ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM

SURFACE WATERS FIELD OPERATIONS MANUAL FOR LAKES

The information in this Adobe Acrobat Reader PDF file is one of several PDF files extracted from this report. The PDF files from the report are:

lake_ove.pdf	Overview of EMAP Surface Waters Lake Sampling, daily operations, lake verification and index site location, and general lake assessment (Sections 1, 2, 3, 4, 9)
lake_hab.pdf	Protocols for temperature, dissolved oxygen, shoreline physical habitat (Section 5)
lake_fis.pdf	Protocols for fish sampling (Section 6)
lake_wat.pdf	Protocols for Secchi transparency, water sample collection, chlorophyll a, zooplankton, sediment diatom (Section 7)
lake_ben.pdf	Protocols for benthic invertebrate sampling (Section 8)
lake_avi.pdf	Protocols for avian assemblages (Appendix A)
lake_vis.pdf	Lake-Visit Checklists for all Field Measurements (Appendix B)
field_for.pdf	Field Data Forms for all Field Measurements (Appendix C)

The Table of Contents, acknowledgments, notice page, listing of figures, listing of tables, and listing of acronyms for the document appear at the end of each pdf file.

In all cases, the source for this information for citation purposes is:

Baker, John R., David V. Peck, and Donna W. Sutton (editors). 1997. Environmental Monitoring and Assessment Program Surface Waters: Field Operations Manual for Lakes. EPA/620/R-97/001. U.S. Environmental Protection Agency, Washington D.C.

For further information contact,

EMAP Surface Waters Group, US EPA, National Health and Environmental Effects Research Laboratory, Western Ecology Division, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4600

EPA/620/R-97/001
June 1997

ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM SURFACE WATERS

FIELD OPERATIONS MANUAL FOR LAKES

Edited by

John R. Baker, David V. Peck[1], and Donna W. Sutton
Lockheed Environmental Systems & Technologies Co.
Las Vegas, Nevada 89119

Contract No. 68-C0-0049

[1] Current Address: U.S. EPA, National Health and Environmental Effects Research Laboratory,
Western Ecology Division, Corvallis, Oregon

Work Assignment Manager
S. A. Peterson
National Health and Environmental Effects Research Laboratory
Western Ecology Division
Corvallis, Oregon 97333

S. G. Paulsen, Technical Director
Surface Waters Resource Group
National Health and Environmental Effects Research Laboratory
Western Ecology Division
Corvallis, Oregon 97333

WESTERN ECOLOGY DIVISION
NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CORVALLIS, OREGON 97333

CHARACTERIZATION RESEARCH DIVISION
NATIONAL EXPOSURE RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89193-3478

ECOLOGICAL EXPOSURE RESEARCH DIVISION
NATIONAL EXPOSURE RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45219

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.

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.

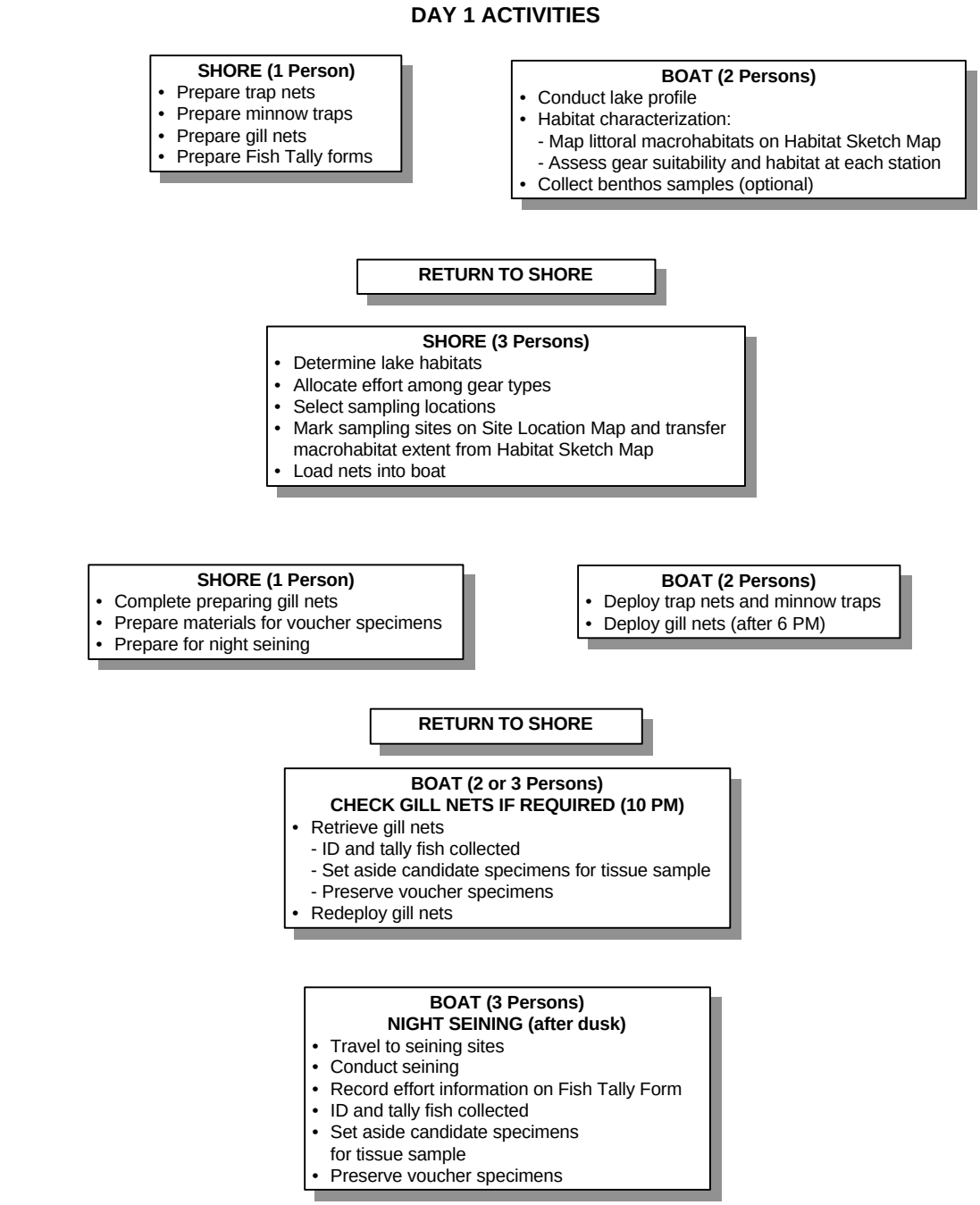


Figure 6-1. Summary of fish sampling activities (page 1 of 2)--Day 1.

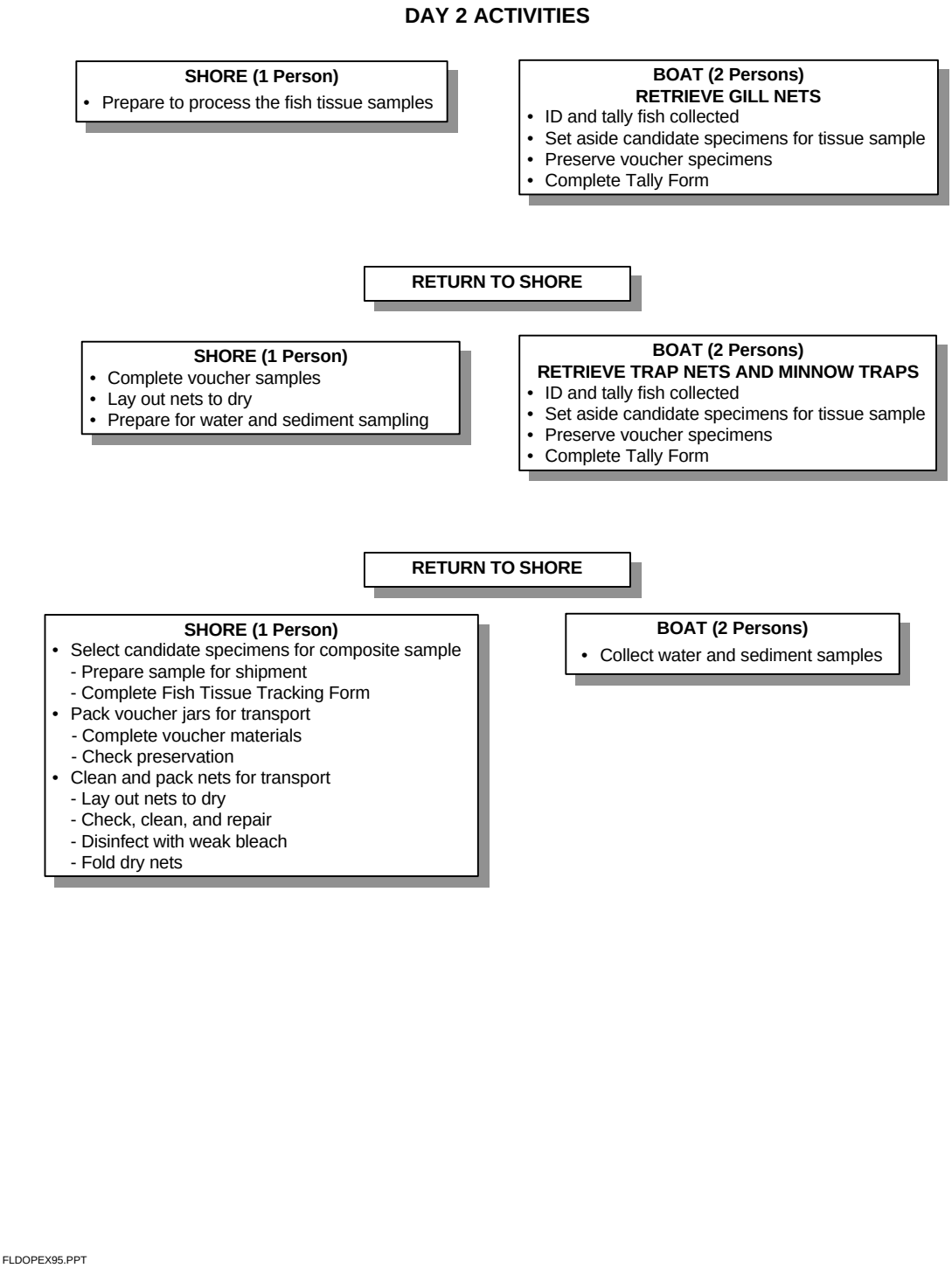


Figure 6-1 (continued). Summary of fish sampling activities (page 2 of 2)--Day 2.

Depending on lake size, 3 to 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 number required in Table 6-1. In order to keep the sampling

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 75ha 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).

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

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.

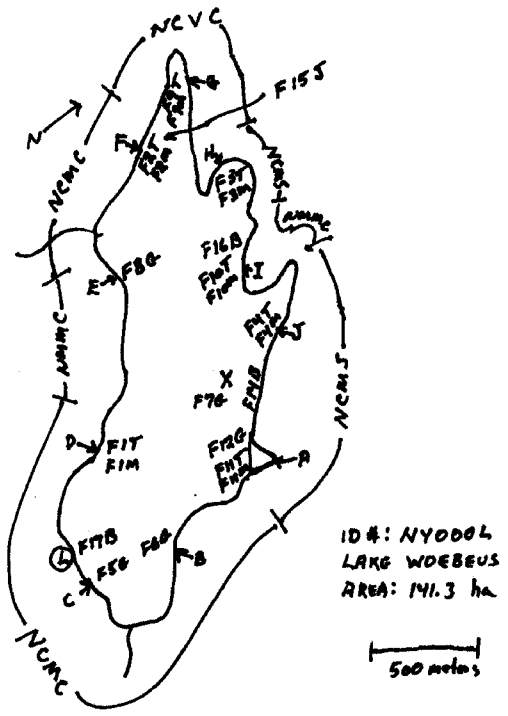
For additional sets follow in order: A-4, A-6, A-3, and A-4 above.

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 GILLNETS
NCMS	20 + 10 = 30 %	J-A, H	
NMMC	8 + 7 = 15 %	I, E	
NCVC	15 = 15 %	G	
	= %		
	= %		
	TOTAL = 100 %		

REVIEWED BY (INITIAL): ga

Rev. 3/95 FLDFRMS.95 Physical Habitat Sketch Map Form - 2

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.

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 (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. WOEBEGUS — 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): (LITTORAL) MIDWATER/SURFACE BOTTOM			TOTAL AREA SEINED: _____ M^2		
			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						

REVIEWED BY (INITIAL): JA

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 the fish assemblage in that macrohabitat. If the

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.

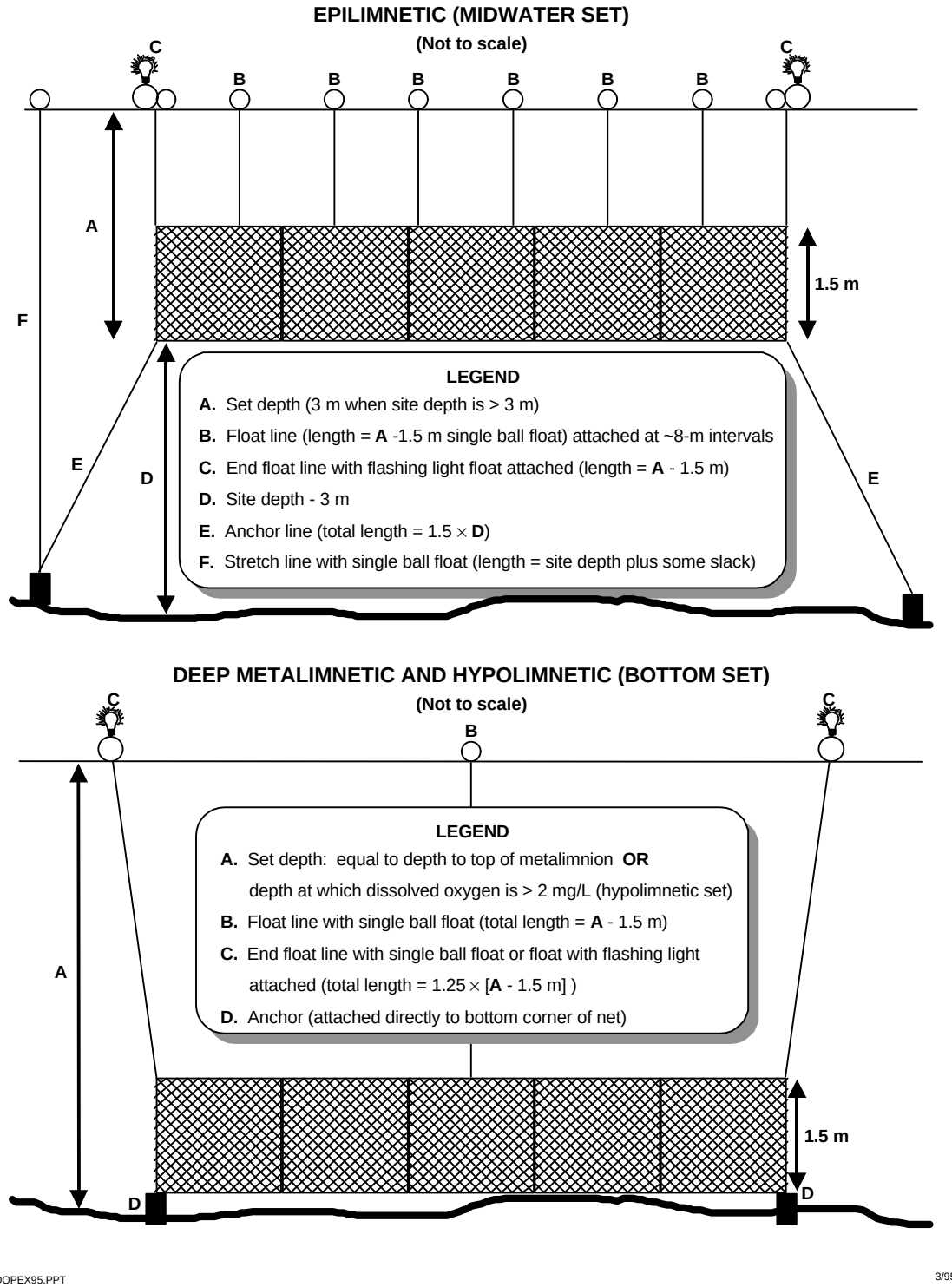


Figure 6-4. Types of gill net sets.

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 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.

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.

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: F 3 G _ _ VISIT #: (1) 2

JAR ID (Barcode): 1 2 3 4 5 6 TAG ID: 0 2

Common Name: WHITE SUCKER			Species Code: C A T O C O			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. The 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 11TJ 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: NY 000 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
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	〃			
〃	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	FALL FISH	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.

REVIEWED BY (INITIAL): JA

Rev. 3/95 FLDFRMS.95 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. WOEBEUS DATE PREPARED: 7/4/94 VISIT #: (1) 2

LAKE ID: NY000L 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	MOROAM	WHITE PERCH	204	1.8		301999
2	〃	〃	210	1.8		〃
3	〃	〃	204	1.8		〃
4	〃	〃	225	2.0		〃
5	MOROAM	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.

REVIEWED BY (INITIAL): JA

Rev. 3/95 FLDFRMS.95

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).

NOTICE

This research has been funded wholly or in part by the U.S. Environmental Protection Agency through its Office of Research and Development (ORD) and was conducted with research partners under the management of the Western Ecology Division, Corvallis, Oregon, the Characterization Research Division, Las Vegas, Nevada, and the Ecological Exposure Research Division, Cincinnati, Ohio under the following contracts and cooperative agreements:

Contract 68-C0-0049 to Lockheed Environmental Systems and Technologies Co., Inc.
Contract 68-C8-0006 to ManTech Environmental Technology, Inc.
Contract 68-C1-0022 to Technology Applications, Inc.
Cooperative Agreements CR818606 and CR816721 to Oregon State University
Cooperative Agreements CR819658 and CR818179 to the University of Maine-Orono
Cooperative Agreement CR814701 to the University of Nevada-Las Vegas
Cooperative Agreement CR818707 to Queens University
Cooperative Agreement CR819689-01-0 to Dartmouth College

The correct citation for this document is:

Baker, John R., David V. Peck, and Donna W. Sutton (editors). 1997. Environmental Monitoring and Assessment Program Surface Waters: Field Operations Manual for Lakes. EPA/620/R-97/001. U.S. Environmental Protection Agency, Washington, D.C.

Section authors are:

Section 1: S. G. Paulsen[1], John R. Baker[2], and Donna W. Sutton[2]
Section 2: John R. Baker[2] and David V. Peck[3]
Section 3: Glenn D. Merritt[4], Victoria C. Rogers[5], and David V. Peck[3]
Section 4: John R. Baker[2] and David V. Peck[3]
Section 5: Philip R. Kaufmann[6] and Thomas R. Whittier[7]
Section 6: Thomas R. Whittier[7], Peter Vaux[8], and Roger B. Yeardley[9]
Section 7: John R. Baker[2], Alan T. Herlihy[6], Sushil S. Dixit[10], and Richard Stemberger[11]
Section 8: Wesley L. Kinney[12], R. O. Brinkhurst[13], Thomas R. Whittier[7], and David V. Peck[3]
Section 9: Alan T. Herlihy[6]
Appendix A: R.J. O'Connor[14] and A.K. Moors[14]

1 U.S. EPA, Western Ecology Division, Corvallis, Oregon.
2 Lockheed Environmental Systems & Technologies Co., Las Vegas, Nevada.
3 Lockheed Environmental Systems & Technologies Co., now with U.S. EPA, Western Ecology Division, Corvallis, Oregon.
4 Lockheed Environmental Systems & Technologies Co., now with Washington Department of Ecology, Olympia, Washington.
5 Lockheed Environmental Systems & Technologies Co., now with Linn-Benton Community College, Albany, Oregon
6 Dept. Of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon
7 ManTech Environmental Technology, Inc., now with Dynamac, Inc., Corvallis, Oregon.
8 Environmental Research Center, University of Nevada, Las Vegas, Nevada
9 Technology Applications, Inc., now with DynCorp, Cincinnati, Ohio.
10 Department of Biology, Queens University, Kingston, Ontario, Canada
11 Department of Biology, Dartmouth College, Hanover, New Hampshire
12 U.S. EPA , Characterization Research Division, Las Vegas, Nevada (retired).
13 Aquatic Resources Center , Franklin, Tennessee
14 Department of Wildlife Ecology, University of Maine, Orono, Maine

TABLE OF CONTENTS

Section **Page**

Section

TABLE OF CONTENTS (Continued)

Section **Page**

TABLE OF CONTENTS (continued)

Section **Page**

Appendix

FIGURES

Figure **Page**

TABLES

TABLES (continued)

ACKNOWLEDGMENTS

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.

Wes Kinney of the EPA in Las Vegas, made significant contributions as the Work Assignment Manager from 1991 through 1994 as well as the lead scientist for the benthic invertebrate indicator. We especially appreciate the members of the sampling crews for their diligent efforts in testing these procedures and in obtaining data of outstanding quality. The following people provided official technical reviews of this manual: B. Baldigo (U.S. Geological Survey), J. Kurtenbach (U.S. EPA), and S. Cline (U.S. EPA) . Many others provided informal but important review comments. The Michigan Sea Grant Program kindly provided the drawings of zebra mussels used in Figure 8-6.

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