae are difficult to identify reliably and, until fairly recently, good taxonomic descriptions of small oligochaetes (naidid worms) were not available.

In the lake sediment sample, the small benthic invertebrates that pass through a No. 30 mesh sieve may far outnumber those larger animals retained by the sieve. Because these small organisms contribute substantially to the total taxonomic diversity and standing stock of all benthic assemblages, to exclude them from the analyses of invertebrate samples could result in the loss of considerable information about the biological integrity of the system in question. For this reason we have elected not to restrict our analyses to the macroinvertebrates, but to include all true, identifiable benthic animals that are retained by a U.S. Standard No. 60 mesh sieve (60 meshes per inch and openings of 250 μm). Excluded from the analyses are the copepods, cladocera, and other forms that are not necessarily true benthic dwellers or that are not reliably identifiable by most aquatic biologists beyond broad taxonomic groups.

Currently there are a number of indices of biotic integrity for invertebrate assemblages in streams, but these indices have not been widely applied to lake assemblages. Considerable research is needed to evaluate and modify those indices for application to lake benthos. It is our intent to focus on the most promising metrics and indices for purposes of validating their use as a measure of biological integrity of lakes and reservoirs.

Benthos sampling is restricted to the sublittoral zones of EMAP grid lakes. Single modified K-B (Glew) corer samples are taken in the soft, weedless sediments at similar depths at 10 approximately evenly spaced locations around the perimeters of each lake. Each of the 10 sites corresponds to the 10 physical habitat observation stations located during the physical habitat and lake shoreline survey. In thermally stratified lakes, the samples are taken in well-oxygenated areas at depths equal to or less than the depth where the upper limits of the metalimnion intersect the lake bottom. In nonstratified lakes, samples are collected in weedless areas at depths greater than 1 m.

Only the upper 13 cm of each core sample are retained for analysis, as the uppermost sediments contain the majority of the animals. At the laboratory, a composite sample are prepared for each lake from individual core samples from alternate sites at the lake (i.e., the composite sample is composed of between 1 and 5 core samples). The composite sample is divided into eight equal fractions in the laboratory, using a device developed specifically for this purpose. Individual fractions are processed under microscopes until 150 animals have been sorted from the debris. This number excludes microcrustaceans, plankton, nematodes, terrestrial insects, dead or empty snail shells, and all other nonbenthic animals that may have settled on the bottom of the lake. After the target number of animals has been achieved, the entire fraction of the sample being examined is completely processed. If a minimum of 150 animals cannot be obtained from the initial composite sample, a second composite sample is prepared from the remaining individual

core samples from the lake, and the process repeated until at least 150 animals have been sorted from the composited fractions. After the individuals have been identified, the numbers are normalized to numbers per tenth of a square meter of substrate surface area.

In addition, team members make a qualitative survey for the exotic zebra mussel at each physical habitat station and at the launch site. They look for mussels attached to hard substrates and, if any are found, collect and preserve an example. This procedure is meant to record and document whether or not the presence of adult zebra mussel is detected for each lake. The larval forms may be detected in the zooplankton collections.

1.3.8 Lake Assessment or Site Characteristics

Observations and impressions made on the lake 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. Team members complete the form at the end of the lake sampling, taking into account all observations made while on site.

1.3.9 Riparian Bird Assemblage

The riparian bird assemblage measures are being developed as an indicator of riparian zone condition and its role linking aquatic conditions with terrestrial sources of disturbance. Observations are intended to evaluate measurement variability among EMAP grid lakes during the spring index period and to determine which species and guild combinations provide the most information about ecosystem condition. Other goals are to correlate avian guild rankings of sensitive and tolerant taxa, trophic groups, wetland dependent species, and habitat specialists with the range of conditions presented at the sampled lakes. Teams of ornithologists generally visit the EMAP grid lakes between late May and early July each year. At each lake, a team traverses a shore transect by canoe around the shore, stopping every 200 m to record birds seen or heard within a 5-minute period and to record habitat information. Procedures for the bird assemblage indicator are provided in Appendix A.

1.4 OBJECTIVES AND SCOPE OF THE FIELD OPERATIONS MANUAL

Two separate documents describe field operations activities for continuing investigations of lakes by the EMAP Surface Waters resource group. The field operations

manual (this document) describes field protocols, quality assurance (QA) and quality control (QC) procedures, and operations directly related to EMAP Surface Waters that should be capable of being implemented consistently across all regions. Section 2 provides a summary of daily field operations. Section 3 describes base site activities both before departure to a site and after sampling. Sections 4 through 6 describe the protocols for the first day in the field, and Sections 6 through 9 describe protocols for activities conducted the second day at a site. Appendix A is the field operations manual developed at the University of Maine for collecting data on riparian bird assemblages. Checklists for equipment and supplies required to conduct various activities are presented in Appendix B. Appendix C contains a complete set of blank field data forms.

The second document, a regional activities plan, contains operations and safety information and other procedures that apply to a specific regional project. This volume is developed by the various regional organizations that implement the field program; its contents may vary from region to region because of different regional requirements.

For use in the field, each team receives a quick-reference handbook that contains tables and figures summarizing protocols and other pertinent information from this Field Operations Manual for Lakes and the regional activities plan. This waterproof handbook is the primary field reference used by field teams after an intensive 2- to 3-week training program. Each field team also receives an information management handbook that contains instructions for tracking samples and generating sampling status reports as well as using the computers and associated hardware and software. 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 EMAP 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 (Stanley and Verner, 1986). Field teams are provided a copy of the integrated QA plan for EMAP Surface Waters (Chaloud and Peck, 1994). The QA plan 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.

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SECTION 2
DAILY OPERATIONS SUMMARY

by
John R. Baker and David V. Peck

2.1 SAMPLING SCENARIO

Two days are required to sample most lakes. A third day is allotted for predeparture and postsampling activities (e.g., cleaning equipment, repairing gear, shipping samples, and traveling to the next lake). In a normal week, if there is no down time due to weather or supply problems, a field team can sample two lakes over 6 days. Larger lakes (>74 ha) require additional travel time on the lake and 3 to 4 days are scheduled to sample these lakes.

A field team is usually composed of three to four people. Under certain circumstances, additional people may be required to assist teams sampling large lakes or hike-in lakes. Two people are always in the boat to execute the sampling activities and ensure safety. The remaining team member(s) usually remains on shore to provide logistical support. Team members should rotate between boat and shore activities.

A daily field sampling scenario showing how the work load may be split between team members is presented in Figures 2-1 through 2-3. Each field team should work with and modify this scenario, defining roles and responsibilities for each team member, to organize field activities efficiently. Most roles and responsibilities should be defined by the end of the training program.

The sequence of sampling events presented in Figures 2-1 through 2-3 cannot be changed without prior direction from the Communications Center (see Section 3.2.3). 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.

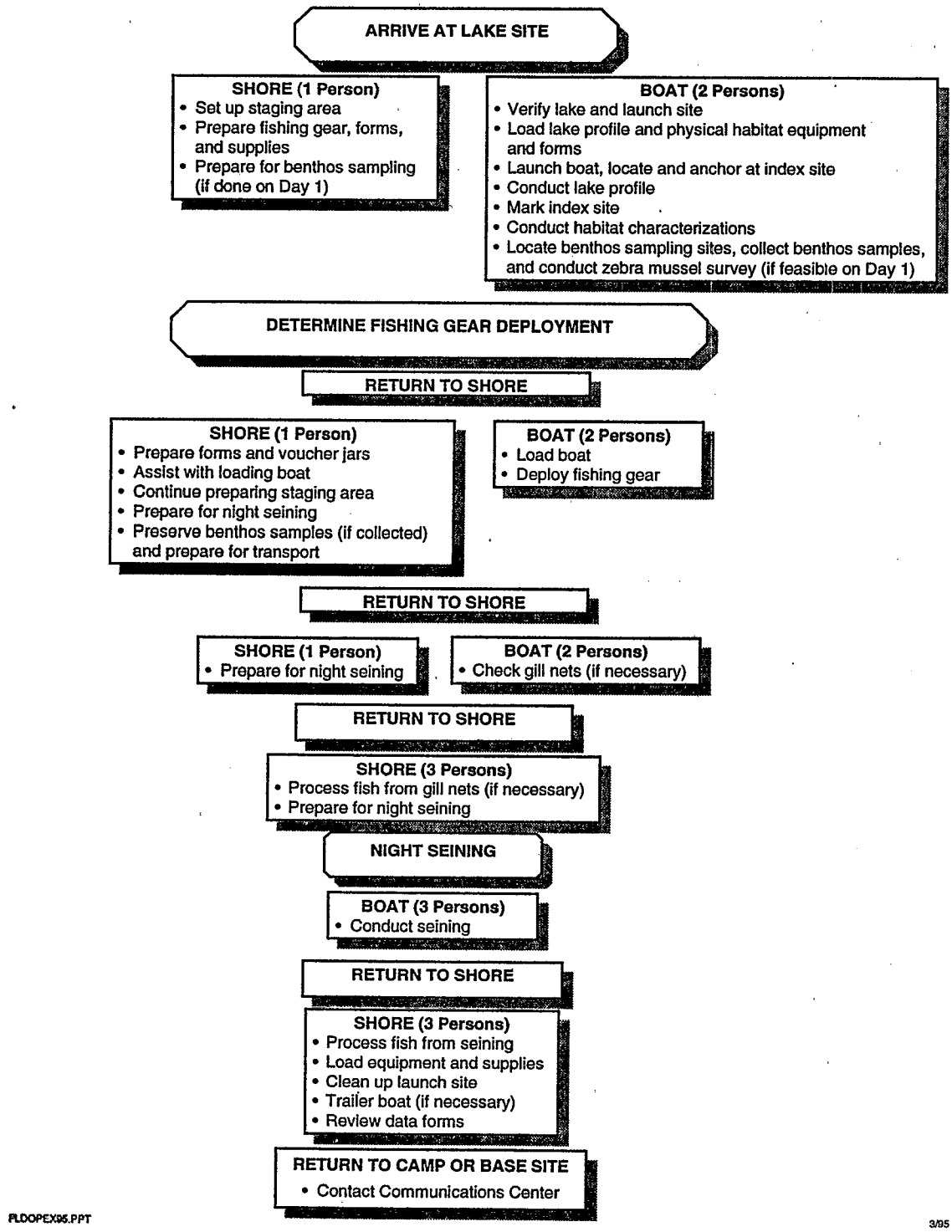

Figure 2-1. Day 1 field sampling scenario.

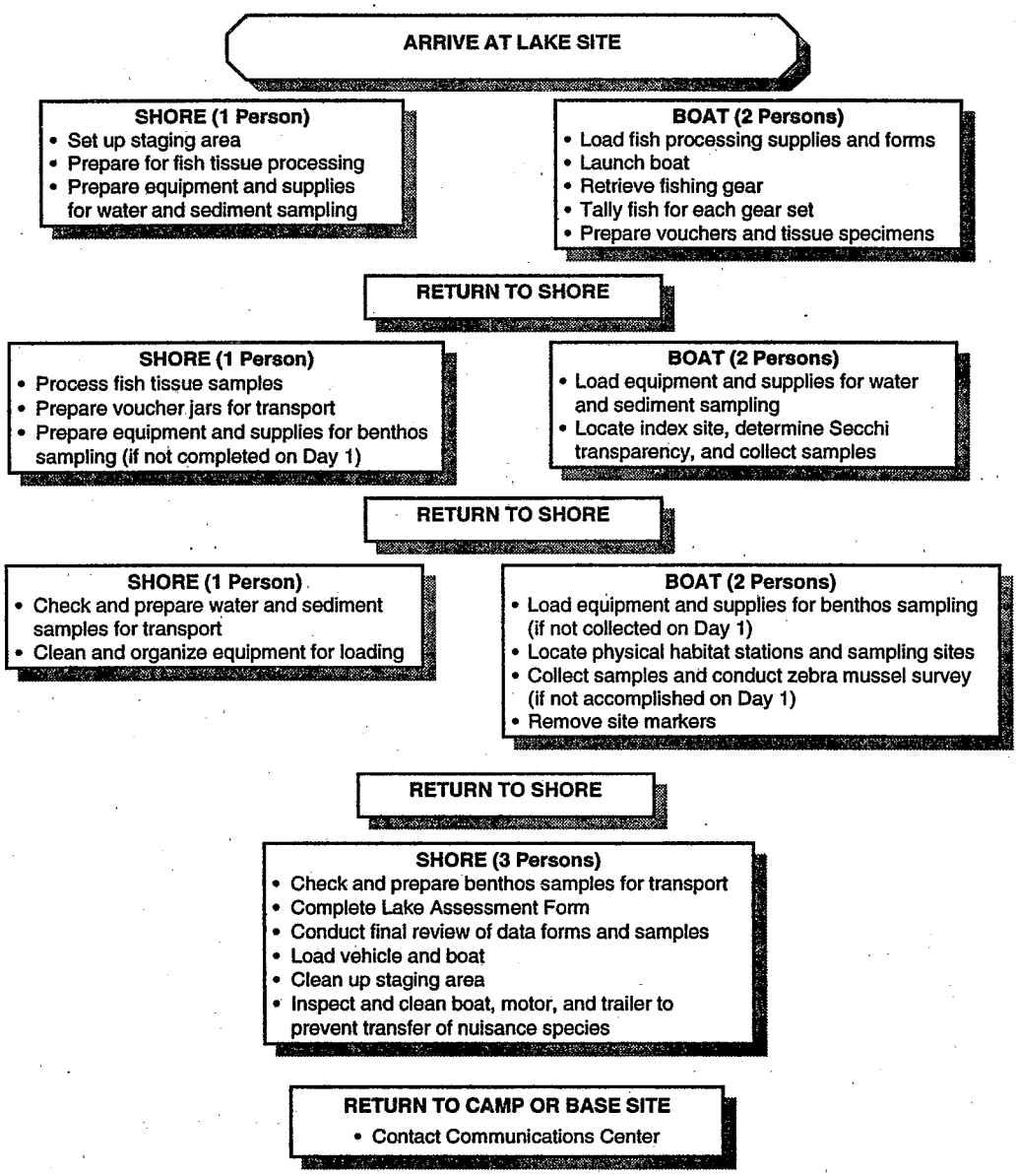

Figure 2-2. Day 2 field sampling scenario.

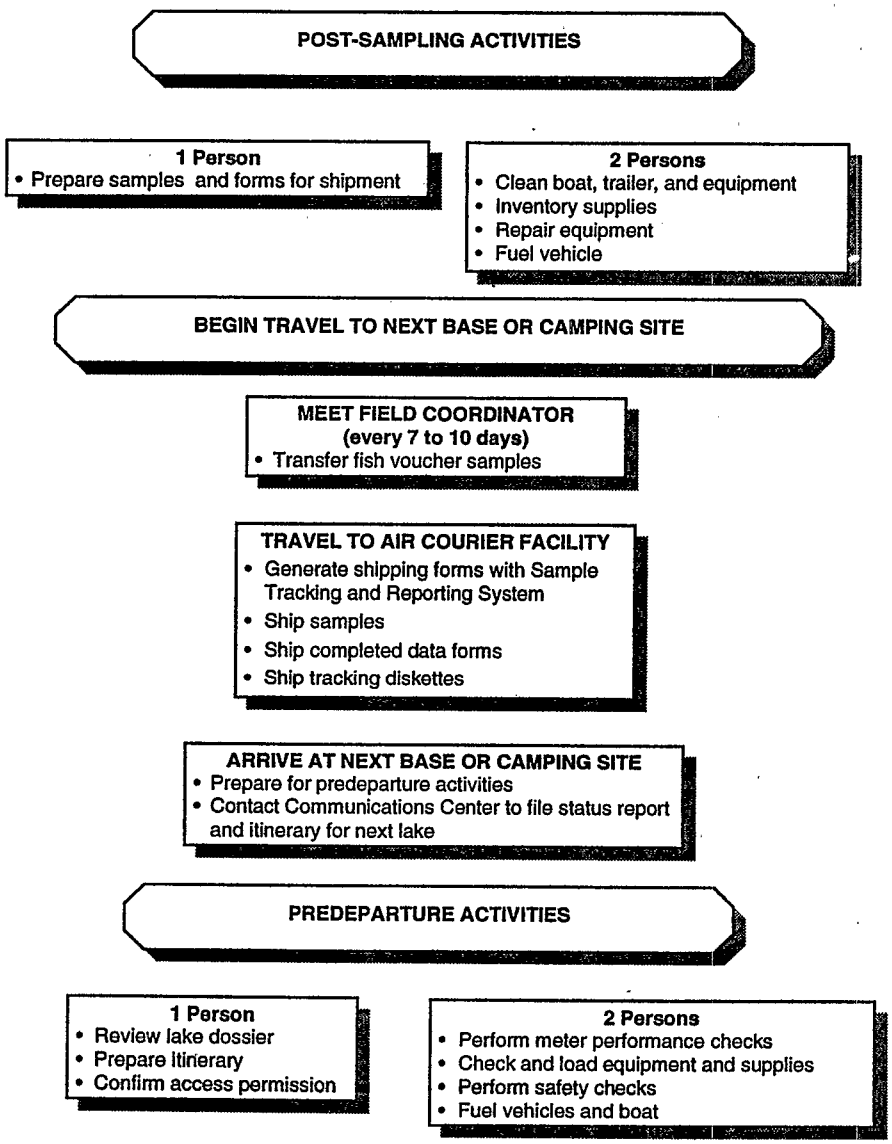

Figure 2-3. Day 3 field sampling scenario.

Day 1

Sampling activities on the first day will extend past dusk. The team should arrive at the lake before midmorning to accomplish all of these activities. The sampling sequence for Day 1 is to:

- verify lake and locate index site,
- conduct depth profile measurements of dissolved oxygen and temperature,
- conduct physical habitat characterization (optional: collect benthos sample and conduct zebra mussel survey),
- deploy fishing gear, and
- check gill nets (if required by permit) and conduct night seining activities.

Protocols for these activities are described in Sections 4 through 6.

Day 2

A full day is required for Day 2 sampling activities. The team should arrive at the lake in the early morning to complete the sampling at a reasonable time. The sampling sequence for Day 2 is to:

- retrieve fish gear and tally fish,
- process fish tissue samples,
- prepare fish voucher specimens,
- determine Secchi disk transparency,
- collect water chemistry samples and filter chlorophyll sample,
- collect zooplankton samples,
- collect sediment diatom samples, and
- collect benthos samples (if not previously collected) and conduct zebra mussel survey.

Protocols for these activities are described in Sections 6 through 9.

A third day is allotted for these lake activities on large lakes (>74 ha) with only half the fish gear set out on Day 1; the first half of the gear is retrieved and the second half is set out on Day 2. On Day 3 the second half of the gear is retrieved and the remainder of Day 2 activities are completed.

Day 3

Section 3 of this manual discusses Day 3 activities at a base site. These activities consist of preparations required before departing for a lake site and of postsampling activities required after leaving the lake site.

2.2 RECORDING DATA AND OTHER INFORMATION

During the 2- to 3-day visit to a lake, a field crew is required to obtain and record a substantial amount of data and other information for all 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.

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 are 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.

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. Use No. 2 pencil only (fine-point indelible markers can be used if necessary) to record information on forms. Record data and information using correct format as provided on data forms. 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. In cases where information is to be recorded repeatedly on a series of lines (e.g., fish species codes or 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, then connect these using a wavy vertical line. 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. K = Measurement not attempted or not recorded. Q = Failed quality control check; remeasurement not possible. U = Suspect measurement; remeasurement not possible. F*n* = Miscellaneous flags (*n*=1, 2, etc.) assigned by a field crew during a particular sampling visit (also used for qualifying samples). 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. The Field Coordinator or the Communications Center personnel must review all data forms for consistency, correctness, and legibility before transfer to the Information Management Center.

(continued)

TABLE 2-1 (continued)

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. Use a fine-point indelible marker 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. Use a No. 2 pencil only (fine-point indelible fine-tipped markers can be used if necessary to record information on forms). 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. K = Sample not collected or lost before shipment; resampling not possible. U = Suspect sample (e.g., possible contamination, does not meet minimum acceptability requirements, or collected by non-standard procedure). F*n* = Miscellaneous flags (*n*=1, 2, etc.) assigned by a field crew during a particular sampling visit (also used for field measurements). 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. Review labels and sample collection form for accuracy, completeness, and legibility before leaving lake. The Field Coordinator or the Communications Center personnel must review sample collection forms for consistency, correctness, and legibility before transfer to the Information Management Center.

SECTION 3
BASE SITE ACTIVITIES

by

Glenn D. Merritt, Victoria C. Rogers, and David V. Peck

Field teams conduct a number of activities at their base site. These include tasks that must be completed both before departure to the lake site and after return from the site (Figure 3-1). A full day is allotted to these predeparture and postsampling activities. Close attention to these activities is required to ensure that the field teams know where they are going, access is permissible and possible, equipment and supplies are available at the lake in good order to complete the sampling effort, and samples are packed and shipped appropriately. All activities are organized through the Field Coordinator who provides team supervision.

3.1 PREDEPARTURE ACTIVITIES

Predeparture activities include development of sampling 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 Coordinators are responsible for developing sampling schedules and Team Leaders are responsible for developing daily itineraries. The Team Leader reviews each lake dossier to ensure that it contains the appropriate 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. Each Team Leader is required to provide the Field Coordinator (through the Communications Center) with a team schedule for each week of sampling. Schedules include departure time, estimated duration of excursion, routes of travel, location of any overnight stops (including telephone number), and estimated time of arrival at the final destination for each lake and for each day. The portable computer each team takes into the field is furnished with an electronic "road atlas" software package that provides general assistance in planning routes to the site. Changes in the itinerary

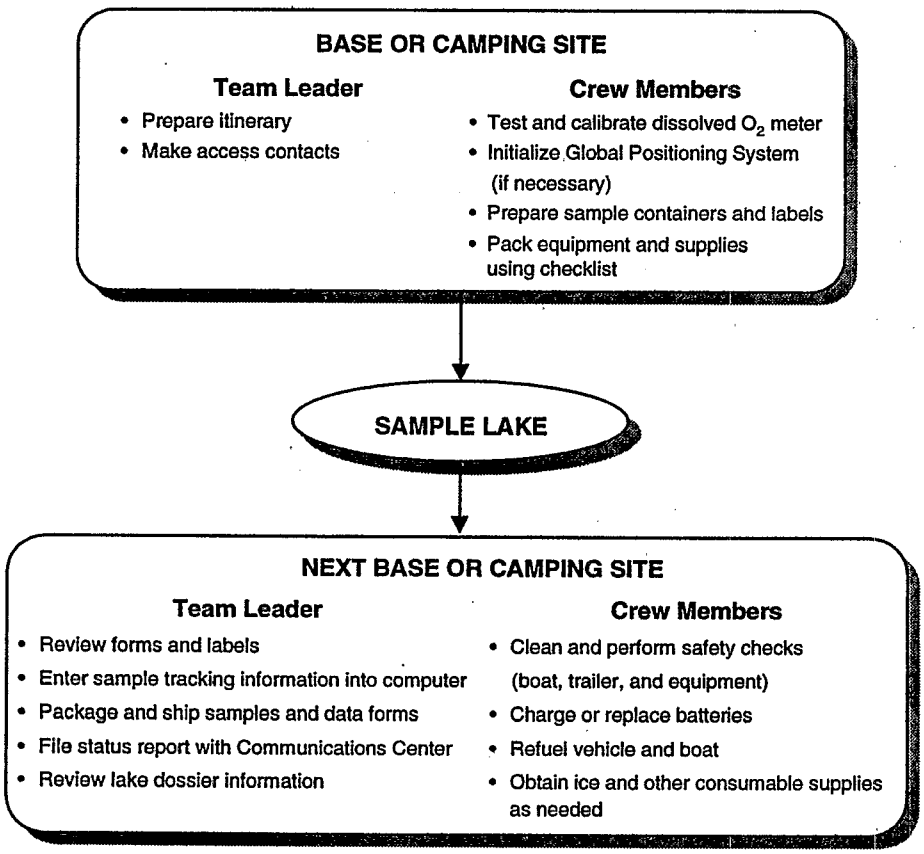

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Figure 3-1. Overview of base site activities.

during the week must also be relayed by the Team Leader through the Communications Center to the Field Coordinator as soon as possible. Miscommunications can result in the initiation of expensive search and rescue procedures and disruption of carefully planned schedules. Communications requirements and schedules are described in the regional activities plan.

3.1.2 Instrument Checks and Calibration

Each field team must test and calibrate instruments prior to departure for the lake site. Field instruments include a Yellow Springs Instrument (YSI) Model 57 dissolved oxygen (DO) meter equipped with a 60-m cable and a Magellan NAV 5000 Global Positioning System (GPS) receiver. The procedures described here are designed for these instruments. Additional backup instruments are available through the Field Coordinator if instruments fail the performance tests or calibrations described in the following subsections.

3.1.2.1 Dissolved Oxygen Meter Performance Test--

Test and precalibrate the dissolved oxygen meter prior to departure from the lodging location. Figure 3-2 summarizes the dissolved oxygen meter performance test and calibration procedure. Turn on the instrument, place the function selection switch to "ZERO," and adjust the electronic zero. Verify that the salinity switch is turned to the "ZERO-FRESH" position. Set the function selection switch knob to "RED LINE" and align the needle with the red line using the adjustment knob. Replace the batteries if the instrument will not adjust to the red line. These checks and adjustments ensure that the batteries are charged and the electronics are functional.

Follow this procedure by checking the membrane of the dissolved oxygen probe. If bubbles are present, if the membrane is discolored or torn, use a backup probe and replace the membrane on the original probe. (Note: new membranes must stabilize for 24 hours before use if possible.)

To test whether the dissolved oxygen meter can be calibrated, place the probe in an air-filled calibration chamber. Submerge the chamber in a water bath with the air valve open and the air tube above water. After thermally equilibrating for 15 minutes, determine the chamber temperature by turning the function selection switch to "TEMPERATURE." Check temperatures measured with the thermistor against an accurate thermometer. If temperatures differ by more than ±1.0 °C, replace the probe. Determine the theoretical oxygen concentration for water-saturated air at the chamber temperature by using the temperature and altitude-correction factor tables provided on the back of the meter or in the manufacturer's operation manual. Multiply the theoretical oxygen value by the altitude-correction factor (estimated to the nearest 100-ft elevation) to get the calibration value. Then

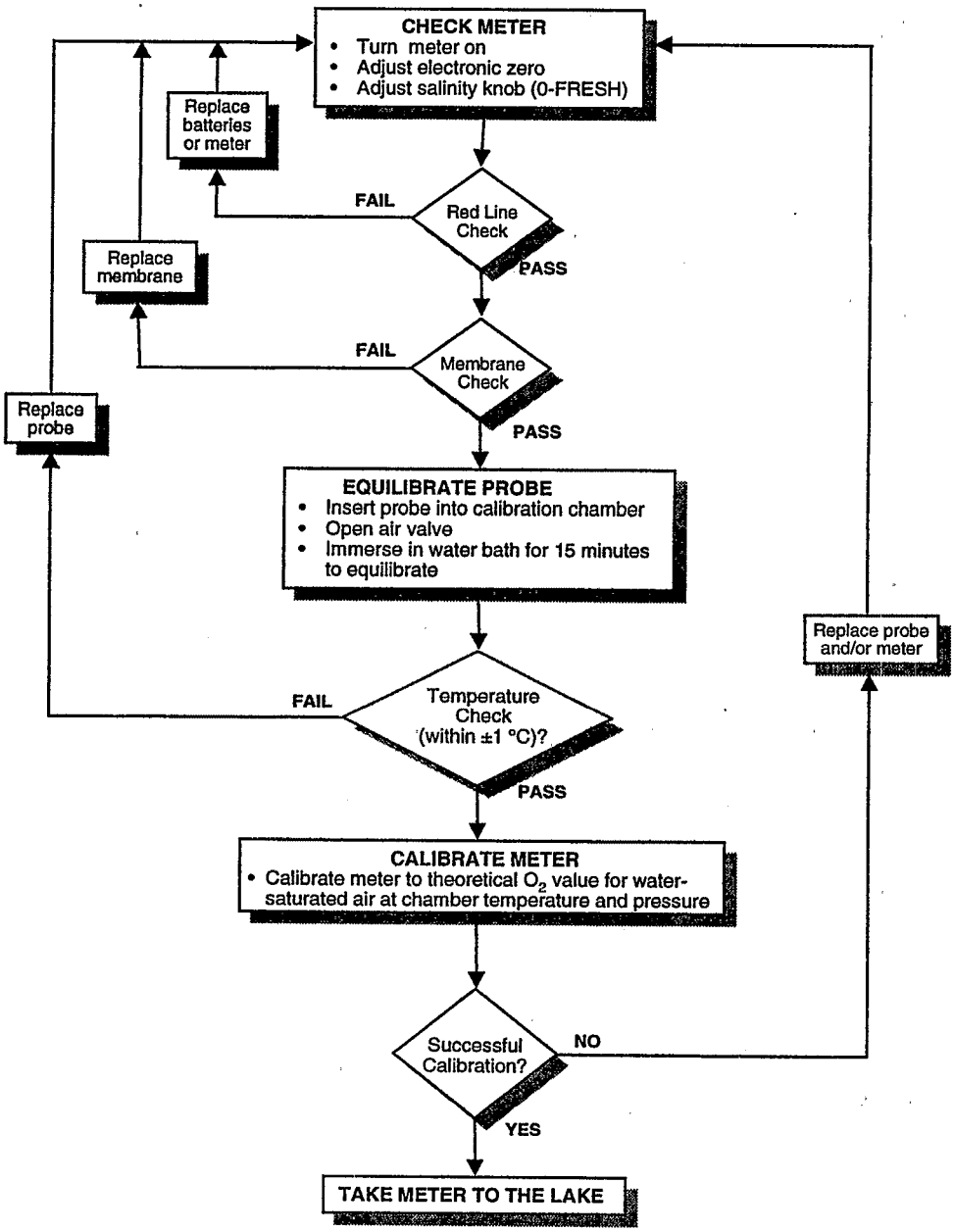

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Figure 3-2. Performance test and calibration procedure for the dissolved oxygen meter.

set the function selection switch to one of two dissolved oxygen scales and adjust the oxygen calibration knob to the calibration oxygen value. Do not record the base site performance test information at this time. The meter is calibrated again at the lake. Calibration information is recorded at that time.

If the instrument does not pass the performance test and calibration, replace the meter and/or probe. After the test, turn the meter off, fill the calibration chamber with tap water, and insert the probe for storage. Each field crew receives a copy of the manufacturer's calibration procedures and maintenance information.

3.1.2.2 Global Positioning System Battery Check and Position Initialization--

Turn on the GPS receiver and check the batteries prior to departure. During the self-test procedure the display indicates battery operation by displaying "battery power." Low battery power is indicated by a battery symbol that appears in the lower right-hand corner of the display. This symbol remains until the batteries are replaced. Replace batteries immediately if a battery warning is displayed.

WARNING: The batteries must be replaced when you see the second warning display: "REPLACE BATTS OR LOSE DATA." If shut off within 2 minutes of this display, the unit will retain memory for a month if the batteries are not removed. Replacing the battery packs must be completed within 2 minutes or the memory will be lost.

The GPS receiver must be Initialized prior to its first use. The receiver must be initialized again if it transported more than 300 miles from the previous initialization point. Instructions for initializing the unit are in Table 3-1.

3.1.3 Equipment Preparation

To ensure that all activities at a lake can be conducted completely and efficiently, field teams must check all equipment and supplies before traveling to a lake site. In addition, they must label and assemble packets of sample containers.

Check the inventory of supplies and equipment prior to departure using the lake-visit checklists. Appendix B contains a complete set of checklists. 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 3-2. Follow the regulations of the Occupational Safety and Health Administration

TABLE 3-1. INITIALIZATION PROCEDURES FOR THE GLOBAL POSITIONING SYSTEM[a]

1. Turn unit ON.

2. At the "READY" display, push "SETUP."

3. Press "CLEAR" to erase previous position.

4. Enter the latitude of a known reference point from a USGS quadrangle map to the nearest degree. Trailing zeroes are entered automatically. Press "→" to get the "N" display. Press "ENTER" to store.[b]

5. Enter the longitude of the same reference point to nearest degree. Trailing zeroes are entered automatically. Press "→" to get the W display. Press "ENTER" to store.[b]

6. Press "↓" and then "CLEAR" to erase altitude. Enter the altitude to the nearest 50 feet. Press "ENTER" to store.

7. Initialization completed. Turn unit OFF or press "POS" for position.

[a] These procedures are specific to the Magellan NAV 5000 global positioning system unit used during EMAP-Surface Waters surveys.
[b] Initialization is effective for a 300 mile radius from the reference point. If a GPS receiver is transported outside of this radius, the receiver must be re-initialized using a new reference point.

TABLE 3-2. 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.
Sucrose (saturated)	To equalize osmotic pressure of zooplankton samples.	Add 320 g granular sucrose per liter of distilled water. Chill. Add 1 to 2 mL formalin per liter as preservative.
Borax buffered formalin[a] (pH 7-8)	Preservative for fish vouchers and for zooplankton samples.	Add 400 g borax to each 20-L carton of 100% formalin. Test with pH paper.
Carbonate buffered formalin[b] (pH 10)	Preservative for benthic invertebrate samples.	Add 500 g Na_2CO_3 to each 20-L carton of 100% formalin. Test pH with paper.

[a] Handle formalin according to 29 CFR 1910.1048.
[b] High pH solution required to preserve mollusk shells.

(OSHA). Those pertaining to formalin are in 29 CFR 1910.1048 (see regional activities plan). Add 10 mL of saturated sucrose solution to 4 mL of stock formalin (100%, pH 7-8) to each of two zooplankton sample bottles, using either a syringe or a bottle labeled with the appropriate volumes. Seal the jars with electrical tape prior to departure and place each jar in a 1-qt self-sealing plastic bag.

In addition, inspect the vehicles, boats, and trailers every morning before departure. Pay particular attention to the trailer hitch, electrical connections, tiedowns, and air pressure in tires and 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. Figure 3-3 provides examples of preprinted labels. Labels or tags that will be placed with samples stored in formalin must be printed on 100 percent rag content or water resistant paper. 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 (syringes, syringe valves, Cubitainers, bottles, chlorophyll filters, foil, gloves, and labels) in the vehicles. Inventory these extra supply kits prior to each lake visit.

3.2 POSTSAMPLING ACTIVITIES

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

3.2.1 Equipment Cleanup and Check

Table 3-3 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 water-milfoil and zebra mussels do not occur between lakes. Prior to leaving a lake, drain all bilge water or live wells in the boat and discard all water from the fish buckets. Inspect, clean, and handpick plant and animal remains from vehicle, boat, motor, and trailer that contact lake water. Be especially careful

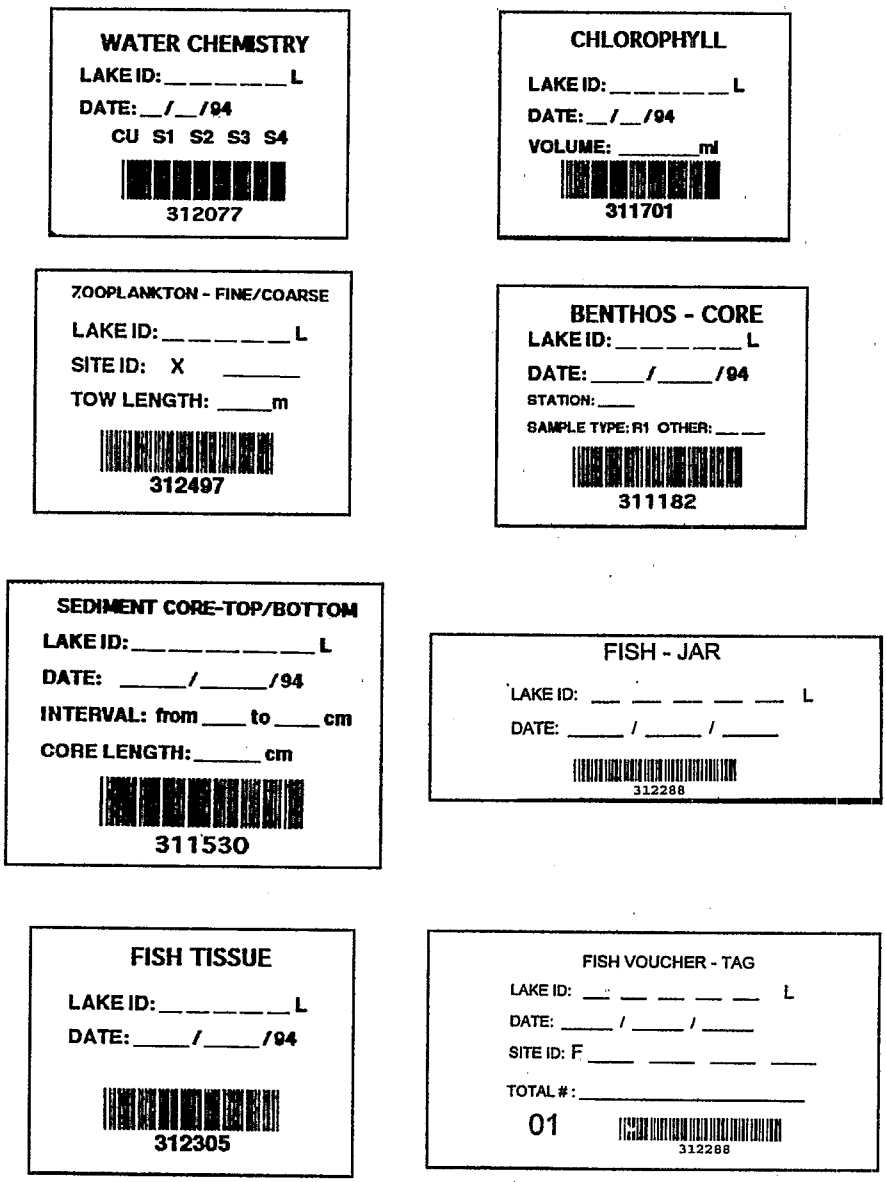

Figure 3-3. Sample container labels.

TABLE 3-3. POSTSAMPLING EQUIPMENT CARE

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

   - Prior to departing from a lake, drain all bilge and live-well water from the boat and discard water in fish buckets.

   - 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 gill nets, trap nets, seines, and minnow traps and inspect and remove any remnant vegetation or animal life. If the weather is rainy and fishing gear cannot be dried, then use a different (backup) set of gear at the next lake, if available. 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, trailer, and fishing gear and thoroughly clean (hot water pressurized rinse--no soap).

2. Clean and dry other equipment prior to storage.

   - Rinse chlorophyll filtration chamber 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. Check fish nets for holes and repair, if possible; otherwise, set damaged gear aside and locate replacements.

4. Inventory equipment and supply needs and relay orders to the Field Coordinator through the Communications Center.

5. Remove dissolved oxygen meters 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.

6. Recharge batteries (e.g., 12-V wet cells and computer batteries) overnight if possible. Replace other batteries (e.g., GPS unit and dissolved oxygen meter) as necessary.

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

8. Replenish fuel.

that all nets are cleared of any fish or fish parts. Dry out gill nets, trap nets, seines, and minnow traps and inspect and remove any remnants of vegetation or animal life. If weather is rainy and fishing gear cannot be dried out, then use a different (backup) set of gear, if available, at the next lake. If an additional set of gear is not available, disinfect with a 10 percent bleach solution. Take care regarding application of bleach to nets to avoid damage to lawns and plantings. Pavement is a preferred location for treatment of trap nets with bleach solution. Before moving to the next lake, if a commercial car wash facility is available, wash vehicle, boat, trailer, and fishing gear and thoroughly clean (hot water pressurized rinse--no soap).

3.2.2 Shipment of Samples and Forms

The field team ships samples as soon as possible after collection. Samples are usually shipped on the full day allotted for predeparture and postsampling activities. The regional activities plan gives specific information for shipping destinations and times within a region. Initiate sample tracking at this time using the notebook computers, bar-code readers, and the Information Management Handbook. Log samples into the sample tracking and reporting system. For more detailed information refer to the Information Management Handbook. If the computer and bar-code reader are inoperable, complete the tracking information by hand on the backup forms provided. Packaging and shipping guidelines for each type of sample are summarized in Table 3-4.

Ship samples of chlorophyll, water chemistry, and fish tissue samples in coolers packed with ice. Line each shipping cooler with a large 30-gallon plastic bag. Inside, contain the ice separately within numerous (as many as possible) 1-gallon self-sealing plastic bags and ensure that the ice is fresh before shipment. Use block ice when available. It should be sealed in a 30-gallon plastic bag. 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.

To ship the Cubitainer and syringes, line the shipping cooler with a 30-gal plastic bag. Place another garbage bag in the cooler, and place the samples in the second bag. For each sample ensure that the Cubitainer and each of the four syringes have identical bar codes. Ensure that all entries are complete and close the bag of samples. Place bags of ice around it. Then close the cooler liner (outer garbage bag). Ship water samples on the day of collection whenever possible. If not possible, they must be shipped the next day.

The chlorophyll sample is collected and wrapped in foil and placed into a 1-quart self-sealing plastic bag as described in Section 7. When preparing this sample for shipping, make sure that the label with bar code is on the foil, all entries are complete, and the label is

completely covered with clear plastic tape. Place each 1-quart sample bag in a 1-gallon self-sealing plastic bag. Place the self-sealing plastic sample bags inside the cooler liner in a manner that protects them from exposure to water from melting ice. Then seal the cooler liner. Ship the chlorophyll samples with the corresponding water chemistry samples on the day of collection whenever possible. If this is not possible, they must be shipped the next day.

The composite fish tissue sample(s) is prepared, packed in one plastic bag which is then sealed in a second plastic bag, and chilled at the lake (as described in Section 6). For shipping, upon arrival at the base site, open the cooler and the cooler liner. Remove the bags of ice and replace them with fresh bags of ice. Put in as many bags of ice as will fit into the cooler. Then seal the cooler liner. Close the cooler. Package and label the cooler for shipping as described in the regional activities plan. Ship fish tissue samples the same day they are processed, whenever possible. If not possible, they must be shipped the next day with fresh ice.

For sediment core samples, open the hard plastic box and ensure that the labels with bar codes are complete, covered with clear plastic tape, and attached to each of the two bags of sediment (top and bottom). Close the box and seal it with electrical tape. Place the box in the shipping cooler. Core samples can be placed in coolers containing fish tissue samples, if desired, for shipping.

Zooplankton samples are preserved in a 10 percent solution of sucrose and borax-buffered formalin and then sealed at the lakeside (as described in Section 7). To prepare zooplankton samples for shipping, ensure that there is a different label with bar code taped on each of the two jars (one labeled "coarse" and one "fine"). If a sample requires an additional jar, make sure the bar code number of the corresponding labeled sample is recorded on the label and it is marked either "coarse" or "fine" to agree with first jar. Verify that each jar is sealed with electrical tape and sealed in a quart-size self-sealing plastic bag. Place both quart-size self-sealing plastic bags in a gallon-size self-sealing plastic bag. Zooplankton samples can be included in a hardshell plastic cooler with benthic samples for transport.

Benthic invertebrate samples are preserved in 10 percent carbonate-buffered formalin (4 percent formaldehyde) and sealed at the lakeside as described in Section 8 where up to twenty 500-mL jars are placed in each hardshell plastic cooler and surrounded with crumpled newspaper or vermiculite. Ensure that the bar code number is entered on the jar label, and the label is covered with tape. For shipping, label the shipping containers and complete the airbills as directed in the regional activities plan for such samples. Zooplankton samples can be shipped with benthic samples.

TABLE 3-4. SAMPLE PACKAGING AND SHIPPING GUIDELINES

The regional activities plan gives specific information for shipping destinations and times within a region. Log samples into the sample tracking and reporting system developed for the region.

In general, ship samples that require preservation in hardshell plastic coolers packed with ice:

1. Line each cooler with a large, 30-gallon plastic bag.
2. Pack ice in as many 1-gallon self-sealing bags as possible to fit inside the 30-gallon plastic bag. Use block ice when available (seal it in a 30-gallon plastic bag). Mark each bag "ICE" with an indelible marker to prevent misidentification of any water leakage as a possible hazardous material spill.
3. Place samples and bags of ice inside the cooler liner and seal the cooler liner.
4. Close the cooler.
5. Package and label the cooler for shipping as described in the regional activities plan.

A. Water chemistry, chlorophyll, and fish tissue samples

Water chemistry--Cubitainer and syringes.

1. Place another garbage bag inside the cooler liner.
2. Confirm that the Cubitainer and each of the four syringes are labeled and have identical bar codes.
3. Place the Cubitainer in the second bag and close. Place syringes in a plastic box, seal it with electrical tape, and put the box in the cooler with the Cubitainer.
4. Ship water samples on the day of collection whenever possible. If not possible, these samples must be shipped the next day with fresh ice.

Chlorophyll--previously wrapped in foil and placed in a 1-qt self-sealing plastic bag.

1. Confirm that the label with bar code on the foil is completed and covered with clear tape.
2. Place the 1-qt sample bags in a 1-gal self-sealing plastic bag.
3. Place the 1-gal bag in the cooler. To reduce the risk of exposure to meltwater, the sample may be placed in the container with the water chemistry syringe samples.
4. Surround the bag with bags of fresh ice. It is important to keep chlorophyll samples as cold as possible.
5. Ship the chlorophyll samples, with the corresponding water chemistry samples when appropriate, 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.

Fish tissue--previously prepared, bagged, and chilled.

1. At the base site open the cooler and the cooler liner.
2. Remove the bags of ice and replace them with fresh bags of ice. Put in as many bags of ice as will fit into the cooler.
3. Ship the fish tissue samples the same day they are processed whenever possible. If not possible, they must be shipped the next day with fresh ice.

B. Sediment Core Samples--stored in plastic box.

1. Open the box to confirm that the labels with bar codes attached to each of the two bags of sediment (top and bottom) are complete and covered with clear plastic tape.
2. Close the box and seal it with electrical tape.
3. Place the box in the shipping cooler. Core samples may be placed in coolers containing fish tissue samples, if desired.

(continued)

TABLE 3-4. (continued)

C. Zooplankton samples--preserved in a 10% solution of sucrose and borax-buffered formalin and then sealed at the lake.
   1. Confirm that the two jars have different labels (one for "coarse" and one for "fine") with the bar code taped on each. If a sample requires an additional jar, confirm that the bar code number of the corresponding labeled sample is recorded on the label.
   2. Verify that each jar is sealed with electrical tape and sealed in a quart-size self-sealing plastic bag.
   3. Place both quart-size self-sealing plastic bags in a gallon-size self-sealing plastic bag.
   4. Place the bags in the appropriate shipping container. Zooplankton samples may be placed in the cooler with the benthic samples for transport.
   5. Samples can be held for a short period before shipment. Transport the samples as described in the regional activities plan.

D. Benthic invertebrate samples--preserved in 10% carbonate-buffered formalin and sealed at the lake.
   1. Check to make sure jars are sealed with electrical tape.
   2. Place up to twenty 500-mL jars in each cooler.
   3. Surround the jars with crumpled newspaper, vermiculite, or other absorbent material.
   4. Transport the samples as described in the regional activities plan. Benthic samples can be shipped with zooplankton samples as hazardous materials.

E. Fish voucher specimens--preserved in 10% borax-buffered formalin and sealed at the lake. For shipping:
   1. Make sure jars are sealed with electrical tape.
   2. Place the voucher sample containers in plastic coolers.
   3. Surround the jars with crumpled newspaper, vermiculite, or other absorbent material.
   4. Transport the samples as described in the regional activities plan. The Field Coordinator may collect the coolers of voucher specimens, the team may deliver them directly to the museum, or the team may need to ship these samples by courier as hazardous materials.

Fish voucher specimens are preserved in 10 percent borax-buffered formalin (4 percent formaldehyde) and sealed at the lakeside as described in Section 6 and the regional activities plan. Check to confirm that each jar has a completed label, completely covered with clear tape. Voucher sample containers are placed in hardshell plastic coolers and surrounded with crumpled newspaper, vermiculite, or other absorbent material. The Field Coordinator may periodically collect the coolers of voucher specimens, takes them to the museum, and supplies the team with cases of empty containers for vouchers. In some instances a team may deliver vouchers directly to the museum and obtain empty bottles. In other cases, samples and containers may need to be shipped by courier. If shipping by courier, complete airbills as directed in the regional activities plan for such samples. If required, attach the appropriate hazardous material label to the outside of the cooler or other container used to ship the samples.

To improve their fish identification skills, team members may examine their voucher specimens, but it is essential to maintain voucher integrity and specimen quality and to follow appropriate safety precautions. Handling of specimens should be very limited during the first 72 hours after collection to allow the fish tissue to harden. Open only one bottle at a time to prevent inadvertent mixing of vouchers; return specimens to the bottle when finished. Only handle specimens with forceps and wear protective clothing (see the regional activities plan). Open bottles and examine vouchers in a well-ventilated area, preferably outdoors.

3.2.3 Communications

A regional communications center (see regional activities plan for regional locations and telephone numbers) is the central point of contact for information exchange among field teams, the EMAP-Surface Waters management and QA staffs, the information management team, analytical laboratories, and the public. The Communications Center also monitors all aspects of field sampling activities, including coordinating and tracking field sample shipments to the analytical laboratories, and responds to supplies replenishment requests.

Requests to replenish consumable 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. Requests for supplies can be shipped with the lake data package by overnight courier. Should supplies need to be replenished more quickly, notify the Communications Center by telephone and the appropriate sources will be contacted.

As specified in the regional activities plan, each field Team Leader must call the Communications Center and provide a brief description of activities during the previous week including lakes visited, samples shipped, problems encountered, and requests for

information. The Communications Center compiles a periodic status report from reports submitted by the Team Leaders which is distributed to the management team, other Team Leaders, and any interested individuals.

SECTION 4
LAKE VERIFICATION AND INDEX SITE LOCATION

by
John R. Baker and David V. Peck

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 EMAP Surface Waters 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 Coordinator (via the Communications Center) 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. Figure 4-1 summarizes the activities described in this section.

4.1 LAKE VERIFICATION AT THE LAUNCH SITE

Record directions to the lake and a description of the launch site on the Lake Verification Form, Side 2 (Figure 4-2) regardless of whether the site is sampled or not. This information is very important and will be used in the future when the lake is revisited by another sampling team. Provide information about signs, road numbers, gates, landmarks, and any additional 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?

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. Table 4-1 provides operational instructions for the GPS receiver. Record locational coordinates for the lake on the Lake Verification Form, Side 1 (Figure 4-3). Record the map coordinates for the lake

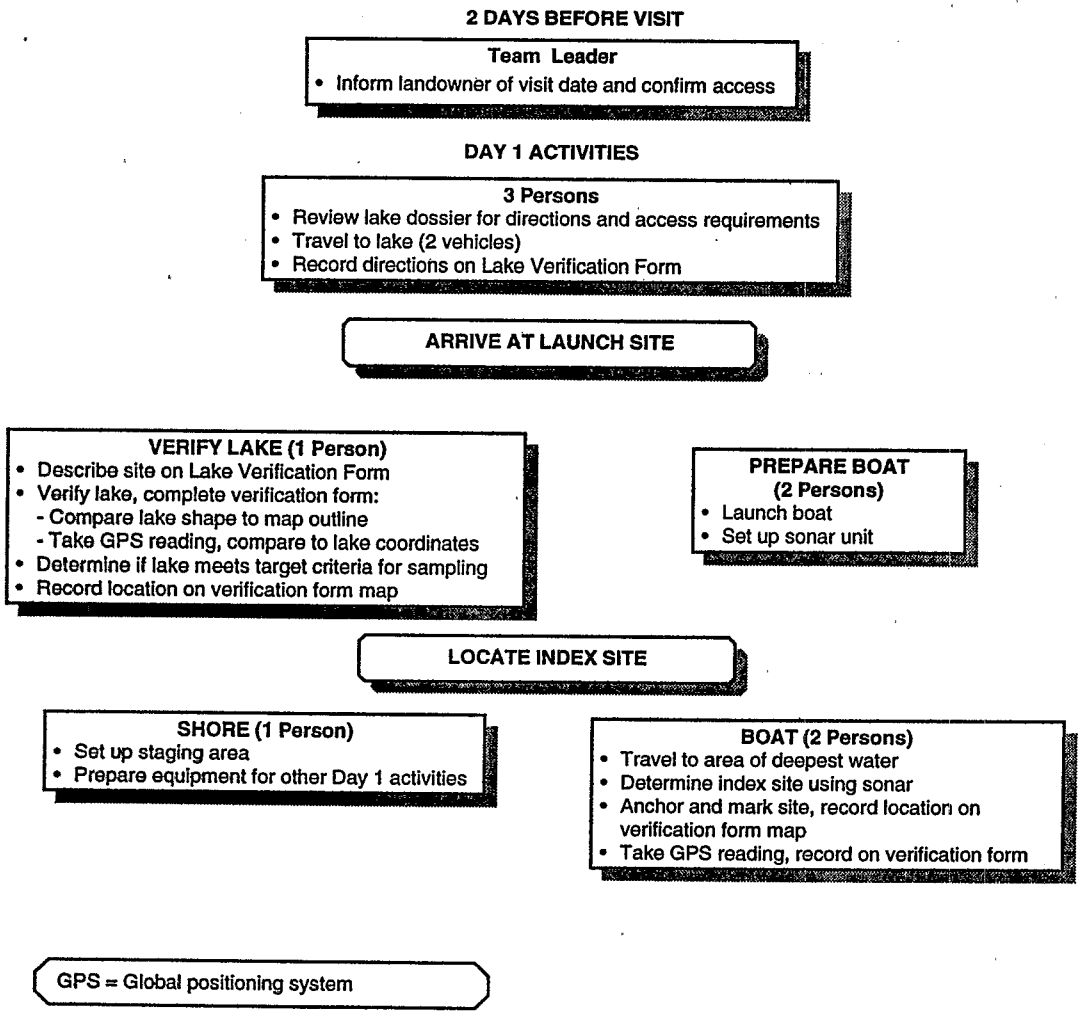

Figure 4-1. Summary of lake verification and index site activities.

LAKE ID: NY0001L LAKE VERIFICATION FORM (continued) VISIT #: (1) 2

DIRECTIONS TO LAKE & LAUNCH SITE

From Boomtown, take Rt. 999 E for 2 mi. Turn left at police station. Follow road for 5.6 mi, then turn left. Follow road for ~6 mi. until road forks. Take right-hand fork and follow for 3 mi. until you reach Peaceful Acres camp (third camp on left). Boat can be launched at camp.

LAUNCH SITE DESCRIPTION

Boat must be launched by hand. Vehicle can get to within 50 meters of shore. Portage is easy, as launch site is open (no trees), with little or no slope.

GENERAL COMMENTS

Residents friendly. Public launch is available about 0.25 mi. past Peaceful Acres camp on right.

EXPLANATION FOR NOT SAMPLING THE LAKE (continued from front)

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Figure 4-2. Lake Verification Form, Side 2.

TABLE 4-1. GLOBAL POSITIONING SYSTEM SURVEY PROCEDURES

1. Turn the unit ON.[a]

2. At the "READY" display, push "SETUP." Press "↓" once and check if the mode is "AUTO." Otherwise, use the "→" key to move to "AUTO." Then push "POS" for position.

3. If fix is "3D," note it on the Lake Verification Form. If fix is "2D," go to "SETUP," press "↓" once, press clear. Type in the altitude (ft) and "ENTER," then push "POS" and write down the 2D fix.

4. For both 2D and 3D fixes, push "↓" twice and note the lowest signal quality (SQ) and geometric quality (GQ)[b] as a number from 0-9 on the Lake Verification Form, Side 1.

5. If battery warnings appear, make sure that the unit is turned off immediately and the fresh battery pack is inserted in the unit (six size AAs are needed).

6. Turn unit OFF.

[a] These procedures are specific to the Magellan NAV 5000 global positioning system unit used during EMAP-Surface Waters surveys. Initialization of unit is required if it is moved more than 300 miles from last position fix. See the unit manual.

[b] If GQ ≤3, the crew should try to obtain another fix because the geometric quality is inadequate.

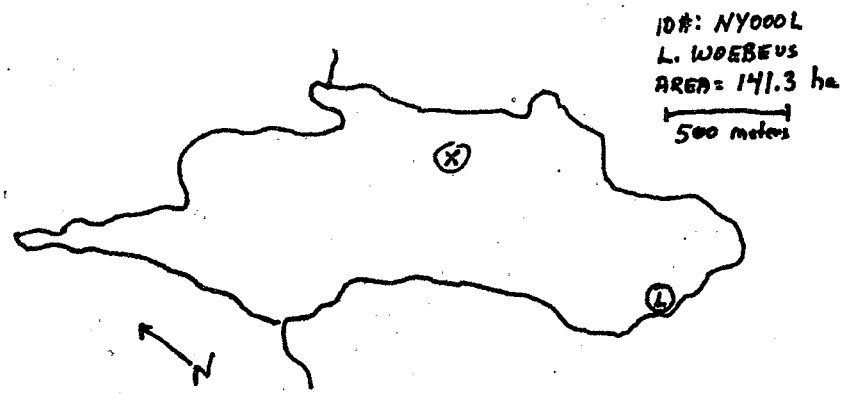
LAKE VERIFICATION FORM

LAKE NAME: L. WOEBEUS DATE OF VISIT: 7/14/94 VISIT #: (1) 2

LAKE ID: NY000L MODE OF ACCESS: (VEHICLE) HIKE-IN AIRCRAFT

TEAM ID (CIRCLE): 1 (2) 3 4 5 6 7 8 9 10 OTHER:____

ARROW INDICATES NORTH MARK SITE: L = LAUNCH X = INDEX



LAKE VERIFICATION INFORMATION

LAKE SHAPE COMPARES TO MAP? X YES ☐ NO

LAKE VERIFIED BY (✓ all that apply): X GPS ☐ LOCAL CONTACT ☐ SIGNS ☐ ROADS X TOPO. MAP

☐ Other (Describe Here): ☐ NOT VERIFIED (Explain in Comments)

COORDINATES	LATITUDE (dd mm ss) North	LONGITUDE (ddd mm ss) West	TYPE OF GPS FIX	SIGNAL QUALITY	GEOMETRIC QUALITY	Are GPS Coordinates w/i ±1 min. of map?
Map:	45.16.43.	067.50.20.				
Launch Site:	45.16.52.	067.50.42.	☐ 2D X 3D	8	5	X YES ☐ NO
Index Site:	45.16.37.	067.50.35.	☐ 2D X 3D	6	9	X YES ☐ NO

LAKE SAMPLED? X YES ☐ NO

REASON NOT SAMPLED (EXPLAIN BELOW): ☐ NOT VISITED ☐ NON-TARGET ☐ INACCESSIBLE ☐ OTHER

Explanation:

CHECK HERE IF EXPLANATION IS CONTINUED ON BACK. ☐

DESCRIBE LAUNCH SITE, LAKE DIRECTIONS, AND ADD COMMENTS ON BACK

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Rev. 3/95 FLDFRMS.95 Lake Verification Form - 1

Figure 4-3. Lake Verification Form, Side 1.

provided in the regional activities plan and the lake dossier on the Lake Verification Form. If a GPS fix is 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 dossier map coordinates recorded for the lake with the GPS coordinates displayed for the launch site. Check the Lake Verification Form to see if the two sets of coordinates are within ±1.0 minute 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. If a GPS fix is 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 on the Lake Verification Form, Side 1 (Figure 4-3).

In addition to the GPS, use as many of the following methods as possible to verify the site:

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

If the lake shape on the map on the Lake Verification Form, Side 1 (Figure 4-3) and on the USGS map do not correspond with each other or with the actual lake shape, check "Not Verified" and provide comments on the Lake Verification Form. The lake should <u>not</u> be sampled if there are major differences in lake shape and the sketch map cannot be used for locating the physical habitat stations described in Section 5. At each lake, evaluate whether or not the lake meets the EMAP definition of a lake:

- ≥1 ha in total surface area
- ≥100 square meters of open water
- ≥1 meter in depth

If the lake does not fit this definition, check "nontarget" in the lake sampled section on the bottom of the Lake Verification Form, Side 1 (Figure 4-3) and provide an explanation for not sampling the lake. Add any additional explanation as required.

4.2 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 (if available in the dossier for the lake) and by observing the lake shape and surrounding topography. Table 4-2 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 4-3). If satellite coverage is not available at that time, try again during the sample collection activities on Day 2 (The index site will be marked with a buoy). Identify the index site on the sketch map with an "X" on the Lake Verification Form, Side 1 (Figure 4-3).

Compare the dossier coordinates recorded for the lake with those GPS coordinates recorded for the index site. Check on the Lake Verification Form, Side 1 (Figure 4-3) if the two sets of coordinates are within ±1.0 minute of latitude and longitude. If coordinates at the launch site or the index site are not within ±1.0 minute of the map coordinates listed in the regional activities plan and the dossier, 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 2 (Figure 4-2).

4.3 EQUIPMENT AND SUPPLY LIST

Figure 4-4 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 B that is used at a base site to assure that all equipment and supplies are taken to and available at the lake. Field teams must 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 4-2. LOCATING THE INDEX SITE*

1. Attach the transducer bracket to boat transom. Position the transducer so that the streamlined end faces forward. Connect the power supply and the transducer to the sonar unit.

2. Operate Sonar unit according to manufacturer's specific operating procedures. If possible, depth readings should be made in metric units.

3. Use the sonar in the area expected to be the deepest. Mentally note the location of maximum depth.

4. Return to the location of maximum depth. Anchor the boat.

5. Determine the coordinates using GPS. Record GPS coordinates on Side 1 of the Lake Verification Form.

* Total time to locate index site should be ≤ 30 min.

LAKE VERIFICATION CHECKLIST

	Number Needed Each Lake
Dossier for lake to be sampled	1
Clipboard	1
Lake Verification Form	1
Field notebook	1
Field Operations Manual and Field Handbook	1
Field Quick Reference Handbook	1
EMAP pamphlets	20
Sampling permit	1
Sonar	1
Pigtail adapter for 12-V battery	1
Transducer with bracket and C-clamp	1
12-V wet cell battery (charged) in battery case	1
GPS unit with manual, reference card, extra battery pack	1
Anchor with 50 m line	1-2
Float to attach to anchor	1

Figure 4-4. Lake verification checklist.

SECTION 5
HABITAT CHARACTERIZATION

by
Philip R. Kaufmann and Thomas R. Whittier

Habitat characterization at a lake includes (1) measures of temperature and dissolved oxygen at the index site, (2) measures or observations of littoral and riparian physical habitat structure at 10 predetermined stations, and (3) macroscale classification and mapping of riparian and littoral habitat for the whole lake. All of these data are used by the field crew to determine the placement of fish sampling gear and benthic sampling sites. Those biotic sampling activities are discussed in sections 6 and 8, respectively. Very rigid quality assurance practices are observed in the field. To assure legibility and completeness in recording, one individual completes the field forms and another checks them.

5.1 TEMPERATURE AND DISSOLVED OXYGEN

Most lakes deeper than 3 to 5 m are thermally stratified during the summer. Thus, the vertical distribution of temperature and dissolved oxygen (DO) is important in assessing lake habitat quality. The metalimnion is defined as the middle area of the water column where the vertical temperature gradient is greater than or equal to 1.0 °C per meter of depth (Figure 5-1). The thermocline is the depth, within the metalimnion, where this gradient is greatest. These distribution profiles are used to characterize the pelagic (open water) habitat by determining the depths of the top and bottom of the metalimnion (if present) and the extent of oxygen depletion (operationally defined to be < 2 mg O_2/L). This information is used to select gill net sites (Section 6) and benthic sampling sites (Section 8). All measurements are taken in a vertical profile at the index site after the lake verification and index site location activities described in Section 4. The dissolved oxygen meter must be tested and calibrated at the lake index site just prior to measuring the vertical profile.

5.1.1 Calibration of the Dissolved Oxygen Meter

The dissolved oxygen meter performance test and calibration are summarized in Figure 5-2 (the detailed description is found in Section 3). Each field team also has a copy of the manufacturer's calibration procedures and maintenance information. Record calibration information on the Lake Profile Form, Side 2 (Figure 5-3). If the instrument will

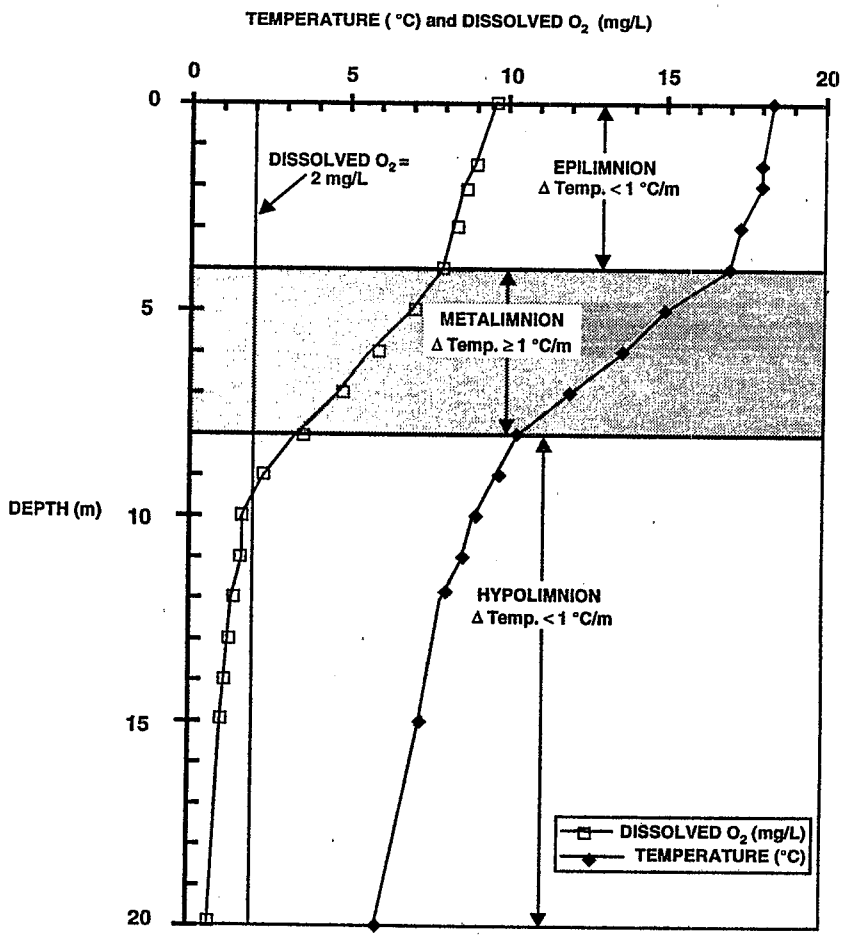

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Figure 5-1. Typical temperature and dissolved oxygen profile of a thermally stratified lake.

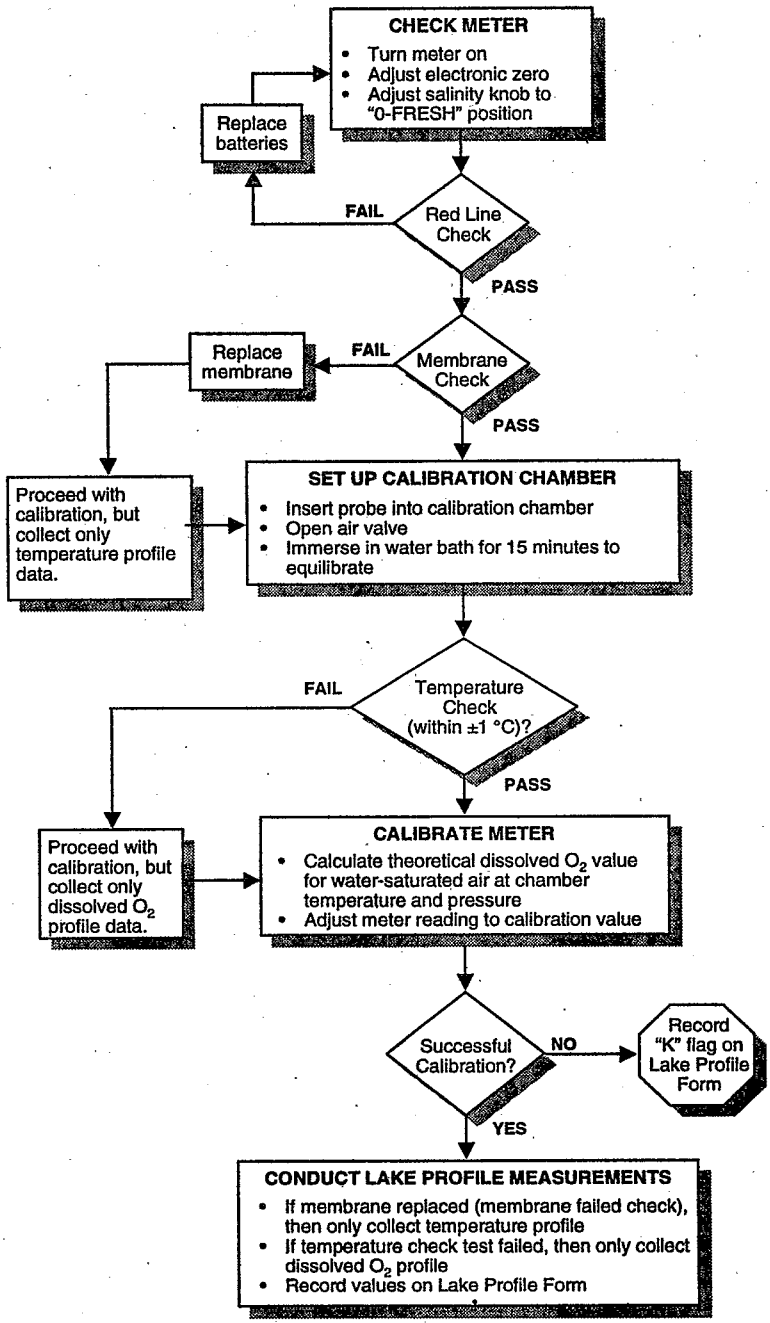


Figure 5-2. Field performance test and calibration procedure for the dissolved oxygen meter.

LAKE ID: NY000OL LAKE PROFILE FORM (continued) VISIT #: (1) 2

OXYGEN METER CALIBRATION INFORMATION

SALINITY KNOB AT "0-FRESH": X	MEMBRANE CHECK X	ELECTRONIC ZERO X	RED LINE: X
CALIBRATION CHAMBER TEMPERATURE: 20.8 °C		SATURATED O_2 @ CHAMBER TEMP.: 8.92 MG/L	
LAKE ELEVATION (FROM TOPO. MAP OR ALTIMETER): 98 FT		ELEVATION CORRECTION FACTOR: × 0.98	
THE CALIBRATION VALUE IS OBTAINED BY MULTIPLYING THE SATURATED O_2 CONCENTRATION TIMES AN ELEVATION CORRECTION FACTOR (BOTH VALUES ARE OBTAINED FROM TABLES PRESENT ON THE BACK OF THE METER, OR PROVIDED IN THE MANUFACTURER'S OPERATIONS MANUAL). ADJUST THE METER READING TO THE CALIBRATION VALUE.		CALIBRATION VALUE: 8.74 MG/L	
		FLAG	COMMENTS

DISSOLVED OXYGEN & TEMPERATURE PROFILE (continued)
For depths >15 m, continue recording at 5-m intervals)

DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T, B)[a]	DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T,B)[b]

DEPTH & FLAG	COMMENTS

REVIEWED BY (INITIAL): JA

Figure 5-3. Lake Profile Form, Side 2.

not calibrate, repeat the calibration procedure. If the meter still fails to calibrate, record a "K" flag on the Lake Profile Form to denote that measurements could not be obtained.

5.1.2 Index Site Conditions and Lake Profile Measurements

At the index site record the observations listed on the top of Side 1 of the Lake Profile Form (Figure 5-4). Note any precipitation, surface conditions, and the presence or absence of odor or scum. Use the sonar to determine the lake depth at the index site and record on the Lake Profile Form. If the sonar is not working, use the Secchi disk line to determine the depth and check the box to indicate that the sonar was not used.

After calibrating the dissolved oxygen meter, attach a messenger (for weight only) to the probe cable near the probe and measure vertical profiles of temperature and DO at the predetermined depth intervals--as indicated on the Lake Profile Form, Side 1 (Figure 5-4). The deepest measurements taken at each lake will always be at 1.0 m above the bottom (or the length of the cable if the depth is >50 m). Figure 5-5 describes the general process for conducting the profile measurements. For shallow lakes (<3 m), measure DO and temperature at the surface and at 0.5-m intervals, until 1.0 m above the bottom. For lakes deeper than 3.0 m, measure DO and temperature at the surface, at 1.5 m and 2.0 m, and at every meter thereafter through 15 m (or until reaching 1.0 m above the bottom). After the measurement at 15 m, record the measurements every 5 m starting at 20 m (or until 1.0 m above the bottom). If the DO drops below 2.0 mg/L during this process, raise the probe back to the last depth measured and, from that point, resume taking measurements at 1-m intervals until you find the depth where the DO is ≥2.0 mg/L. This is the maximum depth for fishing gear. Record this depth and then continue the measurements at 5-m intervals (20, 25, ...) until 1 m above the bottom. Do not lower the probe closer than 1.0 m from the bottom to avoid permanent damage to the membrane and probe.

Note the top (T) of the metalimnion (the top of the depth interval where the change in temperature is greater than or equal to 1.0 °C/m) and the bottom (B) of the metalimnion (top of the depth interval where the change in temperature is less than 1.0 °C/m) on the Lake Profile Form, Side 1 (Figure 5-4). The metalimnion in some lakes may extend to the bottom. If this occurs, note the bottom of the metalimnion as the last depth measured.

After completing the DO and temperature profile, clip an orange float to the anchor line leaving the anchor, line, and float at the index site so that it can be easily located the next day. This procedure should not be followed if there is a chance of theft or the presence of the float presents a safety problem. If the marker float cannot be left, you must relocate the index site the next day using the procedure described in Section 4. Refill the calibration chamber with lake water and store the probe in the calibration chamber.

LAKE PROFILE FORM

LAKE NAME: L. WOEBEGUS DATE OF PROFILE: 7/4/94 VISIT #: (1) 2

LAKE ID: NY0000L SITE ID (circle): (INDEX) OTHER:

TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER:

PRECIPITATION (circle): (NONE) LIGHT HEAVY

SURFACE CONDITIONS (circle): FLAT (RIPPLES) CHOPPY WHITECAPS

ODOR? [X] No ☐ Yes Description:

SCUM? [X] No ☐ Yes Description:

INDEX SITE DEPTH: 18.9 M CHECK (✓) IF SONAR NOT USED: ☐

FLAG: COMMENTS:

DISSOLVED OXYGEN & TEMPERATURE PROFILE

(Depth of Measurement[a] [m]: Surface, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45, and 50 m), Also include readings at 1 m above bottom.

DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T, B)[b]	DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T,B)[b]
SURFACE	8.8	21.1			11.0	4.2	12.1		
1.5	8.8	21.0			12.0	3.8	12.0		
2.0	8.8	21.0			13.0	3.7	11.9		
3.0	8.8	21.0			14.0	3.4	11.8		
4.0	8.8	21.0		T	15.0	3.4	11.8		
5.0	7.0	18.8			17.9	1.9	11.3		
6.0	5.7	15.6			16.0	3.0	11.2		
7.0	4.4	14.2			17.0	2.1	11.3		
8.0	4.9	13.2		B					
9.0	4.3	12.9							
10.0	4.4	12.5							
SURFACE (Dup.)	8.8	21.1							

IS THE DUPLICATE O_2 READING WITHIN ±0.5 MG/L OF THE INITIAL SURFACE READING? [X] Yes ☐ No

CHECK HERE IF ADDITIONAL PROFILE MEASUREMENTS ARE RECORDED ON THE REVERSE SIDE: ☐

[a] If the site depth is ≤ 3 m, take readings at the surface, every 0.5 m, and 1 m above the bottom.
[b] METALIMNION = The region of the profile where the temperature changes at a 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 of change becomes less than 1 °C per meter) with a "B." After the metalimnion is encountered, take readings every 1 m until bottom of the metalimnion is reached. Record the depth of the top of the metalimnion on the Benthos Sample Location and Collection Form.

FLAG CODES: K = No Measurement or Observation Made; U = Suspect Measurement or Observation; Q = Unacceptable QC Check Associated with Measurement; F1, F2, etc. = Miscellaneous Flags Assigned by each field crew. Explain all flags in comments section on back of form.

REVIEWED BY (INITIAL):_____

Figure 5-4. Lake Profile Form, Side 1.

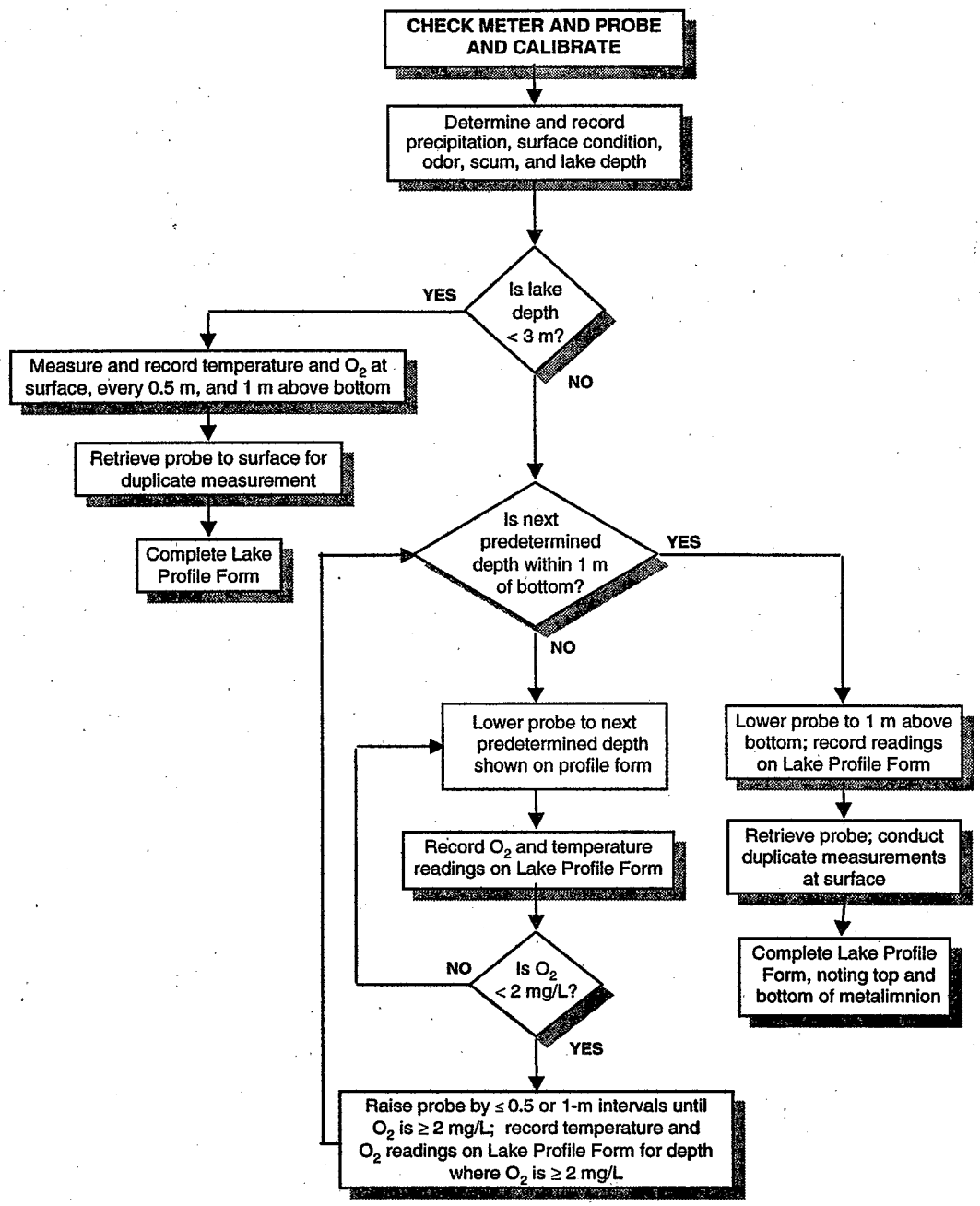


Figure 5-5. Dissolved oxygen and temperature profile procedure.

5.2 SHORELINE PHYSICAL HABITAT CHARACTERIZATION

Lake physical habitat and shoreline disturbances are characterized based on observations of the lake riparian and littoral habitat at 10 physical habitat (P-Hab) sampling stations spaced evenly around the lake. These station locations (marked A through J) are shown on a preprinted lake outline map (Habitat Sketch Map Form, Side 1, Figure 5-6). The sketch map forms for each lake are provided as part of the dossier compiled for each lake (Section 3.1.1).

While traveling between P-Hab stations the field team also classifies and maps macro-scale riparian and littoral habitats of the lake. These activities are described in Section 5.2.3. The field team makes one near-shore pass around the lake, conducting both the 10 P-Hab station observations and the macrohabitat characterization in one operation.

5.2.1 Locating Each Physical Habitat Station and Defining the Shoreline Boundary

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 lake outline on the Habitat Sketch Map Form Side 1 (Figure 5-6) and a topographic map, locate and stop at each of the 10 P-Hab stations. Mark each station with a ribbon, then position the boat at a distance of 10 m (~30 ft, offshore), anchor if necessary, and make the semi-quantitative measurements enumerated on the Physical Habitat Characterization Form, sides 1 and 2 (Figures 5-7 and 5-8).

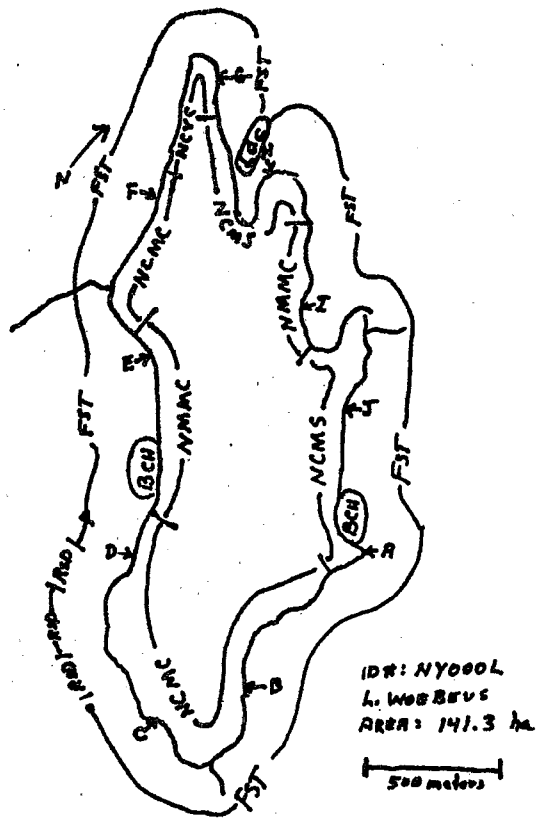
Make every reasonable attempt to record physical habitat observations and measurements for all 10 P-Hab stations. However, there are circumstances where this is impossible. In such cases, record a "K" flag (see Section 5.2.2 below) in each field to clearly indicate on the form that no observations were made at that particular station. In some cases, the mapped lakeshore may be different from what you actually see in the field. If, for example, a bay is dry or inaccessible because of excessive vegetation and shallow water, show the new shoreline clearly on the Habitat Sketch Map Form, Side 1 (Figure 5-6). If one or more of the P-Hab stations are "lost" as a result of the lakeshore changes, reposition one or more new P-Hab stations identified by an "X" following the station letter. Place the new stations at approximately the same interval along the shore as the rest of the P-Hab stations. Note, for example, that two "lost" stations B and C may be replaced by one new station BX, equidistant between stations A and D. On the Physical Habitat Characterization Form (Figures 5-7 and 5-8), change station "B" to "BX," and indicate that no observations were made at station C by entering K flags. If more stations must be added than were "lost," there will be more than 10 stations on the lake. Use an additional Physical Habitat

PHYSICAL HABITAT SKETCH MAP FORM-LAKES

LAKE NAME: L. WOEBEUS VISIT #: (1) 2

LAKE ID: NY000L START TIME: 10:30 END TIME: 13:20

TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER: ____



Sketch and label riparian, in-lake, shoreline, and littoral fish habitats around the lake, using codes below. To identify littoral fish habitats on the map, compose a four-character code as: (Disturbance) (Cover class) (Cover type) (Substrate type). EXAMPLE: NCVS for Natural, Cover, Vegetated, Sand/Gravel.

RIPARIAN AND IN-LAKE CODES: WET = Wetland; BCH = Beach; RSD = Residences; PRK = Park; FST = Forest; ALT = Altered shoreline; DCK = Dock(s); MNA = Marina; CRP = Cropland; PTR = Pasture; LFL = Landfill/Dump; IND = Industry; MNG = Mining; LGG = Logging; FLM = Floating macrophytes; SBM = Submerged macrophytes; EMM = Emergent macrophytes; SHL = Shoal or Rocks.
LITTORAL FISH HABITAT CODES: (DISTURBANCE): Human, Natural, Mixed. (COVER CLASS): Cover, Open, Mixed. (COVER TYPE): Artificial structure, Fill, Vegetated, Woody, Boulders, Mixed, None. (SUBSTRATE TYPE): Mud/Muck, Sand/Gravel, Cobble/Boulders, Bedrock.

MAP OF FISH SAMPLING SITES ON BACK REVIEWED BY (INITIAL): JA

Rev. 3/95 FLDFRMS.95 Physical Habitat Sketch Map Form - 1

Figure 5-6. Habitat Sketch Map Form, Side 1.

PHYSICAL HABITAT CHARACTERIZATION FORM-LAKES

LAKE NAME: L. Woebeus — DATE OF VISIT: 7/14/94 — VISIT #: (1) 2

LAKE ID: NY000L — TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 — OTHER: ___

	NEW STATION ID (if needed):										
RIPARIAN ZONE	STATION ID:	A	B	C	D	E	F	G	H	I	J
VEGETATION TYPE (N=NONE, D=DECID., C=CONIF., M=MIXED)	CANOPY LAYER (> 5 M)	M	M	M	M	N	M	M	C	M	M
	UNDERSTORY (0.5 TO 5 M)	M	M	M	M	D	M	M	M	M	M
AREAL COVERAGE CATEGORIES 0 = ABSENT 1 = SPARSE (<10%) 2 = MODERATE (10 TO 40%) 3 = HEAVY (40 TO 75%) 4 = VERY HEAVY (> 75%)											
CANOPY LAYER (> 5 M HEIGHT)	TREES ≥ 0.3 M DBH	1	2	2	2	0	1	3	2	1	2
	TREES < 0.3 M DBH	2	3	3	2	0	2	2	2	2	3
UNDERSTORY (HEIGHT=0.5 TO 5 M)	WOODY SHRUBS & SAPLINGS	2	3	2	2	2	2	4	4	3	3
	TALL HERBS, FORBS, & GRASSES	2	1	1	1	2	1	0	1	2	1
GROUND COVER (< 0.5 M HEIGHT)	WOODY SHRUBS & SEEDLINGS	2	3	2	3	2	1	4	4	3	3
	HERBS, FORBS, & GRASSES	3	1	2	2	3	3	1	1	2	1
	STANDING WATER OR INUNDATED VEGETATION	0	0	0	0	2	0	0	0	0	0
	BARREN OR BUILDINGS	0	1	2	2	0	2	0	0	0	1
SHORELINE SUBSTRATE ZONE	BEDROCK (> 4000 MM; BIGGER THAN A CAR)	0	0	0	0	0	0	0	0	0	0
	BOULDERS (250 - 4000 MM; BASKETBALL - CAR SIZE)	1	0	4	3	2	0	1	0	0	3
	COBBLE/GRAVEL (2 - 250 MM; LADYBUG - BASKETBALL SIZE)	3	4	0	1	1	3	3	3	3	0
	LOOSE SAND (0.06 TO 2 MM; GRITTY BETWEEN FINGERS)	0	0	0	0	0	0	0	0	0	0
	OTHER FINE SOIL/SEDIMENT (< 0.06 MM; NOT GRITTY)	0	0	0	0	0	0	0	0	0	0
	VEGETATED	2	0	2	3	3	3	3	3	3	3
	OTHER (EXPLAIN IN COMMENTS)	0	0	0	0	0	0	0	0	0	0
BANK FEATURES (WITHIN PLOT)	ANGLE: V = NEAR VERTICAL/UNDERCUT, S = 30-75°, G = <30°	G	G	S	G	G	G	G	S	G	V
	VERTICAL DISTANCE (M) FROM WATERLINE TO HIGH-WATER MARK	0.3	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.2	0.2
	HORIZONTAL DISTANCE (M) FROM WATERLINE TO HIGH-WATER MARK	1.0	1.0	0.6	1.0	F3	1.0	1.0	0.6	1.0	0.3
HUMAN INFLUENCE	0 = ABSENT CHECK (✓) = PRESENT WITHIN PLOT B = OBSERVED ADJACENT TO OR BEHIND PLOT										
	BUILDINGS	0	✓	0	B	0	B	0	0	0	0
	COMMERCIAL	0	0	0	0	0	0	0	0	0	0
	PARK FACILITIES	0	0	0	0	0	0	0	0	0	0
	DOCKS/BOATS	0	0	0	B	0	0	0	0	0	0
	WALLS, DIKES, OR REVETMENTS	0	0	0	0	B	0	0	0	0	0
	LITTER, TRASH DUMP, OR LANDFILL	0	0	0	0	0	0	0	0	0	0
	ROADS OR RAILROAD	0	0	0	✓	0	0	0	0	0	0
	ROW CROPS	0	0	0	0	0	0	0	0	0	0
	PASTURE OR HAYFIELD	0	0	0	0	0	0	0	0	0	0
	ORCHARD	0	0	0	0	0	0	0	0	0	0
	LAWN	0	✓	0	B	0	✓	0	0	0	0
	OTHER (EXPLAIN IN COMMENTS)	0	0	0	0	0	0	0	0	0	0

FLAG CODES: K = MEASUREMENT OR OBSERVATION NOT OBTAINED; U = SUSPECT MEASUREMENT OR OBSERVATION; F1, F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS ON SEPARATE COMMENTS FORM.

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Physical Habitat Characterization Form - 1

Figure 5-7. Physical Habitat Characterization Form, Side 1.

LAKE ID: NY000 L **PHYSICAL HABITAT CHARACTERIZATION FORM (continued)** VISIT #: (1) 2

LITTORAL ZONE — STATION ID:	A	B	C	D	E	F	G	H	I	J
NEW STATION ID (if needed):										
STATION DEPTH (M) AT 10 M OFFSHORE	0.8	1.1	0.8	0.7	0.8	0.6	1.0	1.8	0.7	0.8
SURFACE FILM TYPE (S=SCUM, A=ALGAL MAT, P=OILY, N=NONE/OTHER)	N	N	N	N	N	N	N	N	N	N
BOTTOM SUBSTRATE: AREAL COVERAGE: 0=ABSENT 1=SPARSE (<10%) 2=MODERATE (10 TO 40%) 3=HEAVY (40 TO 75%) 4=VERY HEAVY (>75%)										
BEDROCK (>4000 MM; LARGER THAN A CAR)	0	0	0	0	2	0	0	0	0	0
BOULDERS (250 - 4000 MM; BASKETBALL - CAR SIZE)	1	0	1	1	0	0	1	0	0	0
COBBLE (64 - 250 MM; TENNIS BALL - BASKETBALL SIZE)	2	0	1	3	0	2	2	3	2	3
GRAVEL (2 TO 64 MM; LADYBUG TO TENNIS BALL SIZE)	2	4	0	2	0	2	2	3	2	3
SAND (0.06 TO 2 MM; GRITTY BETWEEN FINGERS)	1	1	3	1	0	2	1	1	1	1
SILT, CLAY, OR MUCK (< 0.06 MM; NOT GRITTY)	0	0	0	0	2	0	0	0	0	0
WOODY DEBRIS	1	1	1	0	2	2	1	0	2	2
COLOR (BL=BLACK, GY=GRAY, BR=BROWN, RD=RED, N=NONE OR OTHER)	K	K	K	K	GY	GY	K	K	GY	K
ODOR ($S=H_2S$, A=ANOXIC, P=OIL, C=CHEMICAL, N=NONE)	K	K	K	K	N	N	K	K	N	K
MACROPHYTES AREAL COVERAGE: 0=ABSENT 1=SPARSE (<10%) 2=MODERATE (10 TO 40%) 3=HEAVY (40 TO 75%) 4=VERY HEAVY(>75%)										
SUBMERGENT	1	0	1	1	1	1	1	1	1	1
EMERGENT	1	0	0	2	1	1	0	0	1	0
FLOATING	0	0	0	1	2	0	0	0	0	0
TOTAL WEED COVER	1	0	1	2	3	2	1	1	2	1
DO MACROPHYTES EXTEND LAKEWARD? (Y OR N)?	N	N	Y	Y	Y	Y	Y	N	Y	Y
FISH COVER — 0=ABSENT 1=PRESENT BUT SPARSE 2=PRESENT IN MODERATE TO VERY HEAVY DENSITY										
AQUATIC WEEDS	1	0	1	2	2	1	1	1	1	1
SNAGS > 0.3 M DIAMETER	0	0	0	0	2	0	1	0	0	0
BRUSH OR WOODY DEBRIS < 0.3 M DIAMETER	1	1	1	0	2	1	1	0	1	2
INUNDATED LIVE TREES > 0.3 M DIAMETER	0	0	0	0	0	0	0	0	0	0
OVERHANGING VEGETATION < 1 M ABOVE SURFACE	0	0	0	0	2	1	1	0	0	1
ROCK LEDGES OR SHARP DROPOFFS	0	0	0	0	0	0	0	2	0	0
BOULDERS	1	0	1	1	0	0	1	0	0	0
HUMAN STRUCTURES (E.G., DOCKS, LANDINGS, PILINGS, RIPRAP, ETC.)	0	0	0	0	0	0	0	0	0	0
LITTORAL FISH HABITAT CLASSIFICATION										
DISTURBANCE (H=HUMAN N=NATURAL M=MIXED)	N	N	N	N	N	N	N	N	N	N
COVER CLASS (C=COVER, O=OPEN, M=MIXED)	M	O	M	C	C	M	M	C	M	M
COVER TYPE (A=ARTIFICIAL F=FILL V=VEG. W=WOODY B=BOULDERS M=MIXED N=NONE)	M	N	M	M	M	M	M	M	M	M
SUBSTRATE (M=MUCK/SILT, S=SAND/GRAVEL, C=COBBLE/BOULDER, B=BEDROCK)	S	S	S	C	M	S	S	S	S	S
GEAR (G=GILL NET, T=TRAP NET, S=SEINE, O=NONE)	T	S	S	T	T	T	G,T	G	T	T
GEAR LOCATION (DIST. & DIR. TO NEAREST REPRES. MACROHABITAT)	0	0	30m	0	0	0	0	0	0	0

FLAG CODES: K = MEASUREMENT OR OBSERVATION NOT OBTAINED; U = SUSPECT MEASUREMENT OR OBSERVATION;
F1, F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS ON SEPARATE PHYSICAL CHARACTERIZATION HABITAT COMMENTS FORM.

REVIEWED BY (INITIAL): JA

Figure 5-8. Physical Habitat Characterization Form, Side 2.

Characterization Form to record the data, indicating the new or additional stations by writing "X," "Y," or "Z" after the appropriate station letter. This step is summarized in Table 5-1.

If the lakeshore you observe in the field is radically different than that shown on the map outline and you are sure you are at the correct lake, redraw the P-Hab station locations. Your new map will need to have 10 stations equidistant around the shoreline. One way to do this in the field is by laying a string to measure the shoreline of new outline, dividing that length by 10, then using the string to lay out the 10 station locations. Include a comment stating why, in your judgment, the lakeshore is different than on the original outline (e.g., drought, flooding, or lake dredging).

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 5-9) 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.

5.2.2 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 5-7 and 5-8). 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 5-1. GENERAL GUIDELINES FOR LOCATING OR MODIFYING THE LOCATION OF PHYSICAL HABITAT STATIONS

At Each Physical Habitat (P-Hab) Sampling Station:

1. Locate station by eye using maps, and mark with ribbon.

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, draw the observed shoreline on Side 1 of the Physical Habitat Sketch Map Form.

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 on both sides 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.

6. If changes add more stations than 10, use an additional form to record the data for the added sites and add X, Y, or Z after the appropriate station letter.

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.

8. Enter a comment on the Physical Habitat Characterization Comment Form stating the apparent reason (e.g., drought, flooding, dredging) the lakeshore is different.

9. At each of the 10 shoreline stations, position the boat at an observation point 10 m from shore. 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. The sampling area and zones are illustrated in the quick reference handbook.

10. Record riparian habitat (inland from the shore) characteristics* on the first side of the Physical Habitat Characterization Form.

11. Record littoral habitat (in the lake) characteristics* on Side 2 of the Physical Habitat Characterization Form.

* For most categories, multiple items may have heavy (3), moderate (2), or sparse (1) cover ratings.

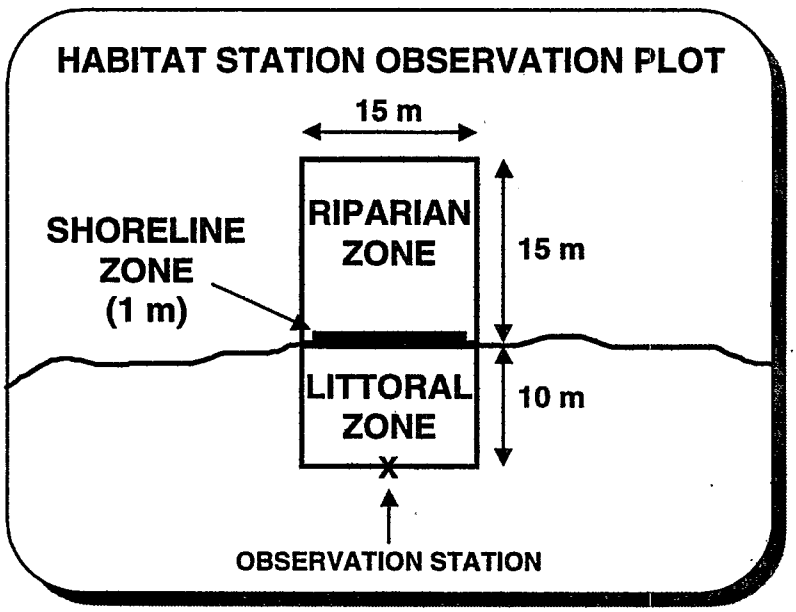


Figure 5-9. Physical habitat characterization plot.

TABLE 5-2. COMPLETING THE PHYSICAL HABITAT CHARACTERIZATION FORM

A. General

1. After completing the temperature and DO profile, begin shoreline survey, filling in the Physical Habitat Characterization Form at each of the 10 physical habitat (P-Hab) sampling sites, anchoring when necessary. Sketch in major features of riparian and shoreline habitats on habitat sketch map and label each using codes provided on the Habitat Sketch Map Form.

2. Survey plot dimensions:
   Riparian Vegetation - 15 m along shoreline and 15 m back onto land.
   Shoreline Substrate and Bank Angle - 15 m along shore and 1 m back.
   Littoral (in lake) - 15 m along shoreline and 10 m out into lake.

3. The semi-quantitative ranking for vegetation, substrate, and aquatic macrophytes is:

   a. Very heavy (greater than 75% coverage) = 4
   b. Heavy (40 to 75% coverage) = 3
   c. Moderate (10 to 40% coverage) = 2
   d. Sparse (present, but less than 10% coverage) = 1
   e. Absent = 0

B. Riparian Habitat (Side 1 of the form)

1. Divide shoreline vegetation into 3 categories:

   a. Greater than 5 m high = canopy layer
   b. 0.5 to 5 m high = understory layer
   c. Less than 0.5 m high = ground cover layer

   (Grasses or woody shrubs and tree branches can occur in more than one layer. The ground cover layer may be vegetation, water, barren ground, or duff.)

2. Record the type of vegetation in the two tallest shoreline vegetation layers (canopy and understory) as none, deciduous, coniferous, or mixed. Define mixed as a segment where at least 10 percent of the areal coverage is made up of the alternate vegetation type.

3. Estimate the areal cover (A-3 above) of the shoreline vegetation, including the following vegetation classes:

   a. Canopy layer: trees greater than or equal to 0.3 m (1 ft) in diameter at chest height.
   b. Understory layer: trees less than 0.3 m in diameter at chest height--"Woody shrubs and saplings" and nonwoody "herbs, forbs, and grasses."
   c. Ground cover layer: "Woody shrubs and saplings," nonwoody "herbs, forbs, and grasses," "standing water," "inundated vegetation," or "barren or buildings."

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.

5. Describe the angle of the shoreline bank back 1 m from the edge of the water):

   a. V = near vertical/undercut, greater than 75 degrees
   b. S = 30 to 75 degrees (steep)
   c. G = 0 to 30 degrees (gradual)

6. Estimate the vertical and horizontal distances between the present lake level and the high water line.

(Continued)

TABLE 5-2. (Continued)

7. For the listed human influence types, enter "√" if present within the shoreline/littoral plot (A-2 above), "B" if visible but outside and adjacent to the plot or within your field of vision behind the plot, or "0" if absent.

C. Littoral Habitat (Side 2 of the form)

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.
2. Note the presence or absence of water surface scums, algal mats, or oil slicks.
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).
4. Rank the littoral substrate sediment particle size, using classes shown on the Physical Habitat Characterization Form, according to areal extent, making multiple probes if the bottom is not visible. Areal extent (coverage) codes are the same as shown in A-3 above. 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).
5. Note sediment color and odor if a sample can be seen or collected.
6. Estimate the areal coverage (as described in A-3 above) of the three aquatic macrophyte types: submerged, emergent, and floating within the 10-by 15-m swath between your boat and the 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.
7. For the listed types of fish cover observed from the shore to the boat (10 m offshore) and 15 m along shore (A-2 above), enter "0" for absent, "1" if the cover type is sparse, and "2" if moderate or abundant.
8. Fish microhabitat classification for 10 m by 15 m littoral area:
   a. Select a single one-letter code for each of the following: disturbance regime, cover class, cover type, and substrate type.
   b. Select one or more one-letter codes to indicate <u>all</u> possible fish collection methods for the site.

For the fish cover entry fields, enter 0 for absence of listed habitat features, 1 if they are present but sparse, or 2 if they are moderate or abundant. On the human influence entry fields, record a check mark ("√") if present within the shoreline/littoral plot. Record a "B" if visible but adjacent or behind (outside) the plot, or a "0" for absence of listed habitat features. A wavy vertical line through all or part of a column may also be used to denote "absent." 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 we have 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 separate Physical Habitat Characterization Comments Form (Figure 5-10) 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. On the comments form, record the data value itself and explain why you think it is suspect (or describe what nonstandard procedure was used and why).

5.2.2.1 Riparian Habitat (Directions for Page 1)--

The riparian habitat characterization includes riparian vegetation cover, shoreline substrate, bank type and evidence of lake level changes, and human influences. Record all measures or observations for these categories on the Physical Habitat Characterization Form Side 1 (Figure 5-7).

5.2.2.1.1 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).

PHYSICAL HABITAT CHARACTERIZATION COMMENT FORM

Page 1 of 1

LAKE ID: NY0000L

VISIT #: (1) 2

TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER: ____

STATION ID	SECTION OF FORM	MEASUREMENT OR VARIABLE	FLAG	COMMENT OR FLAG EXPLANATION
E	BANK FERTURES	DIST. FROM WATERLINE TO HIGH WATER MARK	F3	NO DISTINCT BOUNDARY, WATER EXTENDS INTO WETLAND
A	BOTTOM SUBSTRATE	COLOR	K	SUBSTRATE TOO HARD TO OBTAIN SAMPLE
B				
C				
D				
G				
H				
J	BOTTOM SUBSTRATE	COLOR	K	SUBSTRATE TOO HARD TO OBTAIN SAMPLE
A	BOTTOM SUBSTRATE ODOR	ODOR	K	SUBSTRATE TOO HARD TO OBTAIN SAMPLE
B				
C				
D				
G				
H				
J	BOTTOM SUBSTRATE	ODOR	K	SUBSTRATE TOO HARD TO OBTAIN SAMPLE

FLAG CODES: K = NO MEASUREMENT OR OBSERVATION ATTEMPTED; U = SUSPECT MEASUREMENT OR OBSERVATION; F1, F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW.

CHECK HERE IF INFORMATION IS RECORDED ON OTHER SIDE OF FORM ____

REVIEWED BY (INITIAL): gh

Figure 5-10. Physical Habitat Characterization Comments Form.

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 more than 10 percent of the areal coverage is made up of the alternate vegetation type.

5.2.2.1.2 Shoreline substrate--Rank, by areal coverage, very heavy, heavy, moderate, sparse, and absent particle size classes of the substrate that is 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 the Physical Habitat Characterization Form Side 1 (Figure 5-7). 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.

5.2.2.1.3 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: V = Near vertical/undercut (>75 degrees, S = Steep; >30 to 75 degrees, hard to walk up bank; or G = Gradual, 0 to 30 degrees, easy to walk up). 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.

5.2.2.1.4 Human influences--Check ("√") 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, enter "B." Enter "0" if human activity is not present in either case.

5.2.2.2 Littoral Habitat (Directions for Page 2)--

Lake depth at the habitat survey stations 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; use the codes provided on the form. All measures or observations in these categories are recorded on the Physical Habitat Characterization Form Side 2 (Figure 5-8).

During the littoral portion of the habitat work, look for and collect an example of any freshwater mussel firmly attached to hard substrates. Also do this at the launch site. Procedures are detailed in the benthos section (Section 8) of this manual.

5.2.2.2.1 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 Comment Form) 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 (A-3 in Table 5-2). 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 with codes shown on the form. Enter the code for "None/Other" if sediment color does not match one of the codes. For sediment odor, example entries 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.

5.2.2.2.2 Aquatic macrophytes--To characterize aquatic macrophytes, separately estimate the areal coverage (as defined under A-3 in Table 5-2) for each of the three aquatic macrophyte types (submerged, emergent, and floating) present within the lake area between your boat and the shoreline. Emergent vegetation has erect portions above the water surface. Floating refers to either rooted or nonrooted 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).

5.2.2.2.3 Fish cover--Evaluate the presence and abundance of the listed types of fish 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). Enter "0" for cover types that are absent, "1" for those present but sparse, or "2" for those that are moderate or abundant.

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" may include submerged, floating, or emergent forms and may provide concealment or protection for fish. "Snags" are considered to be inundated or partially inundated dead tree boles, branches, or rootwads with diameter ≥0.3 m (1 ft). "Woody debris or brush" is defined as inundated dead or living woody vegetation that is <0.3 m diameter, whereas "Inundated Live Trees" refers to the inundated portions of trees ≥0.3 m in diameter. "Overhanging Vegetation" is defined as that which is <1 m from the water surface, because this low overhanging vegetation provides concealment from fish-eating birds. Do not include higher overhanging vegetation, which might provide perches for birds such as kingfishers. "Rock Ledges or Sharp Dropoffs" include overhanging banks, submerged rock shelves, and steep sloping rock walls that can provide cover for fish. "Boulders" (>basketball size) also offer fish cover and concealment. "Human Structures" include docks, barges, houseboats, swimming platforms, tires, car bodies, and habitat enhancement structures (e.g., log rafts) that can provide cover for fish.

5.2.2.2.4 Littoral fish habitat classification (four-letter fish habitat codes and possible fishing gear)--The final three tasks relate to fish sampling. Information about the microhabitat at each physical habitat station will help to locate fish sampling sites. As described in Section 6.2, littoral fish sampling sites will be located as close as possible to actual physical habitat stations. At each station, first examine the habitat and assign a four-letter code as described on the Habitat Sketch Map Form and in Table 5-3. Second, assess the site to determine and record whether a gill net, trap net, or seine may be deployed there and use the four-letter codes to map the entire shoreline, including areas between the P-Hab stations (Section 5.2.3). Evaluate whether or not the P-Hab station microhabitat is representative of the macrohabitat; if not, record an estimate of the distance and direction from the station to the nearest representative macrohabitat location.
Table 5-4 describes this procedure.

5.2.3 Riparian and Littoral Macrohabitat Characteristics and Mapping

Information about riparian and littoral macrohabitat characteristics and human activities between the 10 P-Hab stations is valuable. As you proceed between p-Hab stations, complete the sketch map by identifying prominent riparian or in-lake features and the littoral macrohabitat types observed. A macrohabitat is made up of contiguous segments 5 percent of the shore length and total at least 10 percent of the lake shoreline. Table 5-3 describes the procedure and gives the codes for identifying these activities and features. Sketch this information in on the map outline on Side 1 of the Physical Habitat Sketch Map Form. Show

TABLE 5-3. RIPARIAN AND LITTORAL MACROHABITAT CHARACTERISTICS AND MAPPING

Riparian and In-Lake Codes

1. While circling the lake for the physical habitat assessment, record observations about human activities in the riparian zone and in-lake features on the lake outline on the Physical Habitat Sketch Map Form. Use the following codes to note these features near and between physical habitat stations:

WET	Wetland	**PTR**	Pasture
BCH	Beach	**LFL**	Landfill/dump
RSD	Residences	**IND**	Industry
PRK	Park	**MNG**	Mining
FST	Forest	**LGG**	Logging
ALT	Altered	**FLM**	Floating macrophytes
DCK	Dock	**SBM**	Submerged macrophytes
MNA	Marina	**EMM**	Emergent macrophyte
CRP	Cropland	**SHL**	Shoal or rocks

Littoral Fish Macrohabitat Classification

1. Upon arrival at the lake and during dissolved oxygen and temperature profile measurements, make a preliminary assessment of what the major littoral macrohabitats appear to be. Think in terms of broad-scale habitat sections and use the hierarchical classification below.

2. While circling the lake for the physical habitat assessment, sketch the extent of major littoral macrohabitats on the Physical Habitat Sketch Map Form. Use the 4-letter hierarchical codes (e.g., HCAM) below to describe habitat types.

1st level (in-lake disturbance)	**H**uman, **N**atural, or **M**ixed.
2nd level (in-lake cover)	**C**over (major fish cover), **O**pen, or **M**ixed (patchy).
3rd level (cover type)	**A**rtificial Structure (docks, boats), **F**ill (revetment, boulders, etc.), **V**egetated, **W**oody, **B**oulders, **M**ixed (a combination), or **N**one.
4th level (main substrate)	**M**ud/Muck, **S**and/gravel, **C**obble/Boulder, or **B**edrock.

3. Avoid sketching fragments. Macrohabitat segments must be ≥5 percent of shoreline and total at least 10 percent for the whole lake.

4. After completing the shoreline survey at the 10 P-Hab stations, finalize the macrohabitat classification and transfer macrohabitat classes to the map on the Fish Sampling Sites Form. Draw these classes outside the lake outline, leaving the lake area of the map clear to denote sampling site locations. Use Side 1 of the Physical Habitat Sketch Map Form as the preliminary working version (kept as part of the data) and the map on Side 2 (the clean final version of the littoral macrohabitat classification) to assign fish sampling sites.

TABLE 5-4. FISH LITTORAL MICROHABITAT CLASSIFICATION

At each physical habitat station, after completing the habitat assessment, make the following evaluations and record them on the Physical Habitat Characteristic Form, Page 2.

1. Classify the littoral habitat for that station, using the same 4-letter system given for littoral fish habitat codes on the Physical Habitat Sketch Map Form. Microhabitat assessment refers just to the area of the station. Record the information on the Littoral Fish Habitat Classification section of the Physical Habitat Characterization Form, Page 2.

2. Use this assessment to evaluate whether the station microhabitat is representative of the overall macrohabitat determined for that shoreline area.

   a. If the station microhabitat is representative (i.e., it has the same four-letter code as shown on the sketch map), then record a zero (0) in the "distance to repres. location" box.

   b. If not, look in both directions for the nearest location you judge to be representative of the macrohabitat. Estimate and record the distance (in 10s or 100s of meters as appropriate) and direction (L = left, R = right when facing shore).

3. Assess whether gill nets, trap nets, or seines are usable at that site or the nearest "representative" location. More than one type of gear may be usable. Criteria for determining possible fish collection gears for each sampling station are as follows:

   Gill nets
   a. Depth >1.5 m
   b. No ledges or steep drops to distort the net.
   c. No snags to rip the net

   Trap nets
   a. Depth ≤2.5 m at frame mouth (15 m from shore), preferably <1.5 m
   b. No ledges or steep drops to distort the net
   c. Few snags

   Seines
   a. Depth ≤ depth of net (1.2 m)
   b. Bottom smooth, snagless, wadeable.

4. Record the first initial of all appropriate methods for that location (best gear first). It is possible that conditions preclude any sampling there. In that case, record an N (None) and the reason(s) on the Physical Habitat Characterization Comment Form.

riparian and in-lake features near as well as in between the P-Hab stations on the sketch maps. As you proceed by boat along the shoreline of the lake, sketch in the location and extent of residential development, forest cover, wetlands, farmland, and other important riparian features. Also record the location and extent of other features such as lake inlets, outlets, mid-lake reefs, beaches, and aquatic weed beds (floating, emergent, and submerged) or other features such as rock walls for which there may be no code provided.

Littoral fish habitat characterization both classifies *micro*habitat at individual physical habitat stations (Section 5.2.3.2.4) and assigns *macro*habitat types to shoreline segments around the entire lake; it both documents fish habitat extent and provides information to select littoral fish sampling sites (Section 6.2). The hierarchical classification system defined on the Physical Habitat Sketch Map Form (Figure 5-6) 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.

In order to assign macrohabitat types, quickly develop (beginning before going onto the water and continuing while locating the index site) an idea of the number and kinds of major habitats on the whole lake. During the circuit around the lake to each of the physical habitat sites, classify the macrohabitat types using the four-letter codes and mark boundaries between the macrohabitat classes on the sketch map on the Physical Habitat Sketch Map Form, Side 1 (Figure 5-6). Table 5-2 summarizes the process for characterizing lake littoral macrohabitats.

This process emphasizes large-scale habitat areas that characterize broad stretches of the littoral zone and avoids fragmenting the shoreline. Ideally, subdivide the entire littoral habitat into a maximum of four or five macrohabitat types, but generally not more than the number of littoral fish sampling stations (as defined in Section 6.2.1) required for that lake size. During the initial mapping and evaluation, keep this number in mind. For the whole lake, a macrohabitat type needs to cover at least a total of 10 percent of the extent of the entire littoral habitat to be considered major macrohabitat type. Individual classification segments should not be less than 5 percent of the shoreline. For example, if a long stretch of shore (hundreds of meters) has no major human influence, is mostly open with a muddy bottom, and has the occasional 1-2 m weed patch, that area is **all** Natural-Open-None-Mud (NONM). The weed patches are too rare and small to rate them as a major macrohabitat type in that stretch. However, if the weed patches were larger or more common but still

scattered, that stretch is **all** designated Natural-Mixed-Vegetated-Mud (NMVM), rather than a series of small Natural-Open-None-Mud (NONM) and Natural-Cover-Vegetated-Mud (NCVM) areas. Some lakes will consist entirely of one littoral macrohabitat.

Finally, because places suitable for using either the beach seine or the minnow seine will be in short supply in many lakes, look for any possible seining sites while traversing the shoreline. Note these locations (and which gear will work) on the sketch map as you move around the lake.

5.3 EQUIPMENT AND SUPPLY LIST

A checklist of equipment and supplies required to conduct protocols described in this section is shown in Figure 5-11. This checklist is similar to but may be different somewhat from the checklists in Appendix B, 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.

PHYSICAL HABITAT ASSESSMENT CHECKLIST

	Number Needed Each Lake
Sonar	1
Transducer with bracket and C-clamp	1
12-V wet cell battery (charged) in battery case	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 Form	2
Physical Habitat Comments Form	3
Field notebook	1
Sampling permit	1
Quick reference handbook	1
PVC sounding rod, 3-m length, marked in 0.1 m increments	1
Inflatable viewing box	1
DO meter	1

Figure 5-11. Physical habitat assessment checklist.

SECTION 6
FISH SAMPLING

by
Thomas R. Whittier, Peter Vaux, and Roger B. Yeardley

Field teams collect fish by overnight sets of trap nets, minnow traps, and gill nets and by seining after sunset. Team members determine the proportions and locations of major habitats before fishing begins, and sample each habitat regardless of its expected productivity. Thus, fish sampling is stratified by habitat and is random within habitats. Team members identify the fish to species and examine them for external gross pathology. They measure long-lived species for length and preserve specimens of small fishes for species confirmation and museum archival. They collect five large fish for tissue contaminant analysis. The teams observe very rigorous quality assurance practices in the field. To ensure legibility and completeness in recording sample information, one individual completes field forms and labels. Another person checks the forms and labels to verify that all pertinent information is included. Figure 6-1 summarizes activities described in this section.

6.1 PHYSICAL HABITAT DESCRIPTIONS

The field team records physical habitat descriptions on the first day (before fish sampling begins) and uses these descriptions to determine locations for sampling as well as to document the presence, location, and extent of the lake habitats. For EMAP Surface Waters purposes, two primary habitat types are assessed and sampled differently: the littoral and the pelagic. The pelagic (open water) habitats (Section 5.1) are characterized by depth profiles of temperature and dissolved oxygen (DO). The littoral (shallow and near shore) habitat characterizations (Section 5.3) are made during the shoreline physical habitat assessment (Section 5.2).

6.2 SELECTING FISHING SITES

The field team assesses the presence and extent of major fish habitats before selecting sampling sites. Team members select sites using a temperature and DO profile, bathymetric data, physical habitat data, and shoreline maps of littoral habitat. The standard protocol calls for all (oxygenated) major habitats to be sampled regardless of their expected productivity (i.e., gear are not placed to maximize catch). Fish sampling sites are chosen by a stratified (by macrohabitat), random (within habitat) process. Depending on lake size, 3 to

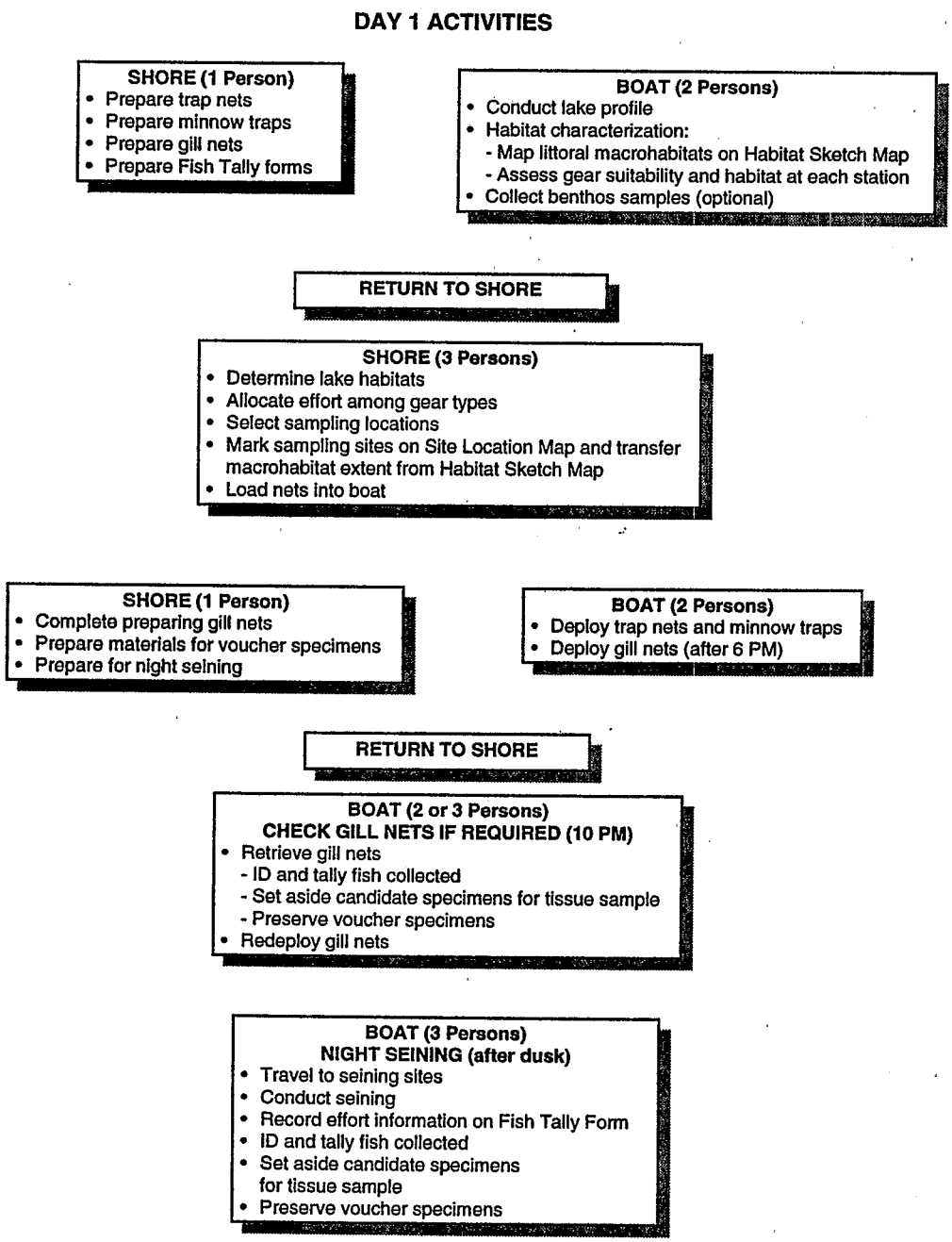


Figure 6-1. Summary of fish sampling activities (page 1 of 2)--Day 1.

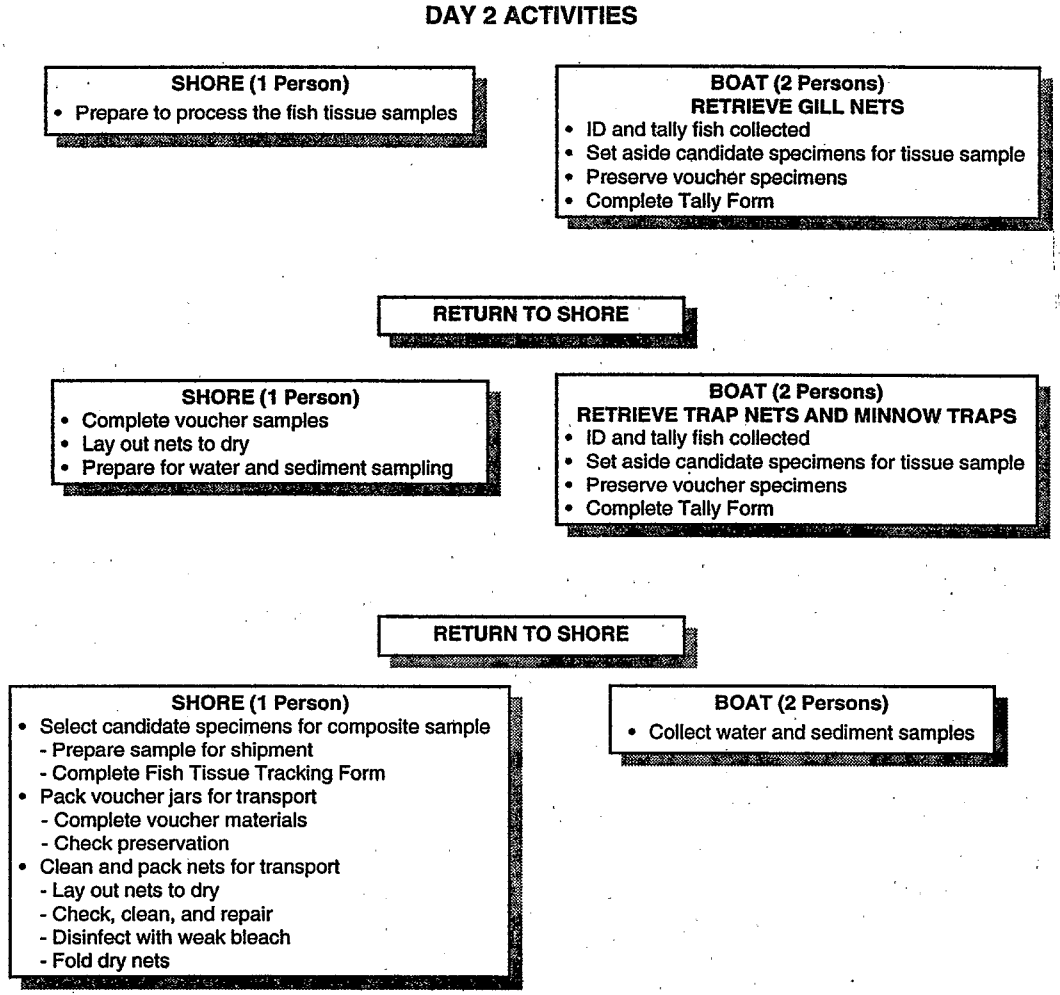


Figure 6-1 (continued). Summary of fish sampling activities (page 2 of 2)--Day 2.

26 fishing sites are selected. In addition to these standard protocol sites, the team selects one or two "best professional judgment" sampling sites.

In the pelagic (midlake) portion of the lake, the water column is stratified into as many as three macrohabitats: epilimnion, metalimnion, and hypolimnion. The presence, location, and extent of these macrohabitats are determined by the temperature and DO profile, size of the lake, and overall bathymetry. In thermally mixed lakes, the water column in the midlake portion is considered to be one macrohabitat. The midlake habitats are sampled by setting gill nets overnight.

The littoral zone is also stratified by macrohabitats (Section 5.3) and is sampled by setting trap nets and minnow traps overnight, by seining after dark, and, at larger lakes, by setting 1 or 2 gill nets. Ideally, littoral fish sampling takes place at randomly selected physical habitat stations in each macrohabitat class.

Some general guidelines for selecting the exact location within a selected sample sites are to:

- Select sample sites that are representative of their macrohabitats. If the procedures (see Sections 6.2.3 through 6.2.5) select a site that is uncharacteristic of that macrohabitat (e.g., the only weed bed in a large area of open water), move the sampling station to the closest representative location.

- Avoid areas with heavy boat traffic or recreational activity.

- Avoid areas with low dissolved oxygen levels. Fishing should not take place in water with less than 2.0 mg/L dissolved oxygen. These areas are not expected to support any fish, based on consultations with fishery biologists throughout the northeastern U.S.

If site selection procedures select a site that is directly out from a private beach or dock it is wise to inform the property owner(s) of the purpose and duration of your activity and that you have a state permit to sample that lake. EMAP is sampling in human influenced areas and needs to include these sites, especially if they make up a major portion of the shoreline.

6.2.1 Fish Sampling Effort Required

Table 6-1 summarizes the amount of fishing effort required as a function of lake size. At some lakes there may be fewer appropriate locations for one or more gear types than the

TABLE 6-1. NUMBER OF FISH SAMPLING STATIONS[a]

Standard Selection Protocol					
Lake area (ha)	Trap net (with minnow trap)	Littoral gill net (with minnow trap)	Midlake gill net	Seining	Best professional judgment units (minimum required)
1 - 4	1	-	1	1	1
5 - 14	2	-	2	2	1
15 - 29	3	-	3	2	1
30 - 49	4	0 or 1[b]	3 or 4[b]	3	2
50 - 74	5	0 or 1[b]	4 or 5[b]	3	2
75 - 149	6	1	5	4	2
150 - 249	7	1	6	4	2
250 - 599	8	2	6	5	2
600 - 999	9	2	7	5	2
1,000 +	10	2	8	6	2

[a] Lakes less than 75 ha are normally sampled in one night. Lakes 75 ha and larger are normally sampled over two nights.

[b] Depends on lake type (see Table 6-2).

number required in Table 6-1. In order to keep the sampling effort consistent across all lakes, the teams are required to set the number of nets listed. For gill nets, set all nets even if the lakes are too shallow for them to fish effectively. For trap nets, some nets may be set deeper than would be ideal. In some lakes seining may only be possible at the launch site. The only allowable exceptions to the number of sets required in Table 6-1 are in response to state permit restrictions, threats to team safety (too steep or deep to seine), or snag-filled areas which would destroy the nets.

6.2.2 Selecting Sites for Midlake Gill Nets

The site selection process for gill nets aims to sample all midlake fish macrohabitats. In thermally stratified lakes these macrohabitats are hypolimnion, metalimnion, and epilimnion. Any areas with DO less than 2.0 mg/L are not considered fish habitats and are not sampled. Conversely, some deep lakes are characterized by extensive volumes of cold oxygenated water. At these lakes, the site selection process is modified to emphasize sampling this habitat. In general for thermally stratified lakes:

- Sample the hypolimnion with bottom sets starting at the index site or deepest oxygenated location (net bottom just above the oxygen depletion depth). Disperse additional hypolimnetic sets randomly away from the first net. If oxygen depletion occurs in the metalimnion or very top of the hypolimnion, do not sample the hypolimnion.

- Sample the metalimnion with bottom sets placed along (not across) the bottom contour at the thermocline (the depth of most rapid temperature change, usually near the middle of the metalimnion). Set the net so that the weighted line at the bottom of the net (lead line) is at the thermocline (refer to Figure 5-1).

- Sample the epilimnion with midwater sets (top of net at 1.5 m) randomly dispersed away from the center of the lake, in water deeper than 3 m.

Using the example shown in Figure 5-1, the deepest net would be set on the bottom with the lead line at 9.0 m, recorded as a hypolimnion set. Using this figure but assuming other dissolved oxygen conditions, then, if the 2.0 mg/L depth had been at 8.0 m, the deepest set would be at that depth and would be recorded as a metalimnion set. The second net (see Table 6-2) would be set on the bottom with the lead line at 5.0 m. If the 2.0 mg/L depth was at 4.0 m, then the deepest set would be a bottom set at that depth and recorded as an epilimnion set.

In mixed lakes, where the change in water temperature is less than 1 °C per meter of depth, consider the midlake area as one habitat and sample by bottom sets starting at the center of the lake. In deep mixed lakes use some midwater sets.

At larger lakes set one or two gill nets at littoral stations (Table 6-1). Select these locations during the littoral station selection process (Section 6.2.3). Use the rules in Table 6-2 to select gill net sites, and mark their location on Side 2 of the Physical Habitat Sketch Map Form (Figure 6-2). Final choice of gill net sites should be such that the nets fish effectively at a depth greater than 1.5 m (if possible), are not set on ledges or steep drops that may distort the net, and are not among snags which will entangle and rip the net. The lead line should not be lower than the oxygen cutoff of 2.0 mg/L. Littoral gill nets are set parallel to shore (top of net 1.5 m deep).

6.2.3 Selecting Sites For Littoral Trap Nets and Gill Nets

To select locations for littoral trap nets and gill nets, first determine the number of trap net and littoral gill net sites for that lake (Table 6-1). Then estimate the proportion of shoreline included in each macrohabitat class by totaling estimated percentages for each segment on the sketch map (the total should be between 90 to 110 percent, otherwise recheck). Record the major habitats, their estimated total extent (percent), and the physical habitat stations in each habitat in the box on page 2 of the Physical Habitat Sketch Map Form (Figure 6-2). Also note which gear may be effectively used at each station.

For some lakes, the lake outline is divided among two or three Physical Habitat Sketch Map and Fish Sampling forms. This segmentation provides more space on the map for recording habitat and sampling information. In these cases, record the major habitats, estimates, and stations shown on the map **on only one** of these forms.

Throughout this process, the field team should consider the number of littoral sampling sites required as they determine the major macrohabitat classifications. For example, at a small lake scheduled for two trap net sites, the team should consider whether the lake can be reasonably viewed as having one or two major littoral macrohabitats, rather than automatically trying to delineate four or five. A macrohabitat must extend over at least 10 percent of the shoreline to be considered "major" and be sampled by passive gear.

There are three possible scenarios for selecting littoral sites for trap nets and gill nets (summarized in Table 6-3). The easy case is when the number of passive littoral sites required (Table 6-1) equals the number of macrohabitat classes. Choose by random methods one station in each habitat listed in the box on the Physical Habitat Sketch Map

TABLE 6-2. SELECTING GILL NET LOCATIONS

Use the following rules to select gill net sites.

Lake Mixed (Unstratified)

A. Lake shallow (<6 meters) and mixed

Set all gill nets on bottom. Set the first net at the deepest point. Set most remaining nets approximately midway between the center and randomly chosen physical habitat stations. Place every fourth net at a littoral station (use littoral site selection procedure to choose locations).

B. Lake deep (≥6 meters) and mixed

Same as A (above) except set every third net in "midwater" (top of net 1.5 m deep) in non-littoral areas.

Lake Stratified

A. Lake stratified with extensive deep oxygenated water

(Defined as a layer of oxygenated water ≥2 m thick below the metalimnion, AND the areal extent of this layer of water exceeds approximately 50 percent of the lake surface area.)

Set gill nets in the following order:

1. deep bottom (index site) or deepest oxygenated water near the center of the lake.
2. metalimnion (bottom set following the contour of the thermocline [the depth within the metalimnion where the vertical temperature gradient is greatest], toward randomly chosen physical habitat station).
3. epilimnion (midwater set--top of net 1.5 m deep, approximately halfway between the center of the lake and a different physical habitat station).
4. deep bottom (away from first net in random direction).
5. metalimnion (see A-2 above).
6. littoral zone.

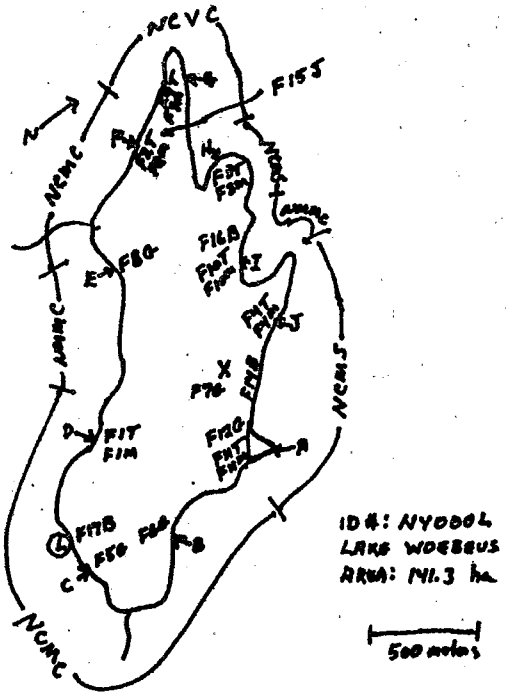
For additional sets follow in order: A-4, A-6, A-3, and A-4 above.

B. Lake stratified without deep oxygenated water

1. deepest oxygenated water on bottom near the center of the lake.
2. metalimnion (see A-2 above) or bottom set in "deep" epilimnion (if the metalimnion is anoxic). Net may be set at the same depth as B-1, but away from the first net in a randomly chosen direction.
3. epilimnion midwater set (as A-3 above).
4. littoral zone.
5. same as B-1 (away from other deep nets in a direction selected randomly).
6. same as B-2.
7. same as B-3.
8. same as B-4.
9. same as B-5.
10. same as B-2.

LAKE ID: L PHYSICAL HABITAT SKETCH MAP FORM (continued) VISIT #: 1 2

USE THIS MAP TO LOCATE LITTORAL MACROHABITAT TYPES AND FISH SAMPLING SITES



RECORD FISH SAMPLING STATIONS AND GEAR TYPE
(G = GILL NET, T = TRAP NET, M = MINNOW TRAP, B = BEACH SEINE, S = SHORT SEINE. EXAMPLE: F1G, F2T, ETC.).
IF A SITE IS SELECTED FOR ADDITIONAL STANDARD PROTOCOL OR JUDGEMENT SAMPLING, ADD AN "X" OR "J" TO THE STATION AND GEAR TYPE CODES.
EXAMPLE: F10GX, F4BJ, ETC.

MACROHABITAT CLASSIFICATION AND EXTENT SUMMARY

MACROHAB. CLASS (XXXX)	% EXTENT(s) AND TOTAL	STATIONS	COMMENTS
NCMC	30 + 10 = 40 %	B-D, F	STATIONS B and F FOR LITTORAL GILL NETS
NCMS	20 + 10 = 30 %	J-A, H	
NMMC	8 + 7 = 15 %	I, E	
NCVC	15 = 15 %	G	
	= %		
	= %		
	TOTAL = 100 %		

REVIEWED BY (INITIAL): JA

Figure 6-2. Physical Habitat Sketch Map Form, Side 2.

TABLE 6-3. SELECTING LITTORAL SAMPLING SITES

Use the following rules to select littoral sampling sites. First determine:

1. the number of passive littoral sampling stations (the number of trap nets plus the number of littoral gill nets),

2. the proportions of shoreline in each macrohabitat (rank by extent). A macrohabitat must comprise a total ≥10 percent of the shoreline to be considered major,

3. which physical habitat stations are in each major habitat.

To select specific locations for littoral sampling stations:

1. If the number of littoral sampling stations is equal to the number of major habitats, randomly choose one physical habitat station per major habitat.

2. If the number of littoral sampling stations is greater than the number of major macrohabitats, randomly choose **one** physical habitat station per major habitat, and assign the remaining sampling sites to physical habitat stations in the most extensive habitats in a manner that disperses sampling evenly around the lake.

3. If the number of littoral sampling stations is less than the number of major macrohabitats, then choose to:

   a. increase the number of littoral stations, noting this fact and the reasons on the Fish Tally Form (append an "X" to the station code),

   OR

   b. if possible, for some of the less extensive macrohabitats, allocate sampling effort to seining,

   OR

   c. re-evaluate habitat classifications and combine similar habitats until the number of stations is equal to the number of major habitats (mark the new macrohabitat classification on Side 2 of the Physical Habitat Sketch Map Form and note the changes in the comments section;

   OR

   d. randomly choose physical habitat stations in the more extensive habitats (not sampling less extensive habitats) and note reasons in comments section.

Form, Side 2 (Figure 6-2). Follow the steps in Section 6.2.6 for recording the location of each net.

The second case is when the number of passive littoral sites exceeds the number of macrohabitats. Here, assign the "extra" nets to physical habitat stations in the most extensive habitats. If one or two macrohabitats greatly predominate, assign the extra nets proportionally to them. Use a random method to choose the first net site in each habitat, then spread the additional sites as evenly as possible around the shore at physical habitat stations in the predominant macrohabitats.

When the number of macrohabitats exceeds the number of passive littoral sites, consider the following alternatives:

1. Increase the sampling effort if the major macrohabitats differ considerably and there is a high likelihood that the fish assemblages also differ. This is the preferred option (teams are encouraged to perform additional sampling at any lake). Treat the additional sets as "extra" samples (Section 6.2.5).

2. Determine if one or more of the less extensive macrohabitats could be more effectively sampled by seining and allocate the sampling effort for that macrohabitat to that method.

3. Reevaluate the macrohabitat classification and combine two (or more) similar habitats. Indicate the new (combined) macrohabitat classification on the Physical Habitat Sketch Map Form, Side 2 (Figure 6-2) and note the changes in the comments section.

4. Choose to not sample the least extensive habitat(s). Note reason in the comments section on Side 2 of the Sketch Map Form.

6.2.4 Selecting Sites for Seining

Seining (done after sunset) differs from the other fishing methods by being an active method. In addition, while very effective, seining works well only in limited habitat conditions: shallow shore areas (generally 1 m or less in depth) with relatively smooth, firm substrate. To be effective, ensure that the lead line of the seine contacts the bottom at all times during the haul. Snags, rocks, and other obstructions cause the lead line to ride up off the bottom or become stuck, permitting the fish to escape.

Another difference associated with seining is that EMAP uses two alternate gears, the beach seine (preferred) and the short seine. Use the short seine only when there are insufficient numbers of clear beach-like areas large enough to effectively use the beach seine. Because it is smaller, use the short seine in areas with modest amounts of vegetation, somewhat rocky bottoms, or between snags. However, the short seine will be less effective, covering a smaller area in each haul and allowing fish to escape more easily. Be sure that all data records clearly distinguish which type of seine you used.

The ideal beach seining sites will be at least 50 m long, with a clear shoreline such that the seine can be drawn up onto the shore. In such locations, mark out in advance (with light sticks or surveyor ribbon) two 25-m segments in which to make separate hauls. These two 25-m segments make up one site and may be discontiguous. To be considered as one site the two segments must be (1) within 5 percent of the lake shoreline length of each other and (2) within the same (contiguous) macrohabitat segment. Choices of where to seine will be very limited at most lakes. Often there will only be one or two possible seining locations, usually shorter than the ideal 50 m. Use those places regardless of which habitat they are in.

If there are no sites where beach seining is possible (or fewer sites than specified in Table 6-1), then choose additional sites for the short seine. Determining what constitutes an acceptable short seine site and a reasonable number and length of short hauls is very subjective. The target level of effort for short seine sites is four hauls (~6 m long) in each of two 25-m lengths of shoreline. A site may include one segment which is a beach seine haul ($\leq$ 25 m) and another segment which includes up to 4 short seine hauls. Section 6.5 provides instructions on how to document the use of a short seine and beach seine at the same site. Every reasonable effort should be made to do some seining.

At some lakes the only beach seining sites will be on private property. Team members should inform the owners of the purpose and duration of the sampling activities and that a state permit has been issued for that purpose.

If there are numerous possible seining locations, then distribute the required effort among the habitats if possible at randomly chosen physical habitat stations not already being fished by passive gear. In this case it may be better to choose beach seining sites first and then allocate passive sampling sites. Use the seine at least 100 m away from the nearest passive gear. These procedures for selecting seining sites are summarized in Table 6-4.

TABLE 6-4. SELECTING SEINING SITES

During the shoreline survey, note any shallow shore areas with relatively smooth, firm substrate, fairly free of snags, rocks, and other obstructions.

In the following order:

1. Give preference to sandy beaches ≥50 m long (where beach seine can be used). In such locations, mark two 25-m segments in advance with light-sticks. Segments may be discontiguous.

2. If no long beaches exist, then choose shorter beaches for beach seining.

3. If there are no sites for beach seining (or fewer sites than required), then choose (additional) sites for the short seine (areas with modest vegetation, somewhat rocky bottoms, or between snags).

4. If there are numerous possible seining locations, distribute effort among the habitats at randomly chosen physical habitat stations, at least 100 m away from any passive gear.

5. Make every reasonable effort to seine. If the only seining sites are on private property, seek permission from owners.

6.2.5 Judgment and "Extra" Sampling

There are two kinds of sampling in addition to the standard selection protocols (Table 6-1). First, at all lakes the teams are required to perform at least one or two units of sampling effort of Best Professional Judgment (BPJ) sampling. The members of each team should decide how they would add sampling effort to improve the overall index sample of fish--i.e., to catch additional species and to get larger numbers of species they expect will be undersampled by the standard protocol. The team may target a microhabitat location (e.g., place a trap net at a stream inlet or the only weed patch) and use one of the standard methods (trap net, gill net, or seining) or use a nonstandard method (e.g., dipnetting or daytime short seining in an area too cluttered for night seining). There are two constraints on nonstandard methods: the state permit must allow the method, and the team must use methods other than angling exclusively. Use "N" as the gear code for all nonstandard methods and record the method in the "other" space on Side 1 of the Fish Tally Form (Figure 6-3): Use the following standard terms for some of the common "nonstandard" gear: dipnet, daytime seining, deep set minnow trap. Team members may fish by angling if they purchase their own state fishing licenses. They should record their time and catch in the comments section on Side 1 of the Fish Tally Form (Figure 6-3), but the team must use some other best professional judgment sampling method in addition. Give these judgment samples site numbers in sequence with the standard selection protocol sites, and appropriate gear code and append a "J" to the site code (e.g., F15TJ).

The second kind of additional effort occurs when the standard protocol misses one or more major habitats (most likely at small lakes). If the number of nets in Table 6-1 is less than the number of macrohabitats and these habitats differ greatly, the crew should add gear under the standard protocols. For example, if the littoral zone at a 4-ha lake is 60 percent HONS and 40 percent NCVM (Table 5-3), add a second trap net and place one net in each habitat. Note the reasons in the comments section of the Fish Tally Form, Side 1 and give the second trap net a site number appended with an "X" (e.g., F2TX).

6.2.6 Recording Gear Type Placement Data

During the above site selection process described in the previous sections, mark sample sites on the map on Side 2 of the Physical Habitat Sketch Map Form (Figure 6-2). Designate each sample site by F1, F2, F3, etc., in order of selection. Add a single letter to denote gear type (e.g., F1T, F1M, F2G). Always place minnow traps with trap nets and littoral gill nets, and assign both sets of gear the same site number (e.g., F1T and F1M indicate trap net and minnow trap at Fish Site 1).

FISH TALLY FORM-LAKES

Page 1 of 1

LAKE NAME: L. Wobegus — VISIT #: 1 2

LAKE ID: NY0000L — TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER:

NEAREST P-HAB STATION (A - J, X): E — DIST. & DIR. FROM STATION: 0 — SITE ID: F8G

SAMPLING EFFORT INFORMATION

START CREW INITIALS: BB, KK, MD	END CREW INITIALS: KK, BB, MD
START DATE: 07/04/94	END DATE: 07/05/94
START TIME: 18:00	END TIME: 11:00

LITTORAL HABITAT CLASSIFICATION

MACROHAB. CLASS (FROM SKETCH MAP FORM): NMMC — MICROHAB. CLASS (FOR FISHING SITE): NMMC

PELAGIC HABITAT CLASSIFICATION (circle one)

ISOTHERMAL — EPILIMNION — METALIMNION — HYPOLIMNION

SAMPLING GEAR INFORMATION (circle one)

(GILL NET)	TRAP NET	MINNOW TRAP	BEACH SEINE	SHORT SEINE	OTHER (SPECIFY):
TYPE OF GILL NET SET (CIRCLE):			TOTAL AREA SEINED: _____ M^2		
(LITTORAL) MIDWATER/SURFACE BOTTOM			TOTAL NUMBER OF SEINE HAULS = _____		

FISHING DEPTHS: MINIMUM: 3.0 M MAXIMUM: 4.1 M

COMMENTS:

JAR ID (Barcode): 999111 TAG ID: 03 CHECK HERE IF NO FISH WERE COLLECTED: _____

Common Name: PUMPKINSEED			SPECIES CODE: LEPOGI			FLAG:		
Adult //			Juvenile //			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:
2	0	2	2	2	2			

Common Name: FALLFISH			SPECIES CODE: SEMOCO			FLAG:		
Adult ////// //			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:
12	5	12						

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Rev. 3/95 FLDFRMS.95 — Fish Tally Form - Lakes - 1

Figure 6-3. Fish Tally Form--Lakes, Side 1.

For each gear type (e.g., gill net, trap net) fill out as much of the Fish Tally Form--Lakes, Side 1 (Figure 6-3), as possible before setting the gear (one form per gear type). Record the lake name, lake ID, nearest physical habitat station start date, microhabitat class and gear type for all gear including gill nets. For gill nets set at the index site, record an "X." After the gear is set, (1) confirm that the mapped sample location is correct and matches the information on the Fish Tally Form and (2) fill out the remaining first day information--team ID, distance and direction from physical habitat station, personnel setting gear, start time, fishing depths (lead line depths of gill nets, leader and frame opening depth of trap nets)--on Fish Tally Form (Figure 6-3). Also record the *micro*habitat for the actual fish sampling location, using the same four-letter coding system. For the majority of fishing sites, this is the same as the *macro*habitat for that shoreline segment. Seining sites are the most likely areas where these two habitat classes differ.

6.3 PREDEPLOYMENT PREPARATION OF FISHING GEAR

While two team members in the boat collect bathymetry, physical habitat, temperature, and dissolved oxygen data, the third team member remains on shore to prepare the trap nets and minnow traps (Table 6-5). This person can also begin to prepare the gill nets (Table 6-6), although this task cannot be completed until the gill net sites are selected and depths are known. A working midwater gill net is shown in Figure 6-4.

6.4 DEPLOYMENT METHODS

On the first day at a lake, following site selection and gear preparation, the team deploys the passive fishing gear (trap nets, minnow traps, and gill nets) and then seines after sunset. To set any gear, the two-person team travels to the locations marked on page 2 of the Physical Habitat Sketch Map Form (Figure 6-2). Determine the exact placement of gill and trap nets following the procedures in Tables 6-2 and 6-3 and in sections 6.2.2 and 6.2.3. If there are no physical constraints (e.g., steep bottom combined with a narrow littoral zone, dense weeds, snags), assign trap nets and littoral gill nets to the selected physical habitat stations at random. Selected sampling stations with steep-sloped bottoms or narrow shallow areas are good candidates for littoral gill nets (set parallel to the shore). Stations with snags and woody debris would preferentially get trap nets. Littoral gill nets can be set in weedy areas, if care is used. Each minnow trap is set 0.5 to 1 m deep, within 50 m of the sampling site trap net or littoral gill net, and is considered to be within the same site (e.g., if the trap net is F4T, then the associated minnow trap is F4M).

Ideally, sites for passive littoral gear were selected (Section 6.2.3) directly at the randomly chosen physical habitat stations. It is important that the sampling results represent

TABLE 6-5. ONSHORE PREPARATION OF TRAP NETS AND MINNOW TRAPS

Determine the minimum number of trap nets and minnow traps for that size lake.

Trap Nets

1. For each trap net:

   a. Set out 4 anchors, each with a 0.5-m line and quick-clip. Place the anchors in a tub.

   b. Set out one float with a 4-m line, quick-clip and two floats, each with a 1.5-m line and quick-clip. Place all the floats in a tub.

   c. Tie the cod end and lay the net on the ground, cod end down.

   d. Pull the leader and each wing out and untangle them. Fold the left wing, then the right wing, neatly on top of their sides of the net. Fold the leader neatly on top of the middle of the net.

2. Load the nets onto the bow with the cod end down, the frame bottom forward, and the floats aft. Load the tubs.

Minnow Traps

1. Place a rock in one half of each minnow trap and clip the two halves closed. (In some regions a trap may be baited with dry dog food.)

2. Clip a 1.5-m line, with a float, to each trap.

TABLE 6-6. ONSHORE PREPARATION OF GILL NETS

Determine the minimum number of gill nets required for the lake. Get out that many net tubs.

After site selection--bottom sets (Refer to the diagram of types of gill net sets.)

For each net:

1. Set out two anchors, each with a 0.5-m line and quick-clip, and three floats, each with a 1.5-m line and quick-clip. Place them in a tub.

2. Determine the set depth (A in the diagram). Subtract 3 m. This will be the distance between the top of the 1.5-m net and the bottom of the 1.5-m float lines. Set out three lines of the appropriate length for this distance. Add 25 percent of the total length of the float line to account for net drift, etc. Each line should have quick-clips on both ends. Place the lines in a tub.

After site selection--midwater (epilimnetic) sets (Refer to the diagram of types of gill net sets.)

For each net:

1. Set out:

   a. two anchors, each with 0.5-m line and quick-clip,
   b. six single-ball floats, each with 1.5-m line and quick-clip, and
   c. two double-ball floats, each with 1.5-m line and quick-clips. Place these in the tub.

2. Determine the water depth at the sampling site. Subtract 3 m. This distance ("D" in the diagram) will be the distance between the bottom of the net and the lake bottom. Multiply D by 1.5 to determine the anchor-line length ("E" in the diagram). Set out two lines, each of the appropriate length for this distance. Each line should have quick-clips on both ends. Place the lines in the tub.

3. Set out a float with a line (with length = to site depth plus slack of 25 percent: "F" in the diagram) and quick clip. This is the "stretch" line. Set it in the tub.

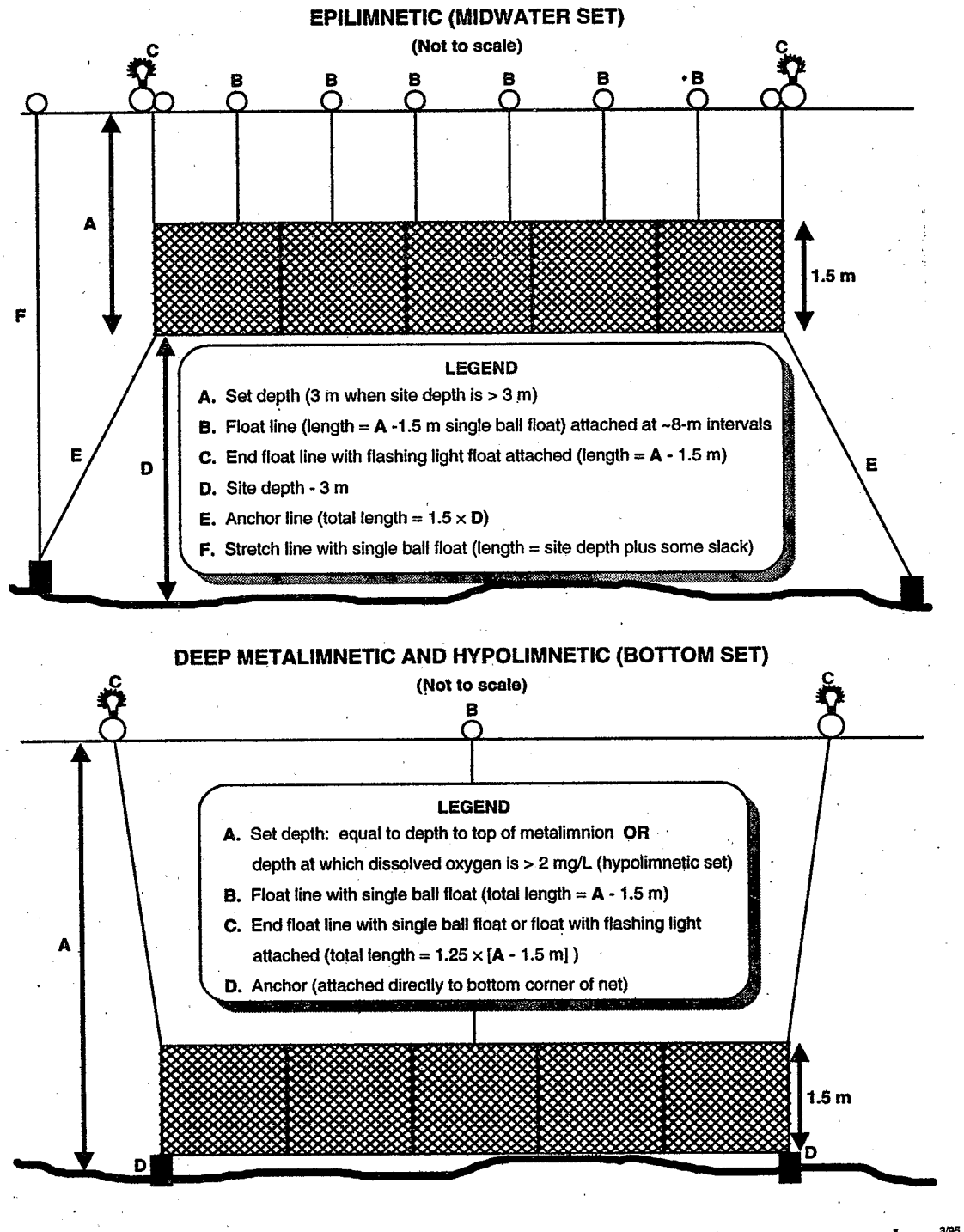

Figure 6-4. Types of gill net sets.

the fish assemblage in that macrohabitat. If the chosen physical habitat station appears nonrepresentative of the macrohabitat class (e.g., the station happens to be vegetated in a long stretch of open habitat), then deploy the gear in the nearest representative area (but not more than 5 percent of the shore length away from the physical habitat station). Record the reason for the move, and the distance and direction from the station on the Fish Tally Form (Figure 6-3) in the comments space on Side 1. If the macrohabitat class includes one of the "Mixed" categories, then try to place the gear in a truly mixed area.

The team also has some leeway regarding the exact placement of sampling units to improve the effective operation of the gear. This does not include simply moving to a location expected to produce a larger catch ("hot spots" may be sampled as part of the BPJ sampling described in Section 6.2.5). For example, trap nets fish most effectively when the top of the leader and trap mouth are not submerged and the frame sits squarely on the bottom. If conditions at the physical habitat station preclude this, the crew may choose to move the net to the closest suitable location. If the net is not set directly at the physical habitat station, then record the reason, distance, and direction on page 1 of the Fish Tally Form (Figure 6-3).

6.4.1 Gill Nets

At some lakes there may be restrictions required by state permits on the length of time gill nets may be left fishing. If such restrictions occur, use the following deployment and retrieval procedures at **all lakes** sampled in that region (for a particular survey) to provide comparable data. Deploy (set) all gill nets in the early evening (2 to 3 hours before sunset) and pull at least two nets that night after a 4-hour interval (or the interval prescribed by the restriction if less than 4 hours) . Process fish in the standard manner (Section 6.6). Append an "A" to the station ID to denote this first set (e.g., F4GA). At lakes with gill net restrictions, pull all nets and do not reset any. At all other lakes start a new Fish Tally Form and reset the nets in the same location. Append a "B" to the station ID to denote this second set (e.g., F4GA and F4GB are the first and second gill net sets at station 4). Pay attention to the timing of dinner and night seining to meet this schedule. Generally, do seining after the gill nets are pulled.

Table 6-7 provides instructions for setting pelagic epilimnetic gill nets. Table 6-8 provides instructions for setting bottom gill nets in the hypolimnion, at the top of the metalimnion. For littoral gill nets follow the instructions in Table 6-8 (bottom set) except as follows:

- The net should be entirely in the littoral zone (bottom depth approximately 3 m) parallel to shore. Center the net across from the physical habitat station flag.

TABLE 6-7. SETTING EACH EPILIMNETIC GILL NET

1. Examine the Physical Habitat Sketch Map Form and go to the appropriate pelagic gill net location.
2. While the boat is stationary, clip an anchor line (length determined in advance) to the lead line. Next, clip a 1.5-m line with a double-ball float to the float line.
3. Drop the anchor into the water, then the float.
4. Put the engine in reverse and slowly pay out the net. Keep it clear of cleats, rivets, or other snags. Also ensure that the float line remains above the lead line.
5. From the tub, take six floats, each with a 1.5-m line and quick-clip. As the net plays out, clip each float to the net, at approximately 8-m intervals.
6. When reaching the opposite end of the net, clip a 1.5-m line with a double-ball float to the float line. Clip the second anchor line to the lead line and a stretch line (length = site depth + slack) with float directly to the anchor.
7. Drop the anchor overboard, but retain the stretch line float.
8. Use the stretch line to pull the net taut, then drop the float overboard.
9. Ensure the net is "fishing" (hanging smoothly from the float line, with no tangles or twists) either visually or with sonar.
10. Fill in the appropriate information on the Fish Tally Form for that location.

TABLE 6-8. SETTING EACH BOTTOM GILL NET--HYPOLIMNION AND METALIMNION

Pelagic Gill Nets

1. Examine the Habitat Sketch Map Form and go to the appropriate location. Use the sonar to locate an area with a relatively flat and snag-free bottom of the appropriate depth (determined earlier).*

2. While the boat is stationary, clip an anchor directly to the lead line and a marker float to the float line.

3. Drop the anchor into the water, then the float.

4. Put the engine in reverse and slowly pay out the net. Keep it clear of cleats, rivets, or other snags. Also ensure that the float line remains above the lead line. Approximately midway clip a float to the float line.

5. When reaching the opposite end of the net, clip an anchor directly to the lead line and a float to its float line.

6. Drop the anchor overboard, but keep the stretch line float on board.

7. Pull the net taut, then drop the float overboard.

8. Cruise slowly between the three floats, using the sonar to check that the actual net depths are as intended and that the net is not over any sharp drops or ledges.

9. Fill in the appropriate information on the Fish Tally Form for that location.

* For littoral gill nets, follow the above instructions, with the following exceptions:
   a. Place the net entirely in the littoral zone (bottom depth approximately 3 m) parallel to shore. Center the net across from the physical habitat station flag.
   b. If the lake is extremely shallow and you are sure there will be no other boat traffic on the lake, you may place the top of the gill net (float line) at a depth less than the recommended 1.5 m.

- If the lake is extremely shallow and the crew is very sure there will be no other boat traffic on the lake, the top of the gill net (float line) may be at a depth less than the recommended 1.5 m.

6.4.2 Trap Nets and Minnow Traps

Table 6-9 provides instructions for setting trap nets. Place a weighted minnow trap within 50 m of each trap net at a depth of 0.5 to 1.0 m, in cover, if it exists.

6.4.3 Fish Tally Form and Instructions

After finishing each set, fill in the following information on the Fish Tally Form:

- Distance (estimated as tens or hundreds of meters, as appropriate) and direction (L = left, R = right, facing shore) from physical habitat station;
- Start time--use 24-hour clock time;
- Macrohabitat class (for that shore segment) and microhabitat class (for that sample site);
- Fishing depths--for trap nets, "Minimum" is the depth of the shore end of the leader and "maximum" is the depth at the frame mouth: For gill nets minimum and maximum refer to lead line depths;
- Comments--related to set or location, etc.

6.5 RETRIEVAL METHODS

Retrieving fishing gear is the first task of the second day at the lake. Team members retrieve one piece of gear at a time, starting with the gill nets, and process the fish in that gear before proceeding to the next gear site. They retrieve gill nets according to procedures in Table 6-10 and trap nets and minnow traps according to Table 6-11. They retrieve minnow traps while retrieving adjacent gear, but keep fish in separate buckets and use separate Fish Tally Forms (Figure 6-3). Before processing the collected fish the crew should complete the retrieval information in the upper half of Side 1 of the Fish Tally Form (date, time, crew initials, any comments). Details on processing the fish are in Section 6.6. If no fish are collected, the appropriate box on Side 1 of the Fish Tally Form (Figure 6-3) should be checked.

TABLE 6-9. SETTING EACH TRAP NET

1. Examine the Physical Habitat Sketch Map Form, and go to the flag for the designated physical habitat site. Find a suitable trap net location as near as possible to the flag* with:

   a. a smooth, firm bottom with gentle slope,
   b. few snags, and
   c. a depth ≤2.5 m at 15 m from shore (frame mouth location).

2. Pilot the boat to shore. Fasten the leader on shore or anchor.

3. Reverse, paying out the leader, until the frame is reached.

4. Put the motor in neutral, attach a float to both wings, and throw wings and floats into lake.

5. Reverse and pay out frame.

6. Attach an anchor and float with 4-m line tied to the cod end.

7. Continue to reverse away from shore, pulling on the cod end to pull the frame erect. Drop the cod end with anchor and marker float. Ensure that stretching the trap does not pull the leader away from the shore.

8. For each wing, retrieve the float and attach an anchor to the bottom of the net. Move each wing to a 45° angle with the leader.

9. Complete the appropriate information on the Fish Tally Form.

* If the microhabitat at the physical habitat station does not represent the macrohabitat for that shoreline segment -OR- the net cannot be set to fish effectively, move to the nearest appropriate location and record the distance, direction, and reason for the move on the Fish Tally Form.

TABLE 6-10. RETRIEVING EACH GILL NET

Gill Net

1. Approach the downwind end of the net. From the bow, grab the marker float and pull up the anchor.
2. Pull the net into the boat, over the bow, and into its tub. Use reverse, if necessary, to keep the boat from drifting into the net. Avoid cutting the net on metal edges on the bow.
3. While pulling the net into the boat, pull fish out and place them into live wells. It may be useful to process large fish as they are pulled from the net.
4. Detach floats and the other anchor.
5. Record the retrieval time, date, and crew initials on the appropriate Fish Tally Form.
6. Process the fish from the live wells.

Minnow Trap (littoral gill nets only)

1. Pull the minnow trap before leaving that station.
2. Either process the fish directly out of the trap or place the fish in a live well (separate from the one used for the gill net) and process later.
3. Record the appropriate data on the Fish Tally Form.

TABLE 6-11. RETRIEVING EACH TRAP NET AND MINNOW TRAP

Trap Net

1. Remove the anchor from each wing.
2. Go to shore. Unfasten the leader from shore.
3. Put the engine in neutral. Pull the leader, frame, then cod end into the boat, shaking the fish down into the cod end. Detach the anchor and float from the cod end.
4. Untie the cod end and empty the contents of the net into live wells. Recheck frame box and other net parts for remaining fish.
5. Pull the wings aboard, detach the floats.
6. Record the retrieval time, date, and crew initials on the correct Fish Tally Form.
7. Process the fish from the live wells.

Minnow Trap

1. Pull the minnow trap before leaving that station.
2. Either process the fish directly out of the trap or place the fish in a live well (separate from the one used for the trap net) and process later.
3. Record the appropriate data on the Fish Tally Form.

6.5.1 Gill Nets

If there are gill net restrictions, pull at least two gill nets at all lakes 4 hours (or less depending upon the restrictions) after the initial set and process the fish. If there are no gill net restrictions for that lake, start a new Fish Tally Form (Figure 6-3) and reset the net in the same location. Use the same site ID for both sets; append an "A" to the first set ID and a "B" to the second. On the morning of the second day, pull gill nets first. At the littoral sites also retrieve the minnow traps. Continue in this fashion for each reset. Table 6-10 provides instructions for retrieving gill nets.

6.5.2 Trap Nets and Minnow Traps

Table 6-11 provides instructions for retrieving trap nets and minnow traps. The trap net retrieval procedures in Table 6-11 may differ from the methods taught in some fisheries courses. Trap nets are retrieved starting with the leader, which acts to chase fish into the net, reducing the chances of losing fish during retrieval. Other procedures for emptying trap nets are more appropriate when nets are set out for extended periods. The reasons for this difference are discussed during training. To ensure consistency, all teams must use the methods described in this manual.

6.5.3 Seines

For the standard protocols, seine after dark at sites marked in advance with light sticks or flagging. See Section 6.2.4 for site selection details for the seining effort. After sunset, proceed to each seining site, which may consist of one or two segments (each one up to 25 m long). At each segment where the beach seine is used, perform one haul. At each segment where the short seine is used, perform up to four passes. Thus each seining site may include up to two beach seine hauls or up to eight short seine passes. Table 6-12 provides instructions for night seining with the beach seine. Table 6-13 provides instructions for night seining with the short seine. After seining, note all pertinent information on the Fish Tally Form (Figure 6-3). Pool fish collected in separate short seine passes at a single site in a live well and record on one Fish Tally Form: Use the same procedure for fish collected in separate beach seine hauls at a site. However, use separate Fish Tally Forms and gear codes (B = beach seine, S= short seine) to record the use of a beach seine and short seine at the same site; use the same site number on each of the separate Fish Tally Forms for the same site.

Before fish processing begins, record the number of hauls and calculate the area seined (sum the products of the working length of the net used times the length of the haul). It is useful, especially for short seining, for three team members to do the seining: two to

TABLE 6-12. NIGHT SEINING WITH THE BEACH SEINE

1. Examine the Physical Habitat Sketch Map Form and go to an appropriate location, where up to two segments are marked off with light sticks or surveyor ribbon.

2. After sunset, two people hold opposite ends of the seine and proceed with one haul per designated segment as described in steps 3 through 7.

3. Stretch the net out perpendicular to shore. Hold the shoreward stake where the water meets the beach. The seine may be shortened somewhat by rolling it onto the stakes if the bottom drops off too quickly or some other factor prevents the full length from being safely used.

4. Haul the seine parallel to shore for up to 25 m of shoreline or until available space is used.

   a. The offshore stake should be hauled with the bottom of the stake preceding the top.
   b. Keep the lead line in contact with the lake bottom.
   c. Move as rapidly as possible, keeping the seine moderately taut and, if possible, preventing the float line from submerging.

5. About 2/3 of the way through the shoreline distance, the offshore person begins to rotate toward shore, aiming for the segment end marker. Meanwhile the shoreward person slows, such that both people meet (about 3 m apart) on shore at the end of the segment.

6. Pull both ends of the net into shore.

   a. Keep the lead line in contact with the bottom.
   b. Don't pull too fast; fish will jump over the float line.
   c. The lead line should be slightly forward of the float line.

7. Pull the "pocket" of the net onto shore.

   a. Keep the floats high.
   b. Keep the lead line taut and on the bottom until the net is out of the water.
   c. Shake fish stranded in the wings toward the center of the net.

After fish are landed (each haul)

8. Remove all fish from the net and place them into live wells.

9. Calculate the area seined by multiplying the working length of the net by the estimated distance seined. Sum the total for that gear at the station and record this and other sampling information on the Fish Tally Form.

10. Process all fish caught.

TABLE 6-13. NIGHT SEINING WITH THE SHORT SEINE

1. Examine the Physical Habitat Sketch Map Form and go to an appropriate location where you marked off up to two segments with light sticks or surveyor ribbon.

2. After sunset, two people hold opposite ends of the seine and proceed with up to 4 passes per designated segment as follows:

3. Stretch the net out. If needed the seine may be shortened by rolling part of it onto the stakes.

4. Moving rapidly, haul the seine, for a few meters in any direction (this depends on the site conditions, but toward shore if possible).

   a. Keep the lead line in contact with the bottom, without submerging the float line.
   b. The bottom of the stake should precede the top.

5. After the desired area has been traversed, while still moving, quickly pull both ends of the lead line forward and out of the water, keeping the float line up out of the water. Keep a pocket in the middle for holding fish while moving to shore.

After fish are landed (each set of 4 passes)

6. Remove all fish from the net and place them into live wells.

7. Calculate the area seined by multiplying the working length of the net by the estimated distance seined. Sum the total for that gear at the station and record this and other sampling information on the Fish Tally Form.

8. Process all fish caught.

operate the net and one to record the number of hauls, estimate the length of each haul, bring the live well to the seiners, and keep tally records.

6.6 PROCESSING FISH

At each fish sampling site, fish processing involves the following general tasks:

- identify individual fish to species, place in a general age class, and examine for external anomalies;
- measure up to 20 fish of each long-lived species;
- set aside specimens for possible use as tissue contaminants samples;
- preserve example specimens of each species as museum vouchers; and
- record comments related to the fish on the Fish Tally Form.

The general chronology for these tasks is summarized in Table 6-14. This procedure assumes the net has been pulled, all header data in the Fish Tally Form are entered, and all fish have been removed from the net.

Most of the fish processing tasks are completed at each station before moving on to the next. Depending on lake size, weather conditions, and numbers of fish collected, the process may be done either in the boat or at the landing. To avoid problems in keeping track of multiple stations and to reduce fish mortality, pull nets from only two stations before returning to the launch site (except if nets come up empty). Processing of portions of the tissue contaminants specimen is done once per lake, at the landing.

6.6.1 Species Identification and Tally

Remove all fish from the net or trap and place in a fresh bucket of lake water before processing begins. Work carefully, but quickly to reduce stress to the fish. Release live fish not needed for tissue analysis (Section 6.6.4) or museum vouchers (Section 6.6.5) to the lake. Avoid holding fish longer than needed. The following procedures will expedite the work. Modify these to fit your work style.

TABLE 6-14. GENERAL FISH PROCESSING CHRONOLOGY

1. Make a preliminary examination of the fish in the live well and develop a preliminary species list on the Fish Tally Form.

2. For each fish:

   a. Identify to species.
   b. Place in general age group and tally.
   c. Examine for external anomalies.

3. For each species

   a. Measure total lengths of approximately 20 individuals of long-lived species.
   b. Set aside (after tallying) any candidates for tissue contaminants sample.
   c. Preserve museum voucher specimens.

4. After all sites have been completed, process fish for tissue contaminants sample.

5. Record any comments related to identification, anomalies, and tallying on Side 2 of the Fish Tally Form.

- As you remove fish from the net or trap and place them in the bucket of water, make mental notes as to the species present. After all fish are out of the net take a few minutes to examine some of them to determine approximate numbers and sizes of most of the species caught. It may be useful to sort the fish by species into additional buckets before further processing.

- Assign one person to handle the fish, while the other records data. The fish handler will probably want to keep the measuring board on his or her lap as a work surface. The recorder uses at least two forms at the same time--the Fish Tally Form and a form to record fish lengths (Section 6.3.3).

- Try to process all (or most) of each species before going on to the next. This should help avoid extra paper shuffling. Also, consider processing all individuals (of a species) within an "age group" together.

- Examine each fish individually. However, you may handle small fish in small manageable groups to speed processing.

- If a net has caught many large fish, you may process them directly from the net while it is being pulled.

- Use the space on the Fish Tally Form (Figure 6-3) for Adult, Juvenile, and YOY (young-of-year) to record partial counts (e.g., hash marks, small group counts) before recording the total count for that age group for that species. Also use this space to keep track of the number of individuals retained as museum vouchers.

- Before leaving each station, double check the forms to ensure that all data have been recorded.

Occasionally, a species will be "observed" but not collected, for example, common carp observed in shallows or "hanging around" docks where they are fed. Include noncrew angler catches (confirmed by a crew member) or dead fish seen. Record these observations on separate Fish Tally forms, giving them a station code appended with a "J." Include other species information from local contacts on the Lake Assessment Form (Section 9), not on a Fish Tally Form. The following subsections describe specific procedures that apply for each kind of data recorded.

6.6.1.1 Species Identification--

- Record on the Fish Tally Form (Figure 6-3) both the common name and the species code (first 4 letters of the genus and first 2 letters of the species).

Species codes are listed in the regional activities plan. If more than five species are collected, use the Fish Tally Continuation Form (Figure 6-5).

- Be alert for possible surprises, such as hybrids and recently introduced species. This also applies to difficult taxonomic groups and very small fishes. When in doubt, record these with the species code of UNKNnn where the nn is filled in starting with 01 at each lake (i.e., first UNKN01, followed by UNKN02). Write your best guess to the lowest taxonomic level that you are comfortable with in the common name space. Always retain as museum vouchers a large number (or all) of any UNKNnn.

6.6.1.2 Age Groups--

- Tally count each species by general age group--adult, juvenile, young-of-year. This is a judgment, based on size, color, and overall appearance. It is **not** critical to be absolutely correct in this decision. The purpose is to have at least qualitative evidence as to whether a species is reproducing and maturing at a lake.

- Measure species expected to regularly exceed 100 mm as adults (Section 6.6.3). Do **not** spend time referring back to previous data to determine where earlier age group cutoff lengths were made.

Table 6-15 summarizes the procedures for tallying, examining, and measuring fish.

6.6.1.3 Nonfish Species--

- Nonfish species will be captured occasionally. Count these and record the common name to the lowest taxonomic level with which you are comfortable on the Fish Tally Form (Figure 6-3). For "Species Code" use "OTHERn" where "n" is replaced by a number 1 through 9 (e.g., OTHER1 for first nonfish species at that lake, OTHER2 for the second). This numbering scheme should be consistent within the data for each lake but not necessarily among lakes.

- Retain examples of amphibians, leeches, mollusks, and crayfish as museum vouchers (Section 6.6.5). Other animals may be photographically documented.

- Record the mortality rate for nonfish vertebrates in the Comments section of the Fish Tally Form, Side 2 (Figure 6-6).

- In the field notebook, keep notes on other animals observed but not captured. At the end of the lake visit, transfer this list to the Lake Assessment Form (Section 9.1).

FISH TALLY CONTINUATION FORM-LAKES	Page 3 of 3
LAKE ID: N Y 0 0 0 L SITE ID: F3G	VISIT #: (1) 2

JAR ID (Barcode): 123456   TAG ID: 02

Common Name: WHITE SUCKER			SPECIES CODE: CATOCO			FLAG:		
Adult //			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:
2	0	2						

Common Name:			SPECIES CODE:			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:			SPECIES CODE:			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:			SPECIES CODE:			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:			SPECIES CODE:			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:			SPECIES CODE:			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

CHECK HERE IF INFORMATION IS RECORDED ON OTHER SIDE OF FORM: ____

REVIEWED BY (INITIAL): [illegible]

Rev. 3/95 FLDFRMS.95   Fish Tally Continuation Form - 1

Figure 6-5. Fish Tally Continuation Form--Lakes, Side 1.

TABLE 6-15. TALLYING, EXAMINING, AND MEASURING FISH

1. Identify each individual to species (if possible) and estimate its age group (adult, juvenile, or young-of-year).[a] Place a hash mark in the appropriate box of the Fish Tally Form. Record its common name **and** species code.[b]

2. Examine each fish for external anomalies. If anomalies are present, record the species code and anomaly code(s), and place a hash mark under "# of Fish" on Side 2 of the Fish Tally Form.

3. If more than five species are collected, use the Fish Tally Continuation Form as necessary.

4. On the Fish Length Form, record total lengths (i.e., with mouth closed and caudal fin compressed) for 20 individuals of long-lived species.[c] If there are ≤20 individuals, measure total length for each. If there are more than 20 individuals for that species, use the following subsampling procedure:

    a. Separate outliers, i.e., exceptionally large or small individuals (generally 30 percent larger or smaller than the rest of specimens). Measure their total lengths separately. Record their lengths on the Fish Length Form, noting that they are outliers.

    b. If the remaining fish (nonoutliers) are fewer than 20, measure all individuals. Otherwise, measure a random subsample. If there is a wide range of sizes with no obvious outliers, measure individuals from the entire size range, even if more than 20 specimens are measured.

5. Save museum voucher specimens.

6. Save candidate specimens for possible use as fish tissue contaminant samples.

---

[a] Age group classification is a judgment based on size, color, and overall appearance.

[b] When in doubt, record species as UNKNnn (nn is a number from 01 to 99 for each lake where 01 is the first unknown species). Codes for most species are the first four letters of the genus and the first two letters of the species.

[c] Place a "U" in the flag box if the measurement is suspect and explain in the comments column. Additional individuals of the same species may be denoted with an arrow (do not use ditto marks).

LAKE ID: NY000L FISH TALLY FORM (continued) SITE ID: F UTJ VISIT #: (1) 2

Common Name: WHITE PERCH			Species Code:			Flag:		
Adult					Juvenile			YOY	
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:
6	0	6						

Common Name:			Species Code:			Flag:		
Adult					Juvenile			YOY	
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

Common Name:			Species Code:			Flag:		
Adult					Juvenile			YOY	
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

IF > 5 SPECIES ARE COLLECTED, CHECK HERE AND USE A TALLY CONTINUATION FORM ____

IS THERE EVIDENCE OF STOCKING (circle)? YES (NO)

Species Code	Anomaly/ Stocking Code	# of Fish	Flag	Species Code	Anomaly/ Stocking Code	# of Fish	Flag
MOROAM	X	2					

ANOMALY/STOCKING CODES: D = Deformities; E = Eroded fins; L = Lesions or ulcers; T = Tumors; F= Fungus; X = Multiple D,E,L,T anomalies; B = Blind in one or both eyes; K = Emaciated; M = Excessive mucus; P = Heavy infestation of external parasites; Z = Other (explain in comments); S = Stocking.

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 comments section. Attach separate comments sheet if necessary.

Reviewed by (initial): JA

Rev. 3/95 FLDFRMS.95 Fish Tally Form - Lakes - 2

Figure 6-6. Fish Tally Form--Lakes, Side 2.

6.6.1.4 Evidence of Stocking--

If there is evidence that the fish collected were stocked (e.g., fin clips, characteristic fin erosion, tags), mark the appropriate space on Side 2 of the Fish Tally Form (Figure 6-6), record the species and number collected, and use an "S" code to describe this evidence in the Anomalies section. Circle "Yes" only if evidence is present for fish caught in that gear.

6.6.1.5 Species of Concern--

Rare, threatened, or endangered fish species are generally not a concern in lakes. However, there will be species of concern for most individual states. These species are listed in the regional activities plan. All states know in advance which lakes the EMAP Surface Waters field teams will be sampling, and they generally know where the species of concern occur. The states provide a list of concerns prior to sampling and these will be included in lake dossiers. There may be special instructions from individual states, but the general rule is to quickly release any live species of concern. If circumstances allow (i.e., the extra handling will not harm the fish), document these species with photographs. If the fish is dead, retain it as a voucher specimen (Section 6.6.5). In either case, inform the appropriate state officials as soon as possible.

6.6.2 External Anomalies

Table 6-16 summarizes the procedures for documenting anomalies. Examine all live or freshly dead fish for easily visible external anomalies (including any within the buccal cavity and on the gills). Do not make exact counts of anomalies present (i.e., the number of tumors, lesions per fish), but record the numbers of fish affected. Record anomalies on side 2 of the Fish Tally Form (Figure 6-6) using the anomaly codes in Table 6-16. Rapidly scan each fish as it is sorted and counted, taking less than one minute per fish. Inspect all body surfaces, fins, eyes, buccal cavity, and gills. For each fish species and anomaly code, record the number of individuals affected. Fish sampling gear may cause some damage to the body surfaces and fins. Do not record these gear-related injuries.

In general examine:

- Body surfaces, fins, buccal cavity, and gills--Note any discolorations of body surfaces (e.g., darkening, hemorrhaging, cloudiness), raised scales, white spots, or parasites. Also look for lumps, growths, ulcerations, fin erosion, deformities of the vertebral column and mandibles, swelling of the anus, short operculum, missing fins, or any other abnormality.

- Eyes--Check for cloudiness, hemorrhage, exopthalmia (pop eye), and depression into the orbits.

TABLE 6-16. EXAMINING FISH FOR EXTERNAL ANOMALIES

Rapidly, but thoroughly, examine each fish tallied for the anomalies listed below.[a] Spend less than 1 minute per fish. Inspect all body surfaces, fins, eyes, buccal cavity, and gills.

Code	Anomaly
D	**Deformities**[a]--can affect the head, spinal vertebrae, fins, stomach shape, scales, operculum, or eyes. Examples include pugheadness, jaw deformities, and clubtail.
E	**Eroded fins**[a]--includes necrosis at the base of the caudal fin (peduncle disease) and erosions of the preopercle and operculum.
L	**Lesions or Ulcers**[a]--appear as open sores or exposed tissue. Prominent bloody areas on fish should also be included. Small, characteristic sores left by anchor worms and leeches should not be included, unless they are enlarged by secondary infection.
T	**Tumors**--result from proliferative cellular growth with tissue that is firm and not easily broken. Parasites may cause tumor-like masses that can be squeezed and broken, but these should not be considered as tumors.
F	**Fungus**--appears on the body or eyes as a white cottony growth and usually attacks an injured or open area of the fish. Ich, a fungus that manifests itself on the skin or fins as white spotting is rare in wild fish populations.
B	**Blind in either eye.**
S	**Emaciated.**
P	**Parasites (heavy)**--include leeches, anchor worm, spinyhead worm, and copepods. The soft tumor-like masses caused by parasites, as well as heavy black spot infestations, should also be included.
M	**Mucous (excessive).**
Z	**Other**--explain these.

Note anomalies on Side 2 of the Fish Tally Form. Use the species code and all appropriate anomaly codes from above.[b]

If possible, preserve examples of fish with anomalies or parasites as part of the museum voucher specimen collection.

[a] Fish can be damaged during capture (especially by gill nets) and handling. Do not note anomalies of this origin.

[b] Do not make exact counts of anomalies present (e.g., the number of tumors per fish).

6.6.3 Length

At each station, measure (to the nearest millimeter) individuals of each species expected to regularly exceed 100 mm as adults. Such species are listed in the regional activities plan. Make the length of these measurements at the same time as the identification, examination for anomalies, and tallying activities. During this process, the data recorder works with two forms at the same time: the Fish Tally Form and the Fish Length Form (Figure 6-7). Thus, the fish handler needs to pace the work accordingly. Record the length data on the Fish Length Form, and record all the other information on the Fish Tally Form (Figure 6-3) as described in Table 6-15. Use the following procedures for the length data:

- Measure the total length--mouth closed and caudal fin compressed to achieve maximum length. Check the flag box on the Fish Length Form and record a comment if caudal fin is eroded enough to affect total length.

- It is useful, but not essential, to measure all of one species before starting the next. Use a wavy vertical arrow (not ditto marks) to denote fish of the same species. Do not use ditto marks (since these can be read as "11") in the lengths column.

- If there are 20 or fewer individuals present (per species to be measured per station), measure all.

- If there are >20 individuals, first separate any obvious outliers (fish noticeably larger or smaller than the majority). "Obvious outliers" is a visual, subjective category; generally those individuals at least 30 percent larger or smaller than the largest or smallest representatives of the nonoutliers. These will generally be <10 percent of the total. Measure these individuals and check the "out" box for outlier. Then measure a random subsample (about 20) of the remaining specimens.

- If there is a wide range of sizes with no obvious outliers, measure individuals from the entire size spectrum (even if you end up measuring more than 20).

FISH LENGTH FORM-LAKES PAGE 2 of 14

LAKE NAME: L. WOEBEUS VISIT #: (1) 2

LAKE ID: NY000L TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER: ____

SITE ID	SPECIES CODE	COMMON NAME	TOTAL LENGTH (mm)	AGE CLASS (A, J, Y)*	OUT (✓)	FLAG	COMMENTS
F6GA	PERCFL	YELLOW PERCH	103	J			
			104				
			100				
			105				
			100				
			113				
			114				
			106	J			
			130	A			
F6GA	PERCFL	YELLOW PERCH	105	J			
F7GA	CATOCO	WHITE SUCKER	293	A			
	〃	〃	286				
1	CATOCO	WHITE SUCKER	296				
F7GA	PERCFL	YELLOW PERCH	143				
F14B	FUNDDI	BANDED KILLIFISH	76	A			
	FUNDDI	BANDED KILLIFISH	25	J			
	SEMOCO	FALLFISH	91	A			
	SEMOCO	FALLFISH	85	A			
	LUXICO	COMMON SHINER	30	J			
F14B	LUXICO	COMMON SHINER	55	J			

CHECK HERE IF ADDITIONAL DATA ARE RECORDED ON REVERSE SIDE: X

*A = ADULT; J = JUVENILE; AND Y = YOUNG OF YEAR

FLAG CODES: K = NO MEASUREMENT COLLECTED; U = SUSPECT MEASUREMENT; F1, F2, ETC. = MISC. FLAGS ASSIGNED BY FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

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Fish Length Form - Lakes - 1

Figure 6-7. Fish Length Form--Lakes.

6.6.4 Tissue Contaminants Samples

For the fish tissue contaminants sample use the best five fish of one species that has a high likelihood of being caught and eaten by predators (wildlife or human) and of containing detectable levels of toxics. Candidate species are listed in the regional activities plan. Collect this sample in a two-stage process. In the first stage select candidate individuals from among all fishes caught. Hold these candidate fish in a live net or keep them on ice until all sampling gear have been retrieved. In the second, final stage, select a five-fish composite sample from among the candidates and process for shipping. The composite sample consists of whole fish; the field teams do not fillet or gut the fish.

6.6.4.1 Selecting Candidate Fish For The Fish Tissue Sample--

Because of the number of criteria regarding a desirable fish tissue sample and the variety of fish catch scenarios, there can be no hard and fast rules or simple hierarchy of criteria governing how the composite sample will be collected. The general criteria (in order) for selecting individuals for the composite sample are:

1. five individuals of one species,
2. a species high on the food chain,
3. large fish,
4. approximately the same size,
5. collected from all areas of the lake, and
6. live or freshly dead.

If there are no top predators, insufficient numbers of them, or they are relatively small, then the selection priority becomes (in order):

1. smaller primary predators,
2. bottom feeders, or
3. any species with sufficient number to make up a sample.

This section provides guidelines for applying as many of these criteria as possible.

At each sampling station, save individuals (large, if possible) of the target species (or nontarget species if target species are absent or rare). See the regional activities plan for the target species priority list and the preferred minimum lengths of each. At first the crew should keep all target species (and sometimes nontarget) individuals. As more gear is retrieved, it will often become apparent that one or more target species are present in sufficient numbers that meet the minimum target size. Thereafter, it is not necessary to keep candidate individuals of lower priority target species. Make an effort to save candidate specimens from as many pieces of gear (stations) as possible.

Immediately following tallying, examination, and measurement, place candidate individuals in a tub filled with lake water. Upon return to shore, place them in the live net. Place candidate specimens that are dead on ice while still in the boat or immediately upon return to shore. Place the ice in plastic bags to prevent melting ice from leaching the fish tissue or contaminating the fish. When it is necessary to retrieve some nets on Day 1, retain some of the most eligible candidate specimens for possible inclusion in the samples prepared on Day 2. Place healthy specimens in the live net; place specimens that are in poor condition or dead, on ice.

To avoid potential contamination, label all containers used to prepare tissue contaminant samples and dedicate them to this activity. Rinse the containers well with lake water before each use and do not use them at other times to store chemicals or equipment.

6.6.4.2 Selecting and processing the final tissue sample--

After fish have been collected from all sites at a lake, set up a work area at the launch site to process the composite sample for shipping. Ensure that all work surfaces are clean (rinsed with lake water). Determine from among the candidates (in the live net or on ice) which species have individuals that meet as many of the selection criteria as possible. Follow the guidelines in Table 6-17 to select the final sample. As a precaution, do not return the nonselected fish to the lake until all sample processing is complete.

To determine whether or not the EMAP Surface Waters sampling gear and strategy collect candidate specimens from different areas in each lake, record the number of nets (sampling stations) from which the fish tissue candidates were collected on the Fish Tissue Sample Tracking Form (Figure 6-8). Note that the term "candidate" does not refer to just the final sample. Candidates are the entire catch (excluding individuals that are too small for consideration) of individuals of that species from which the final sample is chosen. Great precision is not required; give your best estimate. Also record the total number of sampling stations on this form. Follow the procedures in Table 6-18 for processing the sample for shipping.

TABLE 6-17. FINAL SELECTION OF FISH TISSUE SAMPLE

1. Select 3 to 5 individuals of the highest priority species available* that are at or above the preferred minimum length for that species. When possible, the individuals should be of similar size, collected from various areas of the lake, and relatively fresh.

   a. Collect 5 fish if at all possible. Collecting 5 fish is generally a higher priority than getting species higher on the target species list. For example, if 3 of the top priority species and 10 of the third priority species (all of the preferred size) are caught, use the best 5-fish sample of the third priority species.

   b. If the size discrepancy is large (but the species priority rank is the same), choose in favor of 3 or 4 large versus 5 small fish. For example, if there are 3 of species A at 400 mm total length and 5 of species B at 150 mm total length, select species A.

   c. Ideally, individuals should be as large as possible and all of the same size. The guideline is that the length of the smallest fish in the 3-to-5 fish sample be at least 75% of the largest. This size relationship can be estimated visually. This is a goal and not a requirement. Collecting high priority target species at or above the preferred minimum length is more important than meeting this similar size goal.

   d. Select live and freshly dead fish preferentially. However, fish selected do not have to be alive or to have been witnessed "meeting their maker." Using a species high on the target species list is a higher priority than freshness.

2. Decision criteria for some cases where the sample choice may not be clear:

   a. If two predator species have been collected, one species with 3 or 4 individuals (> preferred minimum size) and one species with 5 individuals (> preferred minimum size), **choose the 5-fish sample** even if this species is of lower priority, **unless the 5 fish are much smaller** than the 3 to 4 individuals of the higher ranking species (see 1a).

   b. If 1 to 4 individuals at or above the preferred minimum length of any target species are collected, add smaller individuals of the same species to bring the total to 5.

   c. If **fewer than 5 individuals** of any size of any target species are collected, use a smaller number. In this case, **also** send 5 individuals of a nontarget species or 20 to 60 small fish (minnows or other) if available (resulting in two separate samples).

   d. If neither (b) or (c) above works, use 20 to 60 (preferred number if available) small fish (minnows or other), all of one species if possible. The intent is to obtain a fish tissue sample of some kind from each lake.

3. Release remaining candidate individuals still alive. Properly and discreetly dispose of all dead fish not used.

* Target species and length criteria are presented in the regional activities plan.

FISH TISSUE SAMPLE TRACKING FORM-LAKES

LAKE NAME: L. WOEBEGUS DATE PREPARED: 7/4/94 VISIT #: (1) 2

LAKE ID: NY0001 TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER:

	SPECIES CODE	COMMON NAME	TOTAL LENGTH (MM)	WEIGHT (KG)	FLAG	SAMPLE ID (BARCODE)
1	MORONA	WHITE PERCH	204	1.8		301999
2	〃	〃	210	1.8		〃
3	〃	〃	204	1.8		〃
4	〃	〃	235	2.0		〃
5	MORONA	WHITE PERCH	231	2.1		301999
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

OF STATIONS FROM WHICH FISH TISSUE CANDIDATE SPECIMENS WERE COLLECTED: 4

TOTAL # OF STATIONS SAMPLED: 17

LINE #	FLAG	COMMENT OR FLAG EXPLANATION

CHECK HERE IF MORE DATA ARE RECORDED ON OTHER SIDE: ____

FLAG CODES: K = NO SAMPLE COLLECTED; U = SUSPECT SAMPLE; F1, F2, ETC. = MISC. FLAGS ASSIGNED BY FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

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Fish Tissue Sample Tracking Form- Lakes - 1

Figure 6-8. Fish Tissue Sample Tracking Form.

TABLE 6-18. FISH TISSUE SAMPLE PROCESSING

1. Keep work surfaces and wrapping materials clean and free of potential contaminants (e.g., mud, fuel, formalin, sunscreen, insect repellant).

2. Measure total length of individuals selected. If a scale is provided, obtain a weight for the entire sample, either by weighing all individuals at once or by summing weights obtained for individual fish.

3. Fill out the Fish Tissue Sample Tracking Form completely (including total lengths). Write the bar code number assigned for shipping on the form. **NOTE: Sealing the bags of ice with tape is especially important on Fridays and in other cases when samples may be in transit for more than one day. Use additional ice bags in these situations.**

4. Wrap each fish in aluminum foil (unless there are many small fish) with the dull side of the foil against the fish. Place all the wrapped fish in a self-sealing 1-gal plastic bag or in a 30-gal plastic bag.

5. Expel excess air and seal the bag. Wrap tape around the bag neck to seal and make a surface for attaching the sample label.

6. Complete a fish tissue sample label with bar code (make sure the bar code number is the same as the one recorded on the tracking form) and apply it to the tape surface. Cover the label completely with a layer of clear, waterproof tape.

7. Place labeled self-sealing 1-gal plastic or 30-gal plastic bags containing the sample into a second plastic bag and seal. Repeat steps 5 and 6 applying a duplicate bar code label.

8. Place ice in self-sealing plastic or 30-gal plastic bags (to keep ice and water away from the fish sample). Fold over the bag neck and seal with tape. Place bagged ice in cooler with double-bagged fish sample. Also indicate on the Fish Tissue Sample Tracking Form the number of sites from which candidate specimens were collected, and the total number of sites sampled.

9. Later, during postsampling activities at the next base site, process the tissue sample cooler for shipment. Ship fish as soon as possible after collection, using overnight air courier.

6.6.5 Museum Vouchers

As part of the QA program, and to provide historical documentation, preserve museum voucher specimens of all species. Make exceptions for large individuals of easy to identify species and document these photographically. This exception is mostly a storage consideration for both the crew and the museum. Retain larger numbers (if not all) of small or difficult to identify species, as well as possible hybrids, as vouchers. Where very large numbers of small or difficult to identify species are collected, sort all individual fishes to the lowest taxonomic level (with which you are comfortable), and count and preserve a generous random subsample (or all) of each taxa. Table 6-19 provides an overview of the numbers of fish to preserve from each sample site and at each lake. The regional activities plan presents an overview of the voucher strategy by taxonomic group.

For some species there may be initial uncertainty about whether particular fish should be preserved for museum vouchers or used for tissue contaminants specimens. Until enough additional fish are collected to make a decision, place all candidate fish in individual live nets (minnow traps will serve the purpose) by station, with a museum tag identifying the station. Obtaining an adequate fish tissue contaminants sample has priority over museum vouchers.

6.6.5.1 Preparing Voucher Bottles--

The details of preparing materials, actual preservation, labeling, and transporting vouchered fish are provided in the regional activities plan. Anesthetics are not used to prepare voucher specimens. Before retrieving any gear or seining, prepare containers, labels, and an adequate volume of formalin. Whether or not formalin is taken out on the lake in the boat depends on regional sampling procedures described in the regional activities plan. If formalin is not allowed on the boat, maintain voucher specimens from each gear and site in a separate container with a separate label or tag. In any case, place voucher specimens in 10 percent formalin as soon as possible to produce the best results.

> **Handling Formalin: See the regional activities plan for specific instructions related to handling formalin. Some people are acutely sensitive to formalin and others can become so. It is a hazardous chemical and should be stored and handled with care. Work with formalin only in the open air and wear gloves and eye protection when transferring it to bottles or transferring preserved fishes. Use forceps to handle preserved fishes.**

TABLE 6-19. OVERVIEW OF FISH VOUCHERING*

Group I - Easy to identify as adults, usually large, of less interest to museums.

- Adults--Preserve 1 or 2 specimens **per lake** only if small (<200 mm total length) and space permits. Document others with a photograph.
- Juvenile--Preserve 1 or 2 specimens for each gear type at each station.
- Young of Year (YOY)--Preserve 1 to 5 specimens for each gear type at each station.

Group II - Adults may be tricky to identify OR species uncommon in the region, but size is an issue for preservation and shipping.

- Adults--Preserve 1 or 2 specimens of small adults from each gear type (<200 mm). If only large adults, preserve 1 or 2 specimens per lake and document with photo.
- YOY and Juvenile--Preserve 2 to 10 specimens from each gear type at each station.

Group III - Small to moderate-sized fish, adults (and some juvenile and YOY) easy to identify.

- Adults--Preserve 2 to 5 specimens per lake.
- Juvenile--Preserve 2 to 5 specimens per lake.
- YOY--Preserve 2 to 5 specimens from each gear type at each station.

Group IV - Small or difficult to identify or likely to hybridize.

- Adults--Preserve 2 to 10 or more specimens per gear at each station if <150 mm; otherwise preserve 1 specimen per gear type at each station. When in doubt preserve additional specimens.
- YOY and Juvenile--Preserve 5 to 30 or more specimens per gear type at each station; preserve more (possibly all) if species identity is unclear (species code = UNKNnn).

* Detailed vouchering and preservation procedures are presented in the regional activities plan.

At each sampling station do the following:

- As fish are being tallied and measured, for each species (see the regional activities plan for species specific voucher rules) select **at least one** small individual (alive, if possible) as a voucher specimen. Record the number of individuals of each size group of each species preserved on the Fish Tally Form. This number is compared later with museum species counts and needs to be accurate. Keep vouchers from each gear type at each station separate from each other.

- For most small Group IV fish (Table 6-19), preserve several individuals of each taxa over the range of sizes collected. This procedure will aid the museum in confirming identifications.

- Preserve the fish in as good a condition as possible, that is, as soon after collection as is reasonably possible. The best specimens are placed live directly into the 10 percent formalin, immediately after being taken from the net and tallied. Specimens should not be bent nor crowded. Avoid long-dead individuals or those badly damaged in the nets, if possible. For specimens >6 inches (about 150 mm), make a small slit on the right side to flood the body cavity with preservative.

- If any "species of concern" are collected live, quickly photograph and release them. If they are dead, they should be preserved as vouchers in formalin. It is important to notify the appropriate state officials in either case.

The field crews are encouraged to preserve examples of amphibians, crayfish, leeches, or mollusks taken in the traps or otherwise collected, as well as examples of fish with anomalies or parasites. For these nonfish organisms, use one or two self-sealing plastic bags per lake and keep them separate from the fish vouchers (crayfish can do considerable damage to fish vouchers). Leeches should be anesthetized in Alka-Seltzer water before being placed in formalin (they form tight balls otherwise). See Section 8.4 for mollusk preservation procedures.

Before sealing the jar with the museum vouchers, confirm that the tags placed with groups of specimens are complete and allow specimens to be traced to a station and gear type. These tags must be printed on high-quality (e.g., 100% rag content) or water-resistant paper. Also confirm that groups of specimens are assigned the same ID number as appears on the jar label.

6.7 EQUIPMENT AND SUPPLY LIST

Figure 6-9 consists of a series of checklists of equipment and supplies required to conduct protocols described in this section. These checklists are similar to but may be different somewhat from the checklists in Appendix B, which are used at a base site to ensure that all equipment and supplies are brought to and are available at the lake. Field teams are required to use the checklists presented in this section to ensure that equipment and supplies are organized and available on the boat in order to conduct the protocols efficiently.

Items in (or with) Physical Habitat Tub	Number Needed
Sonar with transducer, bracket, and C-clamp	1
12-V Battery (charged)	1
Pigtail adapter for sonar battery	1
DO meter with cable, probe, weight, and calibration chamber	1
GPS receiver (charged)	1
Surveyor's ribbon, roll	1
Boat anchor and 50-m line	1
PVC sounding pole, 3-m (in 2 sections)	1
Viewing box	1
Clipboard (with topographic map, bathymetric map, Lake Profile Form, Habitat Sketch Map Form, Physical Habitat Characterization Form, and Physical Habitat Comments Form)	1
Field notebook	1
Quick reference handbook	1
Parts kit tackle box	1
Items among 4 Net Tubs	
Net anchors with 0.5-m line and quick clips (3/trap net, 2/gill net, 3 spares)	20
Floats with 1.5-m line and quick clips (2/trap net, 3/bottom gill net, 7/surface gill net, 1/minnow trap, 8 spares)	50
Floats with 4-m line and quick clips (for trap net cod end)	5
Gill nets (number depends on lake area)	7 or 8
Line sections of 5 m (2 quick clips each)	10
Line sections of 10 m (2 quick clips each)	10
Line sections of 30 m (2 quick clips each)	10
Net repair twine, roll	1
Bait for minnow traps (dry dog food, if necessary for regional sampling)	1

Figure 6-9. Fish-related activities equipment checklists (page 1).

Items in Tub of Fishing Accessories	Number Needed
Dip Nets	2
Waders	2 or 3 pr
Headlamps, with batteries	3
Q-beam spotlight with pigtail adapter	1
12-V battery (charged)	1
Measuring board	1
"Cyalume" light sticks	12
Line section of 25-m (to measure seining sites)	1
Fish picks	2
Items in Truck or Boat (too large for tubs)	
Trap Nets	6 or 7
Minnow traps with clips	8 or 9
Live net	1 or 2
Buckets (5-gal)	3 or 4
Beach seine (with poles)	1
Short seine (with poles)	1
"Net hook" on pole	1
Museum bottles (case of 500 mL)	6
Museum bottles (case of 1,000 mL)	6

Figure 6-9. Fish-related activities equipment checklists (page 2).

Items in Cooler for Fish Tissue Sampling	Number Needed
Ice in 1-gal self-sealing plastic bags	≥4
Cooler liner (30-gal trash bag)	1
Foil, 25 yards	1
Bag, self-sealing plastic (qt)	10
Bag, self-sealing plastic (gal)	10
Composite bag (30-gal, clear or white trash bag)	4
Items in Cooler for Formalin/Bleach (labeled)	
Formalin, 100% (37% formaldehyde, pH 7.6 to 7.8, 1 gal)	2
Bleach (gal)	1
Bleach solution sprayer	1
Anionic powdered detergent (Alconox or equivalent) for cleaning tissue sample equipment	1
Scrub brush for cleaning tissue sample equipment	1
Vermiculite or other absorbant (gal)	4
Gloves, butyl, pair	1
Safety glasses	1
Electrical tape, roll	1
Cooler liner (30-gal trash bag)	1
Self-sealing plastic quart-size bags	1 or 2 boxes
Self-sealing plastic gallon-size bags	1 or 2 boxes

Figure 6-9. Fish-related activities equipment checklists (page 3).

Items in Team Leader's "Office"	Number Needed
Taxonomic keys set (as specified in Regional Activities Plan)	1
Fish Tally Form set (1 form/gear or seine site)	1
Fish Tally Continuation Form	judgment
Fish Length Form	judgment
Voucher and museum tag sets (1 tag/gear or seine site)	1 set
Fish Tally Form--Lakes	50
Fish Tally Continuation Form--Lakes	10
Fish Length Form--Lakes	10
Fish tissue labels with bar codes	2
Fish Tissue Sample Tracking Form--Lakes	1
Sampling Permit set (1/state)	1
Field Operations Manual for Lakes	1
Regional Activities Plan	1
Items to Take with You to Set Nets	
Clipboard (w/topo. map, Habitat Sketch Map Form, Fish Tally Forms)	1
Watch (with 24-hour setting)	1
Sonar, etc.	1
Sounding rod	1
Trap nets (with 3 anchors, 2 short floats, 1 long float each)	1/site
Gill nets (with 2 anchors, 3 floats, and appropriate lines -- or -- with 7 short floats and appropriate anchor lines)	1/site
Minnow traps (with bait [if required], weight, and short-line float)	1/site
Light sticks	12
Line, 25-m (to mark seining sites)	1

Figure 6-9. Fish-related activities equipment checklists (page 4).

Items to Take with You to Seine	Number Needed
Clipboard (with Physical Habitat Sketch Map Form--Lakes, Fish Tally Forms, Fish Tally Continuation Forms, Fish Length Forms, and Museum Tags)	1
Watch	1
Measuring board	1
Q-beam (with battery and pigtail adapter)	1
Headlamps (with spare batteries)	2 or 3
Waders	2 or 3
Beach seine	1
Short seine	1
Buckets, 5-gal	2 or 3
Species key (optional)	1
Museum bottle (prepared with dilute formalin, half full)	1 per site
Measuring tape	1
Items to Take With You to Pull Trap Nets (and Minnow Traps)	
Clipboard (with Physical Habitat Sketch Map Form, Fish Tally Forms, Fish Tally Continuation Forms, Fish Length Forms, and Museum Tags)	1
Watch	1
Measuring Board	1
Buckets, 5-gal	2 or 3
Species key (optional)	1
Museum bottle (prepared with dilute formalin, half full)	1
Measuring tape	1
Self-sealing plastic bags	1 per site

Figure 6-9. Fish-related activities equipment checklists (page 5).

Items to Take With You to Pull Gill Nets	Number Needed
Clipboard (with Physical Habitat Sketch Map Form, Fish Tally Forms, Fish Tally Continuation Forms, Fish Length Forms, and Museum Tags)	1
Watch	1
Measuring board	1
Q-beam (with battery and pigtail adapter)	1
Headlamps (with spare batteries)	3
Buckets, 5-gal	2 or 3
Species key (optional)	1
Museum bottles (prepared w/dilute formalin, half full; leave at vehicle)	1 per site
Tub(s) (for nets)	1 per net
Measuring tape	1
Self-sealing plastic bags	1 per site

Figure 6-9. Fish-related activities equipment checklists (page 6).

SECTION 7
WATER AND SEDIMENT SAMPLING

by
John R. Baker, Alan T. Herlihy, Sushil S. Dixit, and Richard Stemberger

Water and sediment samples are collected at the index site. Very rigid quality assurance practices are observed in the field. Prior to launching the boat for index site sampling, ensure that all sample containers are labeled and forms are filled out for lake ID, date, and sample type (e.g., sediment core top and bottom, zooplankton fine and coarse mesh) where required. To ensure legibility and completeness in recording sample information, one individual completes field forms and labels and another checks to verify that all pertinent information is included. Activities described in this section are summarized in Figure 7-1.

7.1 SECCHI TRANSPARENCY

Relocate the "index site" by finding the orange marker float, which was attached to the anchor line after obtaining DO and temperature profiles the previous day, or by sonar as described in Section 4. Anchor the boat by reattaching it to the anchor line. After achieving a stable position and determining the site depth, measure Secchi disk transparency using the procedures in Table 7-1. The Secchi disk chain has depth markers at 0.5-m increments. If the Secchi disk disappearance depth is less than 1 m, measure depth to the nearest 0.01-m (cm) increment by marking the chain at the nearest marker, retrieving the disk, and measuring the remaining distance with the tape measure. It is not necessary to estimate Secchi disk depths greater than 1 m to the nearest 0.01 m. Record the depth of disk disappearance and reappearance on the Sample Collection Form (Figure 7-2). If the Secchi disk is visible at the bottom of the lake, check the "clear to bottom" box on the Sample Collection Form. Comment on the form if there are any conditions that may affect this measurement (e.g., surface scum, suspended sediments, extreme weather conditions).

7.2 WATER SAMPLE COLLECTION

Collect a water sample from 1.5 m (0.5 m if lake depth is less than 2.0 m), using the procedure described in Table 7-2. From the Van Dorn sampler, fill four 50-mL syringes and a single 4-L Cubitainer. Procedures for collecting these samples are presented in Table 7-3. Prior to filling syringes and the Cubitainer, check the labels on these containers to ensure

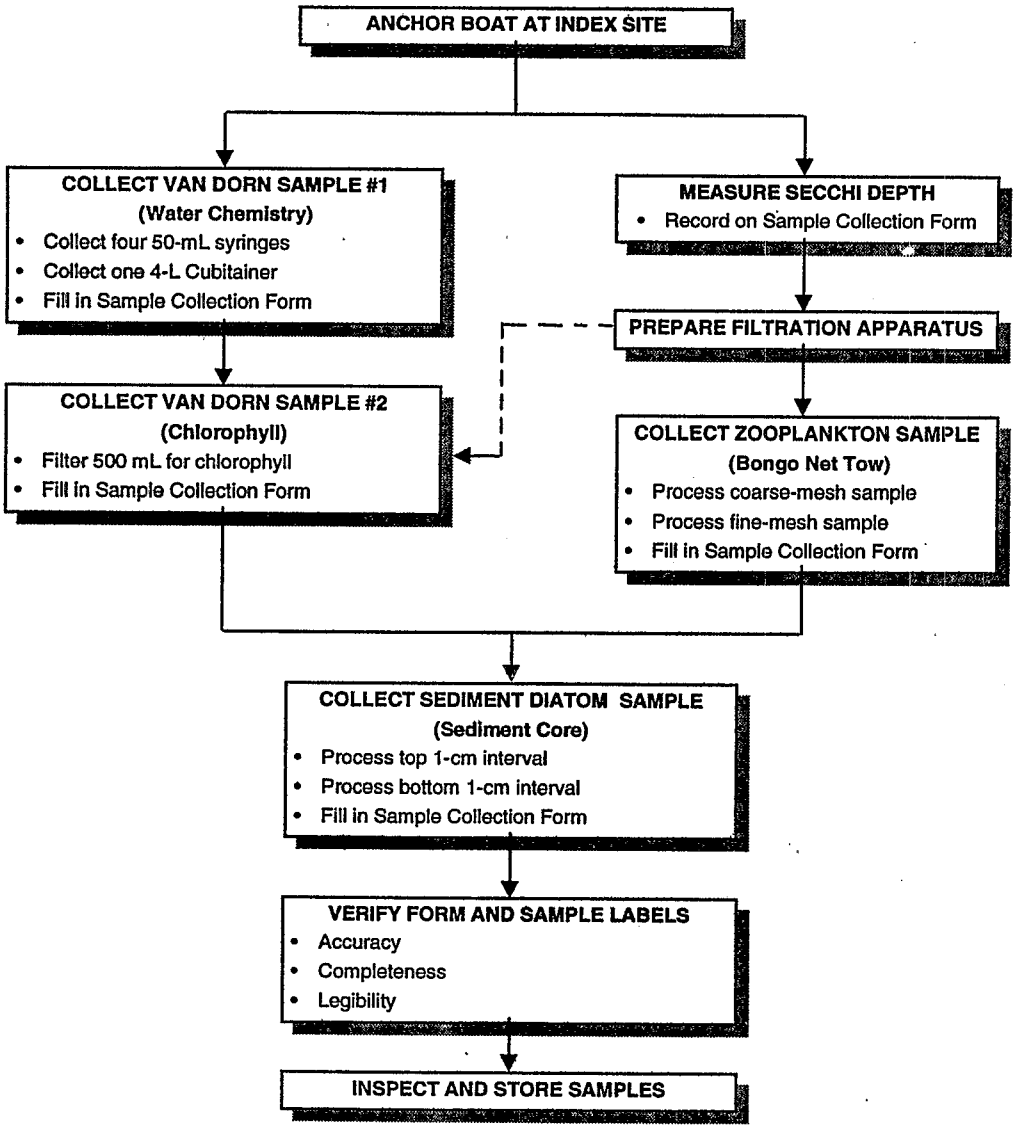

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Figure 7-1. Water and sediment sampling activities summary.

TABLE 7-1. SECCHI DISK TRANSPARENCY PROCEDURES

1. Remove sunglasses unless they are prescription lenses.

2. Clip the calibrated chain (marked in 0.5-m increments) to the Secchi disk. Make sure the chain is attached so that depth is determined from the upper surface of the disk.

3. Lower the Secchi disk over the shaded side of the boat until it disappears.*

4. Read the depth indicated on the chain. If the disappearance depth is <1.0 m, determine the depth to the nearest 0.01 m by marking the chain 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. 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 disk is visible to the lake bottom, check the appropriate box on the Sample Collection Form.

SAMPLE COLLECTION FORM-LAKES

LAKE NAME: L. WOEBEGUS DATE OF COLLECTION: 7/4/94 VISIT #: (1) 2

LAKE ID: NY000L SITE ID (circle): (INDEX) OTHER: _____

TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER: _____

SECCHI DISK TRANSPARENCY

Depth Disk Disappears	Depth Disk Reappears	Clear to Bottom (X)	Comments
4.8 M	4.6 M		

WATER CHEMISTRY (4-L Cubitainer and 4 Syringes)

Sample ID # (Barcode)	Sample Type	Depth Collected	Flag	Comments
300999	R1	1.5 M		
_____		M		

CHLOROPHYLL (Target Volume = 500 mL)

Sample ID # (Barcode)	Sample Type	Depth Collected	Sample Volume	Flag	Comments
103999	R1	1.5 M	500 mL		
_____		M	mL		

ZOOPLANKTON (Fill to Mark on Bottle = 80 mL)

Mesh Size	Sample ID # (Barcode)	Sample Type	Length of Tow	Containers No.	Containers Preserved (✓)	Flag	Comments
COARSE	103998	R1	9.0 M	1	✓		
FINE	103999	R1	9.0 M	1	✓		
	_____		M				
	_____		M				

SEDIMENT CORE SAMPLES (Target Core Length = 35 to 40 cm)

Collected at (circle): INDEX OTHER — If OTHER, record direction and distance from INDEX site:

Sample Class	Sample ID # (Barcode)	Sample Type	Length of Core	Interval From	Interval To	Flag	Comments
TOP	300990	R1	46 cm	0 cm	1 cm		
BOTTOM	300991	R1	46 cm	43 cm	44 cm		
	_____		cm	cm	cm		
	_____		cm	cm	cm		

FLAG CODES: K = No measurement or sample collected; U = Suspect measurement or sample;
F1, F2, etc. = Misc. flags assigned by each field crew. Explain all flags in comments section.

Reviewed By (Initial): JA

Figure 7-2. Sample Collection Form.

TABLE 7-2. OPERATION OF VAN DORN SAMPLER

Note: Collect two Van Dorn samples at the index site (one for water chemistry samples [syringes and the Cubitainer] and one for chlorophyll *a*).

1. Open the Van Dorn sampler by pulling the elastic bands and cups back and securing the latches. Make sure that the mechanism is cocked so that it will be tripped by the messenger weight. Make sure that all valves are closed. **Do not place hands inside or on the lip of the container; this could contaminate samples. To reduce chances of contamination, wear powder-free latex laboratory gloves.**

2. Attach the free end of the messenger line to the boat. Rinse the open sampler by immersing it in the water column.

3. Lower the sampler to 1.5 m below the surface (0.5 m in lakes < 2 m deep).

4. Trip the sampler by releasing the messenger weight so that it slides down the line.

5. Raise the full sampler out of the lake. Set it on a clean, flat surface in an upright position. To avoid contamination, do not set the sampler in the bottom of the boat. Applying some body weight to the top of the Van Dorn sampler often will seal minor air leaks and preserve the sample integrity. If air enters the Van Dorn sampler, discard the sample and obtain another (repeat steps 1-5).

TABLE 7-3. SYRINGE AND CUBITAINER SAMPLE COLLECTION[a]

1. Make sure that the Cubitainer and syringes have the same bar code number (which identifies a single lake) and that the labels are completely covered with clear tape. Record the bar code number on the Sample Collection Form.

2. Unscrew the valve at the top of the Van Dorn sampler. Remove the plug from the Leur-Lok syringe fitting at the bottom of the sampler and fit a prelabeled syringe to the fitting.

3. Slowly withdraw a 20-mL aliquot into the 60-mL prelabeled syringe. Pull the plunger back so that the water contacts all inner surfaces of the syringe. Expel the water from the syringe. Repeat this rinse procedure twice more (there are three rinses for each syringe sample).

4. Reattach the syringe to the Leur-Lok valve on the Van Dorn sampler and slowly withdraw 60-mL of water into the syringe. If air enters the Van Dorn sampler during this process, dispose of the sample and obtain another Van Dorn sample.

5. Place the syringe valve on the syringe tip. Press the green button toward the syringe.

6. Hold the syringe with the tip and valve pointed skyward. Tap the syringe to gather air bubbles to the top. Expel all air from the syringe and press the red button on the syringe valve to seal the syringe with **at least** 50 mL of sample water remaining. (Any extra water, greater than 50 mL, gives the laboratory analyst a greater margin in case of instrument failures.)

7. Repeat steps 2 to 5 for three additional syringes. There should be a total of four syringes for each routine water sample.

8. Place the four syringes in the solid plastic container and place in the cooler. Use ice contained in sealed 1-gal plastic bags to maintain the sample at 4 °C.

9. Unscrew the top valve of the Van Dorn sampler. Unscrew the lid of the prelabeled Cubitainer.[b]

10. Open the bottom valve of the Van Dorn sampler and partially fill the Cubitainer with water (approximately 50 mL).

11. Screw the lid on the Cubitainer. Shake the Cubitainer so that the water inside contacts all sides. Discard the water. Repeat this rinse procedure twice more. Collection of the Cubitainer sample should be preceded by three (3) rinses.

12. Open the Van Dorn valve and completely fill the Cubitainer.[b]

13. Compress the Cubitainer to remove any residual head space. Seal the cap tightly. Wrap electrical tape clockwise around the cap.

14. Place Cubitainer in a cooler with sealed 1-gal plastic bags of ice. Note the depth from which the sample was collected on the Sample Collection Form.

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[a] Wear powder-free surgical gloves while collecting syringe and Cubitainer samples. Syringes may be chilled before use to reduce the occurrence of air bubbles in the sample.

[b] Fill one (1) Cubitainer for each routine lake water sample. **NEVER expand a Cubitainer by exhaling into it!**

that all written information is legible and that each container has the same bar code number. Then place clear packing tape over the label and bar code, covering the label completely. Record the bar code assigned to the sample set (the four syringes and one Cubitainer are considered one sample) on the Sample Collection Form. Also record the depth from which the sample was collected (1.5 m or 0.5 m) on the Sample Collection Form. Enter a flag code and provide comments on the Sample Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity. Store samples in the appropriate containers and verify that they are carefully packed with plenty of ice bags and properly positioned, sealed, and labeled in the sample coolers. Recheck all forms and labels for completeness.

7.3 CHLOROPHYLL *a* SAMPLE COLLECTION

Collect a second Van Dorn sample from the same depth (1.5 m or 0.5 m) as the previous water chemistry sample. Water from this sample is filtered for chlorophyll *a* analysis. Processing procedures for the chlorophyll *a* sample are described in Table 7-4. Chlorophyll can degrade rapidly when exposed to bright light. If possible, prepare the sample in subdued light (or shade) by filtering as quickly as possible after collection to minimize degradation. If the sample filter clogs and all the sample in the filter chamber cannot be filtered, discard the filter and prepare a new sample, using a smaller volume.

After filtering the sample and wrapping the filter in aluminum foil, record the volume filtered on the label, check the label to ensure that all written information is complete and legible. Place a strip of clear packing tape over the label and bar code, covering the label completely. Record the bar code assigned to the chlorophyll *a* sample on the Sample Collection Form (Figure 7-2). Also record the depth sampled (1.5 m or 0.5 m) and the volume of sample filtered on the Sample Collection Form. Verify that the volume recorded on the label matches the volume recorded on the Sample Collection Form. Enter a flag code and provide comments on the Sample Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity. Store the filter sample in a self-sealing plastic bag and ensure that it is carefully packed with plenty of sealed ice bags in the sample cooler. Recheck all forms and labels for completeness and legibility.

7.4 ZOOPLANKTON

A zooplankton sample is collected with both coarse (202 µm) and fine (48 µm) mesh nets towed vertically from near the bottom to the surface. The two nets are arranged side by side on a single metal frame (bongo configuration; Figure 7-3). The calibrated chain used with the Secchi disk is also used to make the vertical tow. Attach the chain to the bongo net so that depth is measured from the mouth of the nets, rather than from the top of the frame.

TABLE 7-4. PROCEDURES FOR COLLECTION AND FILTRATION OF CHLOROPHYLL *a* SAMPLE[a]

1. Place a glass fiber filter (Whatman GF/F or equivalent) in the filter holder apparatus. Do not handle the filter; use clean forceps.

2. Collect 6.2 L of water with a Van Dorn water sampler. Immediately after collection, rinse the graduated cylinder three times with water from the Van Dorn bottle and dispense 250 mL of sample from the Van Dorn into the graduated cylinder.

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.[b] 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).

4. Remove both plugs from 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 of the Van Dorn sample through the same filter.[c] The total sample volume after this portion is filtered is 500 mL.

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 volume of the lower chamber, which traps the filtrate, 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 1,000 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. Wrap the folded filter in a small piece of aluminum foil. Record the sample volume filtered on a chlorophyll label and attach it to the foil. Ensure that all written information is complete and legible. Cover with a strip of clear tape. Place the foil-wrapped filter in a self-sealing plastic bag and then place that bag between two self-sealing plastic bags of ice in a cooler. 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.

10. Prior to sampling the next lake, rinse graduated cylinders with DI water.

[a] Wear powder-free surgical gloves while collecting and filtering the chlorophyll *a* sample.

[b] 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.

[c] Skip step 4 if 250 mL of water would not pass through the filter during step 2. 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.

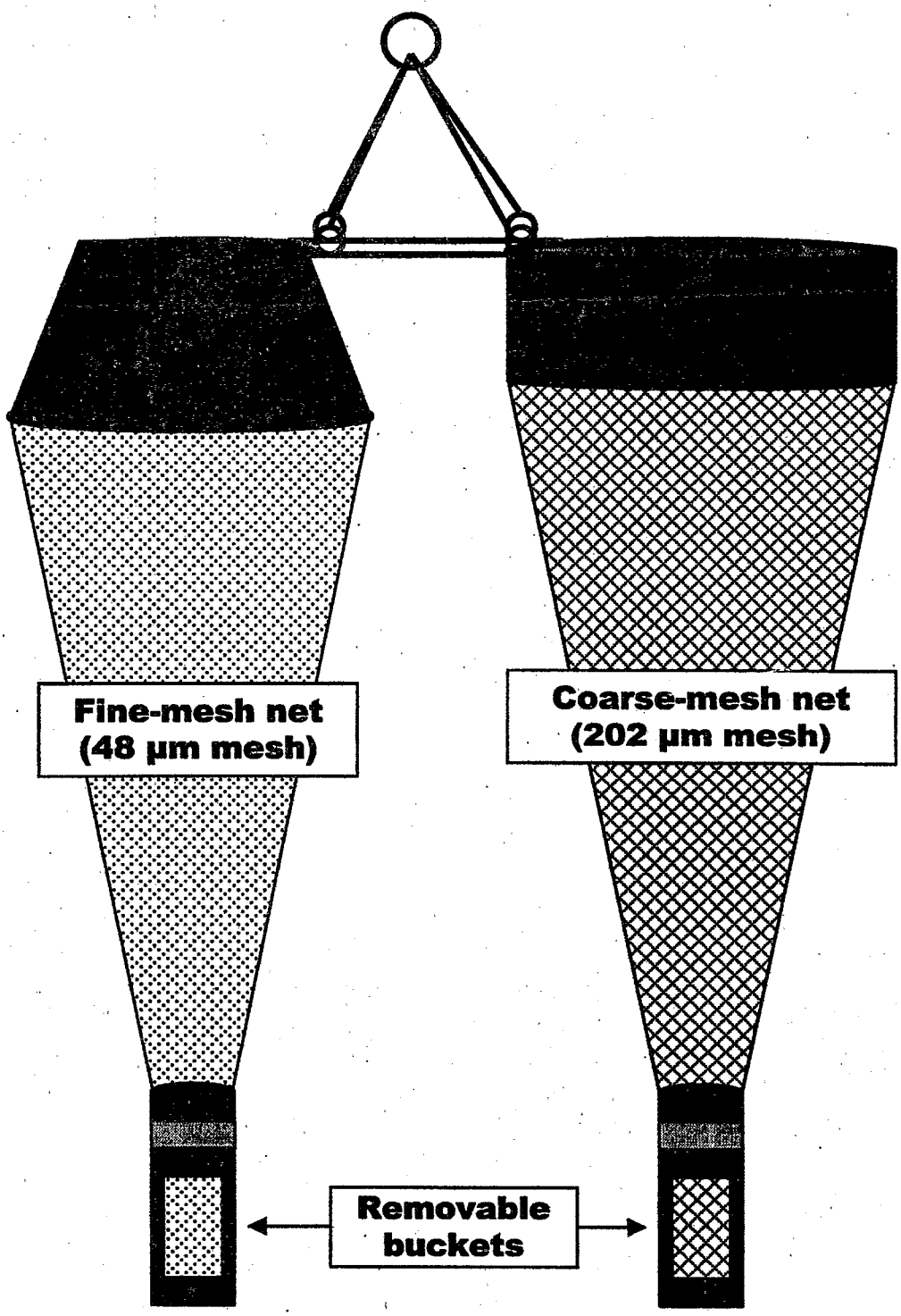

Figure 7-3. Configuration of zooplankton nets.

Zooplankton collection procedures are described in Table 7-5. After collecting the two samples (coarse and fine) and dispensing them into 125-mL jars, check the labels to verify that all written information is complete and legible. Record the length of the tow on the label. Place a strip of clear packing tape over the label and bar code, covering the label completely. Record the bar codes assigned to the two (coarse and fine) zooplankton samples and the length of tow on the Sample Collection Form (Figure 7-2). In clear, shallow lakes (less than 2-m deep, where the Secchi disk can be seen on the bottom), perform a second tow to collect a sufficient number of individuals to adequately characterize the assemblage. The 14 mL of borax-buffered sucrose-formalin preservative is adequate for a total volume of approximately 80 mL. Safety procedures for handling formalin are outlined in the Regional Activities Plan. A zooplankton sample bottle should **not** be filled more than two thirds full. Add additional preservative or use an additional sample bottle if necessary. The presence of preservative in the sample is noted on the Sample Collection Form to assure the integrity of the sample. Record a flag code and provide comments on the Sample Collection Form if there are any problems in collecting the sample or conditions occur that may affect sample integrity. Seal the lids of the jars with electrical tape, place jars in a self-sealing plastic bag, and store samples in the zooplankton net bag for transport. Again, verify that all forms and labels are correct and complete.

If replicate zooplankton samples are required, procedures are described in the regional activities plan.

7.5 SEDIMENT DIATOM SAMPLE COLLECTION

Collect a single sediment diatom sample at the index site with a modified KB corer. If a core sample cannot be collected at the index site, move to an area with a softer bottom, as close to the index site as possible. (Often the boat can be rotated about the anchor line to obtain a good core.) Note the approximate distance and direction in the comments section of the Sample Collection Form (Figure 7-2). Some gravel bottom lakes will have no sediment available to core. If a core sample cannot be collected after attempts at a total of three sites, discontinue sediment coring for that lake. The collection goals for the diatom sample (in order of priority) are first to obtain a sample of undisturbed surface sediments. Second, to obtain a deeper sample (representing conditions present more than 150 years ago) that is uncontaminated with the shallower sediments. Make an effort to get at least a 45-cm core from all lakes that have a Secchi reading of 2.5 m or less. For most other lakes in the Northeast, a core of 35 cm in length is satisfactory. If a lake is artificial or a reservoir, an even shorter core, if a longer core is unobtainable, is sufficient. If a sample cannot be collected, record a "K" flag on the Sample Collection Form. Table 7-6 summarizes operations for the modified KB corer. The procedures for collecting and sectioning core samples are described below.

TABLE 7-5. ZOOPLANKTON COLLECTION PROCEDURE

1. Use a 50-mL syringe to draw up 8 mL of buffered formalin solution. Dispense 4 mL into each of two 125-mL wide-mouth bottles. Use the same syringe to draw up 20-mL of sucrose solution. Dispense 10 mL into each of the two bottles.

2. Record the lake ID and mesh size information (circle "fine" or "coarse") on two labels, for each of the two 125-mL polyethylene jars; verify that 14 mL of buffered sucrose-formalin solution is within each jar.

3. At the deepest part of the lake, lower the bongo net so that the mouths of the nets (horizontal hoops) are ~0.5 m from the bottom. **NOTE: IF THE NETS TOUCH BOTTOM AND MUD ENTERS THE NETS, COMPLETELY RINSE THE NETS AND REPEAT THE PROCEDURE.** This rinse is important. Slowly (0.5 m per sec) haul the net to the surface. If wind creates a large horizontal drift component on a deep lake, record an "F1" flag (miscellaneous field flag), and note the approximate horizontal distance as a comment on the Sample Collection Form. If the lake is deeper than 50 m, the length of the tow is 50 m, the length of the chain.

4. Carefully remove the fine mesh bucket from its net. Do not remove both buckets at the same time as they may be difficult to reattach to the correct bongo 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. The CO_2 from the Alka Seltzer narcotizes the zooplankton to relax their external structure prior to fixation in formalin. This facilitates taxonomic identification. Wait until zooplankton movement has stopped (usually about 1 minute).

5. Verify that the formalin-sucrose solution is in the sample bottle. Record the zooplankton bar code number and check on the Sample Collection Form that it is preserved.

6. Rinse the contents of the fine mesh net bucket into one of the polyethylene jars (prepared in Step 2) labeled "FINE." 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 the DI water. If more than 80 mL of sample have been added to the bottle, add 1 to 3 mL additional sucrose-formalin solution.[a]

7. Repeat steps 4 through 6 for the coarse mesh bucket, using the bottle labeled "COARSE."

8. Record the length of the tows 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.

9. **MODIFICATION FOR CLEAR, SHALLOW LAKES ONLY**: If the depth at the index site is ≤2 m **and** the Secchi disk could be seen on the bottom, then conduct a second tow of the same length. Combine the contents of both tows. Record "2 tows" in the Comments section of the collection form, and write "2 tows" on each of the two sample labels.

10. Seal the lids of the jars by wrapping electrical tape in a clockwise[b] direction so that the lid is pulled tight as the tape is stretched around it. Place jars in a self-sealing plastic bag.

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[a] Note: In some cases, the volume of zooplankton collected in the fine-mesh net may exceed 125 mL. Do not try to force all 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 a **blank** zooplankton 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.

[b] If the sample collection jars being used only have 1 to 2 threads on the bottle, taping in a counterclockwise direction may work better to prevent leakage. Both ways should be tested during training.

TABLE 7-6. COLLECTION PROCEDURE FOR SEDIMENT DIATOM CORES

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 1-qt self-sealing plastic bags. Record the bar code number on the collection form.

2. Determine depth at core site using appropriate means. Sonar is appropriate at depths greater than 3 m and where vegetation does not obscure the true bottom. In some situations it may be necessary to determine depth by sounding. If the bottom is disturbed during the depth determination, move at least 5 m to the side to take the core. (Often you can just spin about or let out the anchor line.) It is critical to the success of the diatom indicator to obtain undisturbed surface sediments.

3. Sediments may contain contaminants, and surgical gloves must be worn during sample collection.

4. Lower the corer until the bottom of the core tube is 0.5 m above the sediment surface.[a] While maintaining a slight tension on the line, let the line slip through your hand, allowing the corer to settle into the bottom sediments. A greater release height may be necessary at some sites to improve penetration and attain a sufficient length of core. If the core is less than 35 cm long, attempt to obtain another core using a controlled free-fall technique. By relaxing the corer from a greater height, a deeper core may be obtained. Immediately after the corer has dropped into the sediment, you must maintain tension on the line 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°. NOTE: This is a 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.

9. Detach the core tube from the corer.

10. 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.

11. 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.

12. 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 plastic bag labeled for the top interval. Record this interval on the Sample Collection Form and on the sample label for the top core.

13. 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.

14. 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 1-quart self-sealing plastic bag labeled for the bottom interval. Record this interval on the Sample Collection Form and on the sample label for the bottom core.

15. Cover the labels on each bag completely with clear tape. Place the bags in a small plastic box, seal with the lid, and place in a cooler with bags of ice.

16. Rinse the corer, collection apparatus, and sectioning apparatus thoroughly with lake water. Rinse with tap water at the base site.

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[a] Note: Different lakes will present different problems. Try to get cores from all lakes. If it is impossible to obtain a core, make detailed notes of the situation with as many suggestions as possible. Shallow, vegetation-filled lakes may present the most problems. Field crews should be innovative within time constraints to resolve coring problems and document the methods used. In very hard bottoms, it is sometimes necessary to drop the corer from several meters above the bottom in order to retrieve any core. Even so, concentrate on a perpendicular drop and try to minimize the disturbance to the stratigraphic layering of the sediments.

After anchoring the boat, insert the core tube into the sampling apparatus and tighten the hose clamp screws to secure the core tube within the sampler housing apparatus. Attach the messenger to the sampler line and slowly lower the sampler to the lake bottom so that it contacts the sediments from a vertical position with as little disturbance to the bottom as possible. Maintain some tension on the sampler line to keep the sampler vertical while deploying the messenger. Activate the sampler by sending the messenger down the line to trip the closing mechanism. Slowly raise the sampler. When it is near the surface, reach under the surface and insert a rubber stopper into the bottom of the core tube. Be sure to seal the tube while the tube is still submerged in water. Bring the sampler into the boat and place it in a vertical position in a large tub to prevent contaminating the boat with sediments. Remove the plexiglas core tube from the sampler. One person should hold the sampler in a vertical position while the second person dismantles the unit. Retain the sample only if it is intact, undisturbed, and essentially free of aquatic plants and debris. A desirable core length is at least 35 to 45 cm; retain cores of shorter length if that is all that can be obtained with the best sampling effort. Measure and record the length of core collected and the core intervals sampled on the Sample Collection Form.

The core tube and sectioning apparatus are illustrated in Figure 7-4. Insert the core extruder through the lower end of the core tube and extrude the sample by forcing the rubber stopper down against the extruder. Carefully remove water overlaying the core with a siphon. Extrude the core slowly until the top of the core is level with the 1-cm mark on the sectioning tube. Carefully slide the sectioning tube containing the top 1 cm of core across the stage and into an appropriately labeled self-sealing plastic bag. Continue extruding the core, discarding the middle portion into the lake, until the bottom of the stopper is 5 cm from the top of the core tube (Figure 7-4). Thoroughly rinse the sectioning apparatus with lake water. Extrude a second 1-cm section of the core beginning 3 cm from the very bottom of the core in the sectioning tube. Place the bottom core sample in an appropriately labeled self-sealing plastic bag.

After collecting the two samples (top and bottom) and dispensing into 1-quart self-sealing plastic bags, check the labels to assure that all written information is completed and legible. Place a strip of clear packing tape over each label, covering the labels completely. Record the bar code for each sample on the Sample Collection Form. Place the sample bags in a plastic box with a lid (e.g., Tupperware®) for protection.

7.6 EQUIPMENT AND SUPPLY LIST

Checklists of equipment and supplies required to conduct protocols described in this section are provided in Figure 7-5. These checklists are organized according to storage containers (e.g., coolers and tubs) used for transportation of equipment and supplies

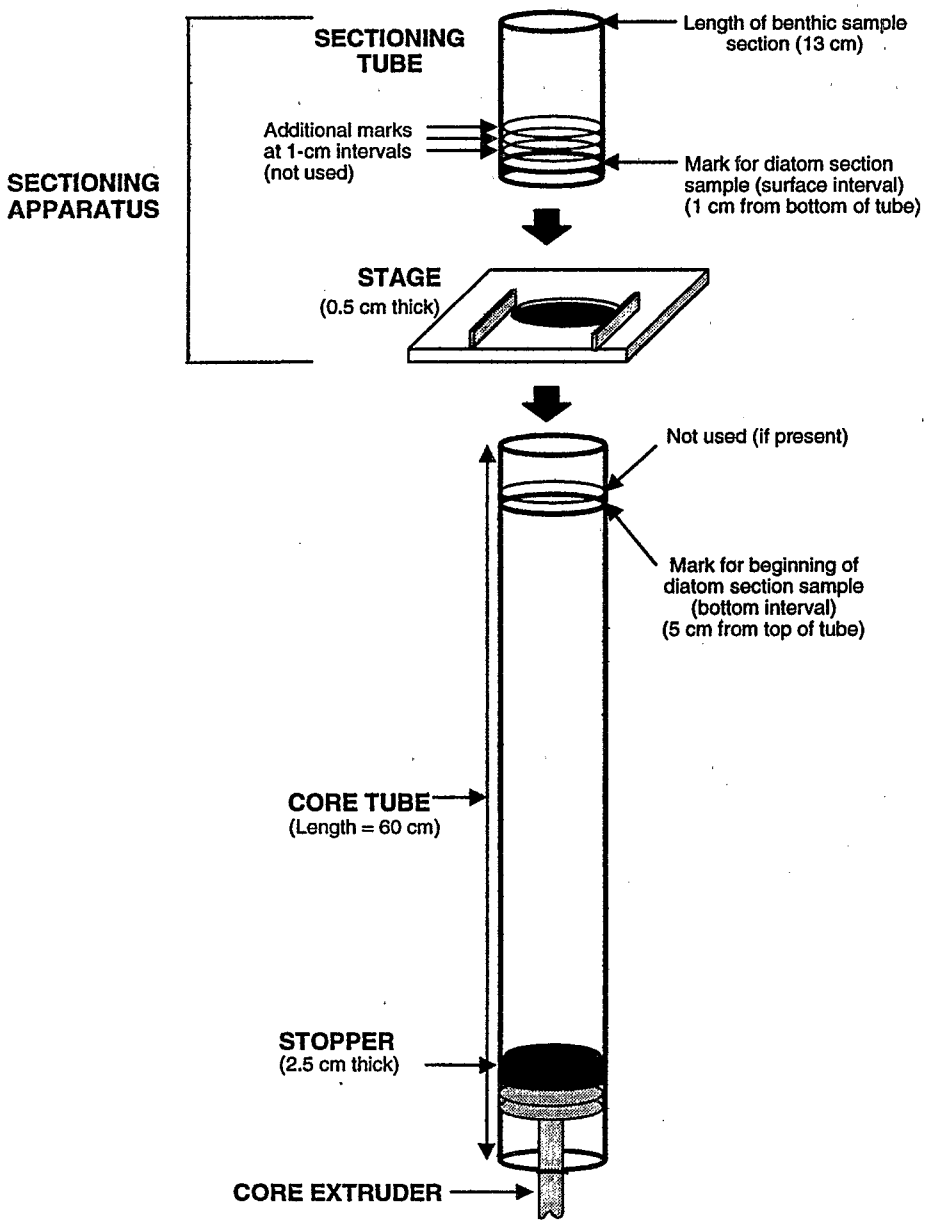


Figure 7-4. Sediment coring tube and sectioning apparatus.

LAKE-VISIT CHECKLISTS

Items in Forms File	Number Needed Each Lake
Lake Verification Form (completed)	1
Sample Collection Form	2

Items in 64-qt Cooler #1	Number Needed Each Lake
Sonar with manual	1
Transducer with bracket and C-clamp	1
12-V wet cell battery (charged) in battery case	1
"Pigtail" connector	1
GPS unit with manual, reference card, extra battery pack	1

Items in 64-qt Cooler #2	Number Needed Each Lake
Corer with 50-m line and messenger	1
Core tubes	2
Ground rubber stoppers	4
Extruder pipe	1
Sectioning tube	1
Sectioning stage	1
Siphon with L fitting	1
Sealable plastic box with lid, with two 1-qt self-sealing plastic bags	1
Surgical gloves	2
Grey tub	1

Items in 30-qt Cooler #1 (Limnology shipping)	Number Needed Each Lake
Sealable plastic box with lid	1
Syringes, labeled	4
Syringe valves	4
Surgical gloves, pair	2
Cubitainer, 4-L	2
Ice in 1-gal self-sealing plastic bags	6
Cooler liner (30-gal garbage bag)	1

Figure 7-5. Water and sediment sampling checklist (page 1).

Items in Tub #1	Number Needed Each Lake
Van Dorn with 3-m line, messenger	1
1-L wash bottle (labeled) with distilled or deionized water (DI)	1
Sounding chain, 50-m with quick-clip	1
Parts tackle box	1
Chlorophyll tackle box:	1
Filter apparatus with filter installed	1
Hand pump with tubing	1
Box of filters (Whatman GFF) in self-sealing plastic bag	1
Forceps in bag with filters	1
Graduated cylinder, 100-mL	1
Graduated cylinder, 250-mL	1
10-cm squares of foil in self-sealing plastic bag	3
Zooplankton net bag:	1
Bongo net	1
Fine mesh bucket	1
Coarse mesh bucket	1
Sample jars, 125-mL Nalgene (with 14 mL of sucrose-formalin solution)	2
Narcotization chamber	1
Alka Seltzer tablets	10
60 mL Syringe (to use with formalin and sucrose solutions)	1
Empty 125-mL Nalgene bottle	2

Figure 7-5. Water and sediment sampling checklist (page 2).

between lakes or for shipping samples. They differ somewhat in organization and number of items listed from the checklists in Appendix B, which are used at a base site to ensure that all equipment and supplies are brought to and are available at the lake. The field teams are required to use the checklists presented in this section to ensure that the equipment and supplies are organized and available on the boat to conduct the protocols efficiently.

SECTION 8
BENTHIC INVERTEBRATE SAMPLING

by
Wesley L. Kinney, R. O. Brinkhurst, Thomas R. Whittier, and David V. Peck

There are two separate activities for benthic invertebrate sampling. The first is a quantitative sampling of sublittoral sediments for all benthic invertebrate organisms using the sediment coring device (Figure 7-3). These procedures are detailed in sections 8.1 and 8.2. The second is a qualitative survey for the presence of zebra mussels (*Dreissena sp.*). These procedures are described in Section 8.3.

Benthos sampling is restricted to the sublittoral zones of lakes. Wherever possible, collect samples in weed-free areas. Take single core samples in the soft sediments at 10 sampling sites located at or near the 10 physical habitat stations established for physical habitat characterizations (Section 5). Very rigid quality assurance practices must be observed in the field. Prior to launching the boat, ensure that all sample containers and forms are filled out for lake ID, date, and sample type where required. Criteria for accepting or rejecting a sample are specified in the following procedures. Every attempt should be made to obtain the full number of cores. To ensure completeness, one individual completes the field forms and another checks to verify that all pertinent information is included. Activities described in this section are summarized in Figure 8-1. Activities associated with collecting replicate benthos samples (if required) are described in the regional activities plan.

8.1 SITE SELECTION AND SAMPLE COLLECTION

The process for locating the site and collecting benthic samples is described in the following section and is summarized in Table 8-1. The actual site location for benthic sampling is determined from the vertical distribution (depth profile) of temperature and dissolved oxygen (DO). In thermally stratified lakes, samples are taken in well-oxygenated areas (where DO is greater than 5 mg/L and at sites where the upper limits of the metalimnion meet the lake bottom) or within the metalimnion where dissolved oxygen concentration still exceeds 5 mg/L. The dissolved oxygen value of 5 mg/L is operationally defined and is intended to ensure that samples are collected from the sublittoral zone rather than from locations that might be more characteristic of the profundal zone. The depth of the top of the metalimnion will generally vary between 3 and 5 m depending upon such factors as time of year, lake depth, lake shape, and

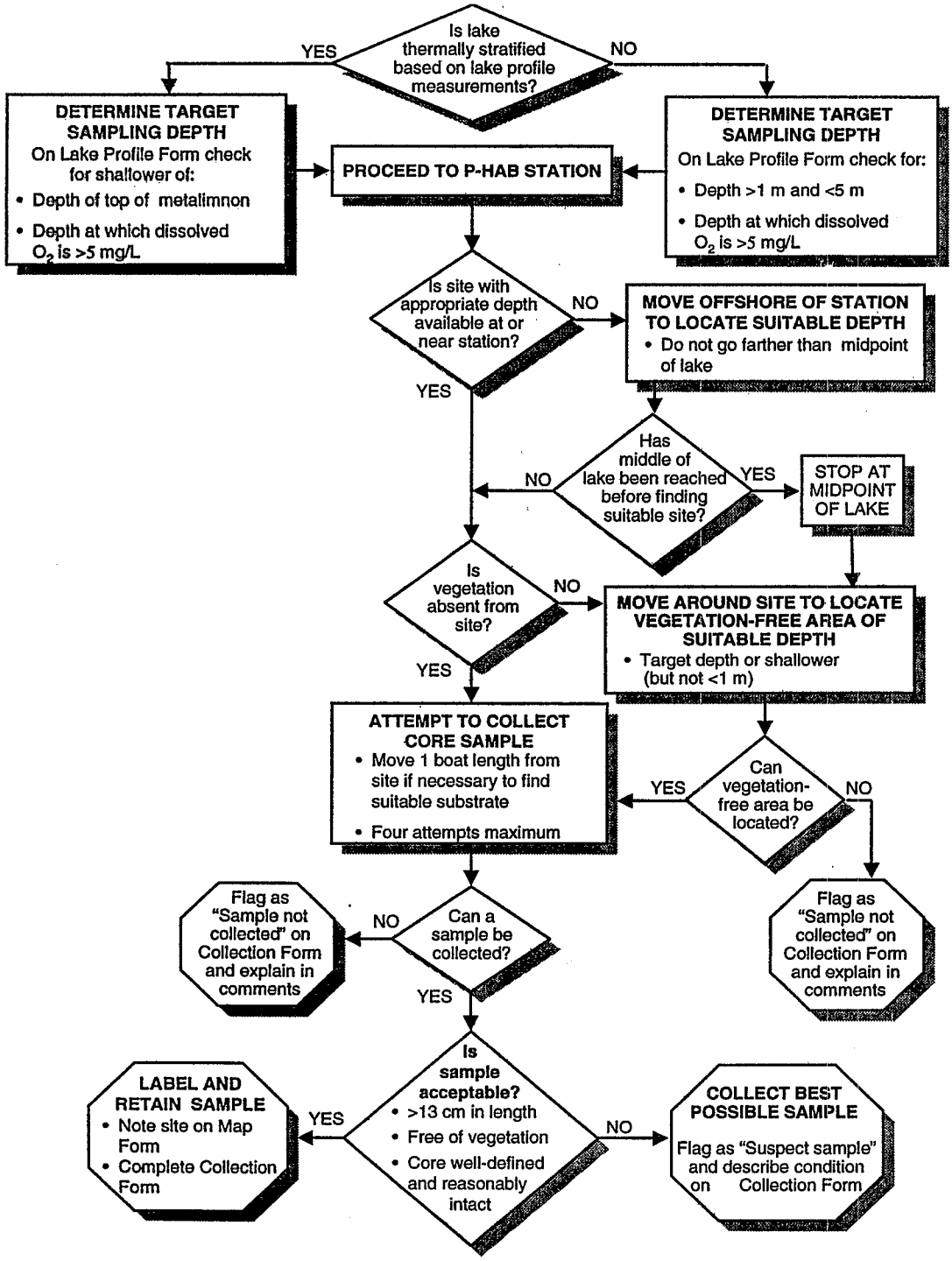


Figure 8-1. Benthic invertebrate sampling activities summary.

TABLE 8-1. COLLECTION PROTOCOL FOR BENTHIC SAMPLING

1. Note the target depth at which the top of the metalimnion was observed during lake profile activities and record on Side 1 of the Benthos Sample Location and Collection Form (benthos collection form).

2. Proceed to the physical habitat station, record the start time on Side 2, and find a suitable location (well-oxygenated [DO > 5.0 mg/L]) at or near a physical habitat observation point:

   a. where the upper limits of the metalimnion meet the lake bottom, or
   b. near the physical habitat station in a shallow area of the lake where the depth is greater than 1 m and there are very few or no weeds. Try to ensure that 10 cores are obtained from widely separated points if the physical habitat sites are located over sediment that is hard to sample.

3. Note this location on the map on Side 1 of the benthos collection form and record any pertinent comments.

4. Collect a core sample.

5. Determine if the core is acceptable. Discard and resample the core if:

   a. the sampler malfunctions and the core is <13 cm long,
   b. the core contains a large amount of aquatic vegetation, or
   c. the core is disturbed (the sediments are stirred up).

6. Obtain a 13-cm long sample from the top of the core using the extruder and sectioning apparatus. Slide the sample into a 1-gal heavy-duty self-sealing plastic freezer bag. Seal the bag and write the station ID and the core length on the bag with a permanent marker. Rinse the remaining sample from the sectioning apparatus using a wash bottle containing lake water.

7. Remove the ribbon marking the physical habitat station and move to the next station. Record the depth collected and substrate type on the benthos collection form.

exposure to wind. Some shallow lakes may be completely mixed from top to bottom. In shallow basins of stratified lakes or in unstratified lakes, collect the samples in weedless areas at or near the physical habitat station where the depth is greater than 1 m.

To locate the upper depth of the metalimnion (see Figure 5-1), refer to the Lake Profile Form (Figure 8-2) which was filled out the previous day. The top of the metalimnion should be noted on this form (if not, refer to Section 5 for directions on determining this depth). On the map portion of the benthos collection form (Benthos Sample Location and Collection Form, Side 1, Figure 8-3), record the depth of the top of the metalimnion (or the deepest depth where DO is greater than 5.0 mg/L, whichever is shallower). Use this depth as a target sampling depth at each of the 10 physical habitat stations. Follow the process identified in Figure 8-4 for locating a suitable sampling site at each station. Use the sonar to locate a suitable sampling site at or near a physical habitat station. Mark the location of each sampling site on the sketch map on Side 1 of the benthos collection form (Figure 8-3). Identify the site on the map with a circled letter corresponding to the nearest physical habitat station.

After the sampling site has been identified, anchor the boat. Wear surgical gloves during the collection process. At the first station, record the "START" time on Side 2 of the benthos collection form (Figure 8-5). Insert the core tube into the sampling apparatus and tighten the hose clamp screws to secure the core tube. Attach the messenger to the sampler line and slowly lower the sampler to the lake bottom so that it contacts the sediments in a vertical position with as little disturbance to the bottom as possible. Maintain some tension on the line to keep the sampler vertical while deploying the messenger. Activate the sampler by sending the messenger down the line, tripping the closing mechanism. Slowly retrieve the sampler to just below the surface. While the sampler tube is still submerged in water, insert a rubber stopper into the bottom of the core tube. Retrieve the sampler into the boat and place it in a vertical position in a large tub to prevent contamination of the boat with sediment. Remove the Plexiglas core tube from the sampler. Have one person hold the sampler in a vertical position while another person dismantles the unit. Examine the sediment sample within the core tube. Retain only undisturbed, intact samples that are essentially free of aquatic plants and debris. An acceptable sample is one that contains fine sediments that fill the core to a depth of at least 13 cm and has an undisturbed surface layer. Unacceptable samples (which are discarded) include cores less than 13 cm in length due to improper functioning of the sampler or due to unsuitable substrate material. It may not be possible to obtain "acceptable" samples at all sites. In such cases, retain the best sample obtainable, record a "U" (suspect sample) on Side 2 of the benthos collection form (Figure 8-5), and explain the flag in the comments section.

LAKE PROFILE FORM

LAKE NAME: L. WOEBEGUS DATE OF PROFILE: 7/4/94 VISIT #: (1) 2

LAKE ID: NY0000L SITE ID (circle): (INDEX) OTHER: _____

TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER: ___

PRECIPITATION (circle): (NONE) LIGHT HEAVY

SURFACE CONDITIONS (circle): FLAT (RIPPLES) CHOPPY WHITECAPS

ODOR? X No ☐ Yes Description:

SCUM? X No ☐ Yes Description:

INDEX SITE DEPTH: 18.9 M CHECK (✓) IF SONAR NOT USED: ☐

FLAG: COMMENTS:

DISSOLVED OXYGEN & TEMPERATURE PROFILE
(Depth of Measurement[a] [m]: Surface, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45, and 50 m), Also include readings at 1 m above bottom.

DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T, B)[b]	DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T,B)[b]
SURFACE	8.8	21.1			11.0	4.2	12.1		
1.5	8.8	21.0			12.0	3.8	12.0		
2.0	8.8	21.0			13.0	3.7	11.9		
3.0	8.8	21.0			14.0	3.4	11.8		
4.0	8.8	21.0		T	15.0	3.4	11.8		
5.0	7.0	18.8			17.9	1.9	11.3		
6.0	5.7	15.6			16.0	3.0	11.2		
7.0	4.4	14.2			17.0	2.1	11.3		
8.0	4.9	13.2		B					
9.0	4.3	12.9							
10.0	4.4	12.5							
SURFACE (Dup.)	8.8	21.1							

IS THE DUPLICATE O_2 READING WITHIN ±0.5 MG/L OF THE INITIAL SURFACE READING? X YES ☐ NO

CHECK HERE IF ADDITIONAL PROFILE MEASUREMENTS ARE RECORDED ON THE REVERSE SIDE: ☐

[a] If the site depth is ≤ 3 m, take readings at the surface, every 0.5 m, and 1 m above the bottom.
[b] METALIMNION = The region of the profile where the temperature changes at a 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 of change becomes less than 1 °C per meter) with a "B." After the metalimnion is encountered, take readings every 1 m until bottom of the metalimnion is reached. Record the depth of the top of the metalimnion on the Benthos Sample Location and Collection Form.

FLAG CODES: K = No Measurement or Observation Made; U = Suspect Measurement or Observation; Q = Unacceptable QC Check Associated with Measurement; F1, F2, etc. = Miscellaneous Flags Assigned by Each Field Crew. Explain all flags in comments section on back of form.

REVIEWED BY (INITIAL): _____

Figure 8-2. Lake Profile Form.

BENTHOS SAMPLE LOCATION AND COLLECTION FORM-LAKES

LAKE NAME: L. Woebegus DATE OF COLLECTION: 7/4/94 VISIT #: (1) 2

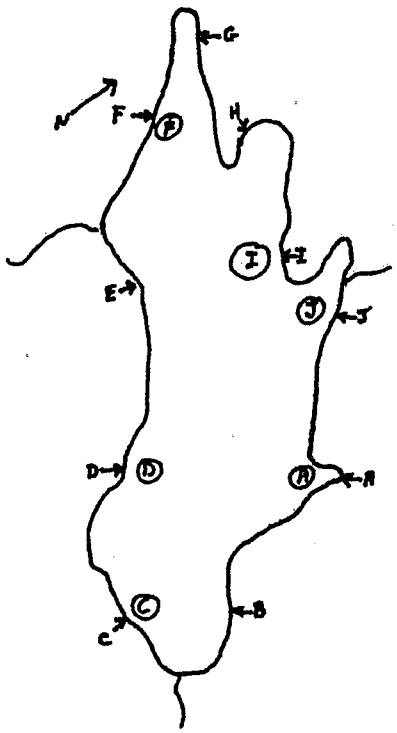
LAKE ID: NY0001L TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER: ___

OUTLINE MAP OF LAKE (WITH PHYSICAL HABITAT STATIONS IDENTIFIED)

INDICATE LOCATIONS WHERE BENTHIC CORE SAMPLES ARE COLLECTED WITH THE LETTER OF THE NEAREST PHYSICAL HABITAT SITE (A - J).

ARROW INDICATES NORTH.

RECORD THE SHALLOWER OF THE FOLLOWING DEPTHS (FROM LAKE PROFILE FORM)
A) THE DEPTH OF TOP OF METALIMNION OR
B) THE DEEPEST DEPTH AT WHICH DISSOLVED OXYGEN ≥ 5 MG/L TARGET DEPTH 4 M



ID#: NY0001L
LAKE WOEBEGUS
AREA: 141.3 ha
500 meters

COMMENTS:

REVIEWED BY (INITIAL):

Figure 8-3. Benthos Sample Location and Collection Form, Side 1.

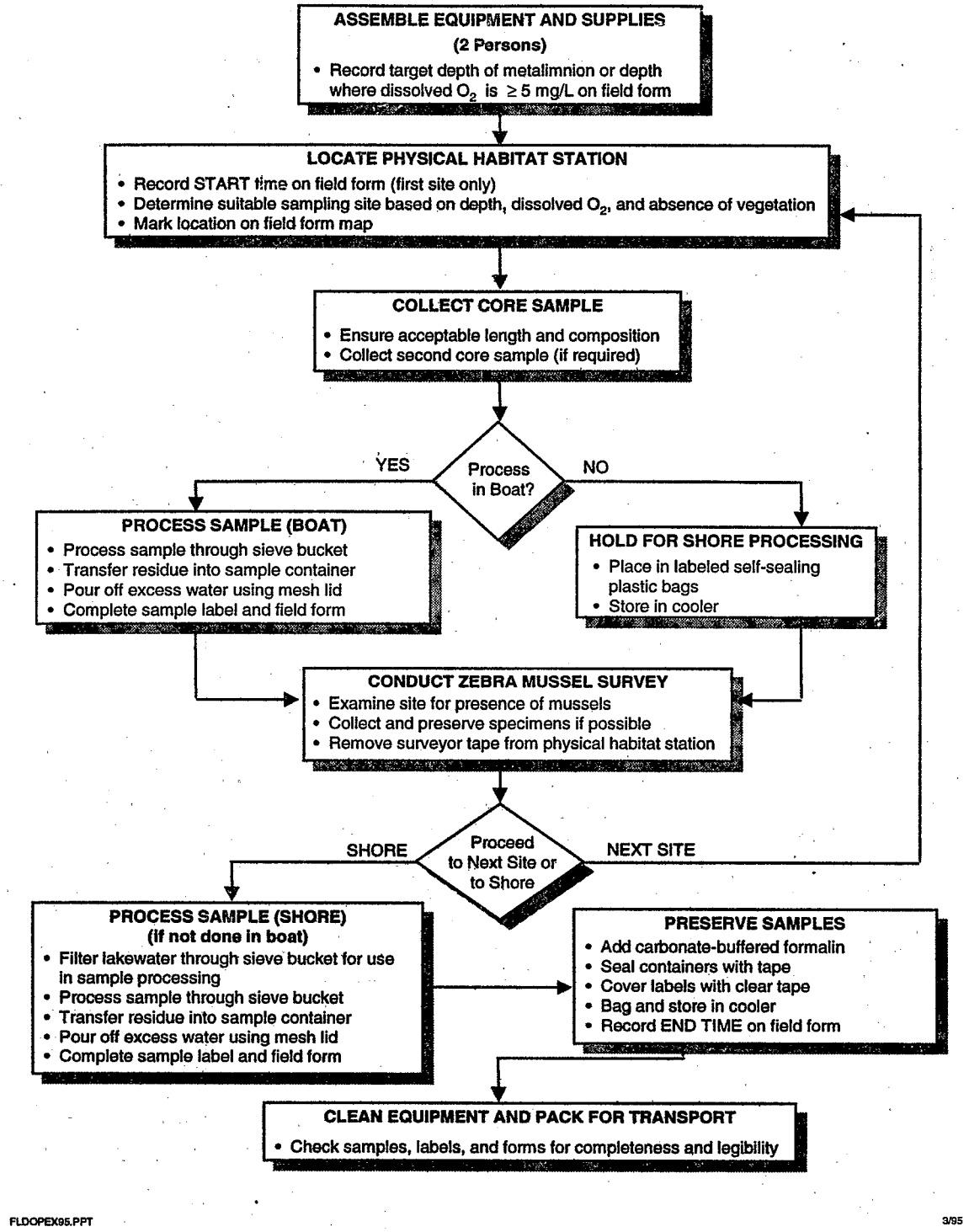


Figure 8-4. Process for selecting benthic sample sites.

BENTHOS SAMPLE LOCATION AND COLLECTION FORM (CONTINUED) VISIT #: (1) 2

LAKE ID: NY0000L DATE OF COLLECTION: 7/4/94

RECORD SAMPLING START TIME: 14:30 RECORD PROCESSING COMPLETION TIME: 19:00

SAMPLE ID # (Barcode)	STATION ID	DEPTH COLLECTED	SUBSTRATE TYPE[a]	FLAG[b]	COMMENTS
302001	A	5.8 M	C		
	B	M		K	NO SAMPLE COLLECTED - ROCKY BOTTOM
302002	C	6.2 M	O		50:50 SAND/CLAY
302003	D	5.5 M	S		
	E	M		K	NO SAMPLE COLLECTED - TOO WEEDY
302004	F	3.5 M	C	U	BEST SAMPLE OUTBOARD WAS IN VEG.
	G	M		K	BEDROCK BOTTOM
	H	M		K	BEDROCK BOTTOM
302005	I	5.5 M	G	U	CORE ONLY 5 cm LONG
302006	J	6.0 M	O		SAND, CLAY, WOODY DEBRIS
		M			
		M			
		M			
		M			
		M			

[a] SUBSTRATE TYPE CODES: G = GRAVEL; S = SAND; C = SILT CLAY, OR MUCK; W = WOODY DEBRIS; O = OTHER (DESCRIBE IN COMMENTS)

[b] FLAG CODES: K = NO SAMPLE COLLECTED; U = SUSPECT SAMPLE; F1, F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

ZEBRA MUSSEL OBSERVATION AND COLLECTION

STATION	OBSERVED (Y/N)	COLLECTED (Y/N)	COMMENTS
A	N	N	
B	N	N	
C	N	N	
D	N	N	
E	N	N	
F	N	N	
G	N	N	
H	N	N	
I	N	N	
J	N	N	
LAUNCH	Y	Y	PRESENT IN LOW NUMBERS ATTACHED TO SMALL COBBLE.
OTHER	N	N	

REVIEWED BY (INITIAL): JA

Figure 8-5. Benthos Sample Location and Collection Form, Side 2.

Insert the core extruder through the lower end of the core tube and extrude the sample by forcing the rubber stopper down against the extruder. Water overlaying the core does not need to be removed by a siphon as described for sediment diatom collection in Section 7. Place screen top lid over the core tube and extrude the water overlaying the core. Remove the lid and place the stage and sectioning tube on the core tube. Slowly extrude the core until the top of the core is level with the top of the sectioning tube (~13 cm; see Figure 7-3). Carefully slide the sectioning tube containing the top 13 cm of core into an appropriately labeled 1-gal heavy-duty, self-sealing plastic freezer bag. Use a wash bottle containing lake water to rinse the sample from the storage and sectioning tube into the bag. Store bags in a cooler until processing.

Discard the remainder of the core by extruding it into the lake. Thoroughly rinse the extruding apparatus, core tube, and sectioning apparatus with lake water. Record the dominant substrate type (gravel; sand; silt, clay or muck; woody debris; or other, to be described in the comments section) of the core on Side 2 of the benthos collection form (Figure 8-5). Also record the actual depth from which the sample was collected. If no sample can be collected from a site, enter a "K" flag (for missing sample) on the benthos collection form, and explain in the comments section why no sample was collected. Remove the ribbon marking the physical habitat station and move to the next station.

8.2 SAMPLE PROCESSING

Sample processing activities are summarized in Table 8-2. At the option of the field crew, the sample may be processed at the collection site while the boat is still anchored in position or it may be taken to shore for further processing. An advantage of processing the sample at the collection site is that there is no need to filter rinse water as the likelihood of introducing benthic organisms into the sample from open lake water is negligible. Water obtained near shore may contain benthic animals dislodged from weeds or shallow, disturbed substrata and must be filtered through the number 60-mesh screen bottom bucket prior to rinsing the sample. Thoroughly rinse the screen bottom bucket before processing samples.

Transfer the 13-cm portion of core retained for processing from the 1-gal self-sealing bag to a plastic bucket with a number 60-mesh screen bottom. Rinse all material adhering to the sides and bottom of the 1-gal self-sealing bag into the screen bottom bucket with lake water (or filtered lake water). Tap the screen bottom bucket on the surface of the lake to force water through the screen bottom. Continue this process until the fine sediments are rinsed through the screen. Samples are adequately screened when water draining through the screen becomes clear and no "sediment cloud" is visible around the bottom of the bucket. When agitating the bucket in the lake, it is very important that the bucket not be submersed to prevent losing some organisms in the sample over the top of the bucket. If the bucket is submersed, discard the

TABLE 8-2. PROCESSING BENTHIC SAMPLE

1. For each station sample, complete a sample label with lake ID, date, and station ID and attach it to a 500-mL bottle. Cover the label completely with clear tape. Copy the sample bar code number from the label onto the benthos collection form. Also record the "depth collected" and the "substrate type" on the form. For stations where no sample is collected, enter a K in the flag field and explain it in the comments section.

2. Processing - Do in boat or on shore. **If performed on shore, all lake water used must first be filtered through No. 60 mesh screen bottom bucket.** Transfer sample from collection bucket into 60-mesh sieve bucket. Rinse 1-gal self-sealing bag into sieve bucket with lake water.

3. Tap the screen bottom bucket repeatedly on the lake water surface to force water through the screen bottom until the water draining through the screen is clear. If the sieve bucket becomes totally submerged, the sample is no longer acceptable because organisms may have been lost.

4. Place the sieve bucket containing the sample over a bucket or pan. Concentrate residue in the sieve bucket in one area. Transfer the residue in the sieve bucket into a 500-mL bottle by hand.

5. Rinse the remaining residue into the container using a plastic funnel, using small amounts of lake water.

6. Attach a lid with 60-mesh screening to the container and pour out the excess water. Rinse the residue on the lid back into the container with water from the rinse bottle. Add the filtered water to bring the total volume (residue plus water) to about 400 mL. Complete the information on the benthos collection form before leaving the site.

7. On shore, fill a plastic syringe with 50 mL of 100 percent carbonate buffered (pH 10) formalin solution. Be sure to use formalin of pH 10. The formalin used for the fish samples is pH 7.6 to 7.8 and will dissolve the chitinous exoskeletons and mollusk shells in the sample. Add the pH 10 formalin to the sample bottle. Cap the container tightly. Seal the container by taping the cap clockwise* with plastic tape.

8. Place all of the sample bottles into a 30-gallon clear or white plastic bag and seal with tape or wire ties. Write the Lake ID number on the bag with a permanent marker and place in a cooler for transport.

---

* If the sample containers have only 1 to 2 threads on the neck, applying the tape in a counterclockwise direction may be better protection against leakage. This should be tested during training to determine the best procedure for taping containers.

sample and collect a new sample. Also, do **not** mix the sample by hand or with a spatula to speed the sieving process. This practice destroys the small and fragile organisms.

Complete a sample label with the Lake ID, date, and site ID and circle the type of sample (CORE). Attach the label to a 500-mL bottle. Check the labels to ensure that all written information is complete and legible. Place a strip of clear packing tape over the label and bar code, covering the label completely. While holding the labeled sample container over another bucket or tub, transfer the residue from the screen bottom bucket, catching any residue that falls outside the sample container in the second container. The objective is to capture all the residue in the sample container while introducing as little water as possible. Tilt the screen bottom bucket during the final stages of sieving to concentrate the residue into a small area on the bottom of the bucket. Transfer the bulk of this material by hand into the sample container. Rinse the remaining residue in the bucket into the sample container through a plastic funnel using a lake water rinse (filtered through number 60 mesh) contained in a 1,000-mL plastic rinse bottle fitted with a rinse spout. Fit a screen top lid (number 60 mesh) onto the sample container and drain off the excess water in the sample container. Gently rinse the residue retained on the screen top lid back into the sample container with small amounts of lake water in the rinse bottle. Add filtered lake water from the rinse bottle to bring the volume in the sample container to 400 mL. Use a marked bottle as a guide. Record the bar code printed on the label on Side 2 of the benthos collection form (Figure 8-5).

Record a "U" flag (for suspect sample) and provide comments on the benthos collection form if:

a. there are any problems in collecting the sample,

b. conditions occur that may affect sample integrity, or

c. a nonstandard procedure was used to collect a sample.

If there are other observations of note about a sample that do not render it suspect, use a miscellaneous flag (F*n*).

After all 10 sites are sampled, return to shore and add 40 to 50 mL of carbonate-buffered formalin to each container to prepare a 10-percent formalin solution. Cap the containers tightly and wrap electrical tape clockwise around each cap to seal it for transport. Invert and shake bottles to mix the formalin throughout the sample. Record the time sample processing ended on Side 2 of the benthos collection form (Figure 8-5).

8.3 QUALITATIVE ZEBRA MUSSEL SURVEY

In the late 1980s at least one species of exotic freshwater mussels (Unionidae: *Dreissena sp.*, known as zebra mussels) became established in the Great Lakes. Since 1990 they have been spreading into other inland surface waters (Ludyanskiy et al. 1993). EMAP is in a position to be able to monitor the rate and extent of zebra mussel invasion into inland lakes (Whittier at al., in press). At this time, the goal is only to detect and document their presence in a lake, not to do quantitative in-lake assessments of abundance. Currently, zebra mussels are not widespread in inland lakes, having been found in a few large lakes and in large rivers. In addition, the zebra mussel appears to require moderately hard water to reproduce successfully.

The general procedure is to actively look for zebra mussels at each of the 10 physical habitat stations, the benthos sampling sites, and at the launch site. Observations of mussels at any other location should also be recorded. If any mussels are observed, example specimens should be collected if possible, and preserved for species verification. Samples need to be collected from only 2 or 3 locations if they are widespread in a lake. Observations and collections may be made during the physical habitat assessment (Section 5) or in conjunction with quantitative benthos sampling. Observations and collection at any other time are also valid. Record any data related to zebra mussels on Side 2 of the benthos collection form (Figure 8-5).

8.3.1 Species Characteristics and Probable Habitat

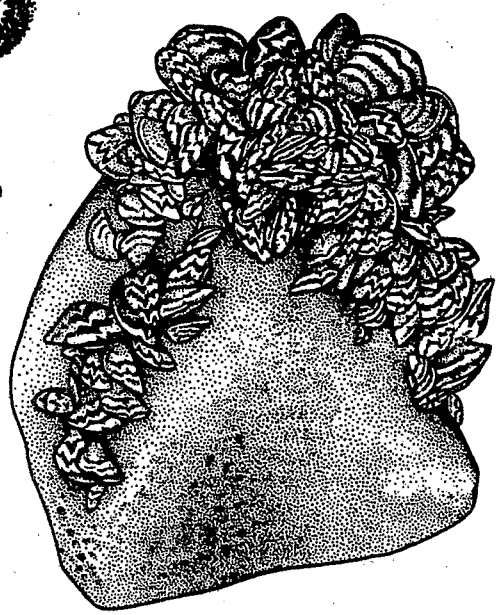
The zebra mussel (Figure 8-6) is a small bivalve (the adults are generally 25 to 30 mm in length) that normally attaches firmly and permanently to solid substrates, in the manner of saltwater mussels. However, there are new reports (only in the Great Lakes so far) of a second zebra mussel species ("quagga" mussel) that will colonize soft substrates. Once established, they usually form large clusters (i.e., you are unlikely to find one lone mussel) on rocks, buoys, pier pilings, woody debris, trash, native freshwater mussels, and each other. In lakes they tend not to survive in locations subject to ice scour or heavy wave action, on soft substrates like sand or mud, or in areas of bright light. They tend to become abundant in water greater than 1 m deep.

8.3.2 Collection and Data Recording

Table 8-3 gives the procedures for the zebra mussel survey. At each physical habitat station, each benthic sampling site, and at the launch site of each lake, make a brief visual search of hard substrates for zebra mussels. Conduct observations in water greater than 1 m deep if possible.

A

Adult total length: 25 to 30 mm



B

Scale: 1 cm = approx. 20 mm

Figure 8-6. Zebra mussel (*Dreissena polymorpha*). A. Single zebra mussel showing byssal threads (Credit: Carol Allaire); B. Cluster of zebra mussels on a rock (Credit: Margaret Van Bolt). (Illustrations provided by the Michigan Sea Grant Program.)

TABLE 8-3. QUALITATIVE ZEBRA MUSSEL SURVEY

1. At each physical habitat station and benthos sampling site, search for likely locations for zebra mussels based on the following guidelines:

   a. Depths >1 m (not subject to ice scour or heavy wave action).
   b. Harder bottom substrates (although some forms may colonize soft substrates).
   c. Possible attachment sites (e.g., rocks, buoys, peer and dock pilings, woody debris, trash, and native freshwater mussels).

2. Use the viewing box to aid in underwater observations of substrate and potential attachment sites.

3. If no mussels are observed, enter an "N" in the "OBSERVED" box on Side 2 of the benthos collection form. Diagnostic features of zebra mussels include:

   - thin shells,
   - adults approximately 25 to 30 mm (1 inch) long,
   - dark color, with characteristic "zebra" striping, and
   - clusters attached on solid substrates.

4. If mussels are observed (even if they are not believed to be zebra mussels), enter a "Y" in the "OBSERVED" box on Side 2 of the benthos collection form. Make a reasonable effort to collect a sample. Use a knife to slice the attachment threads and gently pull or pry one or two individuals from the substrate. Take care to avoid breaking the knife blade. If possible, collect a cluster of mussels that are attached to a small object (e.g., a rock or shell).

   If mussels are observed but are not collectable at the physical habitat stations, benthos sampling sites, or launch site, enter an "N" in the "COLLECTED" box. Attempt to collect them from another location in the lake. Record the locations as comments for the nearest physical habitat station. If this is possible, enter a "Y" in the "COLLECTED" box.

   If mussels are widespread in a lake, collect specimens from only two or three sites.

5. Place specimens in a self-sealing plastic bag with some lake water until they can be transported to the launch site.

6. Preserve specimens in 10 percent carbonate-buffered formalin, using an extra benthic sample container. Prepare a label from a blank sheet of paper (100 percent rag content or water resistant, if possible) with the following information:

   - Lake ID
   - Visit
   - Nearest physical habitat station
   - Identify as "Zebra mussel sample"

   Attach the label to the container with clear tape that covers the label completely. Seal the container and prepare it for transport using the same techniques as those used for benthic samples.

7. Ship zebra mussel samples with the fish voucher samples, unless otherwise directed by the Communications Center.

If you observe mussels, make a reasonable effort to collect a sample. Native North American freshwater lake bivalves are usually found on soft substrates and are mobile. The regional museums are interested in freshwater mollusks in general, so collect examples of other bivalves and gastropods, if possible. Diving or swimming is not required to obtain such a sample. A better alternative is to collect a cluster of mussels attached to a small object (e.g., a small rock or another mollusk shell). If zebra mussels are widespread, collect samples from only two or three locations. If mussels are present in the lake but are not collectable at any of the designated sites, try to get a sample from some other location. The object is to detect and document their presence in a lake. Place the collected mussels in a self-sealing plastic bag for later preservation in formalin. Preserve and label mussel samples along with other nonfish specimens collected (one or two containers per lake); see the regional activities plan for any additional guidance. Preserve mollusks in the carbonate-buffered formalin used for benthic invertebrates (the alkaline pH will minimize breakdown of the shell and associated diagnostic features).

Use the comments section of the benthos collection form to explain why mussels were seen but not collected, as well as to add comments on observations such as substrate or numbers of mussels.

8.4 EQUIPMENT AND SUPPLY LIST

A checklist of equipment and supplies required to conduct the protocols described in this section is provided in Figure 8-7. The field teams are required to use the checklist presented in this section to ensure that equipment and supplies are organized and available on the boat in order to conduct the protocols efficiently.

8.5 REFERENCES

Ludyanskiy, M. L., D. McDonald, and D. MacNeill. 1993. Impact of the zebra mussel, a bivalve invader. Bioscience 43:533-544.

Whittier, T. R., A. T. Herlihy, and S. M. Pierson. 1995. Regional susceptibility of Northeast lakes to zebra mussel invasion. Fisheries 20:20-27.

EQUIPMENT AND SUPPLY CHECKLIST FOR BENTHOS SAMPLING

Completed Lake Profile Form	1
Benthic Sample Collection Form with preprinted lake outline (from dossier)	1
Field Operations Manual	1
Quick Reference Handbook	1
Sediment core tube	1
Sectioning stage	1
Sectioning tube	1
Plastic funnel	1
Sieve bucket	1
Rinse bottle, 500-mL	1
Screen top lid (No. 60 mesh) for sample containers	1
Sample containers, 500-mL (marked at 400-mL)	10
Heavy-duty self-sealing plastic bags, 1-gallon, labeled with station ID	10
Large plastic tub	1
Plastic electrical tape	1 roll
Permanent markers	2-3
Garbage bags, large kitchen size (for storing sample containers)	2
Cooler	1
Benthic sample labels with bar codes	1 sheet
Benthic sample labels without bar codes (for extra containers)	1 sheet
Clear tape strips	1 pkg.
60-cc plastic syringe for dispensing formalin	1
Carbonate-buffered formalin solution (sodium bicarbonate)	500 mL
Surgical gloves	2 pair
Parts kit	1

Figure 8-7. Benthic invertebrate sampling checklist.

SECTION 9
FINAL LAKE ACTIVITIES

by
Alan T. Herlihy

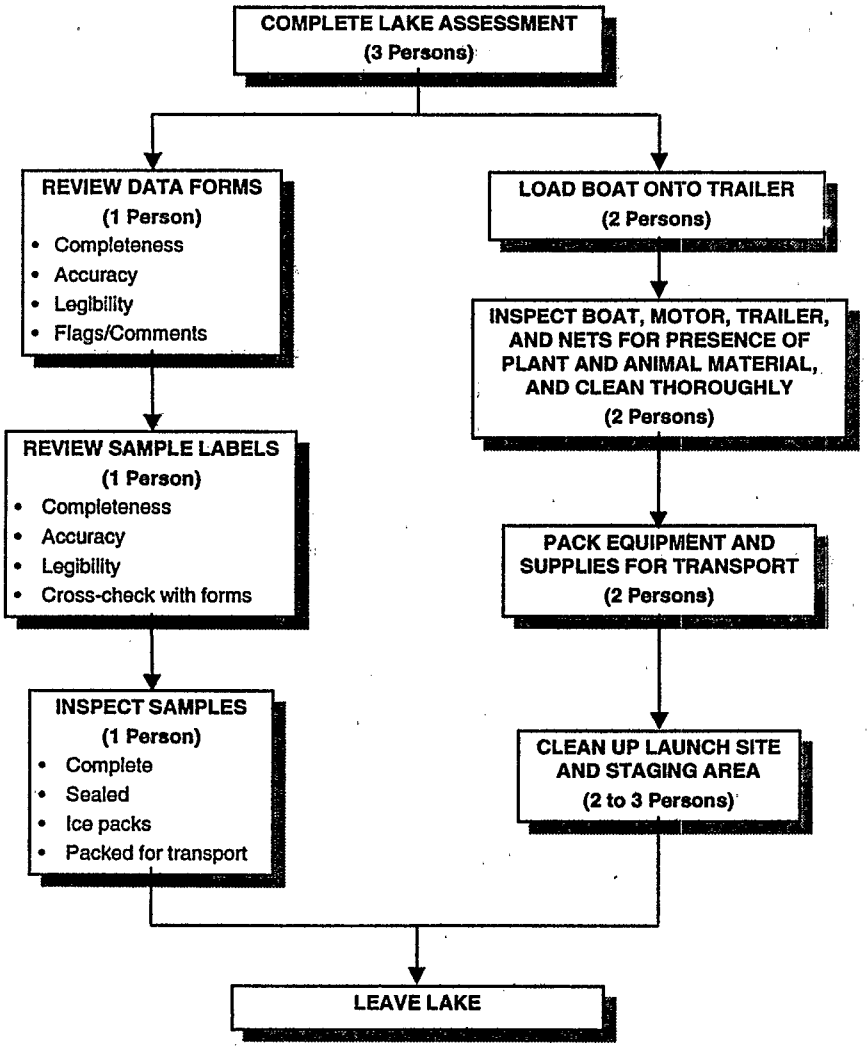
Prior to leaving the lake, the field team makes a general assessment of the lake and makes a final check of the data forms and samples. The objective of the lake assessment is to record field team observations of catchment and lake characteristics that are useful for future data interpretation, ecological value assessment, development of associations, and verification of stressor data. The observations and impressions of field teams are extremely valuable. The objective 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 9-1.

9.1 GENERAL LAKE ASSESSMENT

The team members complete the Lake Assessment Form (figures 9-2 and 9-3) 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: Lake Site Activities and Disturbances, General Lake Information, Shoreline Characteristics, Qualitative Macrophyte Survey, and Qualitative Assessment of Environmental Values.

9.1.1 Lake Site Activities and Disturbances

Record any of the stressors listed in Table 9-1 on the Lake Assessment Form, Side 1 (Figure 9-2), 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, moderate, or heavy by putting an L, M, or H on the line next to the listed stressor. Leave the line blank for any stressor not observed. The distinction between low, moderate, and heavy will be subjective. For example, if there are two to three houses on a lake, mark the "Houses" line with an "L" for low. 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.



FLDOPEX95.PPT 3/95

Figure 9-1. Final lake activities summary.

LAKE ASSESSMENT FORM

LAKE NAME: L. WOEBEGUS DATE OF VISIT: 7/14/94 VISIT #: (1) 2

LAKE ID: NY0001L TEAM ID (circle): 1 (2) 3 4 5 6 7 8 9 10 OTHER:

LAKE SITE ACTIVITIES AND DISTURBANCES OBSERVED (INTENSITY: BLANK = NOT OBSERVED, L = LOW, M = MODERATE, H = HEAVY)

RESIDENTIAL	RECREATIONAL	AGRICULTURAL	INDUSTRIAL	LAKE MANAGEMENT
M Residences	L Parks, Campgrounds, Beaches	___ Cropland	___ Industrial Plants	___ Macrophyte Control
L Maintained Lawns	___ Primitive Parks, Camping, Beaches	___ Pasture	___ Mines/Quarries	___ Liming
___ Construction	___ Resorts	___ Livestock	___ Power Lines	___ Drinking Water Treatment
___ Piers, Drains	___ Marinas		___ Power Plants	M Angling Pressure
___ Treatment Plant	___ Trash/Litter		___ Logging	
___ Landfill, Dumping	___ Surface Films, Scums, or Slicks		___ Evidence of Fire	
			___ Odors	

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	
Swimmability	☒ Good	☐ Fair	☐ Not Swimmable	
Lake Level Changes	☐ Zero	☒ Elevation Change = 0.3 M		

SHORELINE CHARACTERISTICS (% of shoreline)

Forest/Shrub	☐ 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%)
Open Grass	☒ 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%)
Barren (Beach)	☒ Rare (<5%)	☐ Sparse (5 to 25%)	☐ Moderate (25 to 75%)	☐ Extensive (>75%)
Developed	☒ 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%)

QUALITATIVE MACROPHYTE SURVEY

Macrophyte Density	☐ Absent	☒ Sparse	☐ Moderate	☐ Dense
Emergent/Floating Coverage (% Lake Area)	☒ 0 to 25%	☐ 25 to 50%	☐ 50 to 75%	☐ > 75%
Submergent Coverage (% Lake Area)	☒ 0 to 25%	☐ 25 to 50%	☐ 50 to 75%	☐ > 75%

DESCRIPTION:

(Continued on reverse side)

REVIEWED BY (INITIAL): JG

Figure 9-2. Lake Assessment Form, Side 1.

LAKE ID: NY0000L — LAKE ASSESSMENT FORM (continued) — VISIT #: (1) 2

QUALITATIVE ASSESSMENT OF ENVIRONMENTAL VALUES

TROPHIC STATE: ☒ Oligotrophic ☐ Mesotrophic ☐ Eutrophic ☐ Hypereutrophic

VISUAL ASSESSMENT: Clear water - No scum or evidence of algal blooms

ALGAL ABUNDANCE & TYPE: None observed

NUTRIENT STATUS: Appear to be low -- No sources observed around lake

OTHER:

FISHABILITY: ☒ Excellent ☐ Good ☐ Fair ☐ Poor

CONDITIONS:

LOCAL CONTACTS:

OBSERVATIONS: Good trout and salmon populations. Abundant bait fish.

OVERALL BIOTIC INTEGRITY: ☒ Excellent ☐ Impacted ☐ Severely impacted

GENERAL ASSESSMENT: Little human impact is apparent.

WILDLIFE OBSERVED: Moose, Sea Gulls, Frogs, Grouse, Minks, Loon, Deer

WATERBODY CHARACTER (CIRCLE ONE)

PRISTINE	(5)	4	3	2	1	DEVELOPED
APPEALING	(5)	4	3	2	1	UNAPPEALING

COMMENTS:

REVIEWED BY (INITIAL): JA

Figure 9-3. Lake Assessment Form, Side 2.

TABLE 9-1. 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.
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.
Treatment Plant	Presence of sewage treatment facility.
Landfill	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.
Parks, etc.	Presence of organized public or private parks, campgrounds, beaches or other recreational areas around the lake. If there are signs of informal areas (e.g., swimming hole) for camping, swimming, or boating around the lake, record them on the "parks, campground, beaches" line and note that they are informal in the "Comments" section on Side 2.
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.
Scum/Slicks	Relative abundance of scum or slicks on the lake.
Agriculture	Presence of cropland, pasture, orchards, and livestock.
Industry	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.
Mine/Quarry	Any evidence of mining or quarrying activity 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/Fires	Any evidence of logging or fire removal of trees in the lake area.
Odors	Presence of any strong odors.
Macrophyte Control	Any evidence of dredging or the application of chemicals; describe these in the "Comments" section on Side 2.
Liming	Any evidence of liming activities.
Drinking Water Treatment	Presence of any drinking water treatment facilities.
Angling Pressure	Estimate of the intensity of fishing activity in the lake.

Record any other oddities observed or additional information for any specific activity in the "Comments" section on Side 2.

9.1.2 General Lake Information

Observations regarding the general characteristics of the lake are described in Table 9-2, and are recorded on Side 1 of the Lake Assessment Form (Figure 9-2). 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.

9.1.3 Shoreline Characteristics

Shoreline characteristics of interest during the final lake assessment are described in Table 9-3. Observations related to this portion of the assessment are recorded on the Lake Assessment Form, Side 1 (Figure 9-2). 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.

9.1.4 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 EMAP-SW purposes is the percentage of the lake area covered with macrophytes. For both "emergent/floating" and "submergent" coverage, choose one of the four percentage groupings (0 to 25 percent, 25 to 50 percent, 50 to 75 percent, 75 to 100 percent), on Side 1 of the Lake Assessment Form, that best describes the lake. 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 either 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 9-2).

9.1.5 Qualitative Assessment of Environmental Values

The goal of EMAP-SW is to assess three major ecological values with respect to lakes: trophic state, fishability, and biotic integrity. Based on your field experience, record your own

TABLE 9-2. 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 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 9-3. 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 nonforested wetlands (submerged terrestrial vegetation).
Barren	Nonvegetated 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.

assessment of these values on the Lake Assessment Form, Side 2 (Figure 9-3). 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).

Fishability is a fish assemblage containing fish that are catchable, desirable, and safe to consume by wildlife and humans. Write down any observations about fishability derived from impressions of fish habitat, conversations with locals, or the presence of fish and fishermen.

Biotic 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 on 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.

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 EMAP Surface Waters group 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 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.

9.2 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 same team member also inspects all sample containers and packages them in preparation for transport, storage, or shipment. The other 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 9.3.

Ensure that all required data forms for the lake have been completed. It is important to verify that there is a Fish Tally Form completed for every piece of fishing gear used on the lake. 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 (except for those in the fish jars) with clear plastic tape.

9.3 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 and dead fish 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 B).

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. Dispose of fish carcasses as directed by the collecting permit or the fish protocol.

APPENDIX A

AVIAN INDICATOR FIELD OPERATIONS MANUAL

Data on bird assemblages were collected by different crews on separate visits than those who collected data for other indicators. A separate field operations manual was developed specifically for the avian indicator. The manual included in this appendix has been re-formatted and re-organized from the original to be consistent with the rest of the EMAP-SW lakes field operations manual. However, no revisions to the technical content have been made by the editors.

FIELD OPERATIONS MANUAL- BIRDS

1994

by
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1.0 OVERVIEW

Personnel from the Wildlife Department at the University of Maine have been contracted by the Environmental Protection Agency (EPA) to determine whether birds can serve as indicators of the biotic integrity of lakes and ponds in New England, New York, and New Jersey. The following document discusses operations necessary to complete the fieldwork.

1.1 Participating Organizations and Responsibilities

Cooperators on this project include personnel from the EPA's Environmental Monitoring and Assessment Program (EMAP), ManTech Environmental Technology, Inc. (METI), Lockheed Engineering and Sciences Company (LESC), and the University of Maine, Orono campus (UMO). EMAP, METI, and LESC work together to provide UMO with logistics information about the lakes to be surveyed. From here on, we will use the term EMAP to include personnel from EMAP, METI, and LESC. EMAP will provide UMO with a list of the lakes to be surveyed (including latitude, longitude, and size of each lake), landowner permission forms, outlines (to scale) of the lakes, any available directions to the lakes and other logistic information. The list of lakes to be surveyed should be provided to UMO prior to March 15, 1994 so UMO can have enough time to plan fieldwork. EMAP will secure permission for UMO to access those lakes.

UMO is responsible for ensuring that fieldwork is completed according to the strict protocols designed for this project, which will be discussed in Section 4. UMO will provide EMAP with photocopies of all data sheets after the fieldwork is completed. After data is entered and error checked, UMO will send an electronic copy of the data to EMAP.

1.2 Field Personnel, Training, and Quality Assurance

It is anticipated that fieldwork for the 1994 season will require at least five crews. Each crew consists of two people, one person to record habitat data, the other to record bird information. The bird surveyor will be the more experienced field person and will serve as crew leader. Personnel hired for habitat and bird data collection will be trained during April and May 1994. Training will involve going out in the field daily to practice bird censusing and habitat identification on land, as well as implementing the censussing protocols on lakes. Bird surveyors will be required to demonstrate at least a 90% proficiency on a Quality Assurance (QA) test of bird identification skills administered by Norm Famous, QA officer. This test will consist of taped bird calls likely to be encountered in the region the surveyor will be working. Additionally, censussers will be tested on bird identifications in the field using the protocols that will be followed during fieldwork. Habitat personnel will be tested by having

them simultaneously assess habitats in sample census plots. This will allow us to examine how variable estimates are among crews.

One mid-season QA test will be administered by an experienced ornithologist to each crew during an actual survey in mid-June. Each surveyor will be required to have at least a 90% overlap with the species identified by the ornithologist. Habitat personnel will not be required to take a mid-season QA test, but by going out with each crew, the ornithologist will be able to assess whether field personnel differ greatly in their estimations.

1.3 Sampling Schedule - 1994

All lakes will be surveyed during May 28-July 7, 1994. Lakes in the southern region (e.g., New York, New Jersey) will be surveyed earlier in that period than those in northern areas (e.g., Maine).

2.0 DAILY OPERATIONS

Each crew will pre-survey the lake the evening before the actual census to determine if any problems will be encountered in the morning. If the lake is large (>4800 m perimeter), then crews will need to map the habitat types in the evening and stratify census plot locations according to those habitat types. Crews may also wish to record habitat data during the evening pre-survey to save time in the morning. If all of the lakeshore can be seen from land, then it is unnecessary to go out on the water during the pre-survey.

Crews will arrive at the lake an hour before sunrise so that they can start the survey one-half hour before sunrise. An equipment checklist will be completed before launching the canoe to begin the survey (Figure A-1). The survey will be completed by four hours after sunrise or when one circuit around the lake has been completed, whichever is shorter.

After the survey, crews will check all data sheets to make sure everything is filled out appropriately. Crews will then travel to the next lake, find a place to stay, and conduct a pre-survey.

Crews will be required to phone UMO every day and report on their progress. Every third day, crews will photocopy data sheets and mail them to UMO.

3.0 LAKE LOCATION AND VERIFICATION

In general, each crew will be responsible for surveying 20 lakes. Prior to the field season each crew will be provided with maps of their assigned lakes. In the field, each lake

Quantity	Item	
2 pr.	Field glasses	
2	Field notebook (waterproof surveyor's notebook)	
2	Clipboard (2)	
30	Field recording forms	
5	Large ziplock bag (5)	
1 ea.	Maps of lake (topographic and sketch)	
1	Tape recorder	
6	Extra batteries (size D)	
1	Tape with wetland bird songs	
4	Ballpoint pens	
4	B pencils (for use if recording forms become damp)	
1	Compass with clinometer	
1	Thermometer	
1	Stopwatch	
1	Habitat analysis protocol	
1	Bird census protocol	
1	canoe	
1	outboard motor fuel tank (full) bailer	
3	paddles (including 1 spare)	
2	type IV life preservers	
1	first aid kit	
1	fire extinguisher	
1-2	anchor(s) and rope(s)	
DATE:	OBSERVER:	

Figure A-1. Equipment checklist for lake survey field crews.

will initially be located based on topographic maps or road atlases. Crews will then check whether the map of the outline of the lake provided by EMAP matches the actual outline. Verification can also be checked by asking people in the area to identify the lake.

Crews will determine if the lake meets the EMAP criteria (i.e., ≥ 1 ha in total surface area, ≥ 100 square meters of open water, and ≥ 1 m in depth). Any lake that does not match these criteria will be designated as a "non-target" lake and will not be surveyed. EMAP will be notified of any "non-target" lakes so that substitutes can be chosen.

4.0 DATA COLLECTION

Crews will survey both shoreline habitat and birds in a circular plot with a 200 m diameter (Figure A-2). Plots will be established every 200 m on lakes with a perimeter ≤ 4800 m, starting 200 m from the boat ramp (or put in, if no ramp is present) in a clockwise direction until one circuit around the lake is completed. If fewer than 6 census points can be fit on the lake during the first circuit, then the number of points will be determined according the protocol listed in Table A-1. On lakes with a perimeter larger than 4800 m the maximum number of census plots will be 24 and the minimum will be 20. Location of these points will be stratified according the occurrence of major habitat types (Table A-2).

Location of all census plots will be recorded on the map outlines and a description of the census point will be recorded in a field notebook by the crew leader.

4.1 Bird Data

Bird data must be collected between one-half hour before and four hours after sunrise on days that meet the required weather conditions (item 3, Table A-3). All birds seen and heard during five minutes will be recorded according to the protocol (Table A-3). Birds will be identified to the species level. If the surveyor does not see or hear the bird well enough to identify it to the species level, it will be identified to the lowest taxonomic level possible (e.g., genus, family). The method of identification (i.e., visual or aural), location of the bird (e.g., within 100 m, in the air, in the water, or on land), and the number of individuals will be recorded as well (Figure A-3).

4.2 Habitat Data

Habitat data will be taken during the five minutes spent at each census station (figures A-4 and A-5). The percent cover of several habitat types will be estimated by quarter in the census plot . Habitat types are defined in the protocol for the recording of habitat data (tables A-4 and A-5). In forested habitats, the two dominant tree species will be

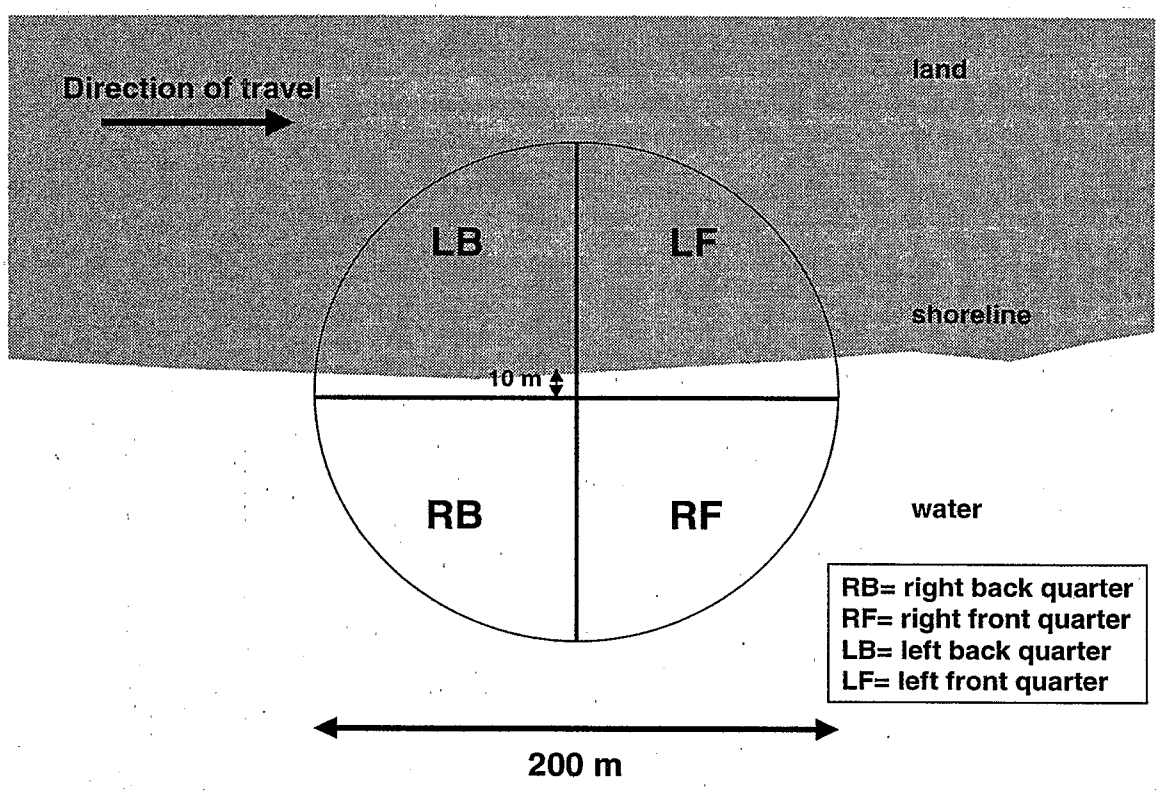

Figure A-2. Census plot design.

TABLE A-1. PROTOCOL FOR THE NUMBER OF STOPS TO BE CENSUSSED

If the lake is larger than 4800 m you will need to allocate the number of stops based on percent of each habitat type listed on the 'habitats to stratify on' sheet that I gave you earlier. When you allocate stops in a particular habitat start 200 m inside that habitat type. If the habitat type is equal to 200 m then put the stop in the middle. If the habitat type is less than 200 m of the shoreline, do not count it as a separate habitat type.

For the small lakes, start 200 m in a clockwise direction from the boat ramp. If six or greater stops can be fit on the first trip around the lake, do only 1 circuit. If only 3-5 stops can be fit, then go around one more time (doing the same stops over again). If only 1-2 stops fit on the lake, continue sampling until you complete 6 stops. For the 2-stop lake that would mean going to the same stops three times. For the 1-stop lake, you will do the same stop six times. Wait 5 mins. between each census.

TABLE A-2. HABITAT TYPES ON WHICH TO STRATIFY PLOT LOCATIONS

Habitat type	Categories on habitat form which are included in the major habitat type
Marsh	tall and short marsh, wet grassland
Bog	low shrub swamp types
Tall shrub swamp	tall shrub swamp
Low shrub swamp	low shrub swamp
Wooded swamp Deciduous Mixed Coniferous	all height and canopy closure classes for these three wooded swamp types
Upland Forest Deciduous Mixed Coniferous	all height and canopy closure classes for these three upland forest types
Agricultural	croplands (grain and vegetable), pasture, hayfield, orchard
Transitional	clear cuts, old-field (grass and shrub)
Urban	urban
Forested suburban	forested suburban
New suburban	new suburban
Old suburban	old suburban
Transportation/ Communication	transportation/communication

Note: the four housing types (urban, suburban, old and new suburban) may need to be combined if separately they do not account for enough of the shoreline to be sampled.

TABLE A-3. PROTOCOL FOR SURVEYING BIRDS

1. Lakes will be visited generally from a south to north direction, thereby taking advantage of any seasonality present in bird behavior. Logistical factors may make it expedient not to follow the south to north sequence rigorously.

2. Whenever possible, crews will visit each lake immediately prior to the first census (typically by visiting it the previous evening), to review the habitat present and to confirm that no special problems will be encountered there.

3. Surveys will be conducted from 0.5 hour before sunrise to 4 hours after sunrise on days with good visibility, and minimal precipitation and wind, following the guidelines of the USFWS BBS. Wind speed will be measured on the Beaufort scale (a 3 or less indicates acceptable conditions); Sky conditions will be noted using Weather Bureau codes. Light fog and rain will be considered acceptable if they are not persistent. If 50% of the census points have sub-standard weather conditions the lake will be surveyed again.

4. Each field crew will use a motorized canoe to follow a transect parallel to 10 m from the lake shore. The direction of travel will be clockwise around the lake unless the crew decides that it is prudent to follow a different course (e.g., in order to avoid obstacles or take advantage of wind conditions). The direction of travel for the second visit will be the same as during the first visit, even if the first circuit was traveled counterclockwise. At each observation point the motor will be shut off and birds seen or heard during a 5-minute period will be noted. Numbers of all birds seen or heard will be recorded in ink or with a letter B pencil on a standard survey form. Observers will distinguish individuals seen:

    - flying overhead vs. on the water vs. on land
    - between observation points vs. at observation points
    - within 100 m of points vs. more than 100 m; for the distant registrations the stop to which they are closest will be recorded
    - from birds heard (though both categories will be recorded)

5. When habitats which normally host typically secretive marsh birds (e.g., bitterns) are present, observers will play a standardized tape recording of the calls of these species, to increase their detection. Thirty seconds of calls for each of the following species will be played: Pied-billed Grebe, Sora, Virginia Rail, American Bittern, American Coot, Common Moorhen, and the Yellow Rail. The taped calls will be played immediately preceding the 5-minute census period.

6. Census points will be 200 m apart, with distance between points judged using a range finder. Each lake will have a minimum of 3 and a maximum of 24 census points. On small lakes, the number of stops censussed will be based on the number that can be fitted (200 m apart) in the first circuit around the lake. On large lakes where the perimeter exceeds 4800 m so that more than 24 points could be accommodated, the 24 points censussed will be stratified by habitats present. The amount of each habitat will be measured using map wheels to quantify the amount of each habitat present based on the evening pre-survey. Census points will be allocated according to the percent of each habitat type found along the shore. The exact location of census points will be based on distance from launch site (preference given to those closest) and will begin 200 m from the closest edge of a habitat type. If the amount of habitat is between 200 and 400 m, then the census point will be located in the middle of it to allow all of the census point to cover that habitat type. If less than 200 m of a particular habitat are present then it will not be considered a separate habitat type and will not be allocated any census points. If a habitat type is greater than 200 m, but comprises less than 1/24 of the perimeter of the lake it will still be allocated a census point.

7. The position of each census point will be marked on a map of the lake. This map should contain sufficient detail with respect to landmarks to allow the census points be identified in later visits.

8. The equipment required by each team is listed in Figure 1. The list will be checked daily.

LAKE SURVEY BIRD DATA SHEET page of

Lake ________________ State___ Date / / Observer ________

mm/dd /yy

Location	Species	ID Method AUDIO or VISUAL	Within 100m ? YES or NO	Habitat AIR or LAND or WATER	# of indiv.

Form UMNEBP/SDF5-04-29-92 New England Biodiversity Project

Figure A-3. Data sheet used to collect information on birds.

WEATHER

100. TEMPERATURE (°C): _____

101. WIND (circle one)

Beaufort No.:	Indicators:
0	smoke rises vertically
1	wind direction shown by smoke drift
2	wind felt on face; leaves rustle
3	leaves, small twigs in constant motion; light flag extended
4	raises dust and loose paper; small branches are moved
5	small trees in sway; white caps on lakes

102. SKY (circle one)

Sky code:	Description:
0	clear of few clouds
1	partly cloudy (scattered) or variable sky
2	cloudy (broken) or overcast
4	fog or smoke
5	drizzle
8	showers

HABITAT ELEMENTS

103. Number of visible boats containing people on water: _____

104. Number of camps and homes within 100 m: _____

105. Number of people within 100 m: _____

106. Islands present within 100 m? _____

107. Dead/dying trees ≥10 cm DBH present within 5m of or in wetland? _____

108. conifer type: (circle one)

white/red/pitch/jack Pine red/black/white Spruce Fir

Larch Hemlock White cedar Other:_____

109. Hardwood type: (circle one)

red/silver/sugar Maple red/white/scrub Oak

quaking/balsam/bigtooth Aspen white/yellow Birch Beech

Other:_____

110. Comments:_____

_____FORM

UMNEBP / SDF6B-05-01-92

Figure A-4. Data sheet used to collect habitat information.

LAKESHORE HABITAT SURVEY FORM

1. Observer _____ 2. Lake _____ 3. State _____ 4. Date __/__/__ (mm/dd/yy) 5. Stop ____ 6. Time ____

NON-FOREST	Quarter (cover code)			
	RF	RB	LB	LF
9. Transport / Comm				
10. Hayfield				
11. Pasture				
12. Old field-grass				
13. Old field-shrub				
14. Cropland-vegetables				
15. Croplands-grains				
16. Orchard				
17. New suburban				
18. Forested suburban				
19. Old suburban				
20. Urban				
21. Non-vegetated				
22. Other terrestrial				
26. Lake / pond				
28. Wet grasslands				
29. Low marsh				
30. Tall marsh				
31. Low shrub swamp				
32. Tall shrub swamp				

HABITAT ELEMENTS (present=1, absent=blank)				
33. Stream				
34. Bridge				
35. Cliff				
36. Sand bank				
37. Farm buildings				
38. Wet road ditches				
39. Isolated trees				
40. Clear cutting				
41. Selective cutting				

COVER CODES: blank = ≤5%, 1 = >5 - 25%,
2 = >25 - 50%, 3 = >50 - 75%, 4 = >75%
FOREST CATEGORY: Deciduous = >75% deciduous,
Mixed = <75% decid .& <75% conif., Coniferous = >75% conif.

FOREST				UPLAND FOREST Quarter (cover code)					WOODED SWAMP Quarter (cover code)			
	CLOSURE	TYPE	HT.	RF	RB	LB	LF		RF	RB	LB	LF
42.	CLOSED	Deciduous	<5m					43.				
44.	(>60% closure)		5-15m					45.				
46.			>15m					47.				
48.		Mixed	<5m					49.				
50.			5-15m					51.				
52.			>15m					53.				
54.		Coniferous	<5m					55.				
56.			5-15m					57.				
58.			>15m					59.				
60.	OPEN	Deciduous	<5m					61.				
62.	(<20% closure)		5-15m					63.				
64.			>15m					65.				
66.		Mixed	<5m					67.				
68.			5-15m					69.				
70.			>15m					71.				
72.		Coniferous	<5m					73.				
74.			5-15m					75.				
76.			>15m					77.				
78.	MIDDLE	Deciduous	<5m					79.				
80.	(20 - 60% closure)		5-15m					81.				
82.			>15m					83.				
84.		Mixed	<5m					85.				
86.			5-15m					87.				
88.			>15m					89.				
90.		Coniferous	<5m					91.				
92.			5-15m					93.				
94.			>15m					95.				

FOREST UNDERSTORY (cover code)	RF	RB	LB	LF
96. Shrub cover				
97. Herb cover				
LOW SHRUB SWAMP Type (cover code)	**RF**	**RB**	**LB**	**LF**
98. Ericaceous shrub				
99. Sphagnum-mat bog shrub				

FORM UMNEBP/SDF6A-04-29-92

Figure A-5. Lakeshore Habitat Survey Form.

TABLE A-4. PROTOCOL FOR HABITAT DATA COLLECTION.

1. Habitats will be surveyed at each bird census stop. Habitat assessment should be completed within the five minutes spent at each stop.

2. The available cover types will be classified into 91 habitat categories, which are described in Table A-5. The sample are includes the four quarters of a circle with a 100 m radius. Quarters will be defined by a line parallel to the shoreline adjacent to the stop and a line perpendicular to the parallel line. When the stop is located at a bend in the shoreline, the perpendicular line will be perpendicular to the forward direction of travel. The 100 m radius will be estimated using a range finder.

3. Percent cover of each cover type will be estimated within each quarter of the circle. The amount of a cover type will be assigned to one of five categories: blank= 0 to 5%, 1= > 5 to 25%, 2= > 25 to 50%, 3= > 50 to 75%, and 4= > 75%. In forested habitats, the two dominant tree species will be listed. The presence of habitat elements, such as streams, cliffs, houses, snags, boats, and farm buildings, within the census plot will be recorded.

4. Weather data including temperature (Celsius, measured with a thermometer), wind (Beaufort scale, Table A-6), and sky conditions (Table A-6) will be taken at all stops.

TABLE A-5. DEFINITION OF HABITAT TYPES

Habitat Type	Definition
Terrestrial Systems	
Cropland - grains	tilled agricultural land planted in grains (e.g., corn, wheat, barley).
Cropland - vegetable	tilled agricultural land planted in vegetable crops (e.g., broccoli, potatoes, tomatoes).
Pasture	grazed grasslands, usually too wet or rocky for cultivation or haying; grass is dominant in the long-term.
Hayfield	mowed grasslands where grass is dominant in the long-term; this can include extensive, mowed road verges and mowed areas at airports.
Orchard	fruit or Christmas trees < 5 m tall with grassy ground cover.
Old field - grassland	abandoned agricultural fields reverting to forest, characterized by ≥ 75% of grass cover, < 25% shrubs, and small trees (< 2 m).
Old field - shrub	abandoned agricultural fields reverting to forest, characterized by < 75% grasses, ≥ 25% shrubs, and small trees (< 2 m); this can include power line right-of-ways.
New suburban	areas with extensive low-cut grass and few trees, which are < 10 m tall, or have ≤ 20% canopy closure; this can include athletic fields, lawns, cemeteries, golf courses, and tract housing.
Old suburban	areas with extensive low-cut grass and few trees, which are ≥ 10 m tall and have > 20% canopy closure; this includes older cemeteries and parks, and suburban areas with large trees.
Forested suburban	houses in small, forest openings surrounded by pre-existing forest.
Urban	greatly developed areas with large buildings and parking lots.
Non-vegetated	non-urban areas lacking vegetation; this includes gravel and dirt pits.
Transportation/ communication	areas used for transportation or communication; this includes airport runways, roads, railroads, and boat ramps.
Upland forest	upland forested habitats will be broken down by three qualities: type, height, and canopy closure. Type refers to the canopy type (i.e., deciduous, mixed, coniferous). Deciduous forests have ≥ 75% deciduous trees, coniferous forests have ≥ 75% coniferous trees, and the mixed forest type has < 75% conifers and < 75% deciduous trees. Height categories will be < 5 m, 5 to 15 m, and > 15 m tall. canopy closure will be placed into three categories: open (< 20% closure), middle (20 to 60% closure), and closed (> 60% closure). This results in 27 (3 x 3 x 3 = 27) possible types of forest.
Other	miscellaneous and rare terrestrial habitats.

(Continued)

TABLE A-5 (continued)

Habitat Type	Definition
Aquatic Systems	
Wooded swamp	forested areas that are inundated by water seasonally or all year; wooded swamps will be described using the same 27 types discussed under upland forest habitats.
Tall shrub swamp	dominated (≥ 75% cover) by woody plants 1 to 5 m tall where soils are inundated by water much of the year; this generally includes alder swamps.
Low shrub swamp	woody plants < 1 m tall dominate (≥ 75% cover); soils are inundated by water much of the year.
sphagnum-mat bog	woody plants ≥ 1 m tall common, but < 75% cover, and sphagnum mats ≥ 25% of cover; soils inundated by water much of the year.
Wet grasslands	areas dominated by non-*Spartina* sedges, grasses, and rushes ≤ 1 m tall; soils are inundated with water in the winter and early spring, and saturated in the summer.
Tall marsh	wet areas vegetated with persistent emergents > 1 m tall, ≤ 50% open water; this includes cattail and reed marshes.
Low marsh	shallow water vegetated with herbaceous broad- leaved emergent plants ≤ 1 m tall, ≤ 50% open water; this includes areas with pickerel weed and lily pads.
Lake/pond	permanent bodies of fresh water ≥ I ha in size; this includes the parts of the lake/pond that are located within the census plot.
Habitat Elements:	
Stream	permanent or intermittent flowing bodies of water < 3 m wide.
Bridge	a structure elevated > 1 m over land or water and > 5 m long.
Cliff	rocky outcroppings > 5m tall.
Sand bank	sandy, abrupt drop-off > 5 m tall.
Farm buildings	barns and storage sheds used for agricultural purposes.
Wet road ditches	ditches along the road that have > 10 m long section of persistent emergent vegetation (e.g., cattails, tall reeds).
Isolated trees	isolated single or group of trees in croplands, hayfields, pasture, and reverting fields that do not register as forest.
Clear cutting	<25% cover of overstory trees and evidence of wood cutting (e.g., wood and brush piles, stumps) within the last 5 years.
Selective cutting	≥ 25% cover of overstory trees and evidence of wood cutting (e.g., wood and brush piles, stumps) within the last 5 years.

recorded. Presence of people, boats, houses, and snags will also be noted. Weather information (cloud cover, temperature, wind) will also be taken by the habitat data recorder (Table A-6).

5.0 SAFETY ISSUES

Strict safety protocols (Table A-7) will be followed while crews are in the field.

5.1 Personnel

Each crew will be provided with a first aid kit, a fire extinguisher, information regarding Lyme's disease, and a mobile telephone. Crews will wear personal flotation devices while in the canoes and will not go out on the water if conditions appear dangerous (e.g., large waves, heavy winds, storm-front moving in). Crews will be required to call the UMO Wildlife Department every day and report where they are and the lakes they plan to survey during the next three days. There will be a person in the UMO Wildlife Department specifically hired to receive these daily calls and to check off lakes as the crews complete them.

5.2 Data

Data sheets from each lake will be photocopied and the copies mailed to the UMO Wildlife Department within three days of visiting that lake. The same person who takes the phone calls at UMO will also keep track of which data sheets have been received.

TABLE A-6. CODES USED TO RECORD WIND AND SKY CONDITIONS.

Weather Variable	Scale	Description of Condition
Wind	Beaufort	
	0	smoke rises vertically
	1	wind direction shown by smoke drift
	2	wind felt on face; leaves rustle
	3	leaves, small twigs in constant motion; light flag extended
	4	raises dust and loose paper; small branches are moved
	5	small trees in sway; white caps on lakes
Sky	Sky code (eighths)	
	0	clear or few clouds
	1	partly cloudy (scattered) or variable sky
	2	cloudy (broken) or overcast
	4	fog or smoke
	5	drizzle
	8	showers

TABLE A-7. SAFETY PROTOCOL

1. Check weather conditions the day before and the morning of the scheduled survey to determine if weather will be hazardous to canoe travel. If thunderstorms or other unsafe weather conditions are predicted for the early morning, the team will have to decide if they can complete the survey prior to the onset of bad weather.

2. When traveling in the canoe all individuals will wear life preservers.

3. A fire extinguisher will be carried when using the motorized canoes

4. A checklist of equipment will be reviewed every morning prior to launching the canoe.

5. Each crew will contact the Wildlife Department every day to notify people of their location, any problems, and itinerary for the next 3 days.

6. An extra spark plug and the tools needed to change the plug will be carried in the canoe when the motor is being used.

7. The fuel tank level will be checked prior to every use to ensure adequate fuel supply for that particular survey.

8. Refer to Lyme disease information sheet that will be provided for precautions to be taken regarding that.

9. Flight safety protocol will include checking to see if the pilot and plane is OAS certified, that a flight plan has been filed, and the weights of all gear should be provided to the pilot so that he can properly place everything. No synthetic clothing should be worn to decrease severity of burns that could occur in a crash.

10. Follow precautions that will be provided while using the cellular phone.

11. To guard against loss of data, data sheets will be photocopied and the photocopies will be mailed to the UMO Wildlife Department every three days.

APPENDIX B

LAKE-VISIT CHECKLISTS

LAKE-VISIT CHECKLISTS

Items in Forms File	Number Needed Each Lake
Lake information packet for lake to be sampled; includes:	1
Benthic Sample Location and Collection Form	2
Physical Habitat Sketch Map Form	2
Lake Verification Form	1
Lake Profile Form	2
Sample Collection Form	2
Lake Assessment Form	2
Physical Habitat Characterization Form	2
Physical Habitat Comments Form	3
Blank Map Forms (Benthic, Verification, and Sketch Map)	5 each
Fish Tally Form	50
Fish Tally Continuation Form	10
Fish Length Form	10
Fish Tissue Tracking Form	2
Field notebook	1
Field Operations Manual	1
Taxonomic keys set	1
Sediment cores label sheet	1
Zooplankton label sheet	1
Fish tissue label sheet	1
Water chemistry label sheet	1
Chlorophyll label sheet	1
Voucher tag sheet	1 set
EMAP pamphlets	20
Sampling permit	1
Quick reference handbook	1
Shipping airbills	10

S	M	T	W	T	F	S	Items in the Boat	Number Needed Each Lake
							Life vests	3
							Anchor with 50-m line and float	1-2
							Bailing bucket	1
							Air horn	1
							Oars, pair	1
							First aid kit	1
							Spare tire (trailer)	1
							Trailer straps	2
							Transom plug	1
							Bow light with good batteries	1
							Stern light with good batteries	1
							Bow line, 5-m	1
							Fuel tank with gas and oil	1
							PVC pipe, 3-m length	1
							Indiana trap nets	1 per expected number of sets
							Beach seine	1
							Short-haul line	1

Items in 80-qt Cooler #1	Number Needed Each Lake
Sonar unit with manual	1
Transducer with bracket and C-clamp	1
12-V wet cell battery (charged) in battery case	1
GPS unit with manual, reference card, extra battery pack	1
Inflatable viewing box	1
Items in 80-qt Cooler #2	**Number Needed Each Lake**
Corer with 50-m line and messenger	1
Sediment core tubes	2
Ground rubber stoppers	4
Extruder pipe	1
Sectioning stage	1
Sectioning tube	1
Siphon with L fitting	1
Plastic container (with lid) with two 1-qt self-sealing plastic bags	1
Items in 80-qt Cooler #3 (Shipping Cooler)	**Number Needed Each Lake**
0.5-gal bottles or 1-gal bottles	4
Borate buffered formalin, 40 percent	1 gal
Bleach, 1 qt	1
Vermiculite (or other absorbent), 4 qts	1
Cooler liner (30-gal garbage bag)	1
1-qt self-sealing plastic bags with punched holes	25
1-gal self-sealing plastic bags with punched holes	20
Butyl gloves	1 pair
Safety glasses	2 pair

Items in Cooler for Benthic Sampling	Number Needed Each Lake
Sieve bucket	1
Plastic funnel	1
Rinse bottle, 500-mL	1
Screen top lid (60-mesh) for sample containers	1
Sample containers, 500-mL (marked at 400-mL)	10
Heavy-duty self-sealing plastic bags, 1-gallon, labeled with station ID	10
Garbage bags, large kitchen size (for storing sample containers)	2
60-cc plastic syringe for dispensing formalin	1
Carbonate buffered formalin solution	500 mL
Surgical gloves	2 pair
Large plastic tub	1

Items in 48-qt Cooler #1 (Limnology Shipping)	Number Needed Each Lake
Plastic container with lid	1
Syringes, labeled	4
Syringe valves	4
Surgical gloves	2 pair
Cubitainer, 4-L	2
Ice in 1-gal self-sealing plastic bags	6
Cooler liner (30-gal garbage bag)	1

Items in 48-qt Cooler #2 (Fish Tissue Shipping)	Number Needed Each Lake
Ice in 1-gal self-sealing plastic bags	4
Cooler liner (30-gal garbage bag)	1
Foil, 25 yards	1
1-qt self-sealing plastic bags	10
1-gal self-sealing plastic bags	10
Composite bags (30-gal garbage bags)	4

Items in 48-qt Cooler #3	Number Needed Each Lake
Ice in 1-gal self-sealing plastic bags	4
Cooler liner (30-gal garbage bag)	1

Items in Tub #1	Number Needed Each Lake
Van Dorn with 3-m line, messenger	1
1-L wash bottle (labeled) with distilled or deionized water (DI)	1
Secchi disk	1
Sounding chain, 50-m with quick-clip	1
2-L bottle of sucrose solution	1
Parts tackle box (see below)	1
Chlorophyll tackle box:	1
Filter apparatus with filter installed	1
Hand pump with tubing	1
Box of filters (Whatman GF/F) in self-sealing plastic bag	1
Forceps in bag with filters	1
Graduated cylinders, 100-mL and 250-mL	1 each
10-cm squares of foil in self-sealing plastic bag	3
Zooplankton net bag:	1
Bongo net	1
Fine mesh and coarse-mesh buckets	1 each
Sample jars, 125-mL Nalgene (with formalin/sucrose solution)	2
Narcotization chamber	1
Alka Seltzer tablets	10
125-mL brown bottle with borate-buffered formalin, 40%	1
125-mL brown bottle with sucrose solution	1
60-mL syringe for dispensing formalin and sucrose solutions	1
Empty 125-mL Nalgene bottles	2

Items in Tub #2 (Trap Net Accessories)	Number Needed Each Lake
Anchors with 0.5-m line and quick-clips	3 per each net used
Floats with 1.5-m line and quick-clips	3 per each net used
Floats with 4-m line and quick-clips	5
Net repair twine, roll	1
Items in Tub #3 (Gill Net Accessories)	**Number Needed Each Lake**
Anchors with 0.5-m line and quick-clips or mesh bags to make anchors	2 per net
Floats with 1.5-m line and quick-clips	3 per bottom set 8 per surface net
Line sections of 5-m (clips on both ends)	10
Line sections of 10-m (clips on both ends)	10
Line sections of 30-m (clips on both ends)	10
Items in Tub #4	**Number Needed Each Lake**
Minnow traps with clips	6
Floats with 1.5-m line and quick-clips	6
5-gal buckets	2
Items in Tub #5	**Number Needed Each Lake**
Livenets, with floats	2
Dip nets	2
Waders	2 pair
Headlamps with good batteries (size C)	3
Q-beam with pigtail adapter	1
12-V wet cell battery (charged) in battery case	1
Items in Tub #6	**Number Needed Each Lake**
Swedish experimental gill nets	1 per no. of sets
Fish measuring board	1

Items in Parts Tackle Box	Number Needed Each Lake
Leatherman or Swiss Army knife	1
Pencils (and sharpener)	5(1)
Marker (permanent)	3
Extra sample labels	1 set
Alka Seltzer tablets	10
Syringe valves (in 1-qt self-sealing plastic bags)	10
Surgical gloves (in 1-qt self-sealing plastic bags)	10 pair
Paper towels	1 roll
Self-sealing plastic bags, 1-qt, 1-gal (in 1-qt self-sealing plastic bag)	10
Clear tape strips, box	1
Foil squares, 10-cm (in 1-qt self-sealing plastic bag)	10 squares
Forceps, watchmakers (pointed)	1
Forceps, Teflon (flat)	1
Messenger (for Van Dorn or corer)	1
Field thermometer, alcohol	2
Surveyor's ribbon	1 roll
Syringes	2
Batteries (AA, C, and D size)	9 AA, 4C, 6D
Electrical tape, roll	1
Strapping tape, roll	2
Metric tape measure	1
Compass	1
Solar calculator	1
O ring (corer)	2
Insect repellent	1
Screwdriver for corer	1
Headlamp	1
Hole punch	1
Pocket magnifier	1
Cotter pins	6
Crescent wrench	1
Pliers	1
"Cyalume" light sticks	6

D.O. Meter Kit in Soft Cooler	Number Needed Each Lake
Meter and manual	1
Cable and probe	1
Membrane kit and filling solution	1
Extra O-rings	1
Calibration chamber	1
Storage bottle	1

Items in Trucks	Number Needed Each Truck
Spare tire	1
Jack	1
Lug wrench	1
Shovel	1
Saw	1
Axe	1
Come-along	1
Camping gear, set	1
Food supply	1
Drinking water supply	1
Tool kit	1
Tow strap or heavy rope	1
Battery charger	1
Jumper cables	1

Information Management Items	Number
Portable computer	1
Phone cord	1
Power supply	1
Power cord	1
Extra computer battery	1
Computer carrying case	1
Surge protector	1
Kodak printer	1
Printer power supply	1
Printer carrying case	1
Computer/printer connection cable	1
Printer cartridge	1
Bar code reader	1
Bar code power supply	1
Extension cord	1
Plug adaptor 3 to 2	2
Filament tape	4
Box sealing tape	2
Boxes of 3 1/2 disks, (10 each)	2
Packs of tape pads	10
Purple file containing sample labels and bar codes	1
Purple file containing blank labels	1
Manila file containing supply replenishment forms	1
Brown file containing weekly report forms	1
Large envelope containing all weather writing paper	1
Empty folders	2
Folder containing shipping and tracking paper backup	1
Computer and printer manual	1
User's Guide	1
Envelope containing overnight shipping airbills	1

APPENDIX C

FIELD DATA FORMS

Field data forms are presented in the general order of their use at each lake:

1. Lake Verification Form
2. Lake Profile Form
3. Physical Habitat Characterization Form--Lakes
4. Physical Habitat Characterization Comment Form
5. Physical Habitat Sketch Map Form
6. Fish Tally Form--Lakes
7. Fish Tally Continuation Form--Lakes
8. Fish Length Form--Lakes
9. Fish Tissue Sample Tracking Form--Lakes
10. Sample Collection Form--Lakes
11. Benthos Sample Location and Collection Form--Lakes
12. Lake Assessment Form

LAKE VERIFICATION FORM

LAKE NAME: **DATE OF VISIT:** / / **VISIT #:** 1 2

LAKE ID: ___ ___ ___ ___ ___ L **MODE OF ACCESS:** VEHICLE HIKE-IN AIRCRAFT

TEAM ID (CIRCLE): 1 2 3 4 5 6 7 8 9 10 **OTHER:** _____

ARROW INDICATES NORTH **MARK SITE:** L = LAUNCH X = INDEX

LAKE VERIFICATION INFORMATION

LAKE SHAPE COMPARES TO MAP? ☐ YES ☐ NO

LAKE VERIFIED BY (✓ all that apply) : ☐ GPS ☐ LOCAL CONTACT ☐ SIGNS ☐ ROADS ☐ TOPO. MAP

☐ Other (Describe Here): ☐ NOT VERIFIED (Explain in Comments)

COORDINATES	LATITUDE (dd mm ss) North	LONGITUDE (ddd mm ss) West	TYPE OF GPS FIX	SIGNAL QUALITY	GEOMETRIC QUALITY	Are GPS Coordinates w/i ±1 min. of map?
Map:	___ ° ___ ' ___ "	___ ___ ° ___ ' ___ "				
Launch Site:	___ ° ___ ' ___ "	___ ___ ° ___ ' ___ "	☐ 2D ☐ 3D	_____	_____	☐ YES ☐ NO
Index Site:	___ ° ___ ' ___ "	___ ___ ° ___ ' ___ "	☐ 2D ☐ 3D	_____	_____	☐ YES ☐ NO

LAKE SAMPLED? ☐ YES ☐ NO

REASON NOT SAMPLED (EXPLAIN BELOW): ☐ NOT VISITED ☐ NON-TARGET ☐ INACCESSIBLE ☐ OTHER

Explanation:

CHECK HERE IF EXPLANATION IS CONTINUED ON BACK. ☐

DESCRIBE LAUNCH SITE, LAKE DIRECTIONS, AND ADD COMMENTS ON BACK

REVIEWED BY (INITIAL): _____

LAKE ID: ___ ___ ___ ___ ___ L LAKE VERIFICATION FORM (continued) VISIT #: 1 2

DIRECTIONS TO LAKE & LAUNCH SITE

LAUNCH SITE DESCRIPTION

GENERAL COMMENTS

EXPLANATION FOR NOT SAMPLING THE LAKE (continued from front)

REVIEWED BY (INITIAL):_____

LAKE PROFILE FORM

LAKE NAME: DATE OF PROFILE: / / VISIT #: 1 2

LAKE ID: ___ ___ ___ ___ ___ L SITE ID (circle): INDEX OTHER: ___

TEAM ID (circle): 1 2 3 4 5 6 7 8 9 10 OTHER: ___

PRECIPITATION (circle): NONE LIGHT HEAVY

SURFACE CONDITIONS (circle): FLAT RIPPLES CHOPPY WHITECAPS

ODOR? ☐ No ☐ Yes	Description:
SCUM? ☐ No ☐ Yes	Description:

INDEX SITE DEPTH: ___ ___ ___ . ___ M CHECK (✓) IF SONAR NOT USED: ☐

FLAG: COMMENTS:

DISSOLVED OXYGEN & TEMPERATURE PROFILE

(Depth of Measurement[a] [m]: Surface, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45, and 50 m), Also include readings at 1 m above bottom.

DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	METALIMNION (T, B)[b]	DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	METALIMNION (T,B)[b]
SURFACE									
SURFACE (Dup.)									

IS THE DUPLICATE O_2 READING WITHIN ±0.5 MG/L OF THE INITIAL SURFACE READING? ☐ YES ☐ NO

CHECK HERE IF ADDITIONAL PROFILE MEASUREMENTS ARE RECORDED ON THE REVERSE SIDE: ___

[a] If the site depth is ≤ 3 m, take readings at the surface, every 0.5 m, and 1 m above the bottom.

[b] METALIMNION = The region of the profile where the temperature changes at a 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 of change becomes less than 1 °C per meter) with a "B." After the metalimnion is encountered, take readings every 1 m until bottom of the metalimnion is reached. Record the depth of the top of the metalimnion on the Benthos Sample Location and Collection Form.

FLAG CODES: K = NO MEASUREMENT OR OBSERVATION MADE; U = SUSPECT MEASUREMENT OR OBSERVATION; Q = UNACCEPTABLE QC CHECK ASSOCIATED WITH MEASUREMENT; F1, F2, ETC. = MISCELLANEOUS FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION ON BACK OF FORM.

REVIEWED BY (INITIAL):_____

LAKE ID: ___ ___ ___ ___ ___ L LAKE PROFILE FORM (continued) VISIT #: 1 2

OXYGEN METER CALIBRATION INFORMATION

SALINITY KNOB AT "0-FRESH": ☐ MEMBRANE CHECK ☐ ELECTRONIC ZERO ☐ RED LINE: ☐

CALIBRATION CHAMBER TEMPERATURE: °C	SATURATED O_2 @ CHAMBER TEMP.: MG/L
LAKE ELEVATION (FROM TOPO. MAP OR ALTIMETER): FT	ELEVATION CORRECTION FACTOR: x
THE CALIBRATION VALUE IS OBTAINED BY MULTIPLYING THE SATURATED O_2 CONCENTRATION TIMES AN ELEVATION CORRECTION FACTOR (BOTH VALUES ARE OBTAINED FROM TABLES PRESENT ON THE BACK OF THE METER, OR PROVIDED IN THE MANUFACTURER'S OPERATIONS MANUAL). ADJUST THE METER READING TO THE CALIBRATION VALUE.	CALIBRATION VALUE: MG/L

FLAG	COMMENTS

DISSOLVED OXYGEN & TEMPERATURE PROFILE (continued)

For depths >15 m, continue recording at 5-m intervals)

DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T, B)[a]	DEPTH (m) XX.X	O_2 (mg/L) XX.X	TEMP. (°C) XX.X	FLAG	META-LIMNION (T,B)[a]

DEPTH & FLAG	COMMENTS

REVIEWED BY (INITIAL): _____

PHYSICAL HABITAT CHARACTERIZATION FORM-LAKES

LAKE NAME: **DATE OF VISIT:** / / **VISIT #:** 1 2

LAKE ID: _____ L **TEAM ID (circle):** 1 2 3 4 5 6 7 8 9 10 **OTHER:** ___

NEW STATION ID (if needed):										
RIPARIAN ZONE STATION ID:	A	B	C	D	E	F	G	H	I	J
VEGETATION TYPE (N=NONE, D= DECID., C=CONIF., M=MIXED) — CANOPY LAYER (> 5 M)										
VEGETATION TYPE — UNDERSTORY (0.5 TO 5 M)										

AREAL COVERAGE CATEGORIES 0 = ABSENT 1 = SPARSE (<10%) 2 = MODERATE (10 TO 40%) 3 = HEAVY (40 TO 75%) 4 = VERY HEAVY (> 75%)

CANOPY LAYER (> 5 M HEIGHT) — TREES ≥ 0.3 M DBH										
CANOPY LAYER (> 5 M HEIGHT) — TREES < 0.3 M DBH										
UNDERSTORY (HEIGHT=0.5 TO 5 M) — WOODY SHRUBS & SAPLINGS										
UNDERSTORY (HEIGHT=0.5 TO 5 M) — TALL HERBS, FORBS, & GRASSES										
GROUND COVER (< 0.5 M HEIGHT) — WOODY SHRUBS & SEEDLINGS										
GROUND COVER (< 0.5 M HEIGHT) — HERBS, FORBS, & GRASSES										
GROUND COVER (< 0.5 M HEIGHT) — STANDING WATER OR INUNDATED VEGETATION										
GROUND COVER (< 0.5 M HEIGHT) — BARREN OR BUILDINGS										
SHORELINE SUBSTRATE ZONE — BEDROCK (> 4000 MM; BIGGER THAN A CAR)										
SHORELINE SUBSTRATE ZONE — BOULDERS (250 - 4000 MM; BASKETBALL - CAR SIZE)										
SHORELINE SUBSTRATE ZONE — COBBLE/GRAVEL (2 - 250 MM; LADYBUG - BASKETBALL SIZE)										
SHORELINE SUBSTRATE ZONE — LOOSE SAND (0.06 TO 2 MM; GRITTY BETWEEN FINGERS)										
SHORELINE SUBSTRATE ZONE — OTHER FINE SOIL/SEDIMENT (< 0.06 MM; NOT GRITTY)										
SHORELINE SUBSTRATE ZONE — VEGETATED										
SHORELINE SUBSTRATE ZONE — OTHER (EXPLAIN IN COMMENTS)										
BANK FEATURES (WITHIN PLOT) — ANGLE: V = NEAR VERTICAL/UNDERCUT, S = 30-75° , G =<30°										
BANK FEATURES (WITHIN PLOT) — VERTICAL DISTANCE (M) FROM WATERLINE TO HIGH-WATER MARK										
BANK FEATURES (WITHIN PLOT) — HORIZONTAL DISTANCE (M) FROM WATERLINE TO HIGH-WATER MARK										

HUMAN INFLUENCE 0 = ABSENT CHECK (✓) = PRESENT WITHIN PLOT B = OBSERVED ADJACENT TO OR BEHIND PLOT

BUILDINGS										
COMMERCIAL										
PARK FACILITIES										
DOCKS/BOATS										
WALLS, DIKES, OR REVETMENTS										
LITTER, TRASH DUMP, OR LANDFILL										
ROADS OR RAILROAD										
ROW CROPS										
PASTURE OR HAYFIELD										
ORCHARD										
LAWN										
OTHER (EXPLAIN IN COMMENTS)										

FLAG CODES: **K** = MEASUREMENT OR OBSERVATION NOT OBTAINED; **U** = SUSPECT MEASUREMENT OR OBSERVATION; **F1, F2,** ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS ON SEPARATE COMMENTS FORM.

REVIEWED BY (INITIAL): _____

LAKE ID: _____ L PHYSICAL HABITAT CHARACTERIZATION FORM (continued) VISIT #: 1 2

NEW STATION ID (if needed):										
LITTORAL ZONE STATION ID:	A	B	C	D	E	F	G	H	I	J
STATION DEPTH (M) AT 10 M OFFSHORE										
SURFACE FILM TYPE (S=SCUM, A=ALGAL MAT, P=OILY, N=NONE/OTHER)										
BOTTOM SUBSTRATE: AREAL COVERAGE: 0=ABSENT 1=SPARSE (<10%) 2=MODERATE (10 TO 40%) 3=HEAVY (40 TO 75%) 4=VERY HEAVY (>75%)										
BEDROCK (>4000 MM; LARGER THAN A CAR)										
BOULDERS (250 - 4000 MM; BASKETBALL - CAR SIZE)										
COBBLE (64 - 250 MM; TENNIS BALL - BASKETBALL SIZE)										
GRAVEL (2 TO 64 MM; LADYBUG TO TENNIS BALL SIZE)										
SAND (0.06 TO 2 MM; GRITTY BETWEEN FINGERS)										
SILT, CLAY, OR MUCK (< 0.06 MM; NOT GRITTY)										
WOODY DEBRIS										
COLOR (BL=BLACK, GY=GRAY, BR=BROWN, RD=RED, N=NONE OR OTHER)										
ODOR (S=H_2S, A=ANOXIC, P=OIL, C=CHEMICAL, N=NONE)										
MACROPHYTES AREAL COVERAGE: 0=ABSENT 1=SPARSE (<10%) 2=MODERATE (10 TO 40%) 3=HEAVY (40 TO 75%) 4=VERY HEAVY (>75%)										
SUBMERGENT										
EMERGENT										
FLOATING										
TOTAL WEED COVER										
DO MACROPHYTES EXTEND LAKEWARD? (Y OR N)?										
FISH COVER 0=ABSENT 1=PRESENT BUT SPARSE 2=PRESENT IN MODERATE TO VERY HEAVY DENSITY										
AQUATIC WEEDS										
SNAGS > 0.3 M DIAMETER										
BRUSH OR WOODY DEBRIS < 0.3 M DIAMETER										
INUNDATED LIVE TREES > 0.3 M DIAMETER										
OVERHANGING VEGETATION < 1 M ABOVE SURFACE										
ROCK LEDGES OR SHARP DROPOFFS										
BOULDERS										
HUMAN STRUCTURES (E.G., DOCKS, LANDINGS, PILINGS, RIPRAP, ETC.)										
LITTORAL FISH HABITAT CLASSIFICATION										
DISTURBANCE (H=HUMAN N=NATURAL M=MIXED)										
COVER CLASS (C=COVER, O=OPEN, M=MIXED)										
COVER TYPE (A=ARTIFICIAL F=FILL V=VEG. W=WOODY B=BOULDERS M=MIXED N=NONE)										
SUBSTRATE (M=MUD/MUCK, S=SAND/GRAVEL, C=COBBLE/BOULDER, B=BEDROCK)										
GEAR (G=GILL NET, T=TRAP NET, S=SEINE, 0=NONE)										
GEAR LOCATION (DIST. & DIR. TO NEAREST REPRES. MACROHABITAT)										

FLAG CODES: K = MEASUREMENT OR OBSERVATION NOT OBTAINED; U = SUSPECT MEASUREMENT OR OBSERVATION;
F1, F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS ON SEPARATE PHYSICAL CHARACTERIZATION HABITAT COMMENTS FORM.

REVIEWED BY (INITIAL): _____

PHYSICAL HABITAT CHARACTERIZATION COMMENT FORM

LAKE ID: ___ ___ ___ ___ ___ L VISIT #: 1 2

TEAM ID (circle): 1 2 3 4 5 6 7 8 9 10 OTHER: _____

STATION ID	SECTION OF FORM	MEASUREMENT OR VARIABLE	FLAG	COMMENT OR FLAG EXPLANATION

FLAG CODES: K = NO MEASUREMENT OR OBSERVATION ATTEMPTED; U = SUSPECT MEASUREMENT OR OBSERVATION;
F1, F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW.

CHECK HERE IF INFORMATION IS RECORDED ON OTHER SIDE OF FORM _____

REVIEWED BY (INITIAL): _____

LAKE ID: ___ ___ ___ ___ L **PHYSICAL HABITAT CHARACTERIZATION COMMENTS FORM (continued)** VISIT #: 1 2

STATION ID	SECTION OF FORM	MEASUREMENT OR VARIABLE	FLAG	COMMENT OR FLAG EXPLANATION

CHECK HERE IF AN ADDITIONAL COMMENTS FORM IS USED ______

FLAG CODES: K = NO MEASUREMENT OR OBSERVATION ATTEMPTED; U = SUSPECT MEASUREMENT OR OBSERVATION;
F1, F2, ETC.= MISC. FLAGS ASSIGNED BY EACH FIELD CREW.

REVIEWED BY (INITIAL): ______

PHYSICAL HABITAT SKETCH MAP FORM-LAKES

LAKE NAME: **VISIT #: 1 2**

LAKE ID: ___ ___ ___ ___ ___ L **START TIME:** : **END TIME:** :

TEAM ID (circle): 1 2 3 4 5 6 7 8 9 10 **OTHER:** ____

Sketch and label riparian, in-lake, shoreline, and littoral fish habitats around the lake, using codes below. To identify littoral fish habitats on the map, compose a four-character code as: (Disturbance) (Cover class) (Cover type) (Substrate type). EXAMPLE: NCVS for Natural, Cover, Vegetated, Sand/Gravel.

RIPARIAN AND IN-LAKE CODES: WET = Wetland; BCH = Beach; RSD = Residences; PRK = Park; FST = Forest; ALT = Altered shoreline; DCK = Dock(s); MNA = Marina; CRP = Cropland; PTR = Pasture; LFL = Landfill/Dump; IND = Industry; MNG = Mining; LGG = Logging; FLM = Floating macrophytes; SBM = Submerged macrophytes; EMM = Emergent macrophytes; SHL = Shoal or Rocks.
LITTORAL FISH HABITAT CODES: (DISTURBANCE): Human, Natural, Mixed. (COVER CLASS): Cover, Open, Mixed. (COVER TYPE): Artificial structure, Fill, Vegetated, Woody, Boulders, Mixed, None. (SUBSTRATE TYPE): Mud/Muck, Sand/Gravel, Cobble/Boulders, Bedrock.

MAP OF FISH SAMPLING SITES ON BACK **REVIEWED BY (INITIAL):**_____

LAKE ID: _____ L PHYSICAL HABITAT SKETCH MAP FORM (continued) VISIT #: 1 2

USE THIS MAP TO LOCATE LITTORAL MACROHABITAT TYPES AND FISH SAMPLING SITES

RECORD FISH SAMPLING STATIONS AND GEAR TYPE
(G = GILL NET, T = TRAP NET, M = MINNOW TRAP, B = BEACH SEINE, S = SHORT SEINE. EXAMPLE: F1G, F2T, ETC.).
IF A SITE IS SELECTED FOR ADDITIONAL STANDARD PROTOCOL OR JUDGEMENT SAMPLING, ADD AN "X" OR "J" TO THE STATION AND GEAR TYPE CODES.
EXAMPLE: F10GX, F4BJ, ETC.

MACROHABITAT CLASSIFICATION AND EXTENT SUMMARY

MACROHAB. CLASS (XXXX)	% EXTENT(S) AND TOTAL	STATIONS	COMMENTS
	= %		
	= %		
	= %		
	= %		
	= %		
	= %		
	TOTAL = %		

REVIEWED BY (INITIAL):_____

FISH TALLY FORM-LAKES

Page ____ of ____

LAKE NAME: VISIT #: 1 2

LAKE ID: ___ ___ ___ ___ ___ L TEAM ID (circle): 1 2 3 4 5 6 7 8 9 10 OTHER: ____

NEAREST P-HAB STATION (A - J, X): ____ DIST. & DIR. FROM STATION: SITE ID: F ___ ___ ___ ___

SAMPLING EFFORT INFORMATION

START CREW INITIALS: _____, _____, _____ END CREW INITIALS: _____, _____, _____

START DATE: ___ ___ / ___ ___ / ___ ___ END DATE: ___ ___ / ___ ___ / ___ ___

START TIME: ___ ___ : ___ ___ END TIME: ___ ___ : ___ ___

LITTORAL HABITAT CLASSIFICATION

MACROHAB. CLASS (FROM SKETCH MAP FORM): ___ ___ ___ ___ MICROHAB. CLASS (FOR FISHING SITE): ___ ___ ___ ___

PELAGIC HABITAT CLASSIFICATION (circle one)

ISOTHERMAL EPILIMNION METALIMNION HYPOLIMNION

SAMPLING GEAR INFORMATION (circle one)

GILL NET	TRAP NET	MINNOW TRAP	BEACH SEINE	SHORT SEINE	OTHER (SPECIFY):
TYPE OF GILL NET SET (CIRCLE):			TOTAL AREA SEINED : _____ M^2		
LITTORAL MIDWATER/ SURFACE BOTTOM			TOTAL NUMBER OF SEINE HAULS = _____		

FISHING DEPTHS: MINIMUM: ___ ___ . ___ M MAXIMUM: ___ ___ . ___ M

COMMENTS:

CHECK HERE IF NO FISH WERE COLLECTED: _____

JAR ID (Barcode): ___ ___ ___ ___ ___ ___ ___ TAG ID: ___ ___

Common Name:			Species Code: ___ ___ ___ ___ ___ ___			Flag:		
Adult			Juvenile			YOY		
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

Common Name:			Species Code: ___ ___ ___ ___ ___ ___			Flag:		
Adult			Juvenile			YOY		
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

REVIEWED BY (INITIAL): _____

LAKE ID: __ __ __ __ __ L   **FISH TALLY FORM (continued)**   SITE ID: F______   VISIT #: 1 2

Common Name:			SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:			SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:			SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:		
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

IF > 5 SPECIES ARE COLLECTED, CHECK HERE AND USE A TALLY CONTINUATION FORM _____

IS THERE EVIDENCE OF STOCKING (circle)?	YES	NO

SPECIES CODE	ANOMALY/ STOCKING CODE	# OF FISH	FLAG	SPECIES CODE	ANOMALY/ STOCKING CODE	# OF FISH	FLAG

ANOMALY/STOCKING CODES: D = Deformities; E = Eroded fins; L = Lesions or ulcers; T = Tumors; F= Fungus; X = Multiple D,E,L,T anomalies; B = Blind in one or both eyes; K = Emaciated; M = Excessive mucus; P = Heavy Infestation of external parasites; Z = Other (explain in comments); S = Stocking.

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 COMMENTS SECTION. ATTACH SEPARATE COMMENTS SHEET IF NECESSARY.

REVIEWED BY (INITIAL): _______

FISH TALLY CONTINUATION FORM-LAKES

LAKE ID: ___ ___ ___ ___ ___ L SITE ID: F___ ___ ___ ___ VISIT #: 1 2

JAR ID (Barcode): ___ ___ ___ ___ ___ ___ TAG ID: ___ ___

Common Name:				SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:	
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:				SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:	
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:				SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:	
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:				SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:	
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:				SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:	
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

Common Name:				SPECIES CODE: ___ ___ ___ ___ ___ ___			FLAG:	
Adult			Juvenile			YOY		
TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:	TOTAL	MUSEUM	# MEASURED FOR LENGTH:

CHECK HERE IF INFORMATION IS RECORDED ON OTHER SIDE OF FORM: _____

REVIEWED BY (INITIAL): _____

LAKE ID: ___ ___ ___ ___ L FISH TALLY CONTINUATION FORM (continued) SITE ID: F VISIT #: 1 2

Common Name:			Species Code: ___ ___ ___ ___ ___ ___			Flag:		
Adult			Juvenile			YOY		
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

Common Name:			Species Code: ___ ___ ___ ___ ___ ___			Flag:		
Adult			Juvenile			YOY		
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

Common Name:			Species Code: ___ ___ ___ ___ ___ ___			Flag:		
Adult			Juvenile			YOY		
Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:	Total	Museum	# Measured for Length:

CHECK HERE IF AN ADDITIONAL CONTINUATION FORM IS REQUIRED: ______

Species Code	Anomaly/ Stocking Code	# of Fish	Flag	Species Code	Anomaly/ Stocking Code	# of Fish	Flag

ANOMALY/STOCKING CODES: D = Deformities; E = Eroded fins; L = Lesions or ulcers; T = Tumors; F = Fungus; X = Multiple D,E,L,T anomalies; B = Blind in one or both eyes; K = Emaciated; M = Excessive mucus; P = Heavy infestation of external parasites; Z = Other (explain in comments); S = Stocking.

FLAG	COMMENTS

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 EACH FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

REVIEWED BY (INITIAL): ______

FISH LENGTH FORM-LAKES

PAGE ____ of ____

LAKE NAME: _____ **VISIT #:** 1 2

LAKE ID: ___ ___ ___ ___ ___ L **TEAM ID (circle):** 1 2 3 4 5 6 7 8 9 10 **OTHER:** _____

SITE ID	SPECIES CODE	COMMON NAME	TOTAL LENGTH (mm)	AGE CLASS (A, J, Y)*	OUT (✓)	FLAG	COMMENTS

CHECK HERE IF ADDITIONAL DATA ARE RECORDED ON REVERSE SIDE: _____

*A = ADULT; J = JUVENILE; AND Y = YOUNG OF YEAR

FLAG CODES: K = NO MEASUREMENT COLLECTED; U = SUSPECT MEASUREMENT; F1. F2, ETC. = MISC. FLAGS ASSIGNED BY FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

REVIEWED BY (INITIAL):_____

LAKE ID: ___ ___ ___ ___ ___ L **FISH LENGTH FORM (continued)** VISIT #: 1 2

SITE ID	SPECIES CODE	COMMON NAME	TOTAL LENGTH (mm)	AGE CLASS (A, J, Y)*	OUT (✓)	FLAG	COMMENTS

CHECK HERE IF AN ADDITIONAL FISH LENGTH FORM IS USED FOR THIS LAKE: ______

* A = ADULT; J = JUVENILE; AND Y = YOUNG OF YEAR.

FLAG CODES: K = NO MEASUREMENT COLLECTED; U = SUSPECT MEASUREMENT; F1. F2, ETC. = MISC. FLAGS ASSIGNED BY FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

REVIEWED BY (INITIAL): ________

FISH TISSUE SAMPLE TRACKING FORM-LAKES

LAKE NAME: **DATE PREPARED:** / / **VISIT #:** 1 2

LAKE ID: _ _ _ _ _ _ _ _ L **TEAM ID (circle):** 1 2 3 4 5 6 7 8 9 10 **OTHER:** _____

	SPECIES CODE	COMMON NAME	TOTAL LENGTH (MM)	WEIGHT (KG)	FLAG	SAMPLE ID (BARCODE)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

 # OF STATIONS FROM WHICH FISH TISSUE CANDIDATE SPECIMENS WERE COLLECTED: _____

TOTAL # OF STATIONS SAMPLED: _____

LINE #	FLAG	COMMENT OR FLAG EXPLANATION

CHECK HERE IF MORE DATA ARE RECORDED ON OTHER SIDE: _____

FLAG CODES: K = NO SAMPLE COLLECTED; U = SUSPECT SAMPLE; F1. F2, ETC. = MISC. FLAGS ASSIGNED BY FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

REVIEWED BY (INITIAL): _____

LAKE ID: _ _ _ _ _ _ L FISH TISSUE SAMPLE TRACKING FORM (continued) DATE PREPARED: / / VISIT #: 1 2

	SPECIES CODE	COMMON NAME	TOTAL LENGTH (MM)	WEIGHT (KG)	FLAG	SAMPLE ID (BARCODE)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

LINE #	FLAG	COMMENT OR FLAG EXPLANATION

FLAG CODES: K = NO SAMPLE COLLECTED; U = SUSPECT SAMPLE; F1. F2, ETC. = MISC. FLAGS ASSIGNED BY FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

REVIEWED BY (INITIAL):_____

SAMPLE COLLECTION FORM-LAKES

LAKE NAME: _____ **DATE OF COLLECTION:** / / **VISIT #:** 1 2

LAKE ID: _ _ _ _ _ _ L **SITE ID (circle):** INDEX OTHER: _____

TEAM ID (circle): 1 2 3 4 5 6 7 8 9 10 **OTHER:** ___

SECCHI DISK TRANSPARENCY

DEPTH DISK DISSAPPEARS	DEPTH DISK REAPPEARS	CLEAR TO BOTTOM (X)	COMMENTS
_ _ _ . _ _ M	_ _ _ . _ _ M		

WATER CHEMISTRY (4-L CUBITAINER AND 4 SYRINGES)

SAMPLE ID # (Barcode)	SAMPLE TYPE	DEPTH COLLECTED	FLAG	COMMENTS
_ _ _ _ _ _ _ _	R1	M		
_ _ _ _ _ _ _ _		M		

CHLOROPHYLL (TARGET VOLUME = 500 mL)

SAMPLE ID # (Barcode)	SAMPLE TYPE	DEPTH COLLECTED	SAMPLE VOLUME	FLAG	COMMENTS
_ _ _ _ _ _ _ _	R1	M	mL		
_ _ _ _ _ _ _ _		M	mL		

ZOOPLANKTON (FILL TO MARK ON BOTTLE = 80 mL)

MESH SIZE	SAMPLE ID # (Barcode)	SAMPLE TYPE	LENGTH OF TOW	CONTAINERS NO.	PRESERVED (✓)	FLAG	COMMENTS
COARSE	_ _ _ _ _ _ _ _	R1	M				
FINE	_ _ _ _ _ _ _ _	R1	M				
	_ _ _ _ _ _ _ _		M				
	_ _ _ _ _ _ _ _		M				

SEDIMENT CORE SAMPLES (TARGET CORE LENGTH = 35 TO 40 CM)

Collected at (circle): INDEX OTHER **If OTHER, record direction and distance from INDEX site:**

SAMPLE CLASS	SAMPLE ID # (Barcode)	SAMPLE TYPE	LENGTH OF CORE	INTERVAL From	INTERVAL To	FLAG	COMMENTS
TOP	_ _ _ _ _ _ _ _	R1	CM	CM	CM		
BOTTOM	_ _ _ _ _ _ _ _	R1	CM	CM	CM		
	_ _ _ _ _ _ _ _		CM	CM	CM		
	_ _ _ _ _ _ _ _		CM	CM	CM		

FLAG CODES: K = NO MEASUREMENT OR SAMPLE COLLECTED; U = SUSPECT MEASUREMENT OR SAMPLE; F1. F2, ETC. = MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

REVIEWED BY (INITIAL):_____

BENTHOS SAMPLE LOCATION AND COLLECTION FORM-LAKES

LAKE NAME: **DATE OF COLLECTION:** / / **VISIT #:** 1 2

LAKE ID: _ _ _ _ _ _ L **TEAM ID (circle):** 1 2 3 4 5 6 7 8 9 10 **OTHER:** ___

OUTLINE MAP OF LAKE (WITH PHYSICAL HABITAT STATIONS IDENTIFIED)

INDICATE LOCATIONS WHERE BENTHIC CORE SAMPLES ARE COLLECTED WITH THE LETTER OF THE NEAREST PHYSICAL HABITAT SITE (A - J).

ARROW INDICATES NORTH.	RECORD THE SHALLOWER OF THE FOLLOWING DEPTHS (FROM LAKE PROFILE FORM) A) THE DEPTH OF TOP OF METALIMNION OR B) THE DEEPEST DEPTH AT WHICH DISSOLVED OXYGEN ≥ 5 MG/L	TARGET DEPTH ____ M

COMMENTS:

REVIEWED BY (INITIAL): _____

BENTHOS SAMPLE LOCATION AND COLLECTION FORM (CONTINUED) VISIT #: 1 2

LAKE ID: ___ ___ ___ ___ ___ L

DATE OF COLLECTION: / /

RECORD SAMPLING START TIME: :

RECORD PROCESSING COMPLETION TIME: :

SAMPLE ID # (Barcode)	STATION ID	DEPTH COLLECTED	SUBSTRATE TYPE[a]	FLAG[b]	COMMENTS
___ ___ ___ ___ ___ ___	A	M			
___ ___ ___ ___ ___ ___	B	M			
___ ___ ___ ___ ___ ___	C	M			
___ ___ ___ ___ ___ ___	D	M			
___ ___ ___ ___ ___ ___	E	M			
___ ___ ___ ___ ___ ___	F	M			
___ ___ ___ ___ ___ ___	G	M			
___ ___ ___ ___ ___ ___	H	M			
___ ___ ___ ___ ___ ___	I	M			
___ ___ ___ ___ ___ ___	J	M			
___ ___ ___ ___ ___ ___		M			
___ ___ ___ ___ ___ ___		M			
___ ___ ___ ___ ___ ___		M			
___ ___ ___ ___ ___ ___		M			
___ ___ ___ ___ ___ ___		M			

[a] SUBSTRATE TYPE CODES: G = GRAVEL; S = SAND; C = SILT CLAY, OR MUCK; W = WOODY DEBRIS; O = OTHER (DESCRIBE IN COMMENTS)

[b] FLAG CODES: K = NO SAMPLE COLLECTED; U = SUSPECT SAMPLE; F1. F2, ETC.= MISC. FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION.

ZEBRA MUSSEL OBSERVATION AND COLLECTION

STATION	OBSERVED (Y/N)	COLLECTED (Y/N)	COMMENTS
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			
LAUNCH			
OTHER			

REVIEWED BY (INITIAL):_____

LAKE ASSESSMENT FORM

LAKE NAME: **DATE OF VISIT:** / / **VISIT #:** 1 2

LAKE ID: ___ ___ ___ ___ ___ L **TEAM ID (circle):** 1 2 3 4 5 6 7 8 9 10 **OTHER:**___

LAKE SITE ACTIVITIES AND DISTURBANCES OBSERVED (INTENSITY: BLANK = NOT OBSERVED, L = LOW, M = MODERATE, H = HEAVY)

RESIDENTIAL	RECREATIONAL	AGRICULTURAL	INDUSTRIAL	LAKE MANAGEMENT
___ RESIDENCES	___ PARKS, CAMPGROUNDS, BEACHES	___ CROPLAND	___ INDUSTRIAL PLANTS	___ MACROPHYTE CONTROL
___ MAINTAINED LAWNS	___ PRIMITIVE PARKS, CAMPING, BEACHES	___ PASTURE	___ MINES/QUARRIES	___ LIMING
___ CONSTRUCTION	___ RESORTS	___ LIVESTOCK	___ POWER LINES	___ DRINKING WATER TREATMENT
___ PIPES, DRAINS	___ MARINAS		___ POWER PLANTS	___ ANGLING PRESSURE
___ TREATMENT PLANT	___ TRASH/LITTER		___ LOGGING	
___ LANDFILL, DUMPING	___ SURFACE FILMS, SCUMS, OR SLICKS		___ EVIDENCE OF FIRE	
			___ ODORS	

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	
SWIMMABILITY	☐ GOOD	☐ FAIR	☐ NOT SWIMMABLE	
LAKE LEVEL CHANGES	☐ ZERO	☐ ELEVATION CHANGE = _____ M		

SHORELINE CHARACTERISTICS (% of shoreline)

FOREST/SHRUB	☐ 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%)
OPEN GRASS	☐ 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%)
BARREN (BEACH)	☐ RARE (< 5%)	☐ SPARSE (5 TO 25%)	☐ MODERATE (25 TO 75%)	☐ EXTENSIVE (>75%)
DEVELOPED	☐ 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%)

QUALITATIVE MACROPHYTE SURVEY

MACROPHYTE DENSITY	☐ ABSENT	☐ SPARSE	☐ MODERATE	☐ DENSE
EMERGENT/FLOATING COVERAGE (% LAKE AREA)	☐ 0 TO 25%	☐ 25 TO 50%	☐ 50 TO 75%	☐ > 75%
SUBMERGENT COVERAGE (% LAKE AREA)	☐ 0 TO 25%	☐ 25 TO 50%	☐ 50 TO 75%	☐ > 75%

DESCRIPTION:

(Continued on reverse side)

REVIEWED BY (INITIAL):_____

LAKE ID: _____ L LAKE ASSESSMENT FORM (continued) VISIT #: 1 2

QUALITATIVE ASSESSMENT OF ENVIRONMENTAL VALUES

TROPHIC STATE ☐ OLIGOTROPHIC ☐ MESOTROPHIC ☐ EUTROPHIC ☐ HYPEREUTROPHIC

VISUAL ASSESSMENT:

ALGAL ABUNDANCE & TYPE:

NUTRIENT STATUS:

OTHER:

FISHABILITY: ☐ EXCELLENT ☐ GOOD ☐ FAIR ☐ POOR

CONDITIONS:

LOCAL CONTACTS:

OBSERVATIONS:

OVERALL BIOTIC INTEGRITY ☐ EXCELLENT ☐ IMPACTED ☐ SEVERELY IMPACTED

GENERAL ASSESSMENT:

WILDLIFE OBSERVED:

WATERBODY CHARACTER (CIRCLE ONE)

PRISTINE	5	4	3	2	1	DEVELOPED
APPEALING	5	4	3	2	1	UNAPPEALING

COMMENTS:

☆U.S. GOVERNMENT PRINTING OFFICE: 1998 -650-001/80177

REVIEWED BY (INITIAL):_____