ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM

SURFACE WATERS FIELD OPERATIONS MANUAL FOR LAKES

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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)

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ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM SURFACE WATERS

FIELD OPERATIONS MANUAL FOR LAKES

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ABSTRACT

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

SECTION 7
WATER AND SEDIMENT SAMPLING

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

7.1 SECCHI TRANSPARENCY

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

7.2 WATER SAMPLE COLLECTION

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

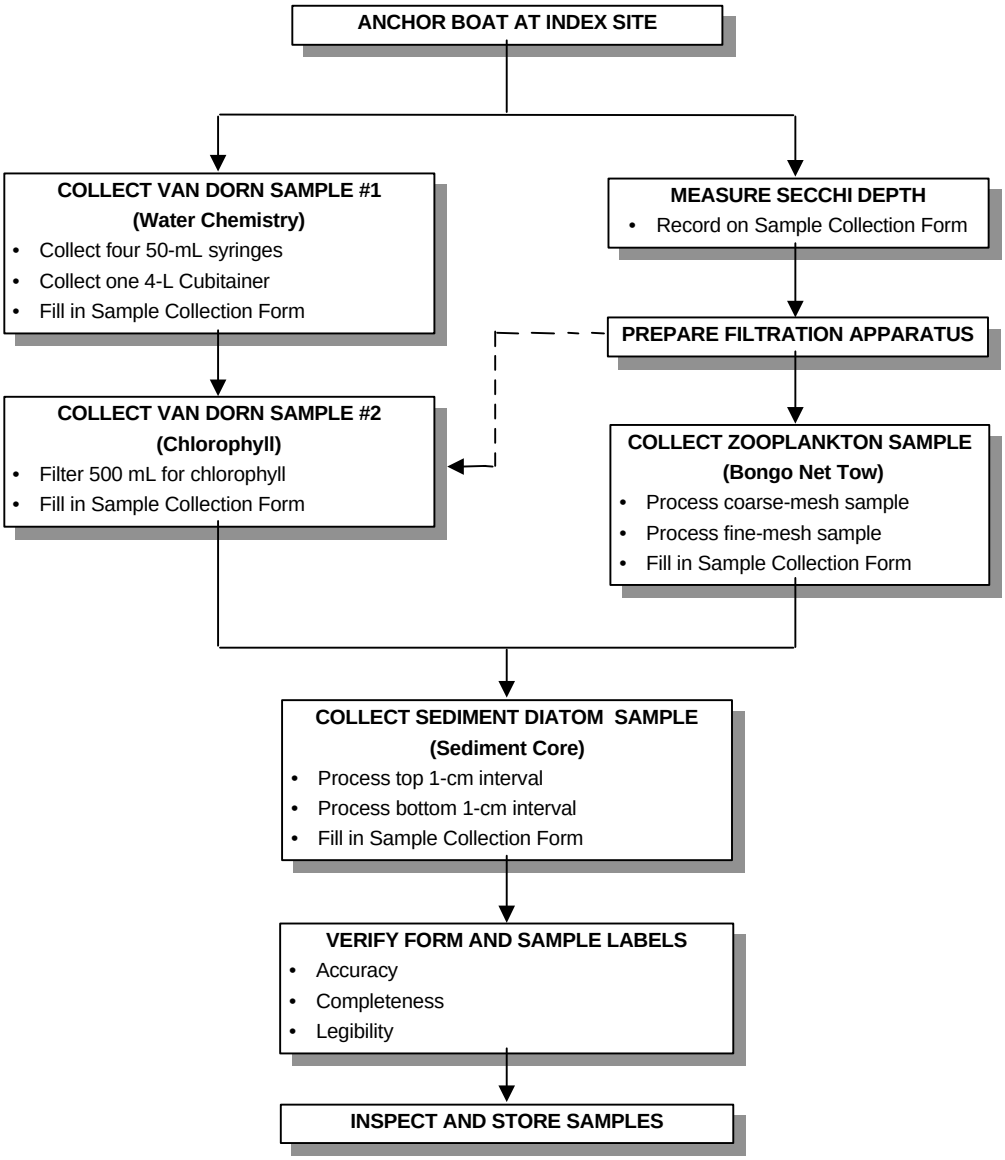

Figure 7-1. Water and sediment sampling activities summary.

TABLE 7-1. SECCHI DISK TRANSPARENCY PROCEDURES

1. Remove sunglasses unless they are prescription lenses.

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

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

4. Read the depth indicated on the chain. If the disappearance depth is <1.0 m, determine the depth to the nearest 0.01 m by marking the chain at the nearest depth marker and measuring the remaining length with a tape measure. Otherwise, estimate the disappearance depth to the nearest 0.1 m. Record the disappearance depth on the Sample Collection Form.

5. Slowly raise the disk until it reappears and record the reappearance depth on the Sample Collection Form.

6. Note any conditions that might affect the accuracy of the measurement in the comments field.

* If the disk is visible to the lake bottom, check the appropriate box on the Sample Collection Form.

SAMPLE COLLECTION FORM-LAKES

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

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

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

SECCHI DISK TRANSPARENCY

DEPTH DISK DISSAPPEARS	DEPTH DISK REAPPEARS	CLEAR TO BOTTOM (X)	COMMENTS
4.8 M	4.6 M		

WATER CHEMISTRY (4-L CUBITAINER AND 4 SYRINGES)

SAMPLE ID # (Barcode)	SAMPLE TYPE	DEPTH COLLECTED	FLAG	COMMENTS
300999	R1	1.5 M		
		M		

CHLOROPHYLL (TARGET VOLUME = 500 ML)

SAMPLE ID # (Barcode)	SAMPLE TYPE	DEPTH COLLECTED	SAMPLE VOLUME	FLAG	COMMENTS
102999	R1	1.5 M	500 ML		
		M	ML		

ZOOPLANKTON (FILL TO MARK ON BOTTLE = 80 ML)

MESH SIZE	SAMPLE ID # (Barcode)	SAMPLE TYPE	LENGTH OF TOW	CONTAINERS NO.	CONTAINERS PRESERVED (✓)	FLAG	COMMENTS
COARSE	103998	R1	9.0 M	1	✓		
FINE	103999	R1	9.0 M	1	✓		
			M				
			M				

SEDIMENT CORE SAMPLES (TARGET CORE LENGTH = 35 TO 40 CM)

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

SAMPLE CLASS	SAMPLE ID # (Barcode)	SAMPLE TYPE	LENGTH OF CORE	INTERVAL From	INTERVAL To	FLAG	COMMENTS
TOP	300990	R1	46 CM	0 CM	1 CM		
BOTTOM	300991	R1	46 CM	43 CM	44 CM		
			CM	CM	CM		
			CM	CM	CM		

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

REVIEWED BY (INITIAL): JA

Rev. 3/95 FLDFRMS.95

Sample Collection Form - Lakes - 1

Figure 7-2. Sample Collection Form.

TABLE 7-2. OPERATION OF VAN DORN SAMPLER

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

7.3 CHLOROPHYLL *a* SAMPLE COLLECTION

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

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

7.4 ZOOPLANKTON

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

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

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

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

3. Pour the 250 mL of water into the top of the filter holder, replace the cap, and pump the sample through the filter using the hand pump.[b] Filtration pressure should not exceed 7 psi to avoid rupture of fragile algal cells. (Occasionally, the pump dials have a systematic offset from 0 psi with no pressure applied. In this case, add 7 psi to the at rest value to obtain the maximum value. Example: If the value at rest = 5 psi (rather than 0 psi) then, 5 + 7 =
12 psi = the maximum apparent pressure allowed on the pressure gauge during filtration).

4. Remove both plugs from the bottom portion of the apparatus and pour off the water from the bottom.

5. Replace the plugs. Pour and pump a second 250-mL portion of the Van Dorn sample through the same filter.[c] The total sample volume after this portion is filtered is 500 mL.

6. Rinse the upper portion of the filtration apparatus thoroughly with DI water to include any remaining cells adhering to the sides and pump through the filter. Monitor the volume of the lower chamber, which traps the filtrate, to ensure that it does not contact the filter or flow into the pump.

7. Observe the filter for visible color. If there is visible color, proceed; if not, repeat steps 3 through 5 until color is visible on the filter or until 1,000 mL have been filtered. Record the actual sample volume filtered on the Sample Collection Form and on the sample label.

8. Remove the filter from the holder with clean forceps. Avoid touching the colored portion of the filter. Fold the filter in half, with the colored side folded in on itself.

9. Wrap the folded filter in a small piece of aluminum foil. Record the sample volume filtered on a chlorophyll label and attach it to the foil. Ensure that all written information is complete and legible. Cover with a strip of clear tape. Place the foil-wrapped filter in a self-sealing plastic bag and then place that bag between two self-sealing plastic bags of ice in a cooler. Double check that the amount for the total volume of water filtered that is recorded on the Sample Collection Form matches the total volume recorded on the sample label.

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

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

[b] If 250 mL of lake water will not pass through the filter, change the filter, rinse all apparatus with DI water, and repeat the procedures using 100-mL of lake water measured in a 100-mL graduated cylinder.

[c] Skip step 4 if 250 mL of water would not pass through the filter during step 2. If the filter clogs before all of the second 250-mL portion is filtered, discard the filter and prepare a new sample using a smaller volume (100 mL). Record the **total** volume filtered on the Sample Collection Form and on the sample label.

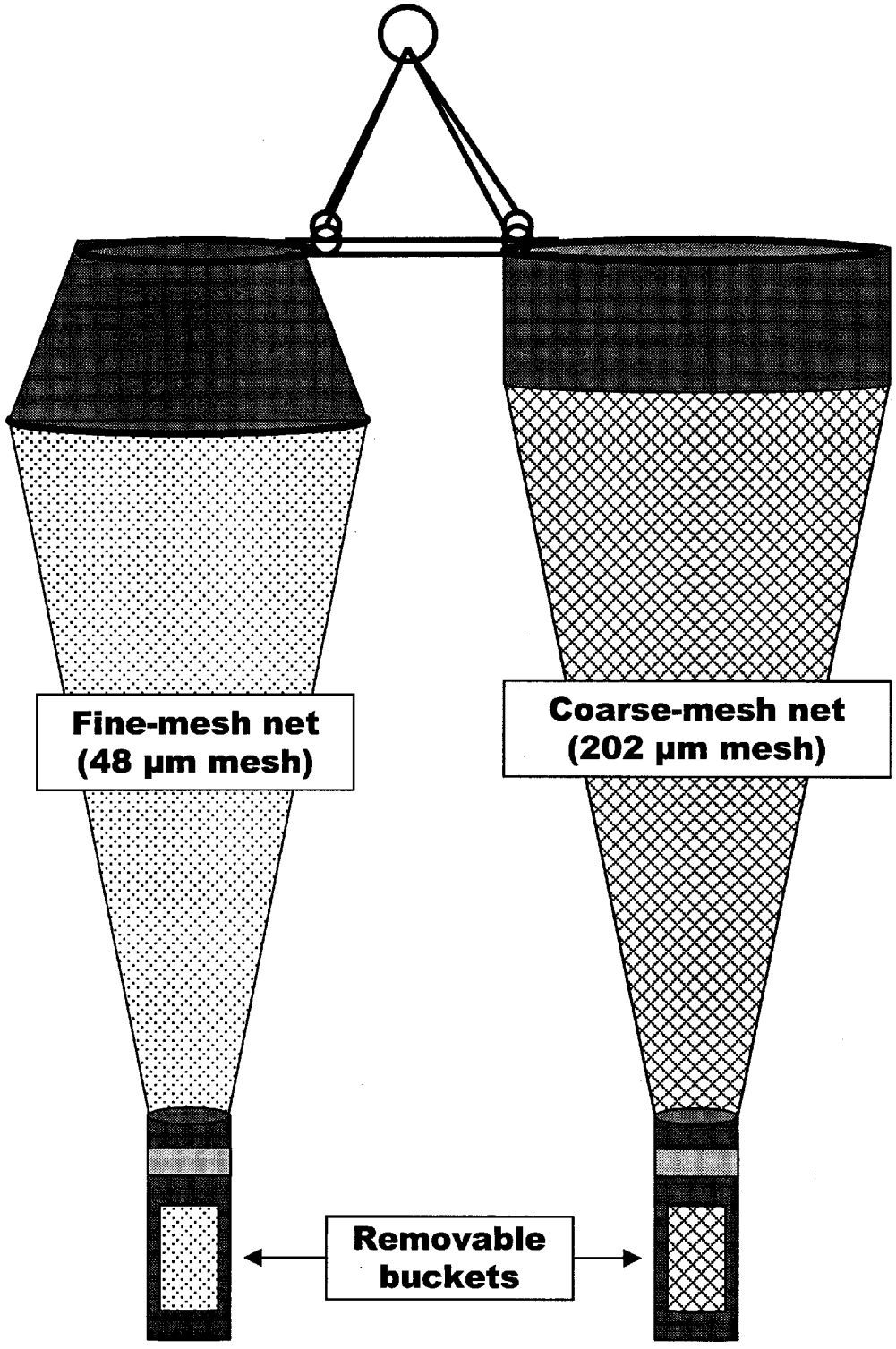

Figure 7-3. Configuration of zooplankton nets.

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

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

7.5 SEDIMENT DIATOM SAMPLE COLLECTION

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

TABLE 7-5. ZOOPLANKTON COLLECTION PROCEDURE

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

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

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

4. Carefully remove the fine mesh bucket from its net. Do not remove both buckets at the same time as they may be difficult to reattach to the correct bongo net. Set the bucket in a 500-mL container filled three-fourths full with lake water to which an Alka Seltzer tablet has been added. The CO_2 from the Alka Seltzer narcotizes the zooplankton to relax their external structure prior to fixation in formalin. This facilitates taxonomic identification. Wait until zooplankton movement has stopped (usually about 1 minute).

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

6. Rinse the contents of the fine mesh net bucket into one of the polyethylene jars (prepared in Step 2) labeled "FINE." Rinse bucket with DI water three to four times or until the majority of zooplankton have been removed. Drain the remaining filtrate into the sample container. Fill the jar of zooplankton to the mark (~80 mL or a little more than half full) with the DI water. If more than 80 mL of sample have been added to the bottle, add 1 to 3 mL additional sucrose-formalin solution.[a]

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

8. Record the length of the tows on the Sample Collection Form and on the sample labels. Verify that all information on the labels and the form is complete and correctly recorded. Cover each label completely with a strip of clear tape.

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

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

[a] Note: In some cases, the volume of zooplankton collected in the fine-mesh net may exceed 125 mL. Do not try to force all the sample into a single bottle or the preservative will not function properly and the sample may be lost. In such cases, use a second bottle to preserve the additional amount of sample. Use a **blank** zooplankton label (i.e., one with no bar code printed on it). Complete the label, and print in the bar code assigned to the first container on the label of the second container. On the Sample Collection Form, record a "2" in the "No. Containers" field.

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

TABLE 7-6. COLLECTION PROCEDURE FOR SEDIMENT DIATOM CORES

1. Record the lake ID and the date on two sample labels. Mark one label for the top interval and the second for the bottom. Attach the labels to two 1-qt self-sealing plastic bags. Record the bar code number on the collection form.

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

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

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

5. Trip the corer by releasing the messenger weight so that it slides down the line.

6. Slowly raise the corer back to the surface, until the core tube and rubber seal are just under the water.

7. While keeping the seal under water, slowly tilt the corer until you can reach under the surface and plug the bottom of the corer with a rubber stopper. To do this without disturbing the water-sediment interface, you cannot tilt the corer more than 45°. NOTE: This is a difficult operation and stoppers are easily lost. Be sure to have spares available at all times.

8. Raise the corer into the boat in a vertical position. Stand the corer in a large tub to prevent contaminating the boat with sediment material.

9. Detach the core tube from the corer.

10. Remove the water above the sediment core by using a siphon tube with a bent plastic tip so that the surface sediments are not disturbed.

11. Measure the length of the core to the nearest 0.1 cm and record the interval on the Sample Collection Form and on the two sample labels.

12. Slowly extrude the sample. To do this, position the extruder under the stopper at the base of the coring tube. Supporting both the core tube and the extruder in a vertical position, slowly lower the coring tube until the sediment is approximately 1 cm below the top of the tube. Place the Plexiglas sectioning apparatus (marked with a line 1 cm from the bottom) on the stage directly over the coring tube. Slowly lower the tube and attached sectioning apparatus until the top of the sediment reaches the 1-cm line on the sectioning tube. Slide the top 1 cm section of sediment into the plastic bag labeled for the top interval. Record this interval on the Sample Collection Form and on the sample label for the top core.

13. Before collecting the bottom section, remove the sectioning apparatus and rinse in lake water. This procedure prevents contamination of the bottom sediment layer with diatoms from the upper portion of the core. This step is critical as a small amount of sediment contains millions of diatoms which would destroy the population structure needed to compare environmental conditions depicted by top and bottom core samples.

14. Continue extruding the sample, discarding the central portion in the tube, until the bottom of the stopper is approximately 5 cm (3 inches) from the top of the coring tube. Affix the sectioning apparatus to the top of the tube. Extrude the sample until the bottom of the stopper reaches the lower black line at the top of the tube (approximately 5 cm from the top of the tube). Section the extruded sediment and discard. Rinse the sectioning tube with lake water. Without removing the sectioning apparatus from the coring tube, **slightly** tilt the tube and wash the sectioning stage with a small amount of water from a squirt bottle. Make sure the rinse water runs off the stage and not into the coring tube with sediment. Lower the tube until the top of the sediment is at the 1-cm mark on the sectioning tube. Collect the 1-cm section of core material in the second 1-quart self-sealing plastic bag labeled for the bottom interval. Record this interval on the Sample Collection Form and on the sample label for the bottom core.

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

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

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

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

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

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

7.6 EQUIPMENT AND SUPPLY LIST

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

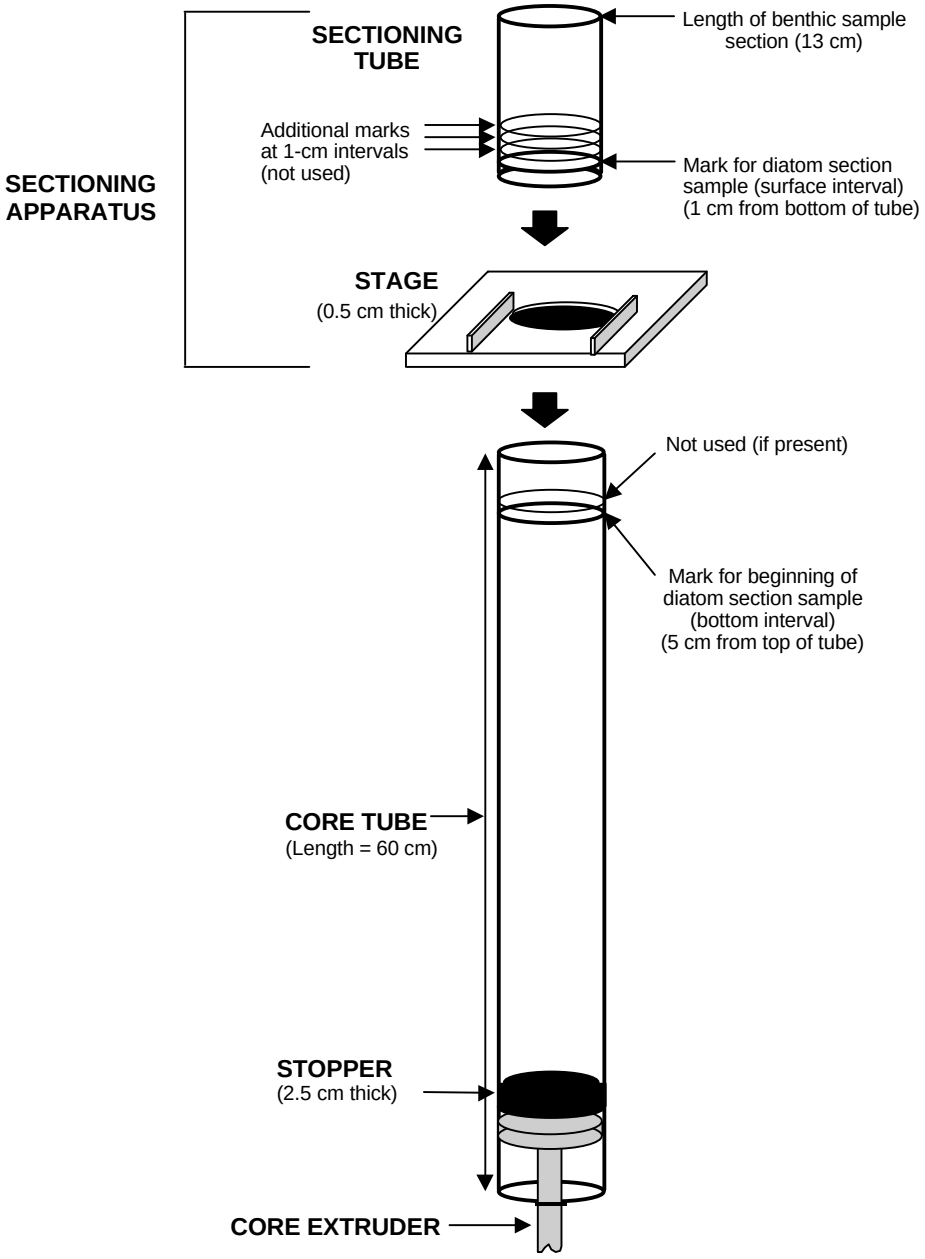

Figure 7-4. Sediment coring tube and sectioning apparatus.

LAKE-VISIT CHECKLISTS

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

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

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

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

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

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

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

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

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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