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.

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ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM
SURFACE WATERS
FIELD OPERATIONS MANUAL FOR LAKES

Edited by

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ABSTRACT

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

SECTION 5
HABITAT CHARACTERIZATION

by
Philip R. Kaufmann and Thomas R. Whittier

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

5.1 TEMPERATURE AND DISSOLVED OXYGEN

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

5.1.1 Calibration of the Dissolved Oxygen Meter

The dissolved oxygen meter performance test and calibration are summarized in Figure 5-2 (the detailed description is found in Section 3). Each field team also has a copy of the manufacturer's calibration procedures and maintenance information. Record calibration information on the Lake Profile Form, Side 2 (Figure 5-3). If the instrument will not calibrate, repeat the calibration procedure. If the meter still fails to calibrate, record a "K" flag on the Lake Profile Form to denote that measurements could not be obtained.

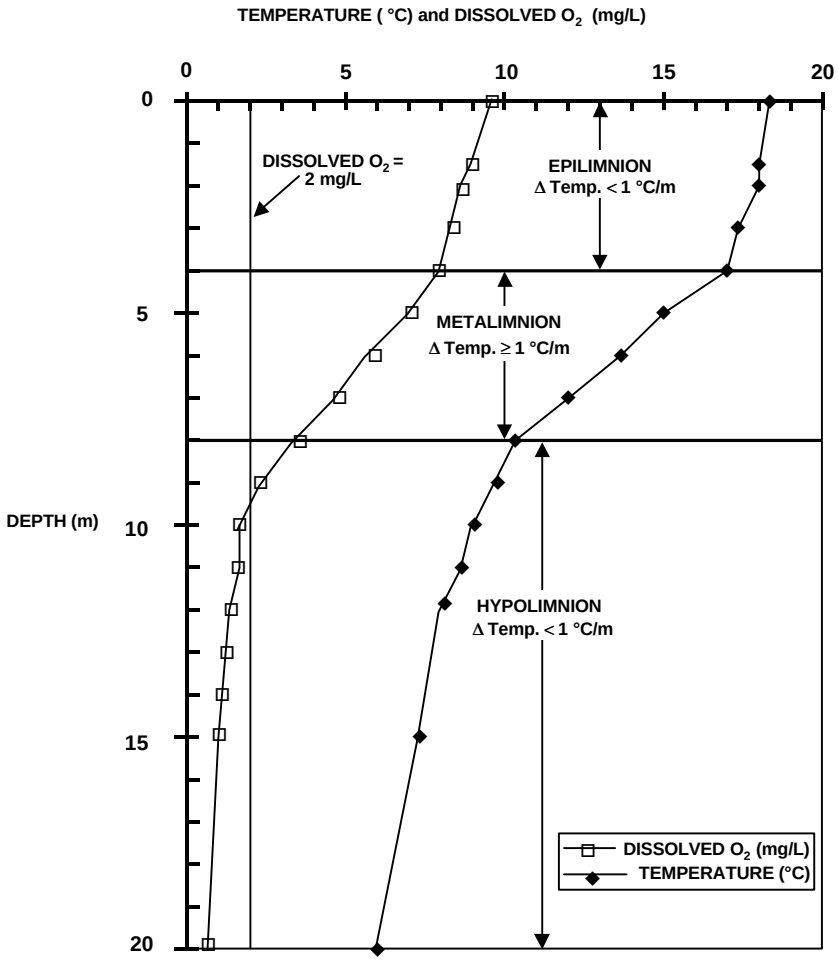


Figure 5-1. Typical temperature and dissolved oxygen profile of a thermally stratified lake.

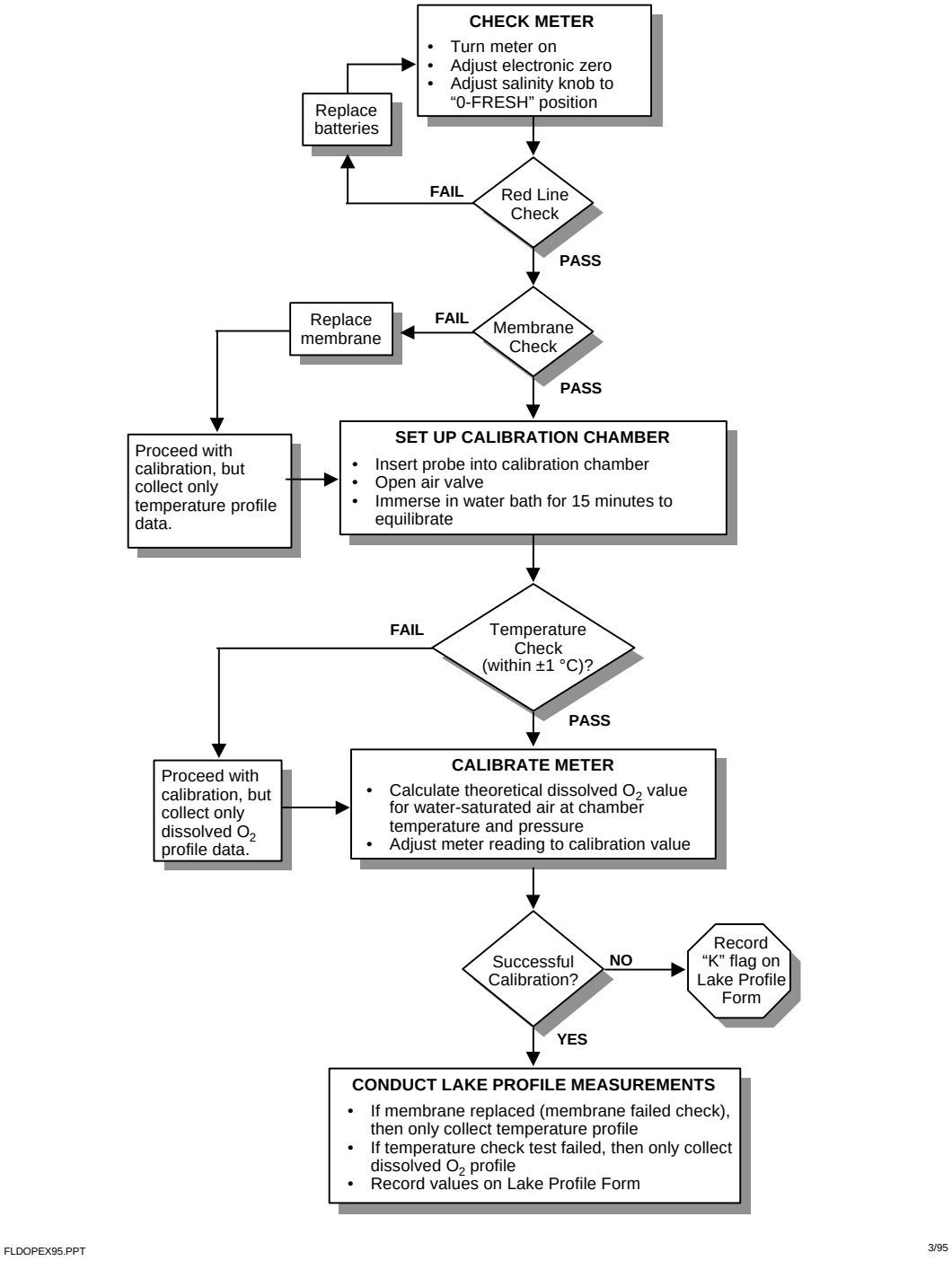


Figure 5-2. Field performance test and calibration procedure for the dissolved oxygen meter.

LAKE ID: NY0000L | LAKE PROFILE FORM (continued) | VISIT #: (1) 2

OXYGEN METER CALIBRATION INFORMATION

SALINITY KNOB AT "0-FRESH": X	MEMBRANE CHECK X	ELECTRONIC ZERO X	RED LINE: X
CALIBRATION CHAMBER TEMPERATURE: 20.8 °C		SATURATED O_2 @ CHAMBER TEMP.: 8.92 MG/L	
LAKE ELEVATION (FROM TOPO. MAP OR ALTIMETER): 98 FT		ELEVATION CORRECTION FACTOR: × 0.98	
		CALIBRATION VALUE: 8.74 MG/L	

THE CALIBRATION VALUE IS OBTAINED BY MULTIPLYING THE SATURATED O_2 CONCENTRATION TIMES AN ELEVATION CORRECTION FACTOR (BOTH VALUES ARE OBTAINED FROM TABLES PRESENT ON THE BACK OF THE METER, OR PROVIDED IN THE MANUFACTURER'S OPERATIONS MANUAL). ADJUST THE METER READING TO THE CALIBRATION VALUE.

FLAG	COMMENTS

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

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

DEPTH & FLAG	COMMENTS

REVIEWED BY (INITIAL): JA

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

5.1.2 Index Site Conditions and Lake Profile Measurements

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

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

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

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

LAKE PROFILE FORM

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

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

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

PRECIPITATION (circle): (NONE) LIGHT HEAVY

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

ODOR? [X] No ☐ Yes Description:

SCUM? [X] No ☐ Yes Description:

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

FLAG: COMMENTS:

DISSOLVED OXYGEN & TEMPERATURE PROFILE

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

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

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

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

[a] If the site depth is ≤ 3 m, take readings at the surface, every 0.5 m, and 1 m above the bottom.

[b] METALIMNION = The region of the profile where the temperature changes at a rate of 1 °C or greater per meter of depth. Indicate the depth of the top of the metalimnion with a "T," and the bottom of the metalimnion (when the rate of change becomes less than 1 °C per meter) with a "B." After the metalimnion is encountered, take readings every 1 m until bottom of the metalimnion is reached. Record the depth of the top of the metalimnion on the Benthos Sample Location and Collection Form.

FLAG CODES: K = NO MEASUREMENT OR OBSERVATION MADE; U = SUSPECT MEASUREMENT OR OBSERVATION; Q = UNACCEPTABLE QC CHECK ASSOCIATED WITH MEASUREMENT; F1, F2, ETC. = MISCELLANEOUS FLAGS ASSIGNED BY EACH FIELD CREW. EXPLAIN ALL FLAGS IN COMMENTS SECTION ON BACK OF FORM.

REVIEWED BY (INITIAL):_____

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

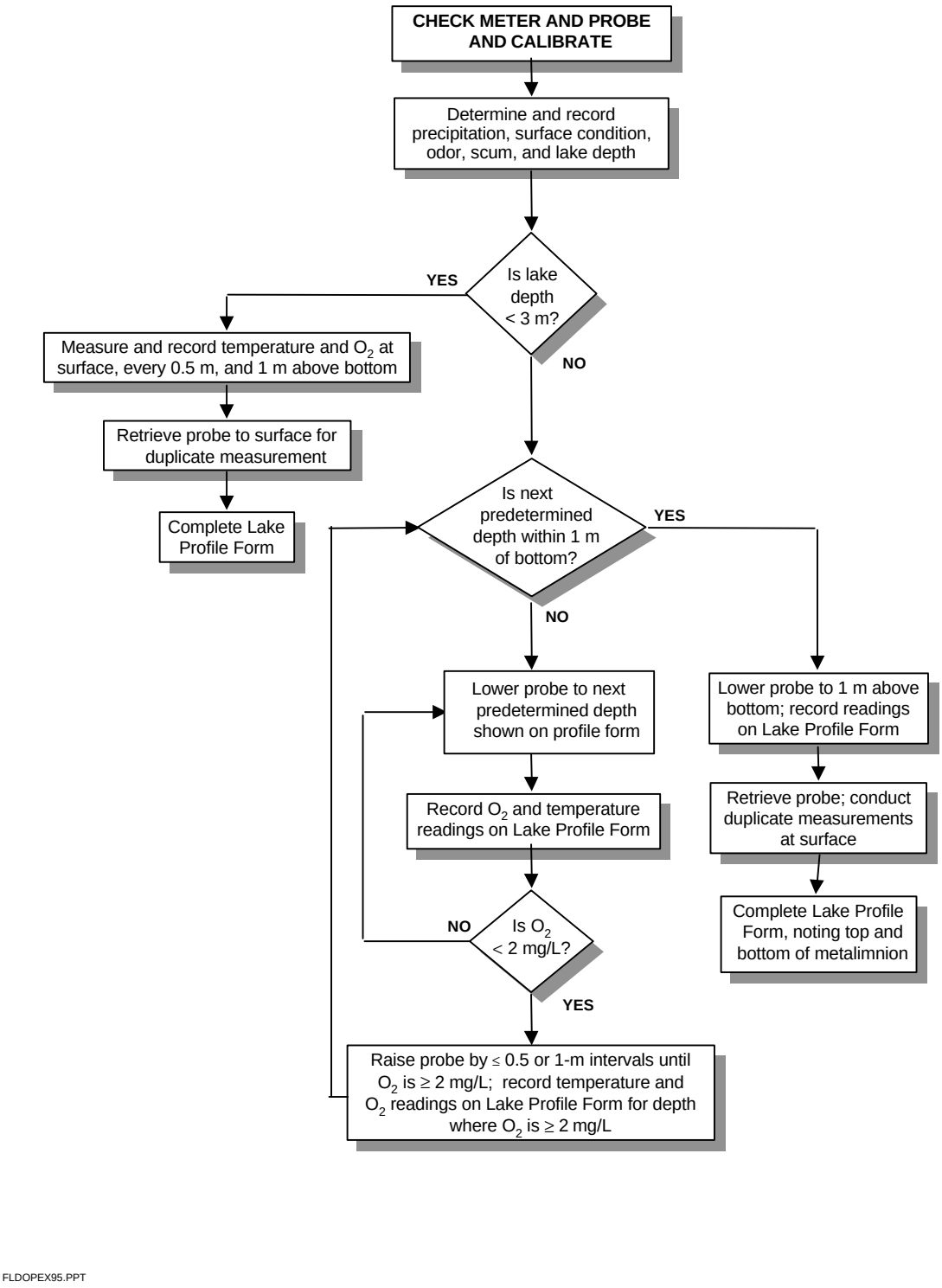


Figure 5-5. Dissolved oxygen and temperature profile procedure.

5.2 SHORELINE PHYSICAL HABITAT CHARACTERIZATION

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

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

5.2.1 Locating Each Physical Habitat Station and Defining the Shoreline Boundary

Starting at the nearest boat access point, proceed by boat around the lake near the shore, observing bank, shoreline, emergent, and subsurface characteristics. Using the lake outline on the Habitat Sketch Map Form Side 1 (Figure 5-6) and a topographic map, locate and stop at each of the 10 P-Hab stations. Mark each station with a ribbon, then position the boat at a distance of 10 m (~30 ft, offshore), anchor if necessary, and make the semi-quantitative measurements enumerated on the Physical Habitat Characterization Form, sides 1 and 2 (Figures 5-7 and 5-8).

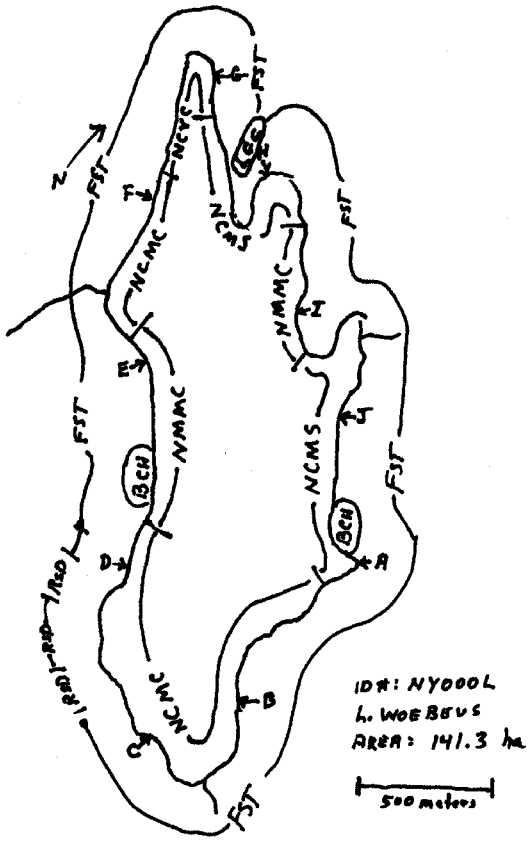
Make every reasonable attempt to record physical habitat observations and measurements for all 10 P-Hab stations. However, there are circumstances where this is impossible. In such cases, record a "K" flag (see Section 5.2.2 below) in each field to clearly indicate on the form that no observations were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

PHYSICAL HABITAT SKETCH MAP FORM-LAKES

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

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

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



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

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

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

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

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

PHYSICAL HABITAT CHARACTERIZATION FORM-LAKES

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

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

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

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

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Physical Habitat Characterization Form - 1

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

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

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

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

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

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

At each P-Hab station, make observations and measurements of the shoreline from the boat which is 10 m offshore (estimated by eye). It is important to be at the proper distance from shore, and to limit bank and shoreline observations at each station to the area that is within your field of vision. The littoral and riparian observation plots have fixed dimensions (Figure 5-9) that are estimated by eye. Littoral measurements pertain to the water and lake bottom in the 10 m (30 ft) distance between the boat and the shoreline and extending 15 m (50 ft) along the shore. Riparian observations at each station pertain to the adjacent land or wetland area that is 15 m wide and extends 15 m back onto land. The bank angle and shoreline substrate observations refer to a narrower shoreline zone that extends 1 m landward from the waterline.

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

5.2.2 Physical Habitat Characterization Form and Instructions

Use the ranking system based on areal coverage in evaluations of riparian vegetation, shoreline substrate, littoral bottom substrate, and aquatic macrophytes. The five entry choices range from 0 (absent) to 4 (> 75% cover) and are defined in Table 5-2 which lists steps required to complete the Physical Habitat Characterization Form (Figures 5-7 and 5-8). When ranking cover or substrate type, mixtures of more than one class might all be given sparse (1), moderate (2), or heavy (3) rankings. One dominant class with no clear subdominant class might be ranked 4 with all the remaining classes either sparse (1) or absent (0). Two dominant classes with more than 40 percent cover can both be ranked 3.

For the fish cover entry fields, enter 0 for absence of listed habitat features, 1 if they are present but sparse, or 2 if they are moderate or abundant. On the human influence entry fields, record a check mark ("√") if present within the shoreline/littoral plot. Record a "B" if visible but adjacent or behind (outside) the plot, or a "0" for absence of listed habitat features. A wavy vertical line through all or part of a column may also be used to denote "absent." If, for some reason, you cannot make measurements at a station, record a "K" flag in all data fields for that station. This entry is very important, as we have no other way of determining whether your intent is to record the absence of features or to denote a missed station.

Entering data qualifiers ("flags") on the Physical Habitat Characterization Form is slightly different than for the other data forms. As there is no defined "FLAG" field for each variable, flags are entered into the data field itself. For any particular measurement variable, if no effort is made to collect data, or if you make an effort but for some reason are unable

TABLE 5-1. GENERAL GUIDELINES FOR LOCATING OR MODIFYING THE LOCATION OF PHYSICAL HABITAT STATIONS

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

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

2. Define shore as either the current waterline OR the boundary between open water and the edge of dense vegetation (terrestrial, wetland, or emergent vegetation) or extensive very shallow water.

3. If the shoreline observed in the field differs from the mapped shoreline, draw the observed shoreline on Side 1 of the Physical Habitat Sketch Map Form.

4. If a P-Hab station is lost because of shoreline changes, position one or more new stations at approximately equal intervals. Add an X to the station letter on both sides of the Physical Habitat Characterization Form.

5. If a station is eliminated, enter "K" flags on the Physical Habitat Characterization Form to indicate no observations.

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

7. If the shoreline observed in the field differs radically from the mapped shoreline and you are sure you are at the correct lake, draw a new map on the same page as the original lake. Use a string to measure the new outline, divide it into 10 equal parts, and lay out the 10 station locations.

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

9. At each of the 10 shoreline stations, position the boat at an observation point 10 m from shore. Limit shoreline and riparian observations to an area 15 m (50 ft) wide by 15 m (50 ft) inland from shore, and littoral observations to an area 15 m wide (50 ft) by 10 m (30 ft) from shore to the boat. The sampling area and zones are illustrated in the quick reference handbook.

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

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

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

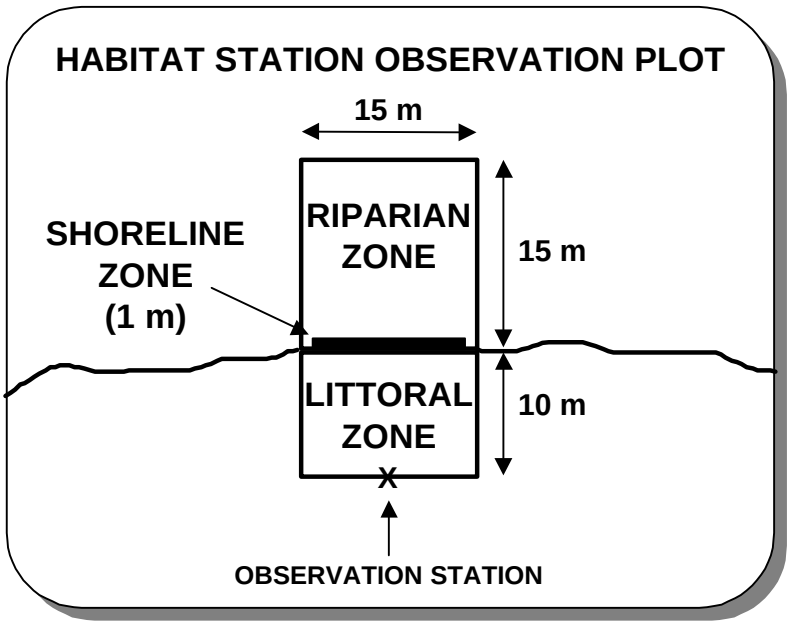

Figure 5-9. Physical habitat characterization plot.

TABLE 5-2. COMPLETING THE PHYSICAL HABITAT CHARACTERIZATION FORM

A. General

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

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

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

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

B. Riparian Habitat (Side 1 of the form)

1. Divide shoreline vegetation into 3 categories:

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

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

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

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

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

4. Rate the shoreline substrate 1 m into the riparian plot for areal coverage in particle size classes shown on the Physical Habitat Characterization Form.

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

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

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

(Continued)

TABLE 5-2. (Continued)

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

C. Littoral Habitat (Side 2 of the form)

1. Measure lake depth 10 m from shore at each P-Hab station, noting new location if the point has to be relocated for some reason.
2. Note the presence or absence of water surface scums, algal mats, or oil slicks.
3. Determine the lake bottom substrate visible from the boat. If the bottom is not visible, attempt to collect a sample or characterize by remote sensing with a sounding tube (e.g., PVC tubing).
4. Rank the littoral substrate sediment particle size, using classes shown on the Physical Habitat Characterization Form, according to areal extent, making multiple probes if the bottom is not visible. Areal extent (coverage) codes are the same as shown in A-3 above. If the bottom is covered with logs, sticks, or other organic debris, choose "woody debris." If the substrate is concealed and remote sampling is not possible, use "Not observed" flag (K).
5. Note sediment color and odor if a sample can be seen or collected.
6. Estimate the areal coverage (as described in A-3 above) of the three aquatic macrophyte types: submerged, emergent, and floating within the 10-by 15-m swath between your boat and the shoreline. If you cannot see or probe the bottom with tube or anchor, move closer to shore and note your new location in the white space in the "Bottom Substrate" section.
7. For the listed types of fish cover observed from the shore to the boat (10 m offshore) and 15 m along shore (A-2 above), enter "0" for absent, "1" if the cover type is sparse, and "2" if moderate or abundant.
8. Fish microhabitat classification for 10 m by 15 m littoral area:
   a. Select a single one-letter code for each of the following: disturbance regime, cover class, cover type, and substrate type.
   b. Select one or more one-letter codes to indicate <u>all</u> possible fish collection methods for the site.

to obtain data, enter a K flag in the data field. Explain on the separate Physical Habitat Characterization Comments Form (Figure 5-10) why data could not be obtained. If you collect data for a variable but have reason to believe it is suspect (or it was collected using a nonstandard protocol), enter a "U" flag in the data field. On the comments form, record the data value itself and explain why you think it is suspect (or describe what nonstandard procedure was used and why).

5.2.2.1 Riparian Habitat (Directions for Page 1)--

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

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

Conceptually divide the shoreline vegetation into three layers:

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

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

Before estimating the areal coverage of the vegetation layers, record the type of vegetation (Deciduous, Coniferous, Mixed, or None) in each of the two taller layers (Canopy and Understory). Consider the layer "Mixed" if more than 10 percent of the areal coverage is made up of the alternate vegetation type.

PHYSICAL HABITAT CHARACTERIZATION COMMENT FORM

Page 1 of 1

LAKE ID: NY000L

VISIT #: (1) 2

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

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

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

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

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Physical Habitat Characterization Comment Form - 1

Figure 5-10. Physical Habitat Characterization Comments Form.

5.2.2.1.2 Shoreline substrate--Rank, by areal coverage, very heavy, heavy, moderate, sparse, and absent particle size classes of the substrate that is visible in the 1-m wide strip nearest to the lake shoreline. These size estimates are made by eye from the boat, using the size classes defined on the Physical Habitat Characterization Form Side 1 (Figure 5-7). If the inorganic substrate is obscured by vegetation, choose "Vegetated"; if there is another type (e.g., organic flotsam), record its coverage rank in the "other" category and then identify the category in the comments section.

5.2.2.1.3 Bank type and evidence of lake level changes--Choose the bank angle description that best reflects the current shoreline that is dominant within your field of vision and 1 m into the riparian plot: V = Near vertical/undercut (>75 degrees, S = Steep; >30 to 75 degrees, hard to walk up bank; or G = Gradual, 0 to 30 degrees, easy to walk up). Estimate the vertical difference between the present level and the high water line; similarly, estimate the horizontal distance up the bank between current lake level and evidence of higher level.

5.2.2.1.4 Human influences--Check ("√") any and all of the human activities and influences that you observe within the defined lake and riparian observation areas. If present adjacent to the plot or within your field of vision behind (outside) the defined observation area, enter "B." Enter "0" if human activity is not present in either case.

5.2.2.2 Littoral Habitat (Directions for Page 2)--

Lake depth at the habitat survey stations is taken using the sonar, calibrated Secchi disk line, or the marked PVC sounding rod. Measure depth at each of the P-Hab stations, 10 m (30 feet) offshore. Note the presence or absence of water surface scums, algal mats, or oil slicks; use the codes provided on the form. All measures or observations in these categories are recorded on the Physical Habitat Characterization Form Side 2 (Figure 5-8).

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

5.2.2.2.1 Bottom substrate--To characterize littoral bottom substrate, restrict observations to the substrate you can detect from the boat. If you can't see the bottom, collect a sediment sample using a long tube (e.g., the 3-m PVC sounding rod). Probe the bottom beneath the boat with the sounding rod (you may have to move closer to shore). Soft sediment can be brought to the surface for examination. Hard sediments can be "felt" with the sounding rod. Sandy substrate can be "felt" or "heard" by twisting the sounding rod and detecting grittiness. If you had to move into shallow water to observe sediment characteristics, flag the observation and record (on the Physical Habitat Characterization Comment Form) the depth where you observed the sediment. Rate the cover of substrate sediment particle sizes that have very heavy, heavy, moderate, sparse, and absent areal coverage (A-3 in Table 5-2). Base these ratings on visual observations and judgments using the size classes defined on the form. If the bottom is covered with logs, sticks, or other organic debris, choose "woody debris." If the substrate is obscured by vegetation and you cannot obtain a PVC sounding rod sample, enter a "K" flag to denote "no observation made." However, probing with the sediment tube usually makes it possible to determine if the sediment is soft (therefore either Sand or Silt/Clay/Muck).

Sediment color and odor are subjective observations to be noted with codes shown on the form. Enter the code for "None/Other" if sediment color does not match one of the codes. For sediment odor, example entries are "H_2S" (sulfurous, rotten egg), "Anoxic" (sewage odor), "Chemical" (strong odor like turpentine, paint, etc.), "Oil/petroleum", or "None/Other" (including musty, no odor, organic, and fishy odors). If "Other" is noted, explain the observation on the comment form.

5.2.2.2.2 Aquatic macrophytes--To characterize aquatic macrophytes, separately estimate the areal coverage (as defined under A-3 in Table 5-2) for each of the three aquatic macrophyte types (submerged, emergent, and floating) present within the lake area between your boat and the shoreline. Emergent vegetation has erect portions above the water surface. Floating refers to either rooted or nonrooted vegetation. Count any plant as being in only one of these types. Then estimate the coverage of all combined types of aquatic macrophytes in the same area. You may have to probe the bottom with the PVC sounding tube or your anchor if the water is turbid. Indicate (yes or no) if the aquatic macrophytes extend further out into the lake than the area included in your observation area (i.e., more than 10 m or 30 ft from shore).

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

"Aquatic Weeds" may include submerged, floating, or emergent forms and may provide concealment or protection for fish. "Snags" are considered to be inundated or partially inundated dead tree boles, branches, or rootwads with diameter $\geq$0.3 m (1 ft). "Woody debris or brush" is defined as inundated dead or living woody vegetation that is <0.3 m diameter, whereas "Inundated Live Trees" refers to the inundated portions of trees $\geq$0.3 m in diameter. "Overhanging Vegetation" is defined as that which is <1 m from the water surface, because this low overhanging vegetation provides concealment from fish-eating birds. Do not include higher

overhanging vegetation, which might provide perches for birds such as kingfishers. "Rock Ledges or Sharp Dropoffs" include overhanging banks, submerged rock shelves, and steep sloping rock walls that can provide cover for fish. "Boulders" (>basketball size) also offer fish cover and concealment. "Human Structures" include docks, barges, houseboats, swimming platforms, tires, car bodies, and habitat enhancement structures (e.g., log rafts) that can provide cover for fish.

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

5.2.3 Riparian and Littoral Macrohabitat Characteristics and Mapping

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

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

Riparian and In-Lake Codes

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

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

Littoral Fish Macrohabitat Classification

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

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

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

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

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

TABLE 5-4. FISH LITTORAL MICROHABITAT CLASSIFICATION

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

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

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

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

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

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

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

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

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

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

sketch in the location and extent of residential development, forest cover, wetlands, farmland, and other important riparian features. Also record the location and extent of other features such as lake inlets, outlets, mid-lake reefs, beaches, and aquatic weed beds (floating, emergent, and submerged) or other features such as rock walls for which there may be no code provided.

Littoral fish habitat characterization both classifies *micro*habitat at individual physical habitat stations (Section 5.2.3.2.4) and assigns *macro*habitat types to shoreline segments around the entire lake; it both documents fish habitat extent and provides information to select littoral fish sampling sites (Section 6.2). The hierarchical classification system defined on the Physical Habitat Sketch Map Form (Figure 5-6) consists of four levels. The first classification level refers to disturbance: is there **major** human influence in the littoral zone (not the shore) or is this area in a more or less natural state (including largely recovered areas)? The second level refers to the presence of cover: is there cover for fish or open water or a mixture of the two? The third level defines the kind of cover: human influence includes "structures" (e.g., docks, boats, floating platforms) and "fill" (e.g., revetment boulders, trash); natural areas include in-lake vegetation, boulders, or woody materials or a mixture. The fourth level describes substrate.

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

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

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

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

5.3 EQUIPMENT AND SUPPLY LIST

A checklist of equipment and supplies required to conduct protocols described in this section is shown in Figure 5-11. This checklist is similar to but may be different somewhat from the checklists in Appendix B, which are used at a base site to assure that all equipment and supplies are brought to and are available at the lake. The field teams are required to use the checklist presented in this section to assure that equipment and supplies are organized and available on the boat in order to conduct the protocols efficiently.

PHYSICAL HABITAT ASSESSMENT CHECKLIST

	Number Needed Each Lake
Sonar	1
Transducer with bracket and C-clamp	1
12-V wet cell battery (charged) in battery case	1
GPS unit with manual, reference card, extra battery pack	1
Anchor with 50-m line	1
Float to attach to anchor	1
Surveyor's tape	1 roll
Habitat Sketch Map Form	2
Physical Habitat Characterization Form	2
Physical Habitat Comments Form	3
Field notebook	1
Sampling permit	1
Quick reference handbook	1
PVC sounding rod, 3-m length, marked in 0.1 m increments	1
Inflatable viewing box	1
DO meter	1

Figure 5-11. Physical habitat assessment checklist.

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ACRONYMS AND ABBREVIATIONS

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

Measurement Units

ha	hectare
m	meter
ppm	parts per million