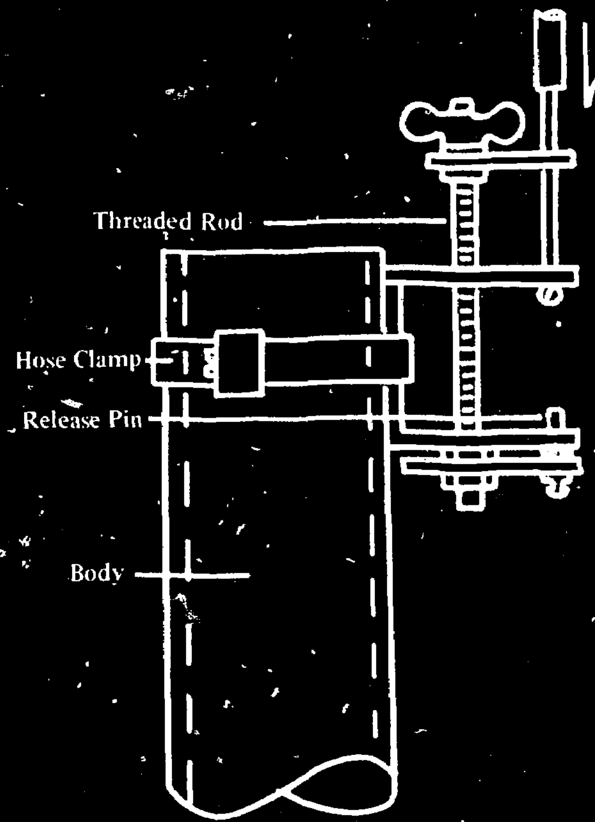
DOCUMENT RESUME

ED 093 648 SE 017 376

AUTHOR	Hershey, John T., Ed.; And Others
TITLE	A Curriculum Activities Guide to Water Pollution Equipment and Environmental Studies, Volume 3.
INSTITUTION	Institute for Environmental Education, Cleveland, Ohio.
PUB DATE	Sep 73
NOTE	130p.
AVAILABLE FROM	Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106 ($6.75)
EDRS PRICE	MF-$0.75 HC-$6.60 PLUS POSTAGE
DESCRIPTORS	*Activity Learning; *Curriculum Guides; *Environmental Education; Environmental Research; Equipment; *Laboratory Equipment; Pollution; Student Developed Materials; *Water Pollution Control; Water Resources
IDENTIFIERS	*Institute for Environmental Education

ABSTRACT

The purpose of this guidebook is to present instructions for constructing low-cost instruments for environmental studies. The instruments discussed were either adopted or designed by students who were presented with the problem of producing low-cost environmental monitoring equipment. This book is a sequel to A Curriculum Activities Guide to Water Pollution and Environmental Studies Volumes 1 and 2, but can be used independently of the guide. Information concerning the publication of the curriculum guide mentioned above is available in this document. (JP)



TRIGGER DETAIL

A Curriculum Activities Guide

to

WATER POLLUTION EQUIPMENT

and

ENVIRONMENTAL STUDIES

OLUME THREE

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A CURRICULUM ACTIVITIES GUIDE

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AND

ENVIRONMENTAL STUDIES

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The project presented or reported herein was performed pursuant to a Grant from the U. S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

The materials in this book were written and compiled during 1972-73 under the Grant No. OEG-0-72-5105 from the Department of Health, Education, and Welfare, Office of Education, Environmental Education, Washington, D. C. 20202, awarded to Documentation Task Force, Project KARE, Colony Office Building, Route 73 and Butler Pike, Blue Bell, Pennsylvania 19422.

Information concerning this publication may be obtained from:

Institute for Environmental Education
8911 Euclid Avenue
Cleveland, Ohio 44106

First edition prepared by the Documentation Task Force, Project KARE, Philadelphia, Pennsylvania, June 1973.

Second edition revised by David Kriebel, Union of Young Environmentalists, Green Bay, Wisconsin and the Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, September 1973.

PREFACE

This publication is one in a series of documents designed to <u>guide</u> others in initiating, continuing, or expanding their environmental education activities. It is a direct sequel to Volumes I & II, described on the inside front cover.

Volume III was prepared during the evolution of a plan which began with an environmental studies course for students in Cleveland, Ohio in 1967 and 1968. The course became a training program for teachers and students at Tilton, New Hampshire in the summers of 1969 and 1970 and at Quincy, Massachusetts, Newtown, Pennsylvania, and again in Cleveland in 1971. It became a full-time responsibility for the Institute for Environmental Education in 1972.

The teachers, students, and administrators who taught, directed, and then wrote the results of their experiences into the Guide Series have increased in numbers and varieties of experience. They now occupy positions of responsibility in educational, environmental, and governmental institutions throughout the country.

This Volume, and these people, are one of the forces behind the new, exciting, promising, and certainly pervasive national environmental education movement.

ACKNOWLEDGEMENTS

Many of the designs and test constructions described in this Guide were made by David Kriebel (now at University of Wisconsin - Green Bay) and Steven Kangisser (University of Kentucky) during a summer training program at the Institute for Environmental Education in Cleveland. Later additions and rewrites were made under supervision of Pat Sparks and two of the four staff who edited Volumes I and II, Jack Hershey and Alan Sexton, all at Project KARE in Philadelphia. A first edition was published by Project KARE, and the second edition, after modification by David Kriebel and Tom Offutt (Institute for Environmental Education) and drawings by Ralph Howarth (University School), was published by the Institute in Cleveland.

Other staff contributors were Peter Goldie, Robert Lippincott, Jerry Ruddle, Tim Tanaka, and Melissa Weiksnar, at the time stationed with Project KARE.

The efforts of Bette Connelly, Sue Faulkner, Diana Geist, and Claire Pilzer made the writers' imperfections tolerable to the Documentation Task Force at Project KARE. Sally Gardner prepared the final copy at the Institute for Environmental Education.

Special thanks go to Donald L. Wright, Director of Project KARE who encouraged the effort to formulate the Task Force in conjunction with the Institute, and Alan C. Harman, Executive Director of Montgomery County Intermediate Unit #23, who facilitated the effort in myriad ways from board approval to accounting procedures. The cooperation of the Intermediate Units of Bucks, Chester, Delaware, and Philadelphia Counties and the Roman Catholic Archdiocese of Philadelphia is also appreciated.

Since the Documentation Task Force began, there have been several personnel changes. Matthew M. Hickey has succeeded Donald L. Wright as Director of Project KARE. Alan D. Sexton has followed Mr. Hickey as the Assistant Director. John T. Hershey became Manager of Environmental Programs for the University City Science Center, Philadelphia. Further materials will be produced for the Guide Series by Project KARE and the Institute for Environmental Education.

Joseph H. Chadbourne
President

Institute for Environmental Education

A CURRICULUM ACTIVITIES GUIDE

TO

WATER POLLUTION EQUIPMENT

AND

ENVIRONMENTAL STUDIES

INTRODUCTION

This book is a sequel to A Curriculum Activities Guide to Water Pollution and Environmental Studies, Volumes I and II. This statement is made to inform the readers that the directions for making much of the equipment necessary to conduct many of the suggested activities in these two volumes are contained in this book. This book can also be used independently of the guide. (1)

One of the most common problems facing students and teachers when they begin environmental studies programs is the high cost of sampling equipment. The purpose of this book is to make available the most equipment at the least possible cost.

In properly conducted environmental investigations, students will perceive the need to extend their senses by using instruments. The projects presented in this guide will help students build these instruments.

Making environmental monitoring equipment is very much in keeping with the philosophy of creative problem-solving that is the basis of environmental education. When a student perceives the need for a particular instrument, and then uses his own ingenuity and materials that he has scrounged from a variety of sources to make it, he has made a significant contribution to the "state of art" in environmental monitoring, and he has also greatly expanded his ability to analyze a problem and arrive at solutions to it.

The instruments discussed in this book were either adapted or designed by students who were presented with the problem of producing low cost environmental monitoring equipment. The quality of the projects in Chapter 1 are, therefore, indicative of the capabilities of students placed in creative problem-solving situations.

(1) U.S. Environmental Protection Agency, A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vols. I & II, 1972, U.S. Government Printing Office, Washington, D.C. 20402. $2.95 per volume. Also available from the Institute for Environmental Education, $6.00 per set.

Introduction (continued)

If circumstances do not permit the making of this equipment by the students involved, the equipment might be made by industrial arts and/or vocational-technical students.

Teachers should also investigate Federal surplus programs handled by State Governments and other scroungeable resources. Extremely sophisticated and expensive equipment can often be obtained for the time spent looking. In other words, making and scrounging develops ingenuity, self sufficienty, and persistance but most of all it is fun.

One final note: Even though the thrust of this book is toward instrumentation, if circumstances are extreme, significant environmental quality investigations can be carried out with no instruments at all. If no time, money or building skills are available, then the best alternative is to observe biological indicators of environmental quality. These have been explained in other guides of this series.

Chapter I   Construction Plans for Water Quality Testing Equipment

Each of the twenty-three pieces of equipment described in Chapter I has been built and field tested by students. Even though most of the equipment is for water studies only, some of the pieces can be used for studying other environmental parameters.

Included for each are directions for making, directions for using, a parts list, and a tools list. Drawings are included with most. If "Scrap" is listed under the Source column (section II), it means that the item would probably be available in a school shop, laboratory, trash pile, etc. Costs are given per unit, usually per one of the item unless others are specified.

Chapter I

A. Algae Substrate

I. Introduction

Algae are an important part of any aquatic ecosystem. They are separated into two broad groups, based upon their habitats. Planktonic algae flow freely suspended in the water. Benthic algae grow attached to rocks, sediments or other submerged objects. While planktonic algae are studied by collecting them in nets, there are at least two other methods for collecting the benthic forms. They can either be scraped from their habitats, or they can be grown on an artificial habitat (substrate) that can be removed from the water for study. Artificial substrates need not be fancy - algae will grow on almost anything. This algae substrate is simple, cheap, and efficient. It has been well-tested, and almost anyone can make it. If you have a microscope, you can use it to study the organisms. If you plan to make a set, as many studies require, the cost is minimal.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Plexiglas-colored	2" x 6"	Scrap	$0.00
1	Microscope slide		Scrap	$0.00
1	Bolt-aluminum	1/4" x 1/2"	Hrd.store	$0.05
1	Wing nut for above		Hrd.store	$0.02
1	Rubber washer		Make it	$0.00

Tools:

Hacksaw or jigsaw

Drill with 1/4" bit

III. Procedure

The basic concept is that a microscope slide can be put in a stream or lake and algae will grow on it. You can then remove the slide and study the algae using a microscope. That's all there is to it -- but, if you just drop a slide in the creek, you will have a rough time finding it a few days later. So, cut out a piece of red, yellow or blue plexiglas about 2" x 6". Drill a hole near one end and stick a bolt through the hole. Add the washer, and fasten with the wing nut. Then loosen the nut and insert a slide between the rubber washer and the plexiglas and retighten the wing nut. When you put this in a stream, you'll be able to see it.

IV. Use

This substrate should be placed on the bottom where most benthic forms from the surrounding community will grow or attach themselves to the plate. You may have to anchor the plate in swift currents. In most habitats, twenty-four hours is long enough to collect considerable numbers of algae, but this population will probably differ from the one that will be there after a week. Once you have removed your plate from the water, wipe off one side and put it on the microscope stage. Don't let the algae dry out. You may want to note such things as number of cells per field of view, number of species, species diversity, etc. The benthic algae are a community about which little is known. Studies that you can do will contribute to the limited data on these organisms.

V. Limitations

There are an incredible number of variables that affect the growth of this community. Try not to get frustrated if simple patterns of growth and "cause and effect" are not readily apparent.

VI. Bibliography

Hynes, H.B.N., The Ecology of Running Waters, Liverpool University

Press, 1970. This is a fantastic discussion of the benthic algae, with specific discussion of the glass slide-substrate method.

Round, F. E., "The Ecology of the Benthic Algae", a paper in Algae and Man. Another good discussion of the benthic algae, with reference to this technique.

B. Clinometer *

I. Introduction

In a comprehensive study of any water system it is important to take a look at the drainage basin as well as the actual water body under study. The drainage basin is the source of all the water in the river or lake. To understand the water, one must know where it comes from. One of the important things to learn about a basin is the slope of the land. The slope helps to determine the rate and extent of runoff from the land into the water system. The clinometer is an instrument that measures this slope. This particular clinometer is easy to make, but not so elementary that it cannot make accurate measurements. Sixth graders should be able to make and use this effectively. The total cost is $1.00.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
3	Plastic protractors		Variety store	$0.15
1 pc.	Clear plastic fish-tank tubing	1/4" x 8"	Pet store	$0.03
6	Steel shot or other sm. beads	1/16" diam.	Scrap	$0.00
2	Right angle braces	1 1/2" x 5/8"	Hrd. store	$0.05
4	Wood screws	For braces	Hrd. store	$0.01
1 pc.	Wood	5"x8"x3/4"	Scrap	$0.00
1 pc.	Wood	4" long	Scrap	$0.00

* See page 53b

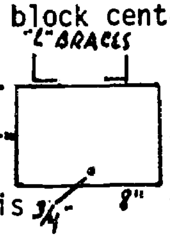
1	Dowel	5/8"x36" dia.	Hrd. store	$0.25
1	Dowel	3/8"x6" dia.	Hrd. store	$0.20
3	Sm. wood screws		Hrd. store	$0.01
2	Sm. fence staples		Hrd. store	$0.01
1	Bolt	1/4"x1 1/2"	Hrd. store	$0.02
2	Wing nuts	For above bolt	Hrd. store	$0.01
2	Washers	For above bolt	Hrd. store	$0.01
1 pc.	Scrap metal	1 1/2"x4"x1/8"	Scrap	$0.00
2	Med. wood screws		Hrd. Store	$0.01
1	Bolt	1/4"x3 1/2"	Hrd. store	$0.03
1 pc.	Wood	1"x6"x6"	Scrap	$0.00

<u>Tools</u>:

Paint	Plastic cement	Wood glue
1/4" screwdriver	Hammer	Hacksaw
Saw	Electric hand drill with 1/4", 3/8", 5/8", 1/8" bits	
Flat, first grade file	Sandpaper	Jigsaw
Level	Paint brush	

III. Procedure

Cut the 8" x 5" x 3/4" block and sand the edges. Next drill a 1/4" hole through the block centered lengh-wise and 3/4" from one of the long sides.



The 4 wood screws will fasten the "L" braces into the 3/4" x 8" end that is opposite the hole. This is the "top" of the block. They should be positioned parallel to the sides and spaced about 6" apart. They will be used as the sights. You may want to put "V" notches in the tops of the braces to use as more accurate sights than the holes. Drill into one of the 5" x 3/4" sides one inch from the bottom corner at an angle of about 20° downward with the 3/8" bit about one inch deep. The 3/8" x 6" dowel should be glued into this hole. It will be used as a handle to aim the clinometer. Saw and file smooth the piece of scrap metal. If aluminum is available, use it. Drill a 1/4" hole about 3/4" from one end of this plate. In the other end drill two holes with the 1/8" drill. This plate will join the upper block, which is the actual measuring device, with the lower block, which is the base of the tripod. Cut the piece of two by four into an equilateral triangle, 4" on a side and 2" thick. Drill a 1/4" hole through the center of the triangle. Then cut a circular block with a diameter of 6" out of the 1" x 6" x 6" block. In the center of this block, drill a 1/4" hole all the way through. The holes for the legs (the 5/8" dowel) must be drilled into this ciruclar block. Since this will be a tripod, it must have three legs. Drill three holes, equally spaced around the circle. The holes must be angled, so the legs can be spread apart. Cut a scrap block of two by four so that it has a 30° angle, with one of the three equally spaced points uphill, and then drill straight down into this point about 3/4" deep; then the leg, when stuck into this hole, will slant out at a sturdy 60°. Drill holes in the other two points. and glue the legs in. You should now have a tripod, a half-finished upper block, a metal plate, and a triangular block. It is time to put it together. Drill two holes in one side of the triangle that correspond to the two in the plate, so that the plate will stand straight up above the tripod. The holes in the block should be small and shallow, as they are only there to get the two wood screws started. Screw the plate on. The upper block is fastened on to the plate, using the 1/4" bolt and wing nut, through the holes in the plate and block. Be sure the upper block is on the side of the plate opposite the side that will be attached to the tripod. To attach the tripod to the triangle, place the 3 1/2" x 1/4" bolt through the triangular and circular blocks, with a washer in between. On the bottom, put the wing nut and the washer. The measuring part of the clinometer is a plastic tube that runs along the rim of a protractor. In it will be a small bead or shot. The shot must be spherical and small enough to roll freely in the tube. The protractor will be fastened onto the upper block in such a way that when the sights are level, the shot will come to rest in the tube next to the zero degree mark of the protractor and that when the clinometer is aimed uphill at an object, the shot will rest next to the mark designating the angle between that object and the horizontal. Cut the protractor in half with the jigsaw, so that you get two quarter-circles. One of them must be mounted on the side of the upper block with its edge extending from the corner to the 90° mark, parallel to the top edge. The other edge, from the corner to the 0° mark, is perpendicular to the top edge. Mount it with the three small screws. Cut a piece of tubing about an inch longer than the distance along the arc of the protractor. Put the bead in it. Seal the ends by melting and pinching them. The tube is then mounted to the block and the edge of the protractor with plastic cement. This must be done carefully, with frequent checks to make sure that the device is level and the bead indicates this. To do this, assemble the clinometer, with the tube temporarily fastened along the edge of the protractor (perhaps with a few tacks). Place the level on top of the device and level it. Then check to see if the bead is resting just below the zero degree mark (always tap the upper block slightly before reading, to insure that the bead is really at its rest position). If the bead is not where it should be, move the tube slightly. Finally, fasten the tube down permanently with cement and one staple hammered over each end. To get readings of horizontal as well as vertical angles for mapping, place two protractors around the edge of the circle plate, so that they make a complete 360° scale. Then fasten a pointer to the front of the traingular block. If you align the tripod with north, then the pointer will show the bearing of any object that you are sighting.

IV. Use

To use the clinometer, place it on the ground at the bottom of a slope. Sight up the hill through the "L" brace holes. Have someone stand directly up the slope and sight on his knees. The sight holes on the clinometer are about knee high off the ground. This height must be accommodated for at the sight so that the slope of the hill will be the only factor determining the angle of the measuring device.

V. Limitations

The main problem with this device lies in the accuracy of the bead-in-tube idea. Fortunately, if you calibrate it carefully, it is reasonably accurate. Be sure to tap the block before making a reading to insure that the bead is in a true rest position.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. I, Second Edition, Institute for Environmental Education, Cleveland, Ohio, 1971. This reference gives a brief exercise demonstrating some runoff characteristics, and the use of a clinometer.

Slope Measuring Device - Clinometer

C. Core Sampler

I. Introduction

There are many things that can be learned about a body of water by studying the bottom characteristics. These characteristics include such things as composition, rocky, clay, or silt, the thickness and source of a silt layer, and the type and quantity of organisms living there. The Core Sampler can be used to collect samples of sediments for these kinds of studies. It will remove a core from any silty bottom.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Steel pipe with at least threaded end	30"x2"	Hrd. store	$5.29
1	Reducer	For above pipe	Hrd. store	$2.25
4	Steel bolts	1/4"x1 3/4"	Hrd. store	$0.03
4	Nuts	For above bolts	Hrd. store	$0.01
1	Steel bolt	1/4"x1 1/4"	Hrd. store	$0.03
1	Wing nut	For above bolt	Hrd. store	$0.02
5	Washers	For above bolts	Hrd. store	$0.01
1	Copper burnishing wheel	2"	Hrd. store	$0.49
1	Dowel	1"x36"	Hrd. store	$0.65
1	Plywood	6"x14"x3/4"	Lumber yd.	$0.30
2	Kitchen drain cover	5" diam.	Hrd. store	$0.39
1	Dowel	1/4"x36"	Hrd. store	$0.20

Tools:

Saw	Sandpaper	Glue
White shellac	1/4" screwdriver	Pliers
Hammer or mallet	Jig or sabre saw	Epoxy
Drill press	3/8" x 1/4" drill bits	

III. Procedure

Cut the handles to the shape and sizes shown in the diagram. Four 1/4" holes must be drilled, two in each half, to fasten the handles to the reducer ring, which is screwed onto one end of the pipe. The holes must be angled into the handles so that the bolts will stick straight out from the reducer ring. The holes can be drilled at the proper angles by placing the handle on the 30° jig block and then drilling straight down (see diagram). Holes must then be drilled in the reducer ring which line up with the holes in the handles. It is important that the handles, when fastened to the ring, are just flush with the top edge of the ring so the valve will function properly. Mark the points on the ring that will line up with holes in the handles by putting the handles in place and pushing a sharp object through the hole to mark the ring. Remove the handles and drill these holes with a 3/8" bit. Now put the handles on the reducer ring, and put the bolts in their holes, from the inside out so there will not be obstructions in the tube. Insert washers and tighten up the nuts on the bolts. The handles should now be firmly mounted on the ring. To keep the two halves of the handles together, drill a 1/4" hole through the neighboring halves of each handle (see diagram). Put some glue in the holes, and pound in two dowels. Trim them off flush. Now sand the handles so that they are comfortable to hold. Finally put on the valve.

Next drill a 1/4" hole in the yoke as shown in the diagram, and a corresponding hole near one edge of the drain cover.

Bolt the cover over the top of the yoke with a bolt, washer and wing nut. The cover (valve) should lie flat over the top of the ring, making contact with it all the way around. When the sampler is shoved down, the valve will rise up slightly, allowing air to escape. When the dredge is pulled out, the valve should form a fairly good seal around the upper edge, thus holding the core in by suction.

Now screw the reducer ring-handles assembly onto the steel pipe. The last bit of construction is the scrubber. This is simply the 1" x 36" dowel with a wire wheel driven firmly into one end. It is used to slide down inside the tube and push out the core sample that has just been collected. Drill a 1/4" hole in one end of the dowel, put some epoxy in the hole, and pound in the wire wheel. It should just fit snugly through the tube. Shellac or paint all wooden parts to protect them from water and mud.

IV. Use

This sampler is designed to be hand-held, and hand-driven into the bottom of a pond or stream. Standing in the water, grasp the sampler, and drive it into the bottom keeping your toes out of the way. Wiggle it around a bit from side to side and carefully pull it out. If the sample falls out of the tube, the bottom is too soft or the sampler was pulled out too fast. To remove the core, lay the sampler on its side in a trough or pan, open the valve, and push the scrubber down the tube. This will push the core out neatly.

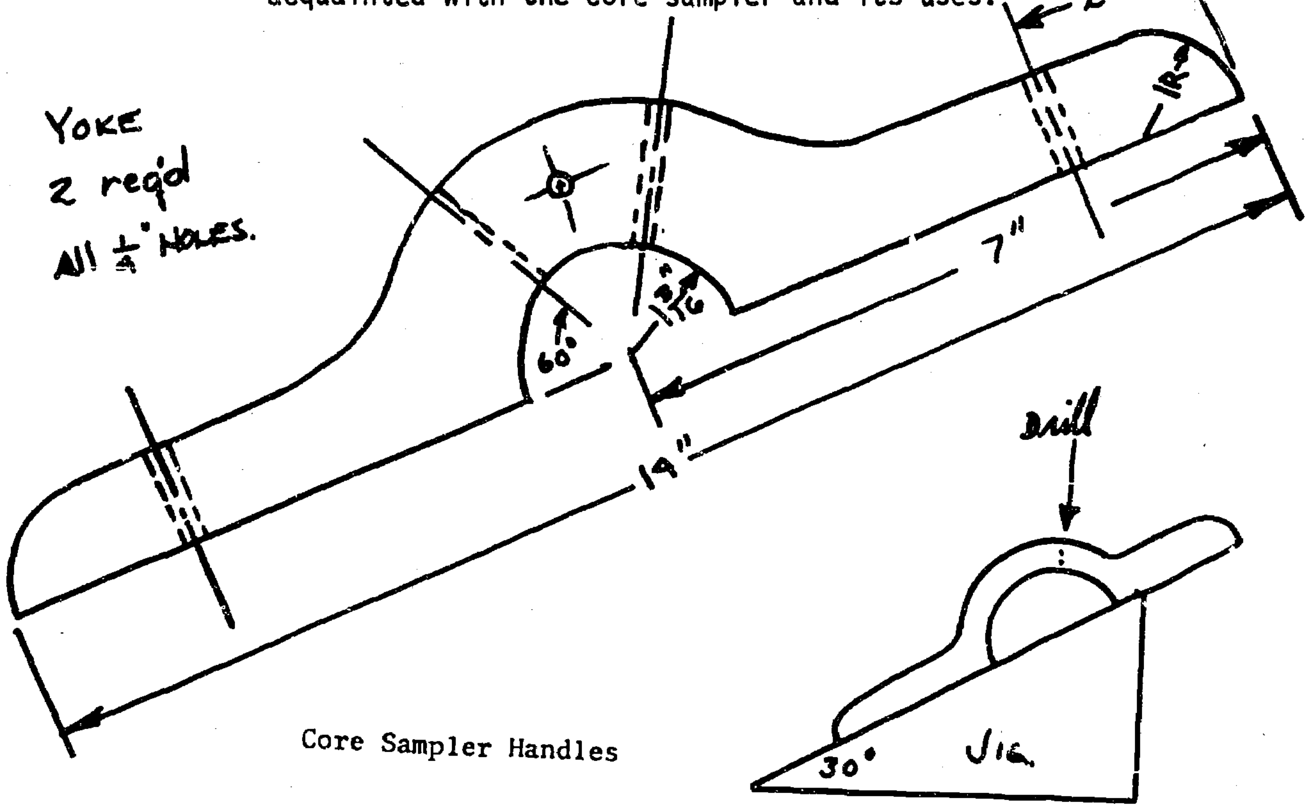
Some veteran core samplers freeze their core samples in pieces of rain gutter to preserve them for later study. Carry an extra valve with you because valves dry out and crack.

V. Limitations

This device cannot be used in rocky bottoms or bottoms that are so fine that the sediments will not compact and stay in the tube.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. I, Second Edition, Institute for Environmental Education, Cleveland, Ohio, 1971. Contains an excellent activity designed to get students acquainted with the core sampler and its uses.



Core Sampler Handles

D. Terrestrial Core Sampler *

I. Introduction

The terrestrial core sampler, like the clinometer and rain guage, is used in studies of streams and lakes in what might seem at first a rather remote way. The core sampler can be used to collect small samples of soil from different parts of a watershed. Soil type and moisture content tell you many things about the nature of the water. The core sampler is more difficult to make than to use. It is not recommended unless you have had some experience in light metal working and know how to use a drill press. This design should cost about $3.50.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
3 pcs.	Sink drain pipe that fit together to make one unit (see text)	2 ft.(total)x 1 1/2" diam. x 1/16" thick	Hrd. store	$0.80/pc.
1 pc.	Maple or other hardwood	10"x3"x1"	Lumber yd. scrap pile	$0.00
4	Bolts	3/16"x1 1/2"	Hrd. store	$0.40
4	Nuts for bolts		Hrd. store	$0.01
1 pc.	Old hacksaw blade (see text)		Scrap	$0.00
5	Bolts	1/8"x1/2"	Hrd. store	$0.01
5	Nuts for bolts		Hrd. store	$0.01
1	Hose clamp	2" diam.	Hrd. store	$0.35
1	Dowel	5/8"x36"	Hrd. store	$0.50
1	Piece of heavy rubber	1 1/2" diam. x 1/2" thick	An old tire	$0.00
1	Screw	1/8" x 1"	Hrd. store	$0.01

Tools:

Hacksaw
Drill press with 3/16", 1/2" and 1 1/2" bits
Screwdriver
Sabre or small hand saw
Pliers
Shellac
Sandpaper
Paint brush
Goggles

* See page 23a

III. Procedure

This core sampler is designed around a length of pipe, which is actually three pieces that fit tightly together. They are a type of thin (1/16") drain pipe that is used in exterior plumbing like sink drains. The author's pipe was made of brass, chrome-plated, but any pipe of roughly the same dimensions will suffice. The upper piece should have a lip on it, but this is not essential. An extender of about 5" fits tightly onto the end of the first piece, and another extender pipe of 7" fits onto the second. This last extender is the tricky part. It must do two things. First, it must bite or cut into the ground. Secondly, it must hold the core that is cut by the "teeth" and allow it to be removed in one piece. The teeth are difficult to attach. They consist of a piece of an old hacksaw blade that is cut to the right length, bent into a circle, and inserted inside the end of the second extender piece. Since some types of hacksaw blades will break rather than bend into such a tight circle, you must <u>carefully</u>, and <u>gently</u> try bending different kinds of blades to find one that will bend, particularly ones that have been discarded - it's cheaper that way. Try those cheaper types of blades that are <u>not</u> tempered. They will tend to bend rather than break. Wear goggles for this testing.

After inserting the blade, adjust it so that the teeth of the blade protrude out below the edge of the pipe. Then, with the blade still in place, drill five 1/8" holes through the end of the pipe and the blade. Bolt the blade in with the bolt heads on the inside. Once the bolts are tightened down as firmly as possible, saw off the ends of the bolts so that they are flush with the nuts so that they will cause as little resistance in the ground as possible. Next, put this third piece of the tube in a vice, and saw one slot down one side of the tube, from its upper end to within two inches of the teeth. Now slip the hose clamp over it, and fit it back on the end of the second piece. Tighten up the clamp on the joint between the two pipes. Next make a plunger to remove cores from the sampler. Cut a piece of thick rubber into a circle so that it just fits inside the tube. Then drill a small hole through its center and screw it to one end of the dowel.

The last major step is the handles. Cut a piece of solid wood 1" x 3" x 10". Then drill a 1 1/2" hole in the center of it. Take the tube apart at the upper joint, and push the tube down through this 1 1/2" hole until the handle piece rests against the lip of the tube. Drill four 3/16" holes through the edge of the handle into the pipe, at angles so that the four bolts will do the most supporting possible. Finally bolt this handle on and give it several coats of water-proof finish. Before use, assemble all three pieces, the upper one with the handles on it, the middle one, and the lower tube with slot and teeth.

IV. Use

Grasp the handle as close to the pipe as possible. Then, placing the sampler into the soil, turn the pipe in such a way as to allow the teeth to cut their way into the soil. Try to place the downward pressure as nearly above the pipe as possible. This will help to minimize the danger of losing the handles due to excessive stress. Twist the sampler into the soil as deep as the hose clamp.

To clear the tube, take off the hose clamp and remove the last section containing the core. To clear the tube using the plunger, place the plunger into the end containing the teeth and, using a judicious amount of force, tap the core sample out. If deeper samples are desired, clear the tube of contents and then redrill the hole until the desired depth is reached. If the sample falls apart when it is leaving the tube, try to tap the core onto a flat surface before clearing the tube.

V. Limitations

If the soil is rather dry, it will probably not come out of the sampler in a firm core. All samplers have this same problem and it really cannot be remedied.

E. The Polluchie--Deep Water Sampler

I. Introduction

One of the most fascinating and revealing studies that anyone can do in a lake, bay, or pond is an investigation of variations in water quality and aquatic life at different depths. Many bodies of water have a hypolimnion, a sharp boundary between upper oxygenated "healthy" water and lower "depleted" water. The level and extent of this boundary are indicative of many basic qualities of that body of water. The deep water sampler is a device for collecting a water sample from a specific depth without contaminating it with water from other levels. This model is easy to make, durable and similar to commercial models costing ten times as much.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Piece plastic(PVC) plbg. pipe	I.D. 2"x2'	Plbg. sply. store	$0.63
2	Solid rubber balls	Diam. approx. 3"	Toy store	$0.25
1	Piece surgical tubing	2' length	Scrap	$0.00
1	Lab tubing	I.D. 1/4"x6"	Scrap	$0.00
1	Brass needle valve	For 1/2" pipe	Plbg. sply. store	$1.29
1	Hose clamp	Diam. 3"	Hrd. store	$0.31
2	Eye bolts	1/4"x4"	Hrd. store	$0.10
2	Nuts	For eye bolts	Hrd. store	$0.02
8	Washers	For eye bolts	Hrd. store	$0.01
2	Wing nuts	For eye bolts	Hrd. store	$0.04
1 pc.	Steel rod, threaded	Diam. 1/2"x4"	Hrd. store	$0.49
1 pc.	Steel, flat stock	1/8"x3/4"x6"	Scrap	$0.00
1 pc.	Steel, flat stock	1/8"x3/4"x2"	Scrap	$0.00
1 pc.	Steel, flat stock	1/8"x3/4"x1 1/2"	Scrap	$0.00
1	Alum. bolt for release pin	1/8"x2"	Hrd. store	$0.01
2	Nuts	For above bolt	Hrd. store	$0.02
2	Nuts for 1/4" steel rod (activator rod)	1/4"	Hrd. store	$0.02
1	Wing nut	1/4"	Hrd. store	$0.04
1 pc.	String		Scrap	$0.00
1 pc.	Woven nylon line	1/4"x3'	Hrd. store	$0.05
1 pc.	Heavy steel pipe	O.D. approx. 1"x6"	Scrap	$0.00

Tools:

Hacksaw

Half round second grade file

Sturdy vice

Hammer	Electric hand drill or drill press with 3/8", 3/16", 1/4" bits	String
Tap of the correct size for the needle valve	Knife	1/4" screw driver
Pliers	Rust-proofing paint	Paint brush
Needle nose pliers	Tape Measure	

III. Procedure

The two-foot length of PVC pipe will be the body of the sampler. The rubber balls are the valves that seal off the ends of the tube and trap a water sample. The surgical tubing is the spring that pulls the balls into position in the ends of the tube. The flat stock is for the trigger mechanism. The piece of heavy steel pipe is the messenger that is dropped down the rope holding the sampler, triggering the sealing of the tube. The plastic pipe should have level, smooth ends with a slight bevel inward, so that the balls will sit tightly against the ends. Bend the 6" piece of flat stock into a "U" with right angle corners, about 2" on each side. Then drill a 3/8" hole through both sides of the piece about 3/4" from the first and directly opposite it. On the other side drill a 3/16" hole. This piece of stock is the body of the trigger mechanism. The side with the two 3/8" holes will be the top or upper side, and the one with the 3/8" and 3/16" holes is the lower. Drill two 3/8" holes in the 2" piece of steel that correspond to the 3/8" holes in the top of the trigger piece. Next take the brass bolt (release pin) and file the final 1/2" of it to a point. This pin holds the cocking lines, which must be able to slide off easily when the messenger releases the pin. The final piece of the trigger mechanism is a 4" length of 1/4" steel rod. If you can find this length in brass or aluminum threaded rod, other than steel, use it--it won't rust. Next, assemble the trigger mechanism. On one end of the steel rod, put a nut, the 2" steel plate, (using the 3/8" hole), and another nut. Put the rod through the two 3/8" holes in the trigger piece so that the top plate sits just above the top "side" of the piece. On the end of the rod extending below the trigger piece, fasten the 1 1/2" steel plate through the 3/8" hole, with two nuts (one above, one below). Secure the release pin in the 3/16" hole in the lower plate with the two brass nuts so that the pointed end sticks up through the 3/16" hole in the trigger piece. Tighten the nuts of the upper plate so that the 3/8" hole in the plate lies just above the outer 3/8" hole in the top of the trigger piece. Next, adjust the trigger so that the threaded rod can move freely up and down through the holes in the trigger piece. When the rod is <u>down</u> as far as it can go (with the top plate's bottom nut resting right on the trigger piece), the release pin should <u>not</u> be protruding through the hole in the trigger piece into the inside of the "U". When the rod is <u>up</u> as far as it can go (with the bottom plate's top nut resting against the trigger piece), the release pin should be protruding about 3/8" above the trigger piece's bottom leg, "inside" the trigger's "U".

Now lay aside the trigger for a while (this would be a good time to paint the steel parts), and start to work on the body. The needle valve must be fastened into the body about one inch from one end. This can be done either by using the proper tap and tapping a threaded hole in the pipe, then screwing in the valve, or by drilling a slightly oversized hole and fastening the valve with a nut on the inside. Drill a 1/4" hole through the center of each rubber ball and put an eye bolt with a washer on it through the hole. Fasten it with a washer and nut on the other side of each ball. Pass the piece of surgical tubing, (it needn't be surgical tubing, just some kind of strong, elastic tubing or cord), through the body tube and fasten it securely through one of the ball's eye bolts using lots of string. Then stretch the tubing fairly taut and secure it to the other eye bolt. The tubing must be stretched enough so that the balls will be held tightly in each end of the tube. However, the tubing must also be elastic enough so that the balls can be pulled out of the tube about 6". Now take the trigger mechanism and fasten it to the tube by means of the hose clamp. It should be fastened with its upper end about an inch from one end of the tube. The final step is to attach the cocking lines. These are pieces of 1/4" braided nylon cord that are formed into loops and by pinching a portion of each loop between two washers and then tightening a nut down on top of them they may be fastened to the bolts sticking out of each ball. To cock the sampler, pull both balls out of the ends and pass the loop from the top ball through the loop from the bottom ball. Then take the upper loop up and hook it over the release pin when the threaded rod assembly is up as far as it can go. The loops must be made the right lengths so when the sampler is cocked, the balls are entirely out of the ends and resting against the side of the tube. When the upper plate is hit, the loops should be released, and the balls should be jerked tightly into the ends of the tube.

IV. Use

To use the Polluchie, pass a 1/4" rope through the 3/8 hole in the upper plate and through the hole below it in the trigger piece. Knot the end securely. The messenger (length of pipe) should already have been put on the rope. Cock the sampler and lower it to the desired depth. Drop the messenger down the rope. If all goes well, the messenger will hit the upper plate, which will push the release pin down, releasing the loops and sealing the ends of the tube with the balls. The sample can be removed from the tube through the needle valve at the bottom. No bubbling occurs in the sealing process, so the sample may be used for dissolved gas testing. The sampler holds about one liter of water.

V. Limitations

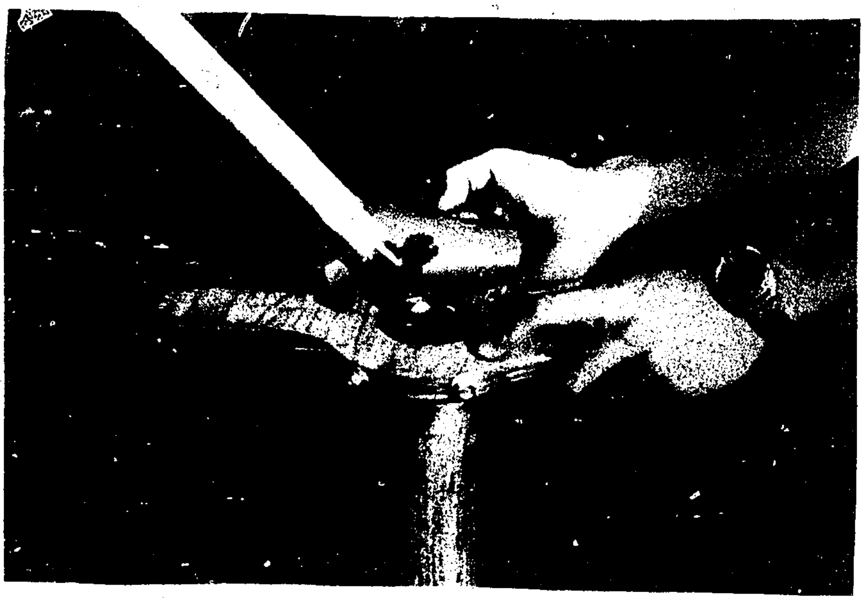
If you've made your sampler well, no water will come out of the valve when you open it because the balls seal the ends so well that air cannot enter the tube to replace the water.

Therefore, the top ball must be moved slightly to let some air in. Also, if the messenger is too light, it won't move the upper plate; if it is too heavy, it will bend or break it.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. I, Second Edition, Institute for Environmental Education, May, 1971, Pp. 2-53 to 2-58. This reference is to an activity involving the use of a deep water sampler (here called a Kemmerer sampler).

Ibid., Vol. II, Pp. A1-143. Discusses briefly the use of deep water samplers in Plankton analysis.



Terrestrial core sampler

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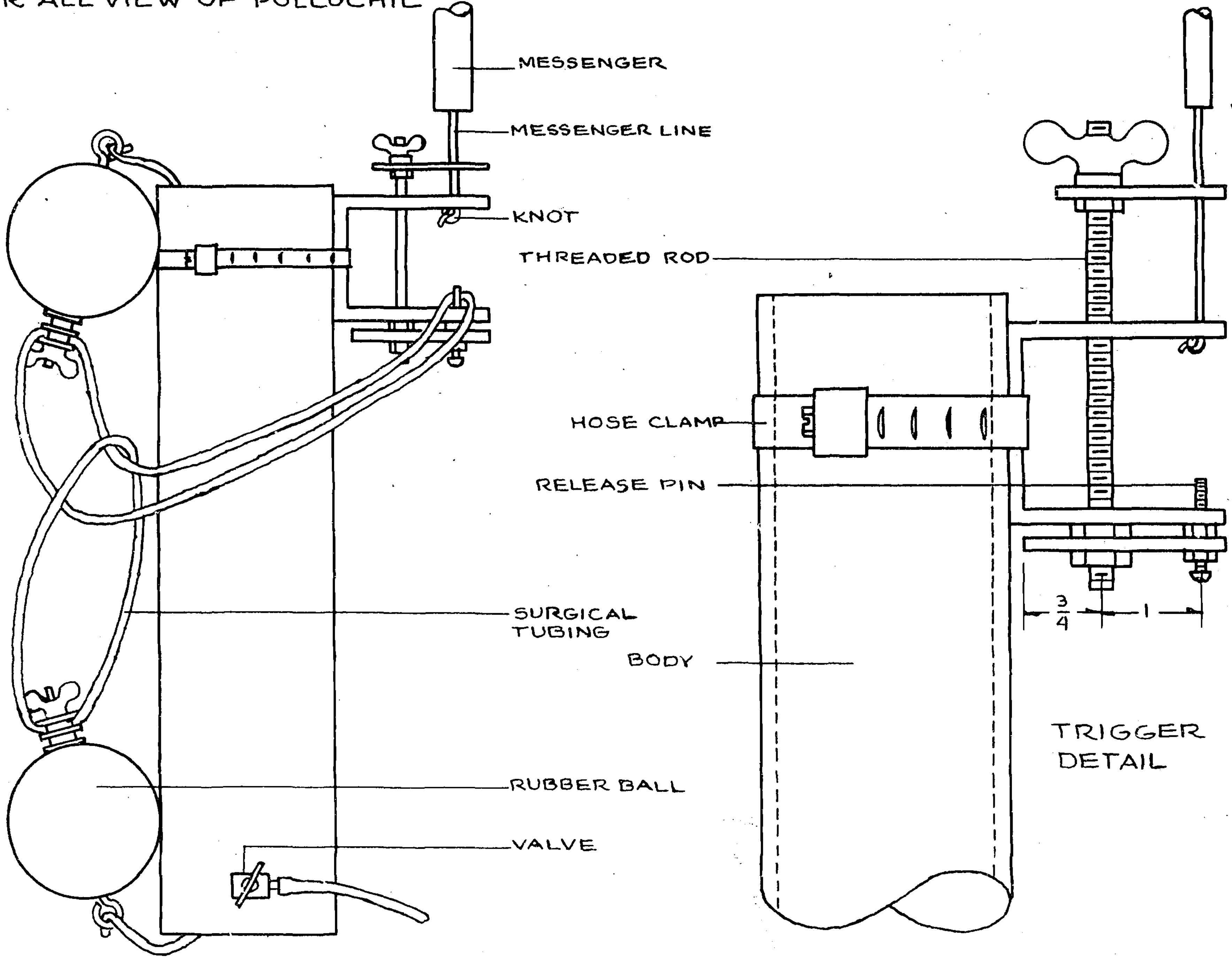


F. Dissolved Oxygen Kit

I. Introduction

Measurement of dissolved oxygen (DO) in the field using the Winkler Method involves the use of some potentially dangerous solutions. This kit is designed to carry three sample bottles as well as the three bottles containing the solutions. The carrier is made from strong materials so that it can take considerable abuse. The box is easily constructed. The price of the unit runs about $2.00.

II. Materials:

Qty.	Item	Dimension	Source	Unit Price
1	Plywood	16"x42"x3/4"	Lumber yd.	$0.30/sq.ft.
1	Dowel	36"x3/4"	Hrd. store	$0.50
40	4 Penny box nails	1"	Hrd. store	$0.20

Tools:

Power or hand saw	3/4" drill bit	Electric drill
Hammer	Wood glue	Sandpaper
Varnish	Paint brush	

III. Procedure

Block out on the 16" x 42" x 3/4" piece of wood, three pieces measuring 12 3/4"x 4"; 6 pieces, 6 1/4" x 4"; 2 pieces, 15" x 7 3/4", and 1 piece, 3/4" x 7 3/4". Cut out the pieces. Take one of the 12 3/4" x 4" boards and cut slots 2" deep leaving a 2 3/4" tab between the slots all the way along its length (see diagram). This is the center divider of the box. Then take the two 15" x 7 3/4" boards and drill a 3/4" hole with center 1" from the end and 3 3/8" from the sides. Drill a hole at these dimensions into both boards. Cut each of the six 6 1/4" x 4" pieces in the following manner: make a 2" deep slot starting 2 3/4" from one end and 3/4" wide. This should leave you with a 2 3/4" wood space between the slot and each end of the board. Next, place the six boards you've just finished cutting into the "center strip" so that the slots on each of the boards slide into the slots of the center strip. You should now have three compartments with inside measurements of 2 3/4". The top of the center strip should be just flush with the 6 1/4" side. Place the dividers on the 12 3/4" x 7 3/4" piece of wood making sure that the sides of the dividers are 3/4" in from the sides of the 12 3/4" x 7 3/4" piece of wood. This 3/4" border is where the sides of the box will be set. Glue and nail the dividers on to the 12 3/4" x 7 3/4" board. Glue on and nail the two 12 3/4" x 4" sides of the box so they are flush with the dividers. This should leave you with a box flush all the way around. Next cut from the 36" x 3/4" dowel a section 14 1/4" long. Place the dowel into each of the holes in the 15" x 7 3/4" boards so that the ends are flush with the sides of the boards. Finally, nail the now completed handle onto the ends of the box. The finished product should have six compartments 2 3/4" x 2 3/4". It should stand 15" high.

IV. Use

This box is used to hold and protect the dissolved oxygen testing bottles and solutions. It is designed to contain all that is needed for the field portion of the Winkler Azide test for DO. The three chemicals that must be taken into the field are: manganese sulfate ($MnSO_4$), alkali-iodide-azide (AIA) reagent, and sulfuric acid (H_2SO_4). In the standard test, 300 ml glass stoppered bottles would be used for collecting the samples. Two milliliters of each chemical is added to the sample. If you cannot afford the glass stoppered bottles, you might want to substitute another type with a tight fitting top. In this case, the proportion:

$$\frac{300\ \text{ml}}{2\ \text{ml}} = \frac{\text{your bottle volume (in milliliters)}}{\text{the amount of each chemical you add (in milliliters)}}$$

will tell you how much of each chemical to add, following the standard procedure with your figures substituted. If you substitute alternate bottles (1 pint plastic ones with screw caps are suitable), then you may have to alternate the plans slightly to fit the size of your bottles.

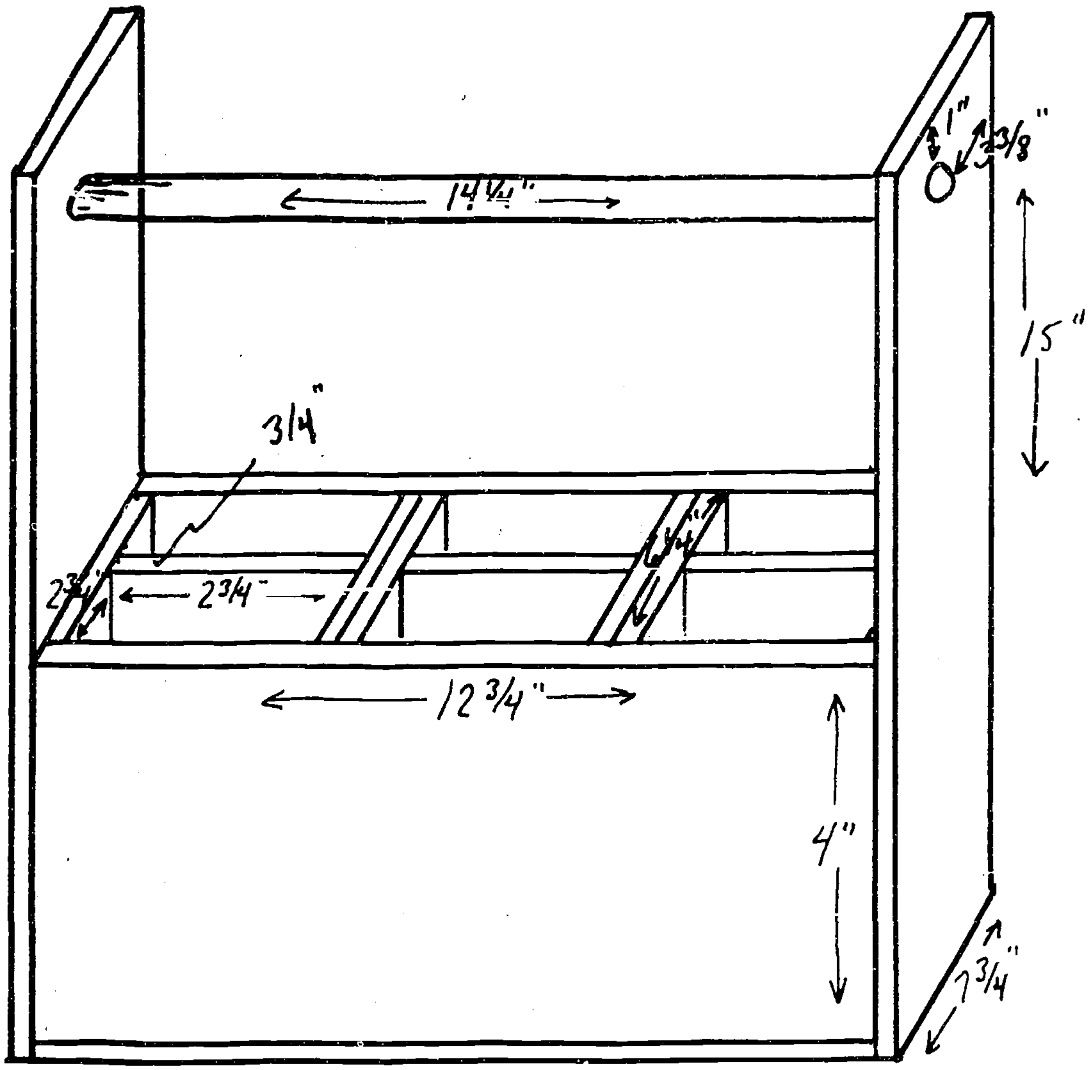
V. Limitations

If sulfuric acid is spilled on the box, it will burn the wood. Because the chemicals are contained, there is much less danger of burns to the individual.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. II, Second Edition, The Institute for Environmental Education, Cleveland, Ohio, 1971.
Gives an excellent step by step procedure for doing this test. It is really restating Standard Methods (see below) but it may be easier reading.

Standard Methods for the Examination of Water and Waste- water, 13th Edition, American Public Health Association, 1790 Broadway, New York, New York, 1971. This is the official standard source of all water chemistry tests and will tell you the correct standard procedure.



D. O. Kit

G. Transect Dredge

I. Introduction

The Transect Dredge is used to collect samples of mud and other soft sediments from the bottom of a pond, lake, or river. It is dragged (towed) along the bottom, cutting and collecting the sediments along one thin strip, or transect. This is particularly useful when studying bottom life because most life does exist in the upper thin stratum. When making this dredge, you will be working almost entirely with sheet metal which requires some skill. Someone experienced in sheet metal work should act as a supervisor. However, little skill is required to use the dredge to collect samples. The cost of construction is approximately $6.00.

II. Materials:

Qty.	Item	Dimension	Source	Unit Price
1	Straight length galvanized sheet metal heating duct	5" diam. x 24"x1/32"	Hrd. store	$0.49
1 pc.	Aluminum flat stock	1"x3/16"x48"	Hrd. store	$2.99/8ft.
3	Eyebolts	1/4"	Hrd. store	$0.10
6	Nuts for eyebolts		Hrd. store	$0.02
1	Snap swivel		Hrd. store	$0.55
2	Hose clamps	3"	Hrd. store	$0.40
1 pc.	Window screening	8" square	Scrap	$0.00
6'	Nylon cord	1/4"x1/2"	Hrd. store	$0.40
12	Round head bolts	1/4"x1/2"	Hrd. store	$0.02
12	Nuts for above bolts		Hrd. store	$0.01
12	Washers for above bolts		Hrd. store	$0.01
1	Float		Scrap	$0.00

Tools:

Tin shears
Second grade flat file
Hammer or mallet
Hacksaw
Knife
Paint and brush
Electric drill or drill press

III. Procedure

The section of duct will be the main body of the sampler. Cut a length of aluminum stock the leng.h of the circumference of the pipe. Bend it into a circle (collar) by working it around a block of wood the same diameter as the pipe. Drill six 1/4" holes, evenly spaced, in the collar. Now bolt the collar onto the outside of the tube about 1" down from one end of the tube with the 1/4" bolts and washers (on the inside) and nuts (also on the inside).

Next drill two 1/4" holes near the front (the collared end) and "on top" of the tube, as shown in the diagram. Put two eyebolts in these holes, facing out. They should be fastened in with one nut inside the tube and one outside. Place them as low to the surface of the tube as possible. This side, shown in the diagram, is "the top". Turn the tube over and drill a 1/4" hole about 6" from the back end and opposite the two eyebolts on top. Put in the other eyebolt and fasten it like the others.

Next put on"the fins" or stabilizers, which prevent the dredge from rolling over when cutting along the bottom. Cut two pieces of aluminum 15" long. At a point 3" in from one end, make a cut with a hacksaw about 1/3 of the way through and straight across the width. Then make a 30° bend in the piece, using the cut as the pivot point. Bend the angle toward the cut side and make two angle pieces. Next drill three holes in each 3" section.

These holes will be used to mount the "fins" to the sides of the sampler. They first should be mounted so they stick straight out from each side, near the back, in other words, one on each side, spaced 90° from the back eyebolt, and about in line with it. Attach the screening over the back end with the two hose clamps. Screw them together to make one large clamp about 6" in diameter.

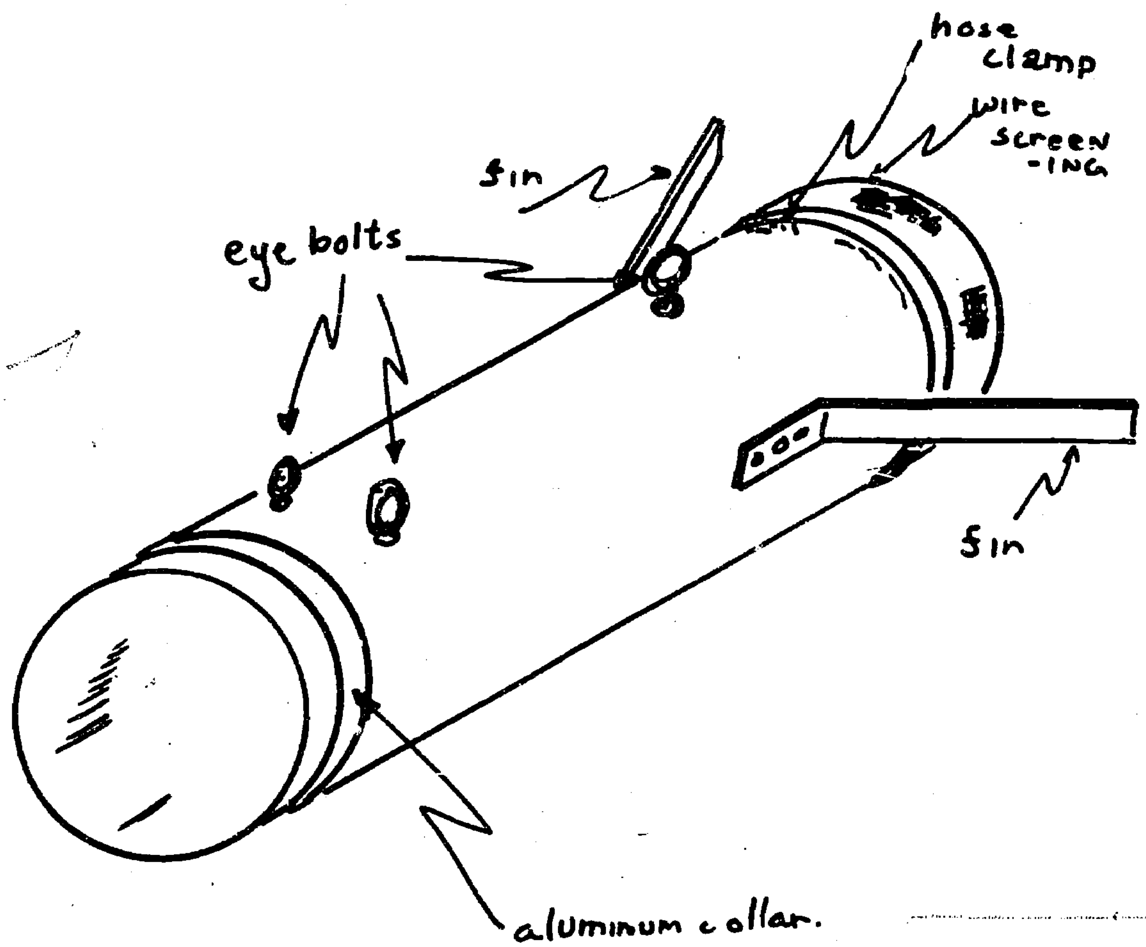
To "rig the rigging", take about 5' of nylon cord and run it through the back eyebolt, through one front eyebolt, then through the other, and tie it to the first end. Tie one end of another line about 10' long to the back eyebolt. To the other of this line tie a small, light buoy. To operate, clip the tow line to the rigging line between the two front eye-bolts. The tow line should slide freely along the front section of the rigging line between the two bolts.

IV. Use

This dredge is designed to be towed from a boat or used from the shore. The float at the rear of the dredge is used to locate the device should it hit an underwater snag. The back line can then be used to help free the dredge. The tow line should be long enough to make the angle between the dredge and the boat as small as possible. A small angle is desirable for proper collection of the sample. When lowering the dredge, be sure to keep the lines free. Drag at a slow speed and, when you think you've got enough, come to a point directly over the dredge and pull it straight up. This reduces the chance of sample's washing out. From the shore, coil the lines and heave the float out as you would a life buoy. To empty the sampler, dump the contents into a shallow pan. To clean it, back flush through the screen.

V. Limitations

Because the sampler runs a risk of snagging, it should be sturdy. This means that high stress items, such as eyebolts, should be of good quality steel. When the sampler is used from the shore, lines may become tangled. To minimize this, coil the float line around the float before throwing it.



Transect dredge

H. Drying Oven

I. Introduction

These plans are for an oven, used for drying soil samples, bottom sediments, and macroinvertebrates so that their dry weights can be measured. It is designed to reach only the medium-high temperatures needed for drying samples. For this reason, it can be built from plywood, with inner walls of ceramic tile. It is heated with a light bulb. This oven is fairly complex. It has some simple electrical wiring and is recommended for people with some knowledge of and skill with tools, wood, and wiring. It is fairly expensive, costing about $20.00 but still far cheaper than anything available from commercial sources.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 lb.	Repair grout		Bldg. sply.	$0.79
1 qt.	Adhesive		Bldg. sply.	$1.89
1	Replacement electrical cord		Hrd. store	$0.99
1	Exterior light socket		Hrd. store	$0.40
1	Red light bulb	75 watt	Hrd. store	$0.39
1	Interior light socket		Hrd. store	$0.45
1	Exterior wall switch		Hrd. store	$0.59
1	Junction box	5" diam.	Hrd. store	$0.35
5'	Electrical wire		Hrd. store	$0.05/ft.
1	Electrical tape		Hrd. store	$0.35
2	Nuts and bolts	1"x1/8"	Hrd. store	$0.06
1	Sash lock		Hrd. store	$0.90
2	Hinges	1" total width	Hrd. store	$0.50
6 sq.'	Tile	1/2"x1/2"	Bldg. sply.	$0.89/ft.^{2}
1	Bulb (flood)	150 watt	Hrd. store	$1.40
9 sq.'	Plywood	4 1/2'x2'x1/2"	Lumber yd.	$0.25/ft.^{2}
1	Staples, insulated		Hrd. store	$0.15
30	4 penny box nails		Hrd. store	$0.13
10	4 penny finish nails		Hrd. store	$0.02

11	Wood screws	1/8"x1/2"	Hrd. store	$0.04
1	Thermometer	110°C	Scientific Supply Co.	$2.00
1	Drying rack	11 1/2"x11 1/2"	Hrd. store	$0.79

Tools:

Power saw	Jig saw	Screwdriver
Hammer	Power drill	Putty knife
Knife	Sandpaper	Diagonal pliers
Drill bits, 1/4" and 3/8"	Shellac	Paint brush

III. Procedure

Cut the six sides of the box out of the 1/2" plywood - one 12" x 12" piece for the door, one 13" x 12" for the right side, two 12 1/2" x 12" for the left side and back, and two 13" x 13" for the top and bottom. Also cut one piece 4"x13" and two pieces 12 1/2" x 4". These will be the legs. The front, back, and sides of the oven will set on the bottom piece. The top comes down and fits over all of them.

Cut a hole slightly smaller than the junction box and drill holes to fasten it to the bottom. Drill several (about ten) 3/8" holes in the top piece to allow the heat to escape. Some of the holes may need to be covered if your oven does not get hot enough. Next put in the tile. You should have six square-foot sheets of small square tiles mounted on a webbed backing. These will be cemented to the plywood with tile adhesive. Temporarily assemble your box with some tape or something (you might want to leave the top off so you can see what's going on inside). Then lay the tile panels in place. You will notice that the inner dimensions of the bottom are 12" x 12". One of the panels will just fit. The top panel will also just fit, with its tile panel centered. The sides and door will have to have their tile panels cut. Put the bottom panel in place temporarily and hold one side at a time in place. Measure how much you need to cut. Probably the door will need one row off the top, and the back and two sides will need one row taken off the top and one off one side. Check to make sure; don't just do it this way. When the size and position of each panel have been determined, cut each panel to the proper size. Also, cut away the tiles covering all the holes in the top and bottom piece. Now fasten the tiles, following directions on the can of adhesive.

After 24 hours the tiles will be ready for grouting. This simply means filling all the cracks with grout paste. Before the epoxy dries, push four little "T" shaped pieces of metal into a crack in the tiles about 5" up from the bottom, two on each side. These are there for the rack to hold the samples. You need not wait for the epoxy to dry fully or for the grout to be applied before putting the oven togethr. Nail the back and sides to the bottom, then to the top, and finally together. Next mount the door on its hinges with small wood screws. The door is designed to fit flush against all sides when shut. The hinges will be mounted onto the edge, or butt, of the left side and then to the door itself. Fasten the sash lock to the other side of the door.

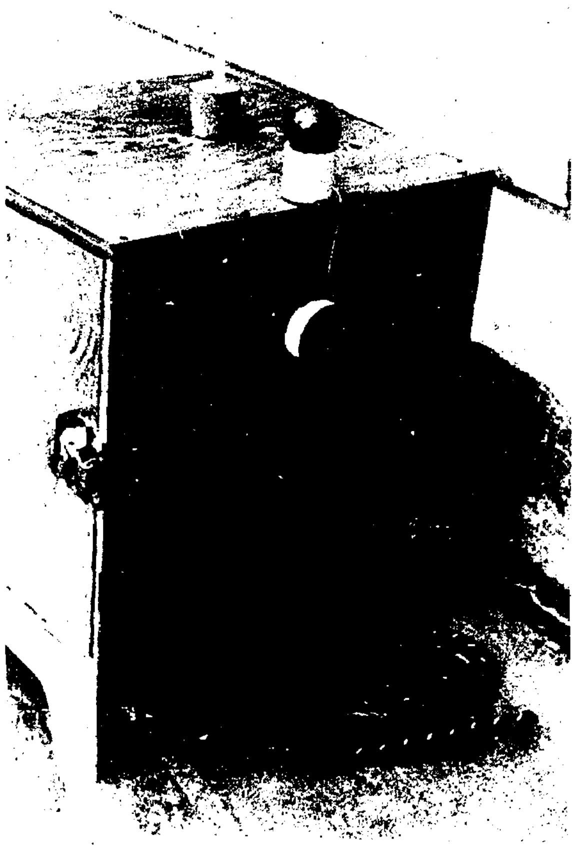
Mount the legs on the bottom, flush with the edges of the box using small blocks of wood on the inside nailed to both box and legs. In the authors' version an ornamental pattern was cut in each of these leg pieces which considerably enhanced the oven's aesthetic appeal, but did nothing for it functionally. The installation of the electrical wiring is the last major step. Mount the interior light socket in the junction box and bring the power cord into it as well. A pilot light and switch should be mounted on the outside of the box. The two bulbs (heat and pilot bulbs) should be wired in parallel, with the switch turning them both off. With this arrangement it is easy to tell when the oven is on because the red outside bulb will light up. Mount the junction box under the oven with screws in the two holes you drilled a while ago. Then screw the flood lamp bulb into the socket. Set the rack on its supports. A thermometer can be placed in one of the upper holes (preferably not one in the middle). Several coats of paint or shellac will finish the outside of the oven.

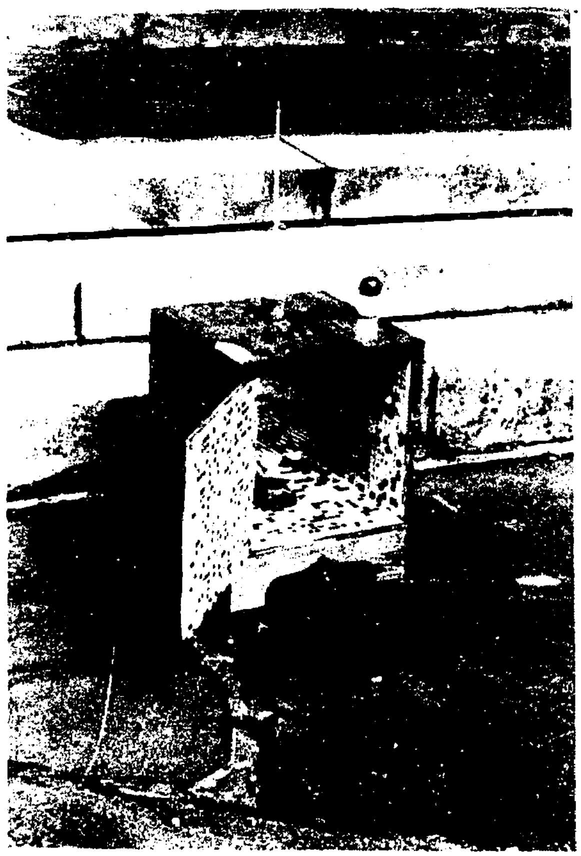
IV. Use

In doing soil tests, it is useful to have a dry weight of any given sample. To arrive at this measurement place your sample in a shallow dish on the oven drying rack and let it dehydrate. The mass of the dry sample is the total mass of both dish and sample, minus the mass of the dish. For use in determining the bio-mass of macroinvertebrates (macros), place the organisms into a weighed dish and allow to dry. The bio-mass of the dehydrated macros is the total mass minus the mass of the dish.

V. Limitations

From the safety standpoint, the first eight hours of operation should be under close supervision, so the wiring and other components of the box can be checked out. Swelling due to absorption of water from the samples may make the door stick. A little bit of sandpaper used judiciously should solve this. Since the light bulb protrudes into the box, care should be taken during the placement and retrieval of samples. The drying times will be shorter nearer to the bulb. A large mass on the drying rack is not desirable. If the 150 watt bulb is not sufficient for your drying purposes, try higher wattages. The life of the bulb may be reduced by the high temperatures.





Drying Oven

Chapter I

I. Fish Measuring Board

I. Introduction

Fish measuring boards are useful for fish studies on productivity and growth rates. The fish measuring board is a flat board with three raised edges. It is marked off in either inches or centimeters, as preferred. Its quick and easy use make it essential for handling and measuring large numbers of fish.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Wood	1"x9"x24"	Scrap	$0.00
1 pc.	Wood	1/4"x2"x42"	Scrap	$0.00
6	Nails, 4 penny box		Scrap	$0.00

Tools:

Saw	Hammer	Wood file
Shellac	Paint brush	Sandpaper

III. Procedure

Cut the 1/4" strip of wood into three pieces, two 9" long and one 24" long, and fasten them to the other piece of wood along the ends and one side (the back) so as to make a raised edge. File or saw grooves in the board at inch or centimeter intervals. Label them, by painting on them or stamping them with metal dies. Preserve the board from mud and fish slime with several coats of water-proof finish.

IV. Use

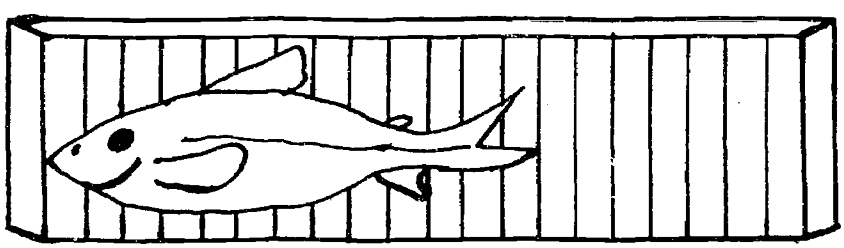
When you get a fish, slap it down on the board, push its head up flush with the lower end, and read the measure at the tip of its tail. Generally, fish are measured by rounding down to the next lowest whole figure. In other words, if fish "X" is almost 6" long, but not quite, it is recorded as 5" long. This method is good because it does not presume more accuracy than can be obtained by just slapping the fish down and taking a quick reading.

V. Limitations

Don't linger when working with the fish - they don't like being measured and like even less being out of water. If large numbers of fish are to be measured, arrange to have adequate help and enough measuring boards. Fish metabolism rates are lower at reduced temperatures so colder times of year are preferable for these studies from the fish's point of view.

VI. Bibliography

Cushing, G. H., Fisheries Biology, University of Wisconsin Press, Madison, Wisconsin, 1970. This is a general reference of fish and fish related studies. It is a college level text, but it will be understood by secondary students and most* teachers.



FISH MEASURING BOARD**

*Ed. note - You will have noticed by now that the guide series are indeed written by high school students.

**Ed. note - This drawing is included more for artistic value than practical use.

J. Fish Tank

I. Introduction

Large aquaria and terraria are often useful for conducting in-depth observations of fish and other aquatic life. Home-built aquaria are not only less expensive than commerical models, but they are also far more durable. These aquaria are not particularly difficult to make, but the more care taken, the better. This plan is for large aquaria, those over about 20 gallons (4,800 cubic inches). It is made of wood and glass. Another procedure follows for smaller aquaria which can be made entirely of glass. The cost of large wood and glass aquaria should not be more than $18. You can make your aquarium about any size you want. The procedure here is for one that is 36" x 18" x 18" and will hold about 40 gallons.

II. Materials:

Qty.	Item	Dimensions	urce	Unit Price
1 pc.	3/4" plywood (marine)	143"x18"x3/4"	mber yd.	$0.40/ft.^{2}
1 pc.	Glass 1/4" thick	13"x24"	Hrd. store	$0.80
	Silicone glue		Hrd. store	$3.99/tube
	Epoxy paint (blue)		Hrd. store	$2.49/qt.
104	Wood screws	1 1/2" long	Hrd. store	$0.02

Tools:

- Saw
- Screwdriver
- Sandpaper
- Electric drill with bit to lead the screws
- Paint brush

III. Procedure

Cut four pieces of the plywood to the following size: two to 35 1/4" x 17 1/4", and two to 17 1/4" x 17 1/4". These are the front, back, and end of the tank. The bottom is a piece 18" x 36", also cut from the 3/4" plywood. The only other piece is a brace, 2" x 18" x 3/4", that will support the front and back. In the center of one of the larger pieces of wood, cut a rectangle, 9" x 20". This will be the window. Place the piece of glass over this hole (on the inside), and fasten it down with lots of silicone glue. When the glue has dried (as per instructions on glue), put a billet of glue all around the edge of the glass to keep it water tight. When the window has dried, assemble the tank. The sides sit on top of the bottom piece and are joined by alternating butt joints. In other words, each side has one other side's butt meeting it, and one of its butt edges meets another side's face. The box should be assembled with lots of silicone glue and screws. The screws should be put in every 1 1/2" in the side joints and every 2" along the bottom edges. The screws should all be started by drilling holes to ease the work and keep the wood from splitting. Apply a billet of the glue, sealing all the inside corners. When this has thoroughly dried, paint the inside of the tank (except the window-naturally) with the epoxy paint. Blue is suggested because it is sort of natural, and white may frighten the fish. Now put the brace from the center of the front piece to the center of the back piece, across their top edges. Fasten it with screws. You will want to sink the brace if a cover is to be placed on the tank. (Then cut it 2" x 17 1/4" x 3/4").

IV. Use

After the tank has had at least three days to dry, fill it with two inches of water to check for leaks. Increase water depth by two inches at a time. If a leak is found, dry the tank; then repair it with silicone glue.

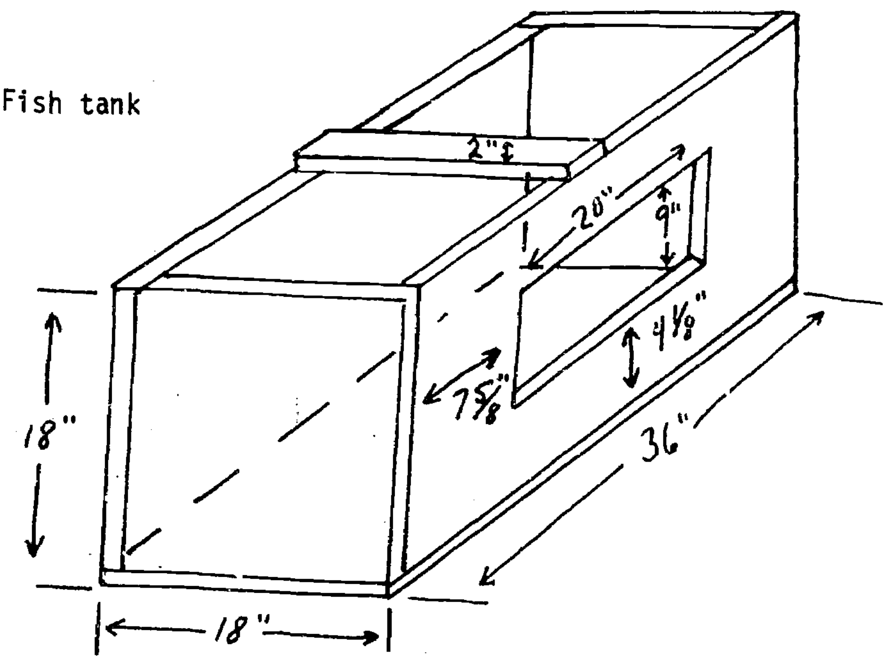
V. Limitations

If thin materials are used, the tank will soon develop leaks. Once the epoxy paint has been mixed, the wood must be painted rapidly because epoxy dries quickly.

VI. Bibliography

Morholt, Evelyn, Brandwein, Paul, and Joseph, Alexander, A Sourcebook for Biological Sciences, Harcourt Brace and World, Inc., New York, 1966. An excellent resource for teachers. Provides a wide range of how-to-do-its for maintaining biological supplies. Gives much information on the maintenance of aquaria and specimens.

Fish tank



Chapter I

K. Flow Meter

I. Introduction

In any study of a stream or river, one important parameter is the amount of water flowing downstream at any given time at any point on the stream. Flow rate is important to the life in a stream. The current affects any aquatic habitat. Flow measurement should, therefore, be a standard part of any water survey procedure. The "standard" way of measuring flow is by making rough calculations of the cross-sectional area of the stream and then multiplying by the rate of flow, found by timing a float. This project is a simple but accurate flow meter adapted from work by F. Gassner, 1955. H.B.N. Hynes, in his book. The Ecology of Running Waters, says of this device "...although crude, it gives results which are probably almost as reliable as those of more complex, and costly, micrometers." This adaptation is very simple, inexpensive, and easy to use. If you have access to a biology lab, it shouldn't cost anything. If you don't it shouldn't cost more than $.50.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Bottle	About 1/2 liter with wide (2") mouth	Scrap	$0.00
1	2-hole stopper		Scientific Supply Co.	$0.10
1	Test tube	About 1/2" I.D. x 4" long	Scientific Supply Co.	$0.10
1	Medicine dropper		Drug store	$0.10
1	Plastic sandwich Bag		Scrap	$0.00
1 pc.	Plastic fishtank tubing		Pet store	$0.05/ft.

1	Small, light float	Scrap	$0.00
1	Graduated cylinder 250 ml.	Borrow	$0.00

Tools:

Small triangular file
Knife
Inside calipers
Electric drill with 1/2" bit
Bunsen burner or alcohol lamp
Goggles

III. Procedure

Cut the bottom off the test tube to make an open tube, 2" in length. Use a file to do this. Wear goggles. Next, widen one of the holes in the stopper with the drill so that the tube will fit snugly in it. Remove the rubber part of the medicine dropper, and using a bunsen burner, bend the glass tube into a right angle, at its mid-point. When it has cooled, push the pointed end of the tube into the other hole in the stopper. Remove the large tube from its hole in the stopper and push the open end of the plastic bag up through the hole from the bottom side of the stopper. Pull the bag far enough through the hole so that the whole open end is sticking out. Now carefully push the cut off test tube back into the hole, inside the bag. Push it in so it is almost flush with the top of the stopper and protrudes below into the bag. You should now have a plastic bag, sealed except for the tube which protrudes down into it. Be careful not to cut or tear the bag. Now place the stopper in the bottle, with the bag inside the bottle. When you blow in the end of the plastic tubing, the bag should collapse. Now attach a small float to the end of the tubing, being careful that the tube remains unclogged. To calibrate, calculate the area of the open end of the test tube by measuring the inner diameter with the inside calipers. Then use the formula $A = \quad r^2$ to get the area.

IV. Use

To use, firmly push the stopper into the bottle. Grasp the bottle in your right hand, blow in the end of the tubing to collapse the bag, and immediately clamp your thumb over the opening of the large glass tube to keep the bag collapsed. Then let go of the piece of tubing and lower the bottle down into the water, facing directly upstream. Remove your finger from the opening and get it out of the way. At the end of a set period of time, say, ten seconds, cover the opening. Remove the bottle, remove the stopper and bag assembly, and carefully pour all the water out of the bag and into the graduated cylinder. Measure how much water flowed into the bag. To calculate the rate of flow, divide the volume, in cubic centimeters (the same as milliliters), by the area, in square centimeters, times the time in seconds. Or, $\frac{V}{AxT} = s$,

where V = volume of water in the bag, A = area of the opening, T = time the orifice was opened, and s = velocity of flow in centimeters per second. Do this several times at the same point and at several points at any one stream side, and average the results.

V. Limitations

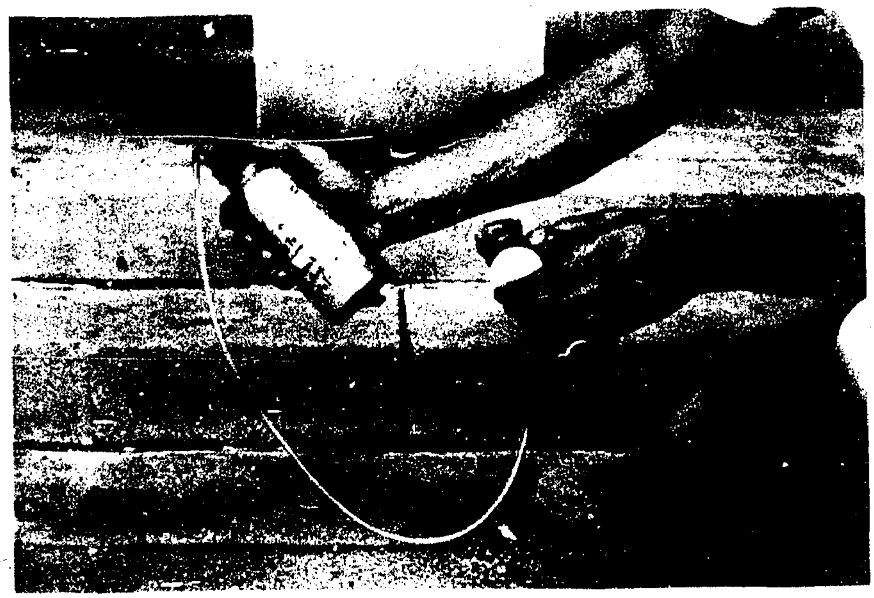
The primary limitation of this device is that it cannot be used in slow moving streams because the water will not move steadily and regularly through the tube if the flow is not very fast.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Second Edition, Vol. II, Institute for Environmental Education, Cleveland, Ohio, 1971, P. A1. Step-by-step procedure for calculating flow by the timed-float method.

Hynes, H.B.N., The Ecology of Running Waters, Liverpool University Press, 1970, Pp. 5,6. Discusses the original design, including drawing.

Gessner, F., Hydrobotanik I. Energiehaushalt, Veb. Deutsch Ver. Wissensch., Berlin, 1955, Pp. 5, 6, 53-4, 61, 70, 75, 81-3, 87-8, 90-2, 99. This is the original reference to the piece, written by the inventor.



Flow meter

Chapter I

L. The Hester-Dendy Sampler

I. Introduction

The Hester-Dendy is a device used for studying the macroinvertebrate life on the bottoms of streams and lakes. It is an artificial substrate on which macroinvertebrates will attach themselves. After a Hester-Dendy has been in an aquatic habitat for about a month, it can be removed, disassembled, and the "critters" on it readily examined. This piece is designed so that its usable surfaces total one square foot. Elementary school students have assembled and used this device.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Hardboard	9"x12"x1/4"	Lumber yd. scrap pile	$0.00
1 pc.	Hardboard	10"x1"x3/8"	Lumber yd. scrap pile	$0.00
1	Eyebolt	1/4" x 6"	Hrd. store	$0.10
2	Washers	For eyebolt	Hrd. store	$0.01
1	Wing nut	For eyebolt	Hrd. store	$0.04

Tools:

Small hand saw

Drill and 3/8" bit

Sandpaper

Hacksaw

III. Construction

Cut the 1/4" hardboard into ten 3" squares and cut the 3/8" hardboard into ten 1" squares. Drill 3/8" holes in the center of all the squares. Assemble the sampler by sliding one of the 1" squares onto the eyebolt and then adding one of the 3" squares. Continue this alternating procedure until you have added eight more of the 1" squares, alternating with eight of the 3" squares. Place the tenth 3" square on the bolt right after the ninth 3" square, making a very narrow crack into which some types of microscopic organisms can crawl. Finally set the tenth 1" square on the bolt, add a washer, and tighten the plates together with a wing nut.

IV. Use

For any investigation, place all samplers in flowing waters, or place all samplers in still waters. (Still waters and flowing waters usually have different benthic populations). The samplers may be placed on the bottom if it is composed of sand, gravel, or rock. If the bottom is made of mud, suspend the sampler just off the bottom. (Otherwise, the sampler may become covered with mud and a representative benthic sample will not be collected.) If the samplers are placed in highly populated or well used areas, they should be hidden so that they will not be disturbed. In most locations, the samplers should be tied to an overhanging branch, a root, or the bank. Heavy (30 lb. test or higher) monofilament fishing line will be less visible than most kinds of string. In very swift water or in locations where attachment is difficult the sampler may be attached to a metal rod which has been driven into the bottom of the stream or lake. To show the effects of an effluent on the benthic macroinvertebrates, place samplers upstream and downstream of the point at which the effluent enters. Samplers should be placed on both sides of the stream. With larger streams and rivers, they should be placed in the middle, too. After the samplers have been in the water for two weeks or more, they should be collected. Immediately after removing each sampler from the water, place it in a plastic bag and add some surface water from which the sampler came. This will prevent the loss and drying out of the organisms. If more than an hour will elapse before you begin to identify the organisms, the plastic bag containing the sampler should be cooled with ice or refrigerated. This will prevent the organisms from decomposing, which can happen very rapidly especially in hot weather. Open the plastic bag over a white porcelain tray and remove the water and the sampler. Disassemble the sampler and scrape off any macroinvertebrates which are still attached. (A laboratory spatula works well for the scraping). If large numbers of organisms are present, remove and collect them from one 3" square at a time. This will make it easier to count and identify them. (The author has collected one sampler which had more than 1,300 macro-organisms on it.) The results should be used to compute diversity. The biomass - mass of the life in a specified unit of the environment, here one square foot - can also be computed. This gives an indication of the productivity of the water. Samples can be preserved by placing them in 95% ethyl alcohol in the field. For prolonged storage they should be placed in a 70% solution of ethanol. Formalin is also effective in 3% to 10% solutions of the commercial formulation. Odor and shrinkage problems exist with this preservative. Neutralized formalin eliminates some of the undesirable effects. For short-term preservation, refrigeration and icing are adequate.

V. Limitations

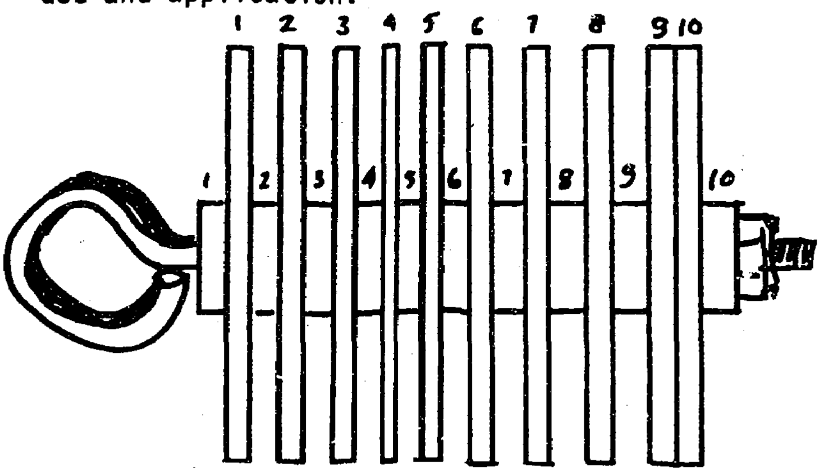
The major limitation of this method is that the animals that will attach themselves to a Hester-Dendy are not necessarily the same as grow on the bottom. There are a few types that will not grow on a substrate.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. II, Institute for Environmental Education, 1971, Pp. A1-138 to A1-142. Provides detailed procedures of use and application; very good.

Hester, F. E., and Dendy, J.S., "A Multiple Plate Sampler for Aquatic Macroinvertebrates," Transactions of the American Fisheries Society, 91(4):420-421, 1962. This is the original source of the piece.

MacKenthum, Kenneth M., The Practice of Water Pollution Biology, United States Department of the Interior, FWPCA, 1969, Pp. 62-63. Contains a brief reference to use and application.



The Hester-Dendy Sampler

Chapter I

M. Louvered Instrument Shelter

I. Introduction

This shelter is designed to protect measuring instruments for such things as weather study or air quality monitoring. It is louvered so that air can flow through without allowing the direct rays of the sun to fall on the instruments. The construction of this shelter requires some basic carpentry skills and should cost about $20.00.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	3/4" Plywood	24" x 8"	Lumber yd.	$0.60
1 pc.	1/2" Plywood	12" x 12"	Lumber yd.	$0.25
2	Hinges	2 1/2 lg.	Hrd. store	$0.65/pr.
4	Louvered shutters	21"x8"x1"	Lumber yd.	$2.29
12	Screws for hinges		Hrd. store	$0.00
1	Hook and eye		Hrd. store	$0.05
32	Wood screws	2" long	Hrd. store	$0.02

Tools:

Saw
Sandpaper
Screwdriver
Paint and paint brush
Electric drill and bit to lead the wood screws

III. Procedure

Cut a piece of the 3/4" plywood to 6" x 8". This piece will be the bottom of the shelter. It is the proper size to be recessed in between the four shutters. It will be fastened to three of them; the fourth is the door. Center a 6" side of the piece along the bottom edge of one of the shutters leaving one inch of shutter sticking out on each side. Fasten the board to the shutter in this position with wood screws (drilling holes to lead the screws will make the job easier). Next attach another shutter to the base fastening it both to the bottom board and to the 1" edge of the last one. This shutter is one of the sides of the box, the first shutter is the back. Fasten the other side shutter, mounting it to the bottom and to the one inch lip of the back shutter that is sticking out. By fastening the sides not only to the bottom but also by this "butt joint" to the back, the box should be quite sturdy. Don't be too stingy with the screws; the strength of the box depends on them. The fourth side of the box is the door, but it is not time to put it on. First make the top piece. Cut a piece of 3/4" plywood to 8" x 9". This should just fit on top of the box, and its edges should be flush with the sides of the box. This piece should be screwed on. Above it will be a slanted roof, to allow rain to run off. This roof will extend beyond the sides, allowing still more protection from precipitation. Cut two pieces of the 3/4" plywood, each 8" long, 2" high at one end and 4" at the other. These are fastened to the top piece to form the slope of the roof. The roof is a piece of 1/2" or 3/4" plywood that measures 12" square. Fasten it to these two sloping spacers on the top with nails or screws. Now attach the door. First screw the two hinges onto the edge of the shutter, one near the top and the other near the bottom. Mount them so that the hinge pin protrudes half way over the edge of the shutter. This is necessary so that when the other side of the hinge is mounted to one side of the box, the hinge will turn just at the corner, and move the door without binding. Lay the box on its back and put the door, with hinges mounted, in its proper place. Mark the holes for the hinges on the side of the box, and pre-drill them. Then screw the door's hinges on. Fasten a hook and eye or other catch to keep the door closed. The box is now ready for painting. Paint it thoroughly with several coats of paint. Generally, these boxes are white partly just "because" and partly so that the sun will reflect off them and not warm them too much. In this way a thermometer inside will give a reading for "in shade".

IV. Use

Set the box in open location where it will not be influenced by buildings or disturbed by people. Rooftops are good places if the buildings are well-insulated. Put your monitoring instruments inside and collect data on a daily basis.

V. Limitations

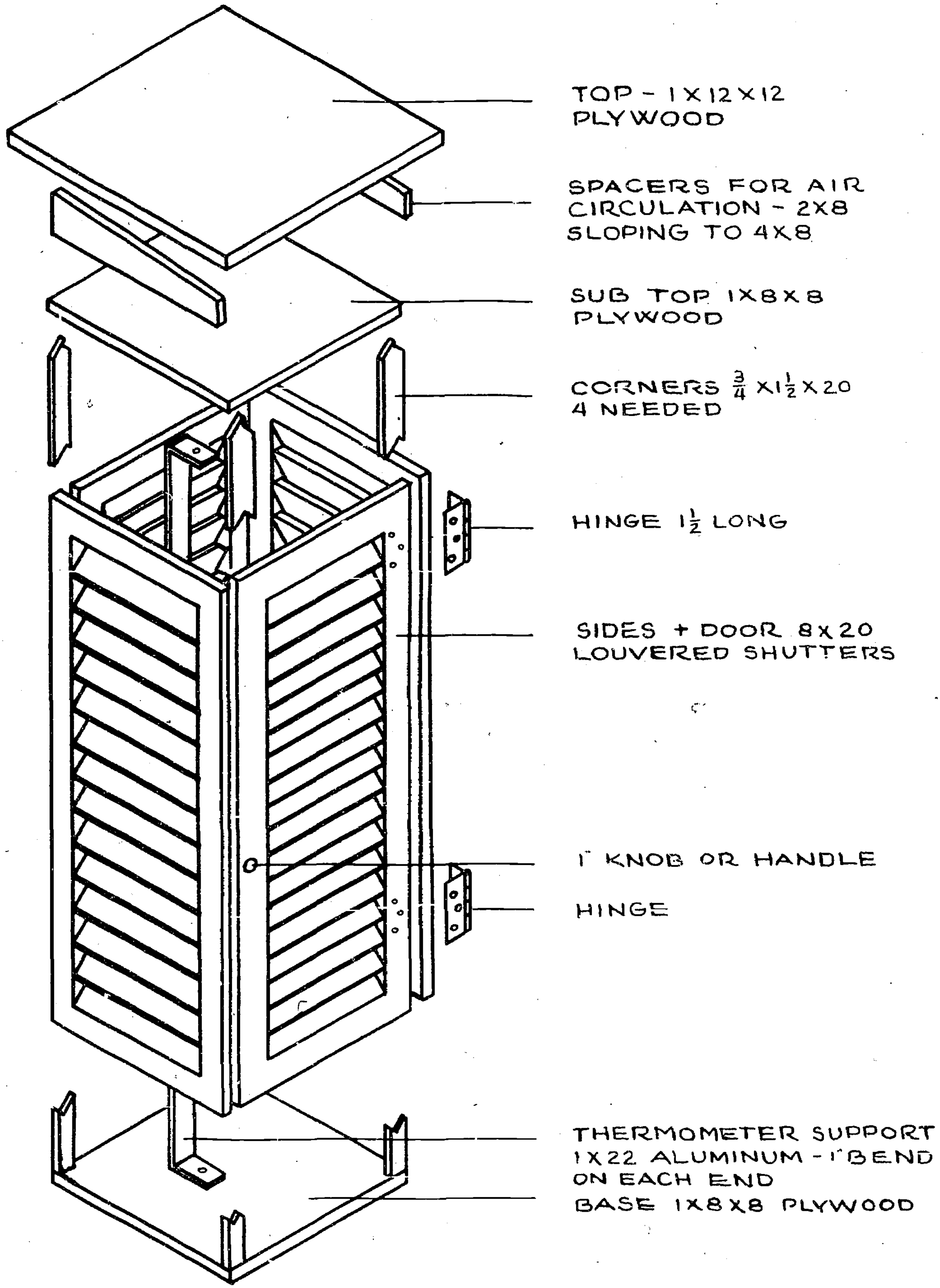
One major limitation may be that the shutters are hard to find. Ask a carpenter or cooperative shop teacher; he may be able to come up with alternatives. You could consider small holes in solid sides. These will not be very rain-proof but a larger over-hang on the roof might help.

VI. Bibliography

Cleaning Our Environment - The Chemical Basis for Action, a report by the Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs, American Chemical Society, Special Issues Sales, 1155 Sixteenth St., N.W., Washington, D. C. 20036, 1969. This text was written

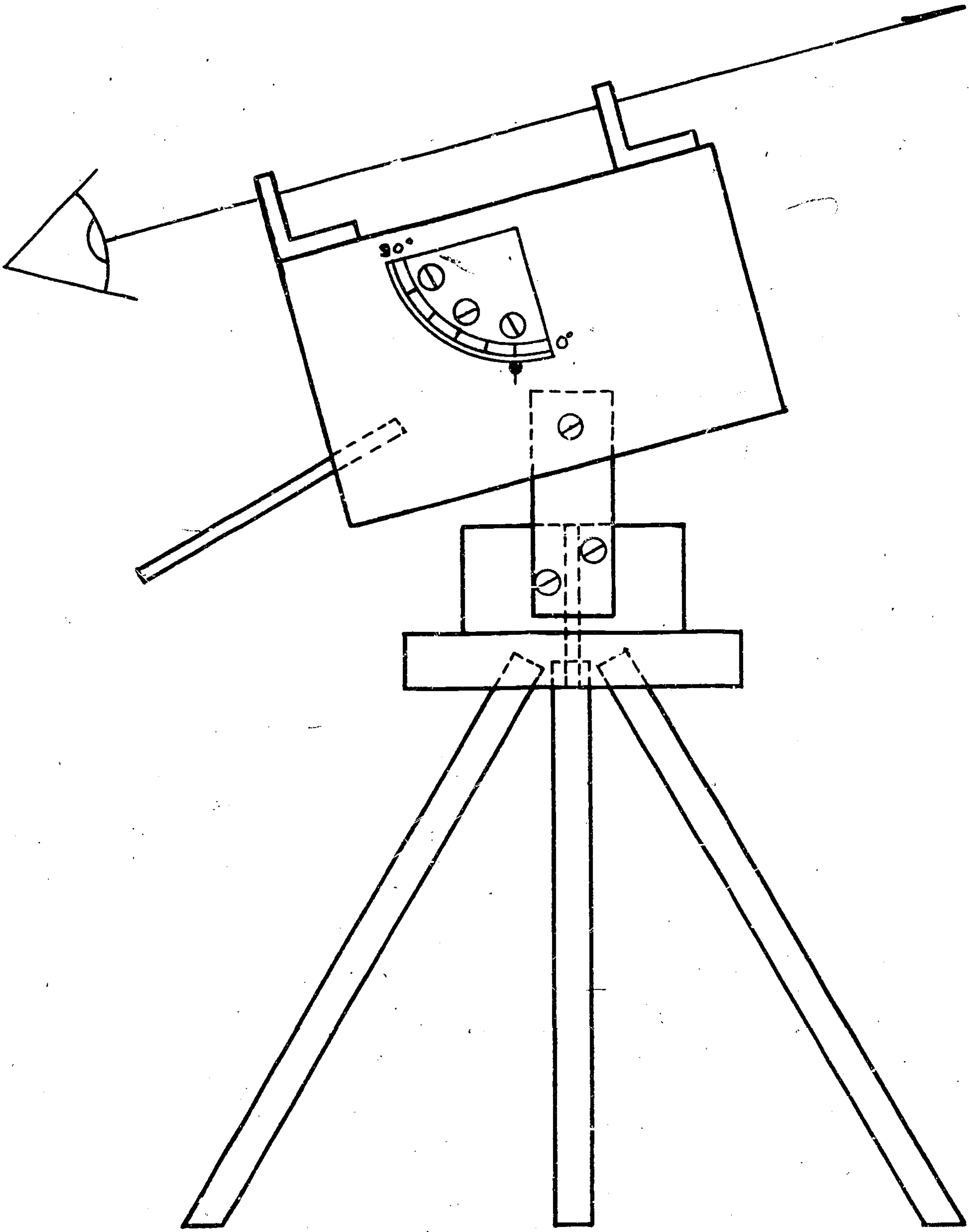
in hopes of boosting the technical awareness of environmental concerns. The focus is on chemistry, chemical engineering, and related disciplines as they relate to air, water, solid wastes, and pesticides.

Storin, Diane, Investigating Air, Land, and Water Pollution, Pawnee Publishing Co., Inc., One Pondfield Road, Bronxville, N.Y., 1971. A short field investigation book that contains a good air quality investigation section. Students are instructed to work with common household materials and chemistry lab equipment to study local air quality. Short sections on solid waste and water quality are included. Recommended for high school level.



INSTRUMENT SHELTER
DESIGNED TO HOLD MAX. & MIN. U-TYPE
THERMOMETER.

CLINOMETER



N. Mapping Table

I. Introduction

A map to locate sites and sources of pollution is a valuable tool in water quality surveys. One method of mapping makes use of a level (plane) table from which sitings may be taken. This method makes possible the mapping of any given area by triangulation of landmarks. Here are the plans for the construction of a plane mapping table. The table can be made with or without a tripod stand. Without the stand, the table can be placed on a trash can (or other suitable object) for use.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Plywood	2'x5'x1/2"	Lumber yd.	$1.50
3	Bolts	3"x5/16"	Hrd. store	$0.10
3	Wing nuts for above bolts		Hrd. store	$0.05
2	Washers for above bolts		Hrd. store	$0.02
3	Dowels	36"x1"	Hrd. store	$0.70
3	Nails, six penny		Scrap	$0.00
1	Circular level	1"		$3.20
1 pc.	Pine	2"x19"x10"	Lumber yd.	$0.50
2	Square nuts for 5/16" bolt		Hrd. store	$0.02
2	Hinges, door	3 1/4"	Hrd. store	$1.20

Tools:

- Power saw
- Screwdriver
- Chisel
- Waterproof finish
- 30° jig made from wood
- Power drill with 5/16", 1/2" and 1" bits
- Hammer
- Sandpaper
- Paint brush

III. Procedure

Out of the 2' x 5' piece of plywood cut two lengths: one 24" x 32" and one 18" x 26". If the plywood is unfinished on one side, this "bad side" should face down, leaving a smooth surface on top. The actual table top will be the 24" x 32" piece of wood. On the unfinished side of the top piece (24" x 32") place the lower board (18" x 26") and center it. This means that the top part is sticking out about 3" on each end and 3" on each side. On the 18" end of the lower board place the door hinges so there is about 12" between them. Mark the hinge positions on both the upper and lower pieces of plywood. These hinges should allow the table top piece (32" x 24") to swing freely and sit flat on the lower piece.

Drill two holes in the 18" x 26" piece so that they are each 6" away from the centerline of the board and 1 1/2" from the end of the board opposite the hinged end. These holes should be drilled using a bit slightly smaller than the size of the square nuts for the 5/16" bolts. The holes should then be cut square to a depth of 1/4" so that the nuts can fit tightly in the holes. Place the nuts in the holes, using a hammer if necessary. Next drill a hole in the center of the same (18" x 26") board, using a 5/16" bit. Note that the table top (24" x 32") has <u>no</u> holes drilled into it. Mount the hinges on the 18" x 24" and 24" x 32" pieces. Make sure that the good side is still up and that the hinges are on the "bad" side of the table top. Mount the bull's eye level on the table top's good surface and screw a 5/16" " steel bolt all the way into each of the square nuts. Their round heads should have the bad side of the table top resting on them. Destroy the threads on the last 1/2" or so of each of the bolts. Place the wing nut on the end and screw as tightly as possible on the banged-up threads. Then bang up the threads on the end of the wing nuts so they cannot come off. These bolt wing nut units are the levelers for the table. By screwing them up and down, the angle of the table top can be varied. Except for the stand, the table is now completed and can be varnished.

The construction of the stand needs a 30° jig, which can be made out of scrap wood. Take the 10" x 10" x 2" piece of pine and draw an equilateral triangle on it. Using the jig, place the block of wood on the 30° slope and drill a 1" hole three quarters of the way through in each corner of the triangle. Nail 1 six penny finishing nail into one end of each 36" x 1" dowel. Place the dowel ends without nails into the holes of the block. The legs should now make a 60° angle with the floor. Finally, take the legs out again (they are not to be glued in place) and, in the center of the block, drill a 5/16" hole. Place the 3" x 5/16" bolt, with washer, through the hole in the 16" x 26" board and then through the correspond-ing hole in the block. Secure it from below with washer and wing nut. Place the legs into the block, and you are done.

IV. Use

An example of how to use the plain table for mapping a pond is given below. The same procedure can be adapted for mapping almost anything.

(1) Determine a base line from the ends (A,B) of which almost all points on the shoreline are visible. Place stakes at point A and B.

(2) Place stakes along the shoreline at the water's edge so that they are visible from points A and B.

(3) Place the table or head board at point A. Using a plumb line or carpenter's level, make sure the table is horizontal. Adjust it by rotating the table around on the tripod or other base and changing the angle of the top by screwing the two adjustor screws in or out.

(4) Tape a piece of paper to the table. At eye level to the table, line up stake B with a ruler and draw a line toward the sighting. This line is called the base line.

(5) From point A line up the other stakes (C-J, or however many there are) with a ruler and draw a line along the line of sight.

(6) Measure the distance between point A and point B with a tape measure.

(7) On the base line sketched in step (4) place point B according to the scale desired. For instance, if the distance between point A and B is 100 feet, point B could be placed 10" from point A on the sketched base line. This would give a scale of 1" equals 10'.

(8) Move the table to point B and again make sure the table is horizontal.

(9) Align the map so that point A may be seen by placing a ruler along the base line and sighting along the top of the ruler.

(10) As soon as the base line is aligned, sight points C-J

and draw the lines toward the sightings.

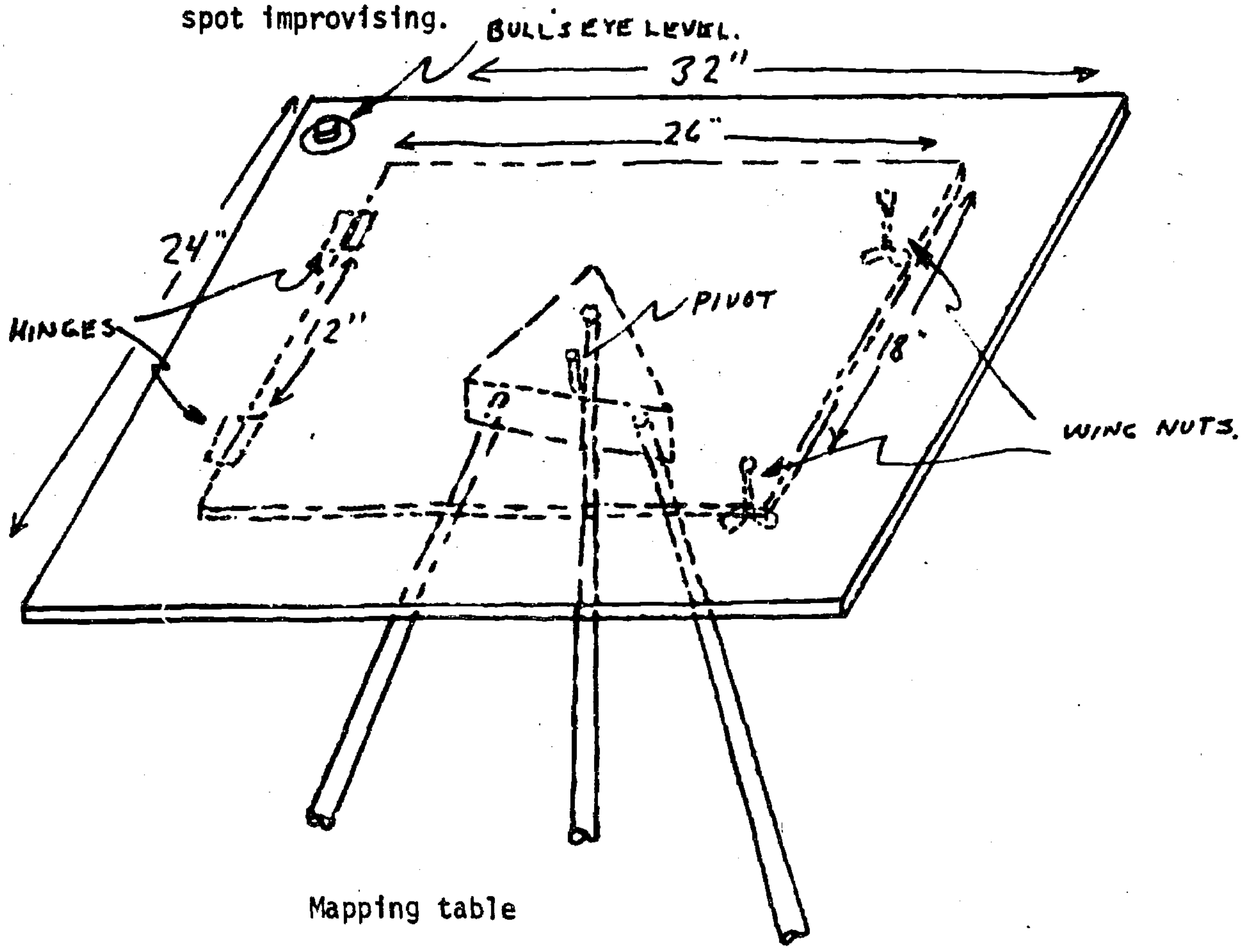
(11) The lines drawn from point B should intersect those lines drawn from point A. Darken those points and erase the construction lines.

(12) Connect all the points with a continuous line. The map is now to scale as determined in step (7).

(13) Fill in the map with whatever information is pertinent (e.g., north-bearing direction, stream inlets, houses, etc.).

V. Limitations

In really rough terrain, it may take a little more effort to level the table top. This is a good place for on-the-spot improvising.



Mapping table

Chapter I

0. Flat-bottomed Dip Net

I. Introduction

A long-handled net is an important tool in almost any aquatic investigation. It can be used to catch minnows and small fish and to scoop up macroinvertebrates. This net has a flat bottom making it ideal for use in streams, where it is important to place the net right on the stream bottom. It can be used to get a qualitative sample of macroinvertebrate population by kicking up the sediments upstream of the net and washing the macros downstream into the net. This net is strong and should be able to withstand rough treatment. It should not cost more than 20 percent of the price of a comparable manufactured net.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Broomstick	Diam. 1"	Hrd. store	$0.50
1 pc.	Aluminum flatstock	3/16"x1"x48"	Hrd. store	$2.69/6'
1	Hose clamp	Diam. approx. 2"	Hrd. store	$0.29
3	Bolts	1/4" x 2"	Hrd. store	$0.02
3	Nuts for above bolts		Hrd. store	$0.01
6	Washers for above bolts		Hrd. store	$0.01
1 pc.	Tent poplin	24" x 45"	Fabric store	$1.29/yd.
1 pc.	Mosquito netting	30" x 36"	Fabric store	$0.69/yd.
	Nylon thread			

Tools:

Metal working (or other sturdy) vice
Flat second grade file
Electric hand drill with 1/4" bit
Two "C" clamps, at least 3"
Large screwdriver (1/2")
Medium screwdriver (1/4")
Large fabric scissors
Awl
Nylon thread
Hacksaw
Hammer
Pliers
Yard stick
Pins
Sewing machine
Large needle
Thimble

III. Procedure

Shape the net frame. Cut a 4' length of aluminum and bend it into a triangle, with an 18" base and two 12" sides. The remaining 6" should be distributed in two 3" ends, bent straight up, perpendicular to the base. These ends serve to fasten the frame to the handle.

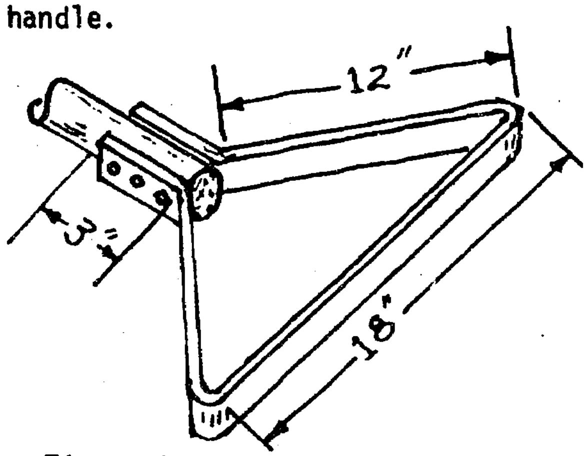


Figure 1. Net Frame

Clamp the net frame to the broomstick handle and drill a 1/4" hole through the center of the 3" strips and the broomstick. Secure it with a bolt, nut, and two washers. Remove the clamp and drill two more holes (on either side of the first hole) approximately 3/4" from the first hole. Secure in the same manner. Attach the hose clamp around the assembly as far down the assembly as possible.

To make the net, cut the poplin into two pieces, 12" x 45". Line the pieces up on top of each other and fold them in half, width-wise, making a four-layer 6" x 45" strip. Sew a double seam along the entire length of the four layers, 2" from the fold. The poplin should have a 2" wide tube running down one edge, and the remaining 4" of width should be free on all four layers. Lay this aside, and cut out the netting. Cut three pieces, roughly triangle-shaped. Start by cutting a rectangle 20" on one side, and 21" on the other. Next measure in 3" from a 20" side and mark this point on both the 21" sides. The netting should be cut on each side, from this point 3" in on the 21" sides, to the mid-point of the far 20" side. In other words, the final product should be a rectangle, 20" by 3", with a triangle with a base of 20" and a height of 18" lying below it. Cut two more pieces of netting - triangles with bases of 14" and heights of 18", with rectangles 14" x 3" below each base. Sew one of the smaller pieces to each side of the large piece, base to base. Then sew the adjacent sides of the triangles together.

Now that the netting is one long, lumpy piece, it should be sewed to the poplin. The 3" base rectangles are placed between the layers of poplin, with two pieces on each side of the netting. Then all four layers of poplin are sewed several times, anchoring the netting in the poplin.

To attach the net to the frame, slide the frame through the 2" tube in the poplin, and position it so that the base of the frame corresponds to the large piece of netting. With the net still on the frame, the third net seam should be sewed, closing up the pyramid of netting. Fasten the frame to the handle, with bolts and clamp. Finally, sew the ends of the poplin by hand.

IV. Use

You really can't do the wrong thing with this net. It's for whatever you want it for. The limits of the net will probably be determined by the strength of the netting and your sewing job. Double stitching all the seams will somewhat extend this limit.

V. Limitations

The major weak spots of any net are at the joint between the frame and the handle and at the covering of the frame. The weakness in this net's joint lies in the possibility of the wooden handle splitting because of the bolts through it. Hopefully, the double poplin cover will withstand considerable wear and tear.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. II, Institute for Environmental Education, Cleveland, Ohio, 1971, Pp. A1-133, A1-134. Reference discusses the use of this type of net for collecting benthic organisms (macroinvertebrates).

Chapter 1

P. Plankton Net

I. Introduction

The plankton net is a must for any aquatic biology investigation. It is designed to filter the larger planktonic (free-floating, microscopic) life forms out of the water. It can either be towed through the water or held in the current of a stream. The plankton caught are washed into a collecting vial at the end of the net by rinsing the outside of the net. For quantitative studies the amount of water that passes through is calculated.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	1/4" copper tubing	1/4" x 27 1/4"	Plbg. sply. store	$0.30/ft.
1 pc.	Fine netting or light cloth (see text)	28" x 18"	Fabric store	$0.25
3	Grommets	1/4" I.D.	Hrd. store	$0.01
1 pc.	Nylon cord	1/8" x 36"	Hrd. store	$0.05/ft.
1	Very small funnel		Hrd. store	$0.25
1 pc.	Thin rubber tubing	3" long	Scrap	$0.00
1	Small wooden plug		Scrap	$0.00
1	Large fishing swivel		Scrap	$0.00
1	Small stoppered vial or baby food jar		Scrap	$0.00
1 pc.	Tent poplin 28" x 6' or canvas		Fabric store	$1.19/yd.

Tools:

Sturdy vice	Hammer	Hacksaw
Sewing machine	Pins	First grade flat file
Yard stick (tape measure)	Grommet tool	Large fabric scissors
	Nylon thread	Epoxy or plastic cement

III. Procedure

Begin by bending the 27 1/4" length of tubing into a circle. This is the hoop of the net. Next make the hoop cover by folding the piece of poplin in half, width-wise, and sewing a double seam 1" from the fold. Now cut the netting to make a cone about 18" deep. Sew this between the layers of the cover. Next join the two edges of the cone and, starting at the tip of the net, sew up the net about half way. Now slide the cover and the net around onto the hoop. Sew the rest of the seam, including the ends of the hoop cover. Before the cover is sewed, the ends of the tubing may be soldered together. At the tip of the net, cut an opening slightly smaller than the mouth of the funnel. Epoxy the funnel into this opening, pointing it out (away) from the hoop. The piece of tubing should be thin-walled and flexible. Stretch it over the end of the funnel, and if necessary, fasten it. Seal off the tube by putting the small plug in its trailing end. Fasten the three grommets in the cover just behind the hoop, equally spaced around it. Cut the cord into 1' lengths, and tie one length in each grommet. Join all three together at their other ends, and fasten them to the swivel. The tow line will be fastened to this swivel.

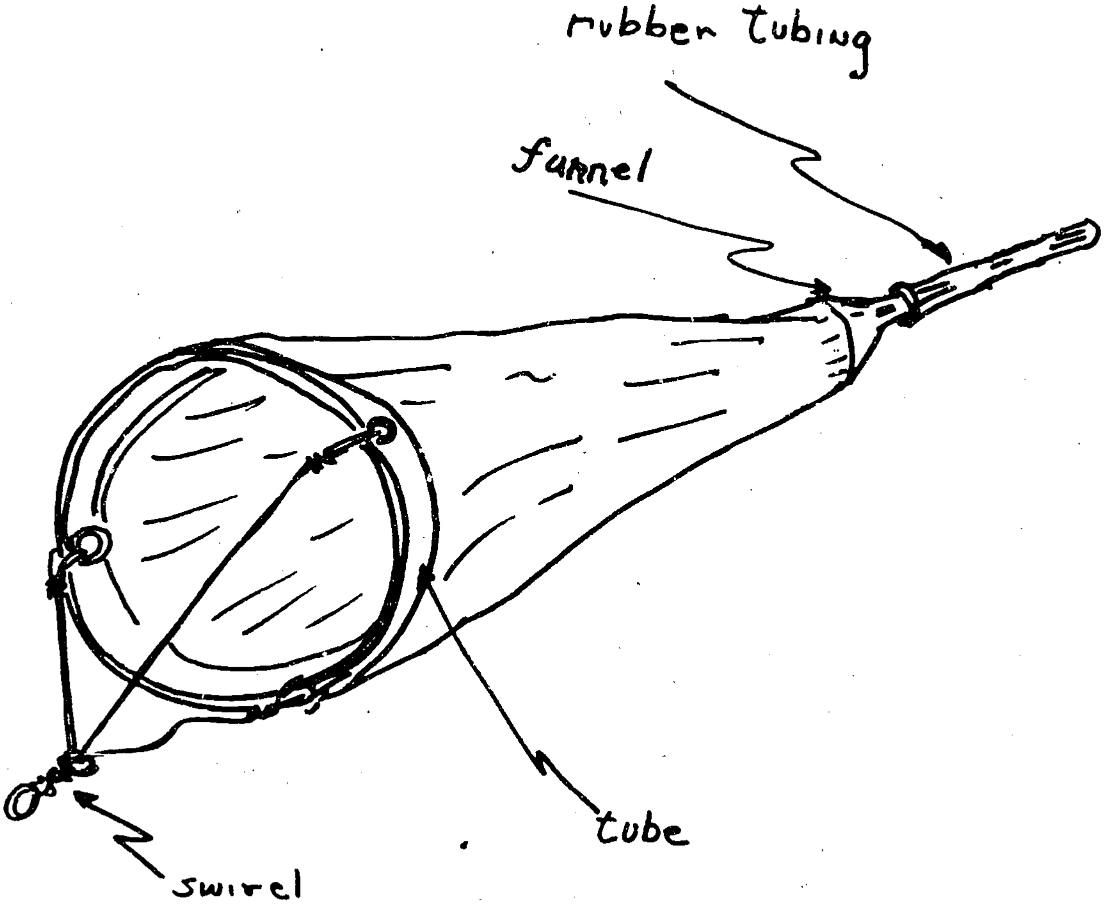
IV. Use

Fasten a tow line to the net and pull it through the water. If you want quantitative results, note how far the net is being towed. This can be done by towing at a given speed for a given time and then calculating: distance = speed x time. To remove the plankton from the net, rinse down the sides with water. Hold the net vertically and rinse from the top down. Stop every few splashes to tip the funnel and pour the water out. Continue rinsing and tipping, thereby concentrating the plankton. When you reach the bottom of the net, rinse it thoroughly, splashing water through the net and into the funnel where the plankton collect. This last bit of water containing most of the plankton is drained out into a small vial by removing the clothespin. The amount of water that has flowed through is calculated by multiplying the distance covered by the area of the mouth of the net. This area is: .04 square meters.

V. Limitations

Plankton nets of any kind isolate only a percentage of the plankton present because many are too small to be caught in a net. The type of netting chosen is important. It should be a synthetic that will not rot, and it should be fine enough to trap algae, but not so fine as to prevent free passage of water. The "standard" Plankton net uses a no. 0 mesh with thirty-four meshes to the inch. A fine net uses no. 12 cloth, with 125 meshes per inch. It will probably be difficult to find a cloth light enough to have a 125 meshes per inch and still allow water to pass through easily. It would be better to aim for the thirty-four type. Buy scraps of light cloth from fabric stores, and check them out for mesh size and thickness.

Plankton net.



Chapter 1

Q. Stationary Plankton Net

I. Introduction

The stationary plankton net is really a sieve. A water sample poured through this "net with legs" allows the larger planktonic life forms to filter out on a small piece of fine netting. Most plankton nets are designed for towing through the water, collecting plankton as the water passes through them. It is often impossible or impractical to tow the net, either because no boat is available or because the body of water is unsuitable. In this case, the net is not put in the water but set on the bank and the water brought to it in a bucket. This net has the advantage of allowing accurate measurement of how much water has passed through the net.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Large plastic funnel	8" across the	Automotive supply co.	$0.69
1 pc.	Aluminum flat-stock	3/16"x1"x72"	Hrd. store	$2.69
1	Hose clamp	Diam. about 2"	Hrd. store	$0.25
6	Bolts	1/4"x3/4"	Hrd. store	$0.01
6	Nuts for above bolts		Hrd. store	$0.01
1	Scrap light, fine mesh polyester fabric	2" x 2"	Fabric store	$0.10
1	Small plastic cup or tube	1" to 2" diam. 1" long	Scrap	$0.00

Tools:

Sturdy vice	Electric hand drill or drill press with 1/4" and 1/8" bits
Hammer	Second grade flat file
Hacksaw	Pliers
1/4" screwdriver	Scissors
Knife	Yardstick
Plastic cement	

III. Procedure

This net is quite simple to make. The aluminum is bent into legs for the funnel, and the fabric is fastened to the tube which is fitted over the end of the funnel. To make the legs, cut three 7" lengths of the aluminum. At a point 3" from one end of each leg (or 4" from the other end), make a groove straight across the piece, 1/16" deep, with a hacksaw. Then make a bend at this groove such that the leg forms 315°. With the hacksaw cut on the <u>inside</u> of the angle. Next, drill two 1/4" holes in the 3" portion of each leg, and match these holes in the sides of the funnel. Obviously, the pairs of holes in the funnel should be spaced 120° apart around the funnel, so the legs are equidistant from each other. The procedure for mounting the small net below the mouth of the funnel will depend largely on the exact dimensions of your funnel and your tube or cup. If your funnel is similar to the one used in the prototype, and you use a small flexible plastic cup, you should: cut the bottom out of the cup and mount the netting over it with a plastic cement or epoxy. Then place three small bolts in the neck of the funnel, so that the plastic cup can just fit over them. When the cement is dry, place the cup on the end of the funnel, and fasten it snugly against the three bolts with the hose clamp. All you are really trying to do is mount the netting over the end of the funnel in such a way that it can be removed and replaced easily.

IV. Use

The stationary plankton net can be conveniently nested inside a bucket when not being used. To use, it is lifted out and set on the ground and a precise volume of water is poured from the bucket. The volume most suitable must be gained by experience. Some guidelines might be:

for clear "unproductive" streams--10 liters or more

for slower, more turbid streams or lakes--5 liters

for lakes densely populated with algae--1 liter

After the water has passed through the net, loosen the hose clamp and remove the net cup. Carefully back-rinse the net into a small container with a wash bottle. This process will remove almost all the plankton caught in the net. The rinse water can then be microscopically examined for numbers or types of plankton.

V. Limitations

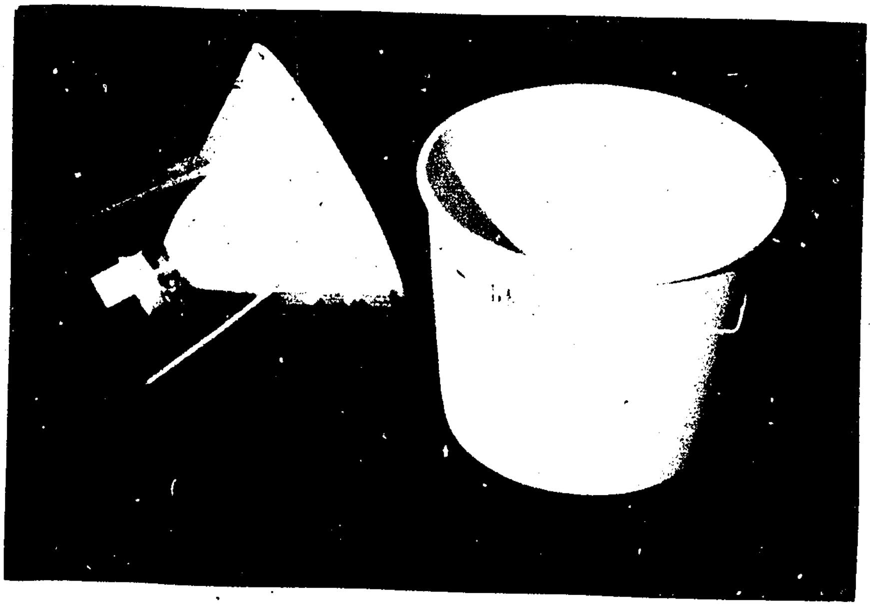
If the netting is too thick water may not pass through freely. If this occurs find a lighter material. One possibility, as a last resort, is nylon stocking. Its meshes are too large for most uses.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. II, Second Edition, The Institute for Environmental Education, 1971, Pp. A1-143, 142 and A1-165-168. Contains a good discussion of general sampling and analysis techniques.

Fresh Water Algae of the United States, Albert Smith, Second Edition, McGraw Hill Book Company, New York, New York, 1950.

A very good, all-around reference, with key, as well as technique discussion.



Stationary plankton net

Chapter 1

R. Rain Guage

I. Introduction

Where does the water in this lake or stream come from? How are such bodies of water kept constantly filled? These kinds of questions lead to one important aspect of the hydrologic cycle-rain. A stream and watershed study must include data on the amount and frequency of rainfall. The rain guage is the elementary yet essential equipment for this study. This rain guage is simple, fun to make, and should be accurate. Sixth graders could handle the construction with some assistance in cutting the bottle. They will certainly be able to take daily readings from it. The guage should cost no more than about $.50.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Bottle (see text)		Glass recycling ctr.	$0.00
1 pc.	Plywood or pine or anything	3/4"x8"x30"	Lumber yd. or scrap	$0.50
8	Four penny box nails		Scrap	$0.00

Tools:

Saw (a power saw would be best)
Sandpaper-coarse and fine
Small triangular file
Bottle cutter
Goggles
Hammer
Glue
Jigsaw or sabre saw
Graduated cylinder
Electric drill and large (about 1 1/4") bit

III. First get a bottle. Since you'll want to measure small quantities of rain, your bottle should be narrow near the bottom so that these small quantities will fill up a measurable amount of the gauge. Look for a clear bottle about quart size that tapers to a thin neck. Remove the base of the bottle using a bottle cutter. Cut the bottle fairly near its base and smooth the edge by filing or sanding. Wear goggles and go slowly. See that your bottle has a cap or can be well-sealed.

To make the stand for a rain guage designed around a quart soft drink bottle cut a piece of wood to 8" x 30". If you don't have a power saw, try to get a lumber yard or a friend to do the cutting. From there it's only three cuts with a hand saw and one (circular) cut with the jig saw. Cut the wood into pieces, two 8" x 9" and one 7" x 9". Save the left-over 1" x 9" piece - you'll use all of the wood. In the center of the 7" x 9" piece cut a hole slightly larger than your bottle. Try not to chop up the circular piece you get out of the hole. You'll use that, too. One of the 8" x 9" pieces will be the bottom of the stand, the 8" x 7" will be the top, the other 8" x 9" will be the back, and the 1" x 9" will brace the front. Fasten the two 8" x 9" pieces together with glue and the four penny nails so that they form a right angle joint with the 8" edge of the bottom piece, meeting an 8" wide face of the back piece. In this way, the overall dimensions of the base should now be 8" x 9 3/4". Attach the top piece onto the back (the 8" x 7") directly above the bottom piece, forming another corner just like the one between back and base. This top piece should be centered against the back piece, leaving a 1/2" space on either side. The 1" piece is a brace that connects the top and bottom pieces by their edges that lie opposite the back piece. If you can, try notching out the top and bottom pieces so that the brace fits in and lies flush. If this is too hard, simply nail and glue it to the two pieces. Drill or cut a hole just larger than the neck of your bottle in the circular piece and fasten it to the bottom piece just below the hole. This piece will hold the end of the bottle in place. The final step is to calibrate the guage. Rain is measured in linear inches. An inch of rain is that amount necessary to fill any straight walled, flat-bottomed container to a depth of 1". Since our collector is only straight walled at the top, and that is the way we want it, 1" of rain will be more than a height of 1" in the neck. Therefore, calculate the volume of water that would fill a container having the same opening as yours, but straight walls, to a depth of 1". Figure the area of the opening, using metric measurements, and multiply by the metric equivalent of 1". The result will be the metric volume of water that will be in the collector when 1" of rain has fallen. Using the graduated cylinder put this much water in your bottle, and mark the level by filing a groove in the bottle. Mark the bottle similarly at the levels of tenths of this 1" volume. These marks indicate tenths of inches. Inches and tenths of inches should be the only markings you need.

IV. Use

Place the rain guage in an open area away from trees or buildings or on a rooftop. Take daily readings of precipitation.

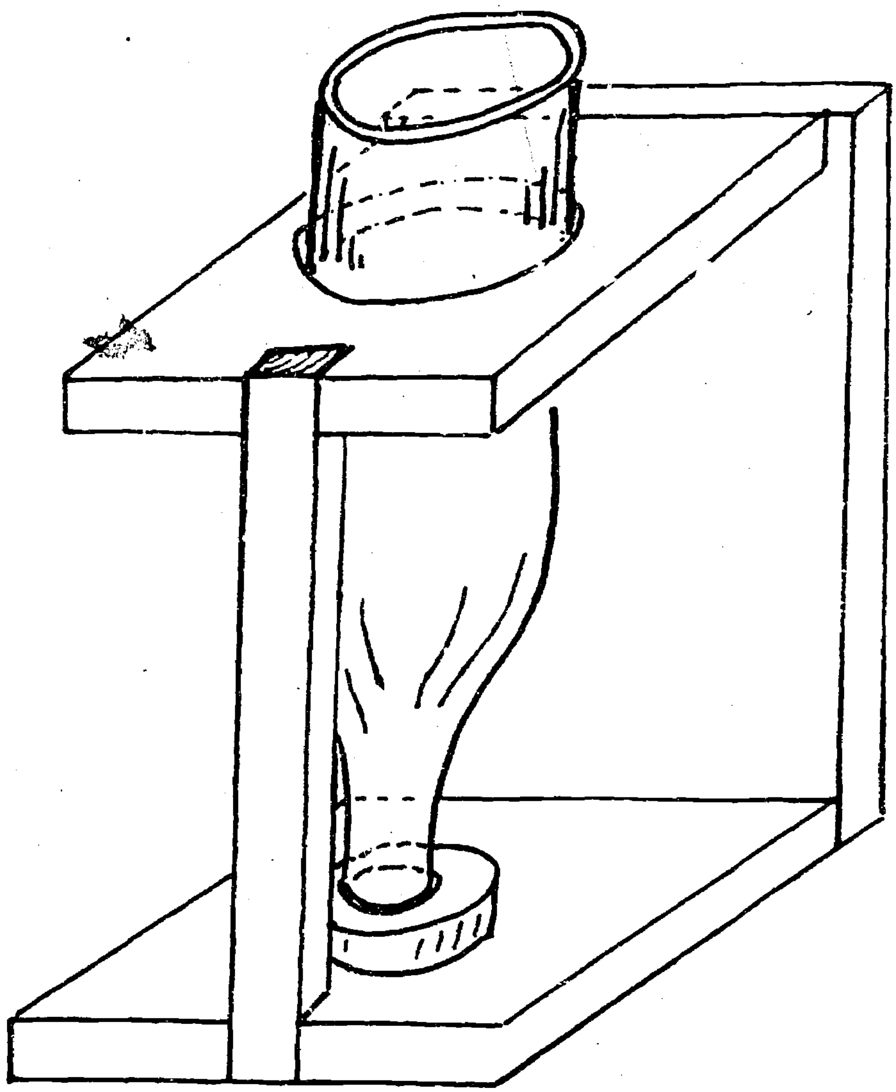
V. Limitations

The primary limitation is the accuracy of the calibration. A careful job will lead to a very successful instrument.

VI. Bibliography

BSCS, High School Biology, Rand McNally & Co., Chicago, Illinois, 1966. This reference discusses the importance of rainfall in biomes and habitats.

Odum, Eugene P., Ecology, W. B. Saunders Co., Phialdelphia, Pa., 1971. Contains a discussion of the importance of rainfall to the environment.



Rain Gauge

Chapter 1

S. Secchi Disk

I. Introduction

The Secchi Disk is used to measure the turbidity of a body of water. Turbidity can be caused by various things, most notably, erosion of soil, surface drainage systems, domestic and industrial wastes, and plankton. The disk works on the principal of direct light penetration into the water. The depth at which the disk can be seen is affected by the amount of suspended matter present in the water. The disk costs about $5.00 but most of this is for the fifty foot line which can be used for other pieces of equipment as well. It can be made by anyone and is simple to use.

II. Material:

Qty.	Item	Dimensions	Source	Unit Price
1	Nylon line	1/4" x 50'	Hrd. store	$0.05/ft.
1	Beaver board	20 cm x 20 cm	Scrap	$0.00
1	Eye bolt	1/4" x 2"	Hrd. store	$0.05
2	Washers	For above bolt	Hrd. store	$0.01
1	Wing nut	For above bolt	Hrd. store	$0.02
1	Pipe	1" x 6"	Scrap	$0.00
1	Enamel	Black (pint)	Hrd. store	$0.75
1	Enamel	White (pint)	Hrd. store	$0.75

Tools:

Power saw
Screwdriver
Indelible marking pen
Power drill
Paint brush
1/4" drill bit
Placement clamp
Masking tape

III. Procedure

Cut the beaver board into a circle with a 20 cm diameter. This is a standard for this particular piece of equipment since disks with different dimensions could give different readings. In the center of the circle, drill a 1/4" hole. Using the clamp, secure the 6" pipe and drill a 1/4" hole in the center of it. This hole should go all the way through the pipe. Paint the entire disk with the white enamel. Then mark one side into quarters. Using the masking tape, edge the lines of two of the quarters. These quarters should be opposite from each other. Paint them black and allow to dry. The disk should now have one side painted with alternating black and white quarters and the other entirely white. After the paint has dried, place a washer on the eye bolt and place the eye bolt with the eye on the black and white side through the 1/4" hole in the center of the disk. Then place the pipe on the end of the bolt and secure the washer and wing nut. Tie the line onto the disk using the eye of the bolt. Mark off the remaining length of line into foot lengths using the marking pen. The disk should be balanced on the line with the black and white quadrants visible.

IV. Use

The range of the Secchi disk goes from a few centimeters to over forty meters. To record the readings of any one site first lower the disk and record the depth of disappearance. Then lower the disk below the recorded point and slowly raise it. Record the depth at which the disk first becomes visible. Average the two readings for the final measurement.

V. Limitations

While the disk gives the depth of light penetration, it cannot give the quantity of suspended solids or the type. The reading it gives is related only to other Secchi readings. The disk should be used in calm waters since movement would interfere with the readings.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Second Edition, Volume I, 1971, Institute for Environmental Education, Cleveland, Ohio. This reference gives a brief exercise demonstrating the use of the Secchi disk.

Secchi disk

Chapter 1

T. Hand Seine

I. Introduction

The hand seine is the basic tool for sampling the nekton populations in streams and ponds. Nekton are macroscopic free-swimming organisms, i.e., fish. The hand seine is a seine small enough to be hand-held by one person.

State fish and game departments have laws governing the use of nets for catching fish. In many states a permit is required for use of any seine larger than four feet square. This seine is just that size.

This seine can be made by anyone with almost no tools but success in catching organisms is determined by the skill and practice involved. The seine should not cost over $4.00.

II. Materials:

Qty.	Item	Dimensions	Source	Unit Price
2	Broomsticks	5'x1" diam.	Hrd. store	$0.50
1 pc.	Netting	4' square	Sterling Marine Products	$2.20
1 pc.	Nylon cord	4'x1/8" diam.	Hrd. store	$0.03/ft.

Tools:
Hand saw
Knife
Electric hand drill with 1/4" bit

III. Procedure

Cut the broomstick to 5' lengths. Drill two 1/4" holes through each pole, one, 1" from end and the other 4' above the first. These holes will be used to fasten the netting securely to the poles. Attach the top edge of the seine (the float line) to the poles by the holes 11" from one end. Then attach the weighted edge (the lead line) to the poles by tying its end strings in the other set of holes. The 1/8" cord is used to lash the netting further to the poles.

IV. Use

Here are some pointers for using this net for catching small fish. Move slowly and try to herd the fish against the bank. Sweeping the net under overhanging banks and bushes may yield good catches. In streams it is often helpful for one person to herd the fish into the net (held by a second person) by splashing and stomping about.

V. Limitations

Before you begin work on this seine you should check your state fish and game ordinances to find out what laws apply to the use of seines. A good person to check with about this might be your local conservation officer.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Volume II, Second Edition, Institute for Environmental Education, 1971, Pp. A1-145, 146. Discusses briefly basic nekton collection techniques.

Chapter 1

U. Separating Sieves

I. Introduction

Separation sieves are used for separating particles of different sizes. In particular, sieves are used to divide samples of soil or sediment into several different size categories. After a sample has been thoroughly sifted through, each sieve will hold those particles larger than its mesh size, but smaller than those of the one above it. This is useful for studying the composition of stream sediments or soil.

This particular set of sieves has a large range of mesh sizes but not too many gradations within the range, since it is difficult to find too many different types of screening. This procedure gives a basic division of particles into five size ranges: smaller than 1/16", between 1/16" and 1/8", between 1/8" and 1/4", between 1/4' and 1/2", and larger than 1/2" in diameter. These sieves are easy to make, sturdy, and reasonably priced. They don't really take much skill to make or use.

II. Materials:

Qty.				
1 pc.	Hardware cloth	1/8"mesh 7"x7"	Hrd. store	$0.33/ft.^2$
1 pc.	Hardware cloth	1/4"mesh 7"x7"	Hrd. store	$0.35/ft.^2$
1 pc.	Hardware cloth	1/2"mesh 7"x7"	Hrd. store	$0.35/ft.^2$
2	3/4" dowels	3/4" x 36"	Hrd. store	$0.30
1 pc.	1/2" plywood	12 1/2" x 48"	Lumber yd.	$0.25/ft.^2$
48	Four penny box nails		Hrd. store	$0.25
2 pc.	1/2" plywood	12" x 12"	Lumber yd.	$0.25
48	Small staples		Hrd. store	$0.25
1 pc.	Window screening	7" x 7"	Scrap	$0.00

Tools:

Saw

Drill with 3/4" and 1" bits

Sandpaper	Hammer	Metal shears
Glue (waterproof)	Jigsaw	Shellac
Rust proofing paint	Paint brush	

III. Procedure

The two pieces of 12" x 12" plywood and the dowels will make a stand for the four sieves so that they can sit on top of each other held firmly together. Cut a square hole, 6" x 6", in the middle of one of the 12" x 12" boards. At the center of each of the 6" sides of this inner square, and 1" in from this edge, drill 3/4" holes. Now drill holes 1" in diameter in the other 12" x 12" piece that correspond to the 3/4" holes in the first piece. Cut four 13" lengths from the 3/4" dowels. Glue these into the 3/4" holes in the first 12" x 12" piece. This piece is the base of the stand. The dowels should stick straight up off this base. The other piece will be the top of the stand and will fit over the dowels on the top of all the sieves that are nesting between the four dowels. To make the sieves: cut sixteen pieces of plywood, 3" x 6 1/2". Four of these fit together to make a box with alternating butt joints. Nail and glue the four sides of each box together. Then cut a 7" square from each of the hardware cloths and the screening. Fasten one of these squares to the "bottom" edges of each of the boxes. You should now have a stand with its top, and four boxes, each with four wooden sides, a wire screen bottom, and an open top. The sieves are designed to stack on the stand, with the finest meshed one at the bottom and the coarsest at the top. Brush several coats of waterproof finish on all of the boxes. Paint the wire mesh pieces with rust proofing paint.

IV. Use

To use the sieves, thoroughly dry a sample of soil or sediment. A drying oven is recommended but not necessary. Place the sample in the top sieve (about a cupful of sample should be put through at a time). Put the top on the set and shake it, until all the particles have come to their proper level, and the smallest ones have come all the way through. Take the sieves apart, and mass the particles located in each sieve and those that have come all the way through. These figures represent the breakdown of particles into the five different size ranges: smaller than 1/16" in diameter, between 1/16" and 1/8", between 1/8" and 1/4", between 1/4" and 1/2", and larger than 1/2" in diameter. The sieves can also be used for separating macroinvertebrates from bottom sediments. The wet (freshly collected) sample is placed on the top sieve and flushed through by pouring water on it. The macroinvertebrates may be clinging to and/or hiding among bits of detritus in each sieve. The contents of each sieve can be back-flushed into clean water in white porcelain trays.

V. Limitations

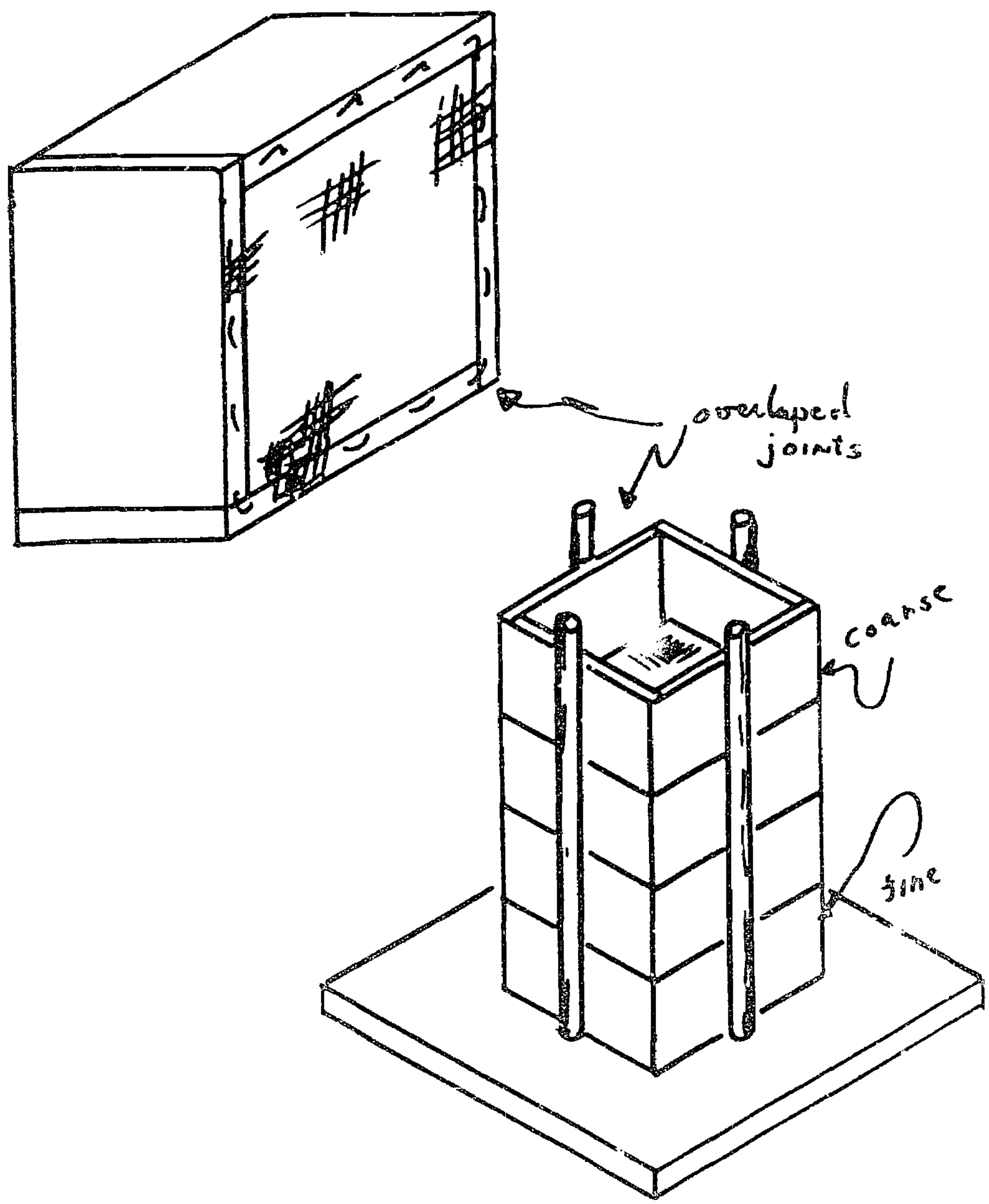
The main problems with this set of sieves are the range of sizes has so few gradations and there are no sizes below 1/16" where many of the particles will fall.

VI. Bibliography

Managing Our Environment, A Report On Ways Agricultural Research Fights Pollution, U. S. Department of Agriculture, Superintendent of Documents, Government Printing Office, Washington,

D.C. 20402, February 1968. An excellent pamphlet on how agricultural research is dealing with pollution. Discusses silting of rivers, farm waste and pesticides. A good background source for grade 5 upward.

Separating Sieves



V. Surber Square Foot Sampler

I. Introduction

The Surber is the standard device for collecting macroinvertebrates from stream bottoms. It is a net-frame combination that is placed facing upstream in a riffle. The frame is set on the stream bottom, and all the rocks and sediments within it are rubbed or brushed to clean them of their benthic inhabitants. These organisms are then washed down into the net by the current of the stream. This net sells for around $70.00 but you can make one just as good for about $8.00. The Surber design discussed here uses a combination brass, aluminum, and steel frame for maximum rust prevention and sturdy construction. Making it requires some metal working skills and some sewing skills. A mother, or a student who sews, would probably be glad to help you make the net part of this sampler.

II. Materials:

Qty.				
9'	Aluminum flat stock	1"x3/16"x96"	Hrd. store	$2.00
8	Right angle corner braces	3/4" wide	Hrd. store	$0.10
32	Aluminum bolts	1/4" x 1/2"	Hrd. store	$
32	Aluminum nuts for above bolts		Hrd. store	$0.01
2	Aluminum bolts	1/4" x 1"	Hrd. store	$0.04
4	Nuts for above bolts		Hrd. store	$0.02
2	Brass hinges, overall open width not more than 2"		Hrd. store	$0.80/pr.
12	Brass nuts and bolts for hinges		Hrd. store	$0.05
1	Small can with plastic top	3" diam. x 5"	Scrap	$0.00
1	Hose clamp	3" diameter	Hrd. store	$0.40
1 pc.	Fiberglass window screening of mosquito netting	26" x 104"	Hrd. store	$0.14/ft.^{2}

1 pc.	Heavy canvas	50" x 8"	Fabric store	$1.00/yd.
1 pc.	Seam binding	1" wide x 8" long	Fabric store	$0.50

Tools:

Hacksaw
Screwdriver
Pliers
Heavy fabric scissors
Rust proofing paint
Second grade flat file
Electric hand drill or drill press with 1/4" and 3/16" bits
Sewing machine
Paint brush

III. Procedure

Begin by cutting eight 1' lengths of the aluminum and one 10" piece. The eight 1' pieces will be bolted together to form two squares, each 1' square. One of these squares will sit on the bottom, the other will be mounted at right angles to the first to hold the net. The two will be hinged together so that they can be folded flat. The ninth piece of aluminum will be a brace that will hold the two frames at right angles when open. Right angle "L" braces will be mounted in the eight corners of the two frames to make sturdy joints. Position these braces one at a time in the corners and drill the four holes to mount them. Use the aluminum nuts and bolts to secure them. Once you have made the two square frames, mount the hinges between them. They should be mounted so that the frames can fold perfectly flat and lie one right on top of the other. These hinges will have to be taken off again, so don't tighten the bolts too tightly. In the 10" brace piece, put a notch or slot 1/4" wide and 1/2" deep in one of the long sides, about 1/4" from an end. Drill a 1/4" hole 1/4" from the other end. This piece will be mounted on one side of the upright frame with a bolt and two nuts locked together so that the brace can rotate around it. The brace will lock onto the lower frame by means of the notch, fitting over a 1/4" bolt, protruding from the side of the frame. To mount the brace, drill a 1/4" hole about 5" up from the bottom on one side of the upright frame. Mount the brace with the 1/4" hole. Now set the frames up so that there is a right angle between them. Then swing the brace around so that its free end lies just next to the side of the lower frame. Mark the point on this frame that is inside the notch in the brace. Drill a 1/4" hole there, stick the bolt through it, and mount it with one nut outside the frame and one inside. Adjust the bolt so that about 1/2" of it protrudes outside the frame. The brace notch should be able to hook onto this and hold the two frames open at right angles. Paint all the pieces that could rust.

To make the net, cut four pieces of fiberglass window screening, each one measuring 13" x 26". Measure in 2 1/2" from the edge on one of the 13" sides of each piece. From two points on this line, one at each edge of the piece, cut a straight line running to the far edge, and meeting in the middle of the opposite edge. In other words, you will have cut four pieces of screening that are almost triangles with bases of 13", and heights of 23 1/2", but you actually have these triangles with rectangles below the base of each triangle. These rectangles measure 13" long and 2 1/2" wide. Sew two of these pieces together with a 1/2" seam all along one side. Because of the strange shape of the pieces, the screening should not lie flat when sewed, but should have a lump where the edges "turn the corner" going from the rectangular portion to the triangular one. Next sew on the third side just as you did the second.

Finally, add the fourth side. Before the last seam is sewed, closing the net, the canvas frame cover must be made, and the net sewed to it. Fold the piece of canvas in half (width-wise) so that you have a double piece measuring 4" x 50". Then sew a double row of stitches the whole length of the canvas, 1 1/2" from the fold. You should then have a 1 1/2" tube with two 2 1/2" extra flaps protruding. The frame can be fit inside the tube by sliding the tube around the frame. First, however, sew the net securely between the two extra flaps of canvas, by placing the 2 1/2" rectangles on each of the four sections of the net between the two flaps and double sewing the flaps and net together. Now you should have a 4' piece of lumpy canvas tube and attached net. Slide the tube over the frame (first take off the hinges and brace). Starting from the pointed end, sew up the last side as far as possible with the sewing machine, the rest by hand. Next, cut the pointy end off the net so that a hole about 3 1/2" in diameter is left. Finish off this end, and the seams of the netting, by sewing a piece of seam binding around the inside and outside of this hole. Paint the can, so it won't rust and cut out the bottom. Stick the can into the opening in the end of the net, and fasten it there with the hose clamp. Now cut small holes in the canvas so that the hinges and brace can be put back on this upper frame that has the netting on it. Your Surber is finished. It should fold up into a flat unit, 12" x 12" x about 2" high. It might be a good idea to make a box to hold it.

IV. Use

To use the Surber, open it out and lock it in the right angle position. Then set it in a riffle in a stream. This is the standard place to take these samples. Place it firmly on the bottom, with the net flowing downstream. Carefully rub the stones and other materials within the frame to dislodge all benthic organisms. The current will carry them into the net. A stiff vegetable brush is useful if the bottom materials are covered with moss. When all the bottom materials are free from macroinvertebrates, the sampling is finished. Before removing the sampler from the water, "fan" the bottom with your hand to kick up any macroinvertebrates which may not have been carried into the net. Remove the net from the water and wash the organisms into the back of the net by dipping it and splashing water through it. When you think you have all the macroinvertebrates from the net in the can, hold a plastic bag over the lower end of it and open the can. Label and seal the bags and return them to the lab for analysis. To insure a representative sampling, three to five square foot samples should be taken at each location.

V. Limitations

Some small types of macroinvertebrates may pass right through this net. The authors, however, feel the Surber's durability, ease of handling and economy outweigh the loss of organisms through the netting. You may want to use a smaller netting, if you are concerned with very high levels of quantification.

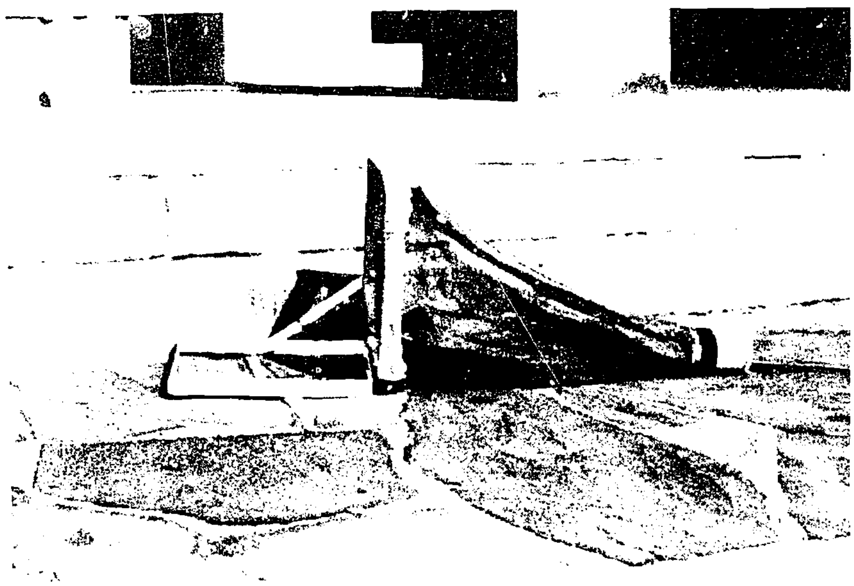
VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. II, Institute for Environmental Education

8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. Pp. Al-132-133. Contains a discussion of the use of this net in water pollution studies.

MacKenthum, Kenneth M., The Practice of Water Pollution Biology, U. S. Dept. of the Interior, Superintendent of Documents, Washington, D. C. 20402, 1969. An excellent guide for water studies written for governmental use. Suitable for high school students as a resource.

Standard Methods for the Examination of Water and Waste Water, 13th Edition, APHA, AWWA, WPCF, American Public Health Association, 1740 Broadway, New York, N. Y. This reference discusses the Surber and other macroinvertebrates sampling devices.



Surber square foot Sampler

I. Introduction

In this chapter water quality testing kits and systems are discussed. None of the individual pieces of equipment described in the preceding chapter is sufficient to give a comprehensive picture of a body of water. Only a combination of many different kinds of tests can reveal the "true" quality of a water system. previous studies (1) indicate that a single group of organisms... is not reliable as an indication of water quality. Only a comprehensive study reveals the true quality of a body of water." (2)

There are four major parameters that comprise any good water quality study. These are physical, chemical, macrobiological, and microbiological factors. This chapter groups water quality tests into the above mentioned categories.

Chapter 2 discusses three exemplary testing systems. Each system is designed for a different level of sophistication and skill. The first, or basic, system can be used effectively and meaningfully by sixth graders. The second, or intermediate, system is designed for use by students in about the eighth or ninth grades. The third, advanced, system may be used by students from grade nine upward.

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(1) Biological Field Methods: Investigative Data For Water Pollution Surveys, U. S. Dept. of the Interior, FWPCA, p. 4.

(2) A Curriculum Activities Guide To Water Pollution and Environmental Studies, Vol. 1, Chapter 3, p. 3-1.

The kits differ not only in the quality of results which may be obtained, but also in the number of parameters tested. In other words, anyone can be challenged by the most basic kit. The sophistication of the advanced kit lies in the variety of tests and concepts covered.

Many of the pieces of equipment referred to in this chapter are described in Chapter 1, complete with detailed construction instructions. Any test or method not discussed in Chapter 1 is described, or cited with a reference, in Vol. II of A Curriculum Activities Guide to Water Pollution and Environmental Studies (the Guide). The kits that are discussed here are merely examples of what students in the past have had success working with. Anyone interested in them is urged to adapt them to his or her own needs.

II. Basic Kit

The Basic Kit investigates three of the four main water quality parameters. The first parameter deals with the physical aspects of a body of water. Measurements of volumetric flow can be obtained by using a float, some rope, a meter stick, and a watch. An in-depth discussion of the procedures involved can be found in Volume II of the Guide. Another important physical parameter is water temperature. This simple yet vital test can be done using any thermometer. A reading of the air temperature should also be taken at each testing site.

The second parameter covered is the chemical content of the water. Three important yet simple chemical tests are dissolved oxygen (DO), pH and total phosphates. Readings give an indication of the ability of the stream to support life. The pH value indicates the level of acidity or alkalinity of the water. The total phosphate test shows how much of this nutrient the water contains. (For further references about these tests, see Vol. II of the Guide.) Reagents necessary for these tests can be made up in the laboratory following the explanations in Vol. II or purchased as individual, one-test kits.

The last parameter to be covered in this basic kit is the macrobiological. A hand dip net (Ch. 1-O) is recommended for gathering the aquatic organisms. Long range sampling for macroinvertebrates can be conducted by using a Hester-Dendy sampler. The tests of the three parameters mentioned are by no means to be taken as inferior because they are basic.

The three testing units -- physical, chemical, and macrobiological -- can either be placed separately into small "action" kits or combined to make one basic water testing kit. The kits should be made of strong wood, and care should be taken to make sure the chemicals used in the DO, pH and total phosphate tests are secure, since these chemical tests contain some potentially harmful reagents.

A good way for students to test water on a basic level is to separate into teams. Each team is responsible for one parameter. When the teams have reached proficiency in each of their respective areas, they switch and help teach the others how to conduct the tests. In this way it is possible for each student to learn the basic parameters covered in the kits and to share his new-found knowledge with others.

III. Intermediate Kit

The Intermediate Kit covers all four major parameters. The physical tests conducted are flow and temperature, involving the same equipment and procedures as in the Basic Kit. Also included is a sounding line for determining the depth of lakes and ponds.

The chemical testing is much more extensive in this system, and for that reason a complete commerical chemical test kit is recommended. LaMotte Chemical Company sells several different kits that are economical, accurate, and reasonably durable. LaMotte's Am-22 water test kit is especially recommended. It can be used for most of the important chemical water quality tests.

As in the Basic Kit, the biological testing is concerned with collection of certain types of organisms for later analysis and interpretation. A long handled dip net (Ch. 1-O) and a Hester-Dendy (Ch. 1-L) are again recommended. In addition, the Surber sampler (Ch. 1-V), is a very good piece of equipment which can easily be handled at this level. The Surber makes it possible to obtain data on biomass or population densities, somethirg the dip net cannot do. At this level the plankton, or microscopic, free floating life, can also be studied quite easily. For this, a plankton net (Ch. 1-P or Q) and a microscope with slides and cover slips will suffice. With this equipment, measurements on species diversity of the plankton population, the population density, and the abundances of so-called

"Indicator Species" that may give some clues to water quality can be made. All these are discussed in Volume II of the Guide.

The fourth parameter, which is not treated in the basic system, concerns the types and numbers of bacteria present in a body of water. At the intermediate level, a test for the number of total coliform bacteria present is recommended. This test provides a relatively simple but very good introduction to microbiological studies and teaches "sterile technique" safely and effectively. The test is the standard bacteriological test for water quality and is used to set public health standards. The equipment and supplies needed for this test can be obtained from the Millipore Corporation. The initial cost for materials is fairly high, but much of the equipment can be re-used and it all is well built. In addition to the Millipore apparatus, sample bottles that can be sterilized will be needed. Sample bottles should be carried in a sturdy box like the one used for the DO Kit (Ch. 1-F). Detailed step-by-step instructions for the total coliform test are given in Volume II of the Guide.

For use in the field it is advisable that you package everything in the Intermediate Kit securely. Wet cardboard boxes have an amazing ability to dissolve while good, sturdy, permanent boxes not only protect contents but help to keep things organized. As mentioned earlier, a box for each major parameter is a good idea. Probably everything should not be in one kit because it will be big and inconvenient if several different people try to use it.

IV. Advanced Kit

The Advanced Kit is designed to contain everything needed for the standard water tests. There are very few tests that cannot be handled by motivated senior high school students. As a result this advanced system is rather large. You may want to choose from it those things that you feel are important.

The physical section again is concerned with flow rates, depth, and temperature. The same equipment as was used in the Intermediate Kit is recommended with the addition of the flow meter (Ch. 1-K). With the flow meter and the "standard" flow procedure, the results can be compared and the best system determined.

The chemistry section should be a commercial test kit, plus equipment for several more precise tests, including the special bottles (300 milliliter glass stoppered), burettes, and chemicals for the Winkler Azide method to determine dissolved oxygen, and the equipment for Immediate Dissolved Oxygen Demand (IDOD) and Biochemical Oxygen Demand (BOD). The Winkler method is standard and highly accurate and a good way to teach titration methods. It is discussed in Vol. II of the Guide. A box for carrying the chemicals and sample bottles for this test is described in Chapter 1-F. The Secchi Disk (Ch. 1-S) for turbidity measurement is another useful piece. It again is an accurate yet simple standard method. A deep water sampler (Ch. 1-E), often needed in studies of a sophisticated nature, is used in any lake or pond study to check for variations in water quality (physical, biological, chemical) at varying depths.

The biological section of the Advanced Kit is quite extensive. It covers all major levels of life found in any fresh water body. The nekton (mostly fish) can be collected with a hand seine (Ch. 1-T) or large net if the law permits. They can be measured on a fish measuring board (Ch. 1-I). The macroinvertebrates can be sampled with: a dip net, (Ch. 1-O), a Hester-Dendy, (Ch. 1-L), a Surber, (Ch. 1-V), a dredge, (Ch. 1-G), and a corer, (Ch. 1-C & D). Microscopic life can be sampled with plankton nets, (Ch. 1-P & Q), and with benthic algae substrates, (Ch. 1-A). These substrates are for studying the benthic, or bottom dwelling, algae.

The microbiological tests in the Advanced Kit should go one step beyond the Intermediate Testing Kit, with sampling for fecal coliform, fecal streptococci, and total bacteria. Additional pieces of equipment that would be needed are: a constant temperature water bath for the fecal colony counts and a good incubator for fecal strep incubation. Any sample of bacteria may contain pathogenic strains. Therefore, care should be taken in the disposal of the specimens (plates or liquid cultures). These procedures are given in Vol. II of the Guide. The ratio of fecal coliform to fecal strep is used as an indicator of the kind of organism that produced the waste. For example, when the ratio exceeds "4", the polluting organism is probably a human. The total bacteria count gives a diversity reading on the types of organisms present. For further information concerning the nature and procedural aspects of these tests, see Vol. II of the Guide.

The advanced section would probably best be separated into individual kits with each kit containing one of the four main water quality parameters. Students could then work in groups and eliminate the confusion caused by one, overly-large kit. The Advanced Kit is by no means the peak of water testing apparatus. Rather it should serve as a good starting point which students can continue with further studies in the field.

Obviously all of the equipment need not be taken into the field for each project. Students may want to place just certain pieces of testing equipment in packs they can carry on their backs. For more sophisticated or longer range studies, some of the heavier equipment might be placed in a trailer and towed to the site.

From the foregoing discussion, it should be apparent that water testing kits should be made to fit specific job requirements. Once students are familiar with testing techniques, they should make the decision on which pieces of equipment they will need and construct their own testing kits for whatever it is they wish to do.

V. Bibliography

1. Physical parameter test references:

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Second Edition, Vol. II, Institute for Environmental Education, 1971, Cleveland, Ohio, Pp. A1-196 to A1-200. Gives a detailed account of the timed float-flow determination method.

Hynes, H. B. N., The Ecology of Running Waters. A good reference on the flow meter.

2. Chemical parameter test references:

   A Curriculum Activities Guide to Water Pollution and Environmental Studies, Second Edition, Vol. II, Appendix I, Institute for Environmental Education, 1971, Cleveland, Ohio. The first third of this appendix discusses, in detail, the important chemical tests.

   LaMotte Chemical Company, Chestertown, Md. 21620. This is the source of many good test kits.

   Standard Methods for the Examination of Water and Waste Water, 13th Edition, APHA, AWWA, WPCF, published by APHA, New York, 1971. Reference gives the oxygen testing procedures, including DO and IDOD.

3. Biological parameters test references:

   A Curriculum Activities Guide to Water Pollution and Environmental Studies, Second Edition, Vol. II, Appendix I, Institute for Environmental Education, 1971, Cleveland, Ohio. Last third of this appendix describes important biological tests.

   Hynes, H. B. N., The Ecology of Running Waters. A good reference for the algae substrates.

4. Microbiological parameter test references:

   A Curriculum Activities Guide to Water Pollution and Environmental Studies, Second Edition, Vol. II, Appendix I, Institute for Environmental Education, 1971, Cleveland, Ohio. The second third of this appendix gives step-by-step procedures for all of the bacteriological tests.

Bergey's Manual of Determinative Bacteriology, by Robert S. Breed, et al, ed., Waverly Press, Inc., Baltimore, Maryland. The "Bible' for bacteriological identification and culture methods.

Millipore Corporation, Bedford, Mass., 01730. This company is source of many excellent technical manuals and application procedures relating to aquatic bacteriology and produces excellent equipment for bacterial culturing and counting.

Chapter 3 Water Quality Studies Equipment Lists

A comprehensive water quality study program requires a great deal of equipment much of which, fortunately, can be obtained locally. This chapter outlines the equipment requirements for a comprehensive water quality study program. The tables are broken into the following topics: measuring devices, scientific equipment, tools, resource materials, supplies, containers and glassware, and miscellaneous items.

Each of the tables has columns which relate to the use of the items mentioned. The abbreviations in the first column are: B for Biology, C for Chemistry, and P for Physics. Most of the items can be used in all three areas, however the principal applications are those listed.

The second column entitled "Guide Ref. Chapter" refers to the chapter of A Curriculum Activities Guide to Water Pollution and Environmental Studies, Volumes I and II in which the use of that piece is discussed. The chapter references are abbreviated as follows: H for Hydrologic Cycle, EP for Ecological Perspectives, HA for Human Activities, and SP for Social and Political Factors.

The third column entitled "Age Range" refers to the age of student who can use the particular item. Under certain circumstances, the age ranges may be extended. However, these age ranges are listed for normal usage.

The final column lists where the item may be procured. Often the items may be obtained from more than one source. If a dash appears in this column, then generally speaking the item must be obtained from a commercial supplier by catalogue. Often the item listed may also be obtained through special sources peculiar to the school system, i.e., local business and industry, community organizations and institutions of higher learning.

Table 3-1, Measuring Devices, lists the device necessary for individual measurements. Items that are contained in kits are not listed in this section. Most of the measuring devices are used to measure distance or time. However, there are some items for measuring light intensity and angles.

Table 3-2, Scientific Equipment, lists those items which are used for collection purposes or as general lab equipment. Kits are also listed. Therefore this list includes some measuring equipment. However, the list is basically field collection equipment and lab support equipment. Most of the materials on this list have to be ordered through catalogues. Sometimes it is possible to obtain the equipment from local businesses and industries which are replacing or upgrading their equipment.

Table 3-3, Tools, lists most of the non-scientific, support tools you'll need to carry out activities. Things like shovels and hatchets are listed in this table. Most of these items may be obtained from a hardware store or borrowed from homes of the students. These items may be stored in an old trunk in the classroom.

Resource Materials are listed in Table 3-4. All of the items listed are maps of one sort or another. Attendant to these maps are other types of resource materials which may be obtained from local, state, or federal agencies.

Table 3-5, which lists Supplies, refers to items which are used up in the process of carrying out the various activities. No chemicals or reagents are listed. The chemicals required for water quality testing, bacteriology, and so on are listed under those particular topics in Volume II of A Curriculum Activities Guide to Water Pollution and Environmental Studies as ingredients in standard solutions and as standard solutions and reagents. They may be ordered either way by consulting Volume II. The supplies listed in 3-5 should be considered back up materials in much the same way that tools are, the difference being the supplies are expendable.

Table 3-6 lists Containers and Glassware. The listing is made in a separate table because so many items are required. Generally the items fall into two categories, those required for scientific experimentation and those for collection purposes. The items listed for experimentation generally must be ordered from catalogues. However, it may be possible to obtain these from local businesses and industries or institutions of higher learning. Items used for collection purposes generally can be found in the home or purchased at the local hardware store.

The last table contains "miscellaneous" items that did not easily fit into the other categories. Most of them are unusual kinds of supplies. The first aid kit and the insect repellent are the most important miscellaneous items.

The primary purpose of the tables in this chapter is to help the reader determine the kinds of equipment and materials that will be needed to begin a program. The lists also show that it is possible to carry out a program without huge expenditures of money.

Table 3-1 Measuring Devices

Device	Use*	Guide Ref. Chapter*	Age Range	Local Source
Alarm clock	B,P	H,EP	9-18	Drug store
Clinometer	P	H	12-18	----
Compass	B,P	H	9-18	Hardware store
Light meter	B,P	H,EP,HA	12-18	Camera shop
Measuring tape (25 meter)	B,P,C	HA,EP	10-18	Hardware store
Meter stick	B,P	H,EP,HA	7-18	Hardware store
Photometer	C,P	H,EP,HA	12-18	----
Ruler	B,P	H,EP,HA	6-18	Hardware store
Stop watch	P	H,EP	9-18	Drug store Jeweler
Watch	B,C,P	H,EP	9-18	Drug store Jeweler
Yardstick	B,P	H,EP,HA	6-18	Hardware store

* Codes are explained on page 101.

Table 3-2 Scientific Equipment

Item	Use*	Guide Ref. Chapter*	Age Range	Local Source
Aerator	B	EP	7-18	Pet Shop
Balance	B,C,P	H,EP,HA	10-18	----
Bunsen burner (portable)	B,C,P	H,EP,HA	12-18	Hardware store
Burette clamp	B,C	EP,HA	11-18	----
Chain (depth)	P	H,EP,HA	10-18	Hardware store
Core sampler	B,C,P	EP,HA	12-18	----
Crucible	C,P	EP,HA	14-18	----
Demineralizer	B,C	EP,HA	11-18	----
Ditto machine	B,C,P	SP	10-18	----
Drying oven	B,S	EP,HA	11-18	----
Ekman dredge	B	EP,HA	12-18	----
Funnel	B,C	H,EP,HA	12-18	----
Funnel holder	B,C	H,EP,HA	7-18	----
Hand line	B,C	H,EPHA	10-18	Hardware store
Hand net	B	EP,HA	7-18	Sports shop
Hester-Dendy Sampler	B	EP,HA	10-18	----
Kemmerer	B	EP	12-18	----
Life raft	B,C	H,EP,HA	10-18	Sports shop
Microscope (dissecting)	B	EP,HA 10-1	10-18	----
Microscope (HP)	B	EP,HA	10-12	----
Millipore kit	C	EP,HA	12-18	----
Movie equipment	B,C,P	SP	10-18	Photography shop

Table 3-2 (continued)

Peterson grab	B	EP,HA	12-18	----
pH kit	C	EP,HA	12-18	Pet shop
Plankton net	B	EP,HA	12-18	----
Plastic tubing	B,C	EP	7-18	Hardware, pet shop
Ring stand	B,C	EP,HA	12-18	----
Rubber gloves	B,C,P	H,EP,HA	7-18	Drug store
Rubber stoppers	B,C,P	EP,HA	7-18	----
Rubber tubing	B,C,P	EP,HA	7-18	Auto supply
Secchi disk	B,P	EP,HA	10-18	----
Sieve	B,P	EP,HA	7-18	5-10 store
Silk screen	B,C,P	SP	12-18	Craft shop
Soil test kit	C	EP,HA	12-18	Hardware store
Tape recorder	B,C,P	EP,HA,SP	7-18	Audio supply store
Winkler set up	C	EP,HA	12-18	----

* Codes are explained on page 101.

Table 3-3 Tools

Item	Use*	Guide Ref. Chapter*	Age Range	Local Source
Clip boards	B,C,P	H,EP,HA	7-18	Hardware store
Dropper	B,C	EP,HA	7-18	Hardware store
Dust pan	P	H,EP,HA	7-18	Hardware store
Field stool	B,C,P	H,EP,HA	10-18	----
Field table	B,P	H,PP,HA	10-18	----
Flashlight	B,C	EP,HA	7-18	Hardware store
Forceps	B	EP,HA	7-18	Hardware store
Hammer	B,C,P	H,EP,HA	7-18	Hardware store
Hand magnifying glass	B,C	EP,Ha	7-18	Hardware store
Hand net	B	EP,HA	7-18	Sports shop
Hatchet	B,C,P	H,EP,HA	12-18	Hardware store
Paper punch	B,C,P	H,EP,HA	7-18	Hardware store
Plumb line	P	H	10-18	Hardware store
Shovel	B,P	H,EP,HA	7-18	Hardware store
Siphon	B,C,P	H,EP,HA	10-18	Hardware store
Sledge hammer	B,C,P	H,EP,HA	12-18	Hardware store
Soil auger	B,C	EP,HA	10-18	----
Stakes	B,P	H,EP,HA	10-18	Hardware store or scrap
Stapler	B,C,P	H,EP,HA	7-18	Hardware store
Straight edge	B,C,P	H,EP,HA	7-18	Hardware store
Triangle	B,C,P	H,EP,HA	7-18	5-10 cent store
Trowel	B,C,P	H,EP,HA	10-18	Hardware store

*Codes are explained on page 101.

Table 3-4 Resource Materials (Maps)

Item	Use*	Guide Ref. Chapter*	Age Range	Local Source
City water maps	B,C	HA,SP	12-18	Local Government
Political sub-division maps	---	HA,SP	12-18	Local Government
Soil maps	B,C,P	H,EP,HA	10-18	Federal Government
Tax maps	---	HA,SP	12-18	Local Government
Topographic maps	B,C,P	H,EP,HA,SP	10-18	Federal Government (Interior)

Table 3-5 Supplies

Item	Use*	Guide Ref. Chapter*	Age Range	Local Source
Aluminum fence edging	P	H	10-18	Hardware store
Aluminum foil	B,P	H,EP,HA	7-18	Hardware store
Baggies	B,P	H,EP,HA	7-18	Grocery store
Cheese cloth	B	EP,HA	12-18	Hardware store
Filter paper	B,C,P	EP,HA	10-18	Drug store
Magic markers	B,C,P	H,EP,HA	7-18	Hardware store
Masking tape	B,C,P	H,EP,HA	7-18	Hardware store
Paper towels	B,C,P	H,EP,HA	7-18	Grocery store
Pencils	B,C,P	H,EP,HA	7-18	Hardware store
Plastic sheeting	B,C	EP,HA	7-18	Hardware store
Screening	B,P	H,EP,HA	10-18	Hardware store
Toilet paper	B,C,P	H,EP,HA	7-18	Grocery store
Wax markers	B,C,P	H,EP,HA	7-18	Hardware store
Wood splints	B,C,P	H,E,EP,HA	10-18	Hardware store

*Codes are explained on page 101.

Table 3-6 Containers and Glass

Item	Use*	Guide Ref. Chapter*	Age Range	Local Source
Aquaria (10-20 gals.)	B,C	EP,HA	7-18	Pet shop
Baby food jars	B,C,P	H	7-18	Home
Beaker (100,500,1M ml)	B,C	EP,HA	10-18	----
Buckets (10 qt.)	B,C	EP,HA	10-18	Hardware store
Burettes	B,C	EP,HA	12-18	----
Collecting pan (10" x 20" x 3")	B	EP,HA	10-18	Hardware store
Evaporating dishes	B,C,P	H	10-18	----
Flask (50, 500 ml.)	B,C	EP,HA	12-18	----
Funnel	B,C	EP,HA	10-18	Hardware store
Garbage cans (50 gal.)	B	EP,HA	10-18	Hardware store
Graduated cylinders (10 ml. - 500 ml.)	B,C,P	H,EP,HA	7-18	----
One gallon bottles	B,C,P	H,EP,HA	7-18	Home
Pipettes (10 ml.)	B,C	EP, HA	12-18	Hardware store
Plankton sample bottles	B	EP,HA	12-18	----
Tin cans	B,C,P	H,EP,HA	7-18	Home
Tubing	B,C,P	H,EP,HA	7-18	----
Waste paper basket	B,P	H,EP,HA	7-18	Hardware store
Water collection Bottles (300 ml.)	B,C	EP,HA	12-18	----

*Codes are explained on page 101.

Table 3-7 Miscellaneous

Item	Use*	Guide Ref. Chapter*	Age Range	Local Source
Cardboard boxes	B,C	EP,HA,SP	7-18	Stores
First aid kit	B,C,P	H,EP,HA,SP	7-18	Drug store
Glue	C,P	H,EP,HA	7-18	Hardware store
Insect repellent	B,C,P	H,EP,HA,SP	7-18	Drug store
Paper tissues	B,C,P	H,EP,HA,SP	7-18	Drug store
Labels	B,C	EP,HA	10-18	Hardware store
Paint	B,C,P	EP,HA,SP	10-18	Hardware store

*Codes are explained on page 101.

This chapter should help the reader determine where to get those items needed for a water quality testing program. Chapters 1 and 2 are useful for making equipment and Chapter 3 outlines the kinds of things needed for an entire program. This chapter deals with how and where to get the needed items.

A good way to approach supplies and equipment is to make what you can, seek donations from your community, and then buy the rest. This sequence allows for a personalized, community orientation which makes dealing with water quality in the community an easier process. It represents also a less expensive route. Students value the opportunity to contribute labor and time to this kind of activity.

Tables 4-1 and 4-2 list Manufacturers and Suppliers, respectively. The "Field" column abbreviates B for Biology, C for Chemistry, and P for Physics. Direct dealing with manufacturers cuts out the middleman and usually results in good continuing service. In the area of kits and associated refills this is an important consideration.

Catalogues may be obtained from each of the manufacturers and suppliers listed. The phone number enables a person with questions to make contact easily. In many cases regional offices are maintained and a sales representative will be glad to visit you.

Compare prices of similar stock items since prices do vary from catalogue. When purchasing a kit, be sure to consider refill and maintenance (batteries, etc.) costs also. Consider as well the utility of the kits. Some kits may be used by more than one person at a time because of the way in which they are sub-divided. Also consider the kit's susceptibility to damage, water, and dirt. If a kit can't be kept from frequent damage, it will be of little use. Some of the supplies in kits require special storage to prolong shelf life. Some reagents are dangerous because of their toxicity. These are important considerations.

Much of the field collection apparatus is expensive. Consider how often it will be used, and how easily it may be damaged. Some of the cheaper versions of field gear are more susceptible to damage, and they are not easily repaired if there is no local talent.

Finally, get advice of experienced teachers. Experienced teachers often attend meetings or run workshops. You may learn of and from them through professional periodicals. The articles they write should help you expand your program.

Table 4-1 Equipment and Supplies Manufacturers

MANUFACTURER	ADDRESS	FIELD	REMARKS
Bridge Mail Division (617) 923-1020	Watertown, Ma. 02172	B,C,P	Kits, equipment
Hach Chemical Co. (515) 232-2533	Box 907, Ames, Iowa 50010	C	Kits, reagents
Koslow Scientific Co. (201) 861-2266	7800 River Rd. North Bergen, N.J. 07047	C C	Kits, heavy metals
LaMotte Chemical Products Co. (301) 778-3100	Chestertown, Md. 21620	B,C,P	Excellent kits and literature
Millipore Corp. (617) 275-9200	Bedford, Mass. 01730	B,C	Excellent bacteriology equipment & literature
Novo Enzyme Corp. (914) 698-7001	1030 Mamaroneck Ave. Mamaroneck, N.Y. 10543	B	Enzyme experiments, kits
Oceanography Unlimited (201) 779-2313	108 Main St. Lodi, N.J. 07664	B,C	Kits, equipment
Wildlife Supply Co. (517) 799-8100	Saginaw, Mi. 48602	B,P	Quality field equipment

Table 4-2 Equipment and Supplies Manufacturers

American Chemical Society (202) 737-3337	1155 16th St., N.W. Washington, D.C. 20036	B,C,P	Lab guide - catalogue of catalogues
Beckman Instruments, Inc. (714) 871-4848	2500 Harbor Blvd. Fullerton, Calif. 92632	C,P	High quality lab equipment
Carolina Biological Supply Co. (919) 584-3771	Burlington, N.C. 27215	B	Specimens, AV equipment
Central Scientific Co. (312) 277-8300	2600 S. Kostner Ave. Chicago, Ill. 60623	B,C,P	Broad line, good service
Damon Corp. (617) 449-0800	115 Fourth Ave. Needham Hts., Ma. 02194	B,C	ESCP, Kits
Eduquip, Inc. (617) 298-0160	1220 Adams St. Boston, Mass. 02129	B,C,P	Supplies from other manufacturers, kits

Fisher Scientific Co. (412) 562-8300	711 Forbes Ave. Pittsubrgh, Pa. 15219	B,C,P	Broad line
Forestry Suppliers, Inc. (601) 359-3565	Box 8397 Jackson, Miss. 39204	B,C,P	Broad line of out-door equipment
Jewel Industries (312) 622-6622	5005 W. Armitage Ave. Chicago, Ill. 60539	B	Aquaria-terraria
Macalaster Scientific Co. (603) 883-4151	Nashua, N. H. 03060	B,C,P	Broad line
Minnesota Environmental Science Fdn., Inc. (612) 544-8971	5400 Glenwood Ave. Minneapolis, Mn. 55422	B,C,P B,C,P	Excellent activities
NASCO (414) 563-2446	901 Janesville Ave. Fort Atkinson, Wis. 53538	B,C,P	Broad line
National Wildlife Fed. (202) 483-1550	1412 16th St., N.W. Washington, D.C. 20036	B,C	Literature, booklets
Northeast Marine Specimens Co. (617) 759-4055	P.O. Box 1 Woods Hole, Mass. 02543	B	Marine specimens
Sargeant-Welch Scientific Co. (312) 677-0600	7300 North Linder Skokie, Ill. 60076	B,C,P	Broad line
Science Kits, Inc. (716) 874-6020	777 E. Park Dr. Towanda, N. Y. 14150	B,C,	Kits
Scott Scientific (303) 484-4706	P.O. Box 2121 Fort Collins Co. 80521	B,C,P	Kits, activities
Turtox/Cambusco (312) 488-4100	8200 S. Hoyne Ave. Chicago, Ill. 60620	B,C,P	Broad line
Wards' Natural Science Establishment, Inc. (716) 467-8400	P.O. Box 1712 Rochester, N.Y. 14603	B,C	Specimens, equipment

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