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ABSTRACT

This book is the third in a series of four books emphasizing student-oriented problem solving related to environmental matters. In properly conducted environmental investigations, it is felt students will perceive the need to extend their senses by using instruments. The instrumentation as presented in this guide should aid students in this respect. Chapter 1 offers construction plans for 23 pieces of water quality testing equipment. Included for each are an introduction to the item, materials and tools needed, procedure for construction, directions for using it, problems encountered, and a bibliography. Basic, intermediate, and advanced water quality kits and systems which can investigate four major water quality parameters--physical, chemical, macrobiological, and microbiological factors--are discussed in Chapter 2. Water quality equipment is listed in Chapter 3 for measuring devices, scientific equipment, tools, resource materials, supplies, containers, and glass and miscellaneous items. Each table identifies the item, use area (biology, chemistry, physics), topic area, age range of user, and local source to obtain it. How and where to get needed items are dealt with in the final chapter. Related documents are SE 016 524 and SE 016 525. (BL)

NOTICE

This book is the third in a series of four books produced by Project KARE with a grant from the Office of Environmental Education under Public Law 91-516. The other titles are:

- Curriculum Activities Guide to Solid Waste and Environmental Studies
- Curriculum Activities Guide to In-Depth Environmental Studies
- Curriculum Activities Guide to Population and Environmental Studies

Additional copies of the books may be obtained from:

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A CURRICULUM ACTIVITIES GUIDE

TO

WATER QUALITY EQUIPMENT

AND

ENVIRONMENTAL STUDIES

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D E D I C A T I O N

As this book goes to print we are deeply saddened by the passing of Ronald H. Spencer, formerly a student at George School and Syracuse University and one of our staff writers.

For four years Ron refused to allow illness to dictate his lifestyle. In spite of pain and frequent trips to hospitals he continued to whet his intellect, to experience new situations, and to maintain his pleasant sense of humor. In addition he constantly demonstrated thoughtfulness toward others and voluntarily contributed his talents to the improvement of the environment.

Mindful of Ron's great love for the natural world, of his skill in building models and of the example he set for us, we dedicate this book to him.

"To live in hearts we leave behind is not to die."

Acknowledgements Draft

There were many people who contributed to the completion of this document. It is a sequel to A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vols. I and II and as such, it leans heavily on the work of others who went through the ordeal of beginning something. Special thanks go to Donald L. Wright, Director of Project KARE, who encouraged the effort to formulate the Documentation Task Force (DTF) idea and to Allen C. Harman, Executive Director of Montgomery County Intermediate Unit #23, who facilitated the DTF effort in a myriad of 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 likewise appreciated.

We are grateful to George Lowe, Assistant Director of the Office of Environmental Education, U. S. Office of Education who encouraged us to continue this work. We appreciate the efforts of Joseph H. Chadbourne, President of the Institute for Environmental Education (IEE) who encouraged his program staff and participants to contribute material related to their needs. Many of the activity ideas and past studies come from participants of IEE programs, past and present. In particular, contributions were received from participants of the Cuyahoga River Watershed Project, Quincy Public Schools. and 1972 Summer Training Programs. The coordinating effort was carried out by summer program director, Alan McGowan, Scientific Administrator, Center for the Biology of Natural Systems and Peter

Gail, Adjunct Professor, Cleveland State University.

This guide was organized and edited by the team of John Hershey, Alan D. Sexton, and Patricia Sparks. They compiled the contributions of conference participants and the DTF staff writers. The staff writers were: Peter Goldie, Jonathan Gormley, Steven Kangisser, David Kriebel, Robert Lippincott, Jerry Ruddle, Ronald Spencer, Tim Tanaka, and Melissa Weiksnar.

The efforts of Bette Connelly, Sue Faulkner, Diana Geist, and Claire Pilzer made the writers' imperfections tolerable to the DTF.

Since the DTF began, there have been several personnel changes. Matthew M. Hickey has succeeded Donald L. Wright as Director of Project KARE. Alan D. Sexton has succeeded Mr. Hickey as the Assistant Director of Project KARE. John T. Hershey is no longer associated with Project KARE and is now the Manager of Environmental Programs for the University City Science Center, Philadelphia, Pa. Mr. Hickey and Mr. Sexton are currently administering the DTF.

This book is one of four which are being produced by the DTF. The other three deal with solid waste, populations, and in-depth studies.

Cover, and other photographs by David Kriebel.

A CURRICULUM ACTIVITIES GUIDE

TO

WATER QUALITY EQUIPMENT

AND

ENVIRONMENTAL STUDIES

Introduction Draft.

This book is a sequel to A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vols. 1 & 2 (1). 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 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 instrumentation as presented in this guide will aid students in this respect.

Students should be encouraged to make their own instruments -- either patterened after those presented in Chapter 1 or those of their own design. Students who become so involved will have the opportunity to use something which they have made to further refine their

(1) U.S. Environmental Protection, Agency, A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vols. 1 & 2, 1972, U. S. Government Printing Office, Wash., D.C. 20402, $2.25 per volume.

observations.

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.

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 1

Chapter 1 Construction Plans for Water Quality Testing Equipment

Each of the 23 pieces of equipment described in Chapter 1 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 . . udying parameters of the environment other than water.

Included for each are directions for making, directions for using and a parts list. Drawings are included with most. If "Scrap" is listed under the <u>Source</u> column (section II), it means that the item would probably be available in a school shop or laboratory.

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. The planktonic algae are those that flow freely suspended in the water. The benthic algae are those that grow attached to rocks, sediments or other submerged objects. Planktonic algae could be studied by collecting them in nets. There are two basic methods for collecting the benthic forms. They can be either scraped or somehow stripped from their habitats, or they can be grown, on an artificial habitat, or substrate, that can be removed from the water for study. Artificial substrates need not be fancy - algae will grow on almost anything. This substrate is simple, cheap, and efficient. It has been well-tested. Just about anyone can make it, and if you can use a microscope, you can study it. If you plan to make a set, as many studies require, the cost will be minimal.

II. Materials and Tools

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	¼" x ½"	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 ¼" bit

III. Procedure

The concept is that the microscope slide can be put in a stream or lake, and the algae will grow on it. Then you can remove it, and look at the algae on the slide using a microscope. That's all there is to it -- but, if you just drop a slide in the creek, you may have a rough time finding it a few days later. So, cut out a piece of red or yellow or blue plexiglas, about 2" x 6". Drill a hole near one end and stick the 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. Then tighten the wing nut. Now, when you put this in a stream, you'll be able to see it.

IV. Use

The idea of this substrate is for it to rest on the bottom and become inhabited with the benthic forms from the surrounding community. Not all types will grow or attach themselves to the plate, but many types will. You may have to anchor the plate in swift currents. In most habitats, twenty-four hours is long enough to get considerable numbers of algae attached to the plate, but this population will probably not be the same as 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 numbers of cells per field of view, number of species, species diversity, etc. The benthic algae are a community about which little is known. Many studies that you can do with these substrates could contribute to our knowledge about 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, and so to help understand the water one must know where it comes from. One of the important things to know about a basin is the slope of the land in it. The slope helps to determine the rate and extent of runoff from the land into the water system.

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 and Tools

Materials:

Qty.	Item	Dimensions	Source	Cost
3	Plastic Protractors		Variety Stre	$ .15
1 pc	Clear Plastic Fish-tank Tubing	¼" x 8"	Pet Store	ft.- $ .03
6	Steel Shot or Other Sm.Beeds	1/16" Diam.	Scrap	$ .00
2	Right Angle Braces	1½" x 5/8"	Hrd.store	$ .05

Qty.	Item	Dimensions	Source	Cost
4	Wood Screws	For Braces	Hrd.Store	$ .01
1 pc.	Wood	5"x8"x3/4"	Scrap	$ .00
1 pc.	2"x4" Wood	4" long	Scrap	$ .00
1	Dowel	Dia.5/8"x 36"	Hrd.Store	$ .25
1	Dowel	Dia.3/8"x 6"	Hrd.Store	$ .20/ 3 ft.
3	Sm.Wood Screws		Hrd.Store	$ .01
2	Sm.Fence Staples		Hrd.Store	$ .01
1	Bolt	¼" x 1½"	Hrd.Store	$ .02
2	Wing Nuts	For Above Bolt	Hrd.Store	$ .01
2	Washers	For Above Bolt	Hrd.Store	$ .01
1 pc.	Scrap Metal	1½" x 4"x1/8"	Scrap	$ .00
2	Med.Wood Screws		Hrd.Store	$ .01
1	Bolt	¼" x 3½"	Hrd.Store	$ .03
1 pc.	Wood	1" x 6" x 6"	Scrap	$ .00

Tools:

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

Sand paper

Jigsaw

Level

Paint brush

III. Construction

Cut the 8" x 5" x 3/4" block and sand the edges. Next drill a 1/4" hole centered length wise and 3/4" from one of the long sides. The 4 wood screws will fasten the "L" bracer into the 3/4" x 8" side that is opposite the hole. They should be positioned parallel to the sides and spaced about 6" apart. They will be used as the sight. You may want to put "V" notches in the tops of the braces to use as more accurate sights than the holes. The side with these braces on it is the top side. Drill into one of the 5" x 3/4" sides one inch from the bottom corner at an angle of about 20^{o} downward with the 3/8" bit, and 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 inches on a side, and two inches 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 circular 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 an extra block of two by four so that it has a 30° angle between two of its sides. If you lay your circular block on this 30° angle, with one of the three equally spaced points up hill, 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 degrees. 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 triangle 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 2 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 triangle and circle blocks, with a washer in between. On the bottom, put the wing nut and the washer.

The hardest part is left for last. The actual measuring part of the clinometer will be a plastic tube that runs along the rim of the 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 sight is 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^{o} mark, is perpendicular to the top edge. Mount it with the three small screws. Next 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 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 that the bead shows it. 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 get it level. 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 angles as well as vertical for mapping, place two protractors around the edge of the circle plate, so that they make a complete 360 degrees scale. Then fasten a pointer to the front of the triangle 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 from you, and sight on his knees. The reason for doing this is that the sight holes on the clinometer are about knee height off the ground. This height must be accomodated for at the point to be sighted so that the slope of the hill will be the only factor determining the angle of the measuring device.

V. Problems:

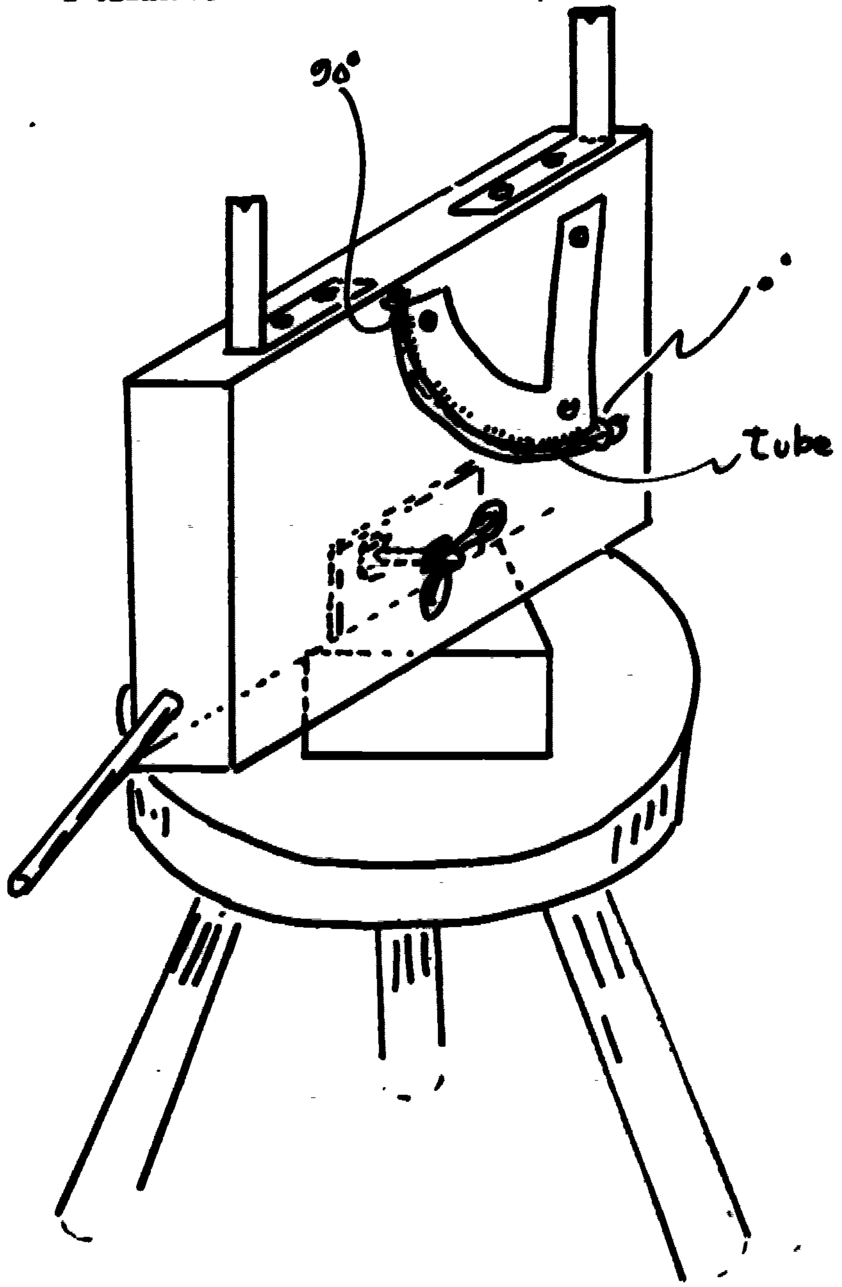
The main problem with this device lies in the accuracy of the bead-in-tube idea. Fortunately, if you calibrate it carefully, it has very reasonable accuracy, and so does not really have any major problems. Be sure to tap the block before you take every reading to insure that the bead has found its true rest position.

VI. Bibliography

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

Slope Measuring Device - Clinometer

a clinometer.



C. Core Sampler

I. Introduction

There are many things that can be learned about a body of water by studying the characteristics of its bottom. These characteristics are such things as the bottom's composition: rocky, clay, or silt, the thickness and source of a silt layer, and also the type and quantity of organisms living there. The Core Sampler can collect samples of sediments for doing these kinds of studies. It will remove a core from any silty bottom, not more than about 3 feet deep.

II. Materials

Qty.	Item	Dimensions	Source	Cost
1	Steel Pipe	30" x 2"	Hardware Str.	$5.29
1	Reducer	For above pipe	Hardware Str.	$2.25
4	Steel Bolts	1/4" x 1-3/4"	Hardware Str.	$ .03
4	Nuts	For above bolts	Hardware Str.	$ .01
1	Steel Bolt	1/4" x 1-1/4"	Hardware Str.	$ .03
1	Wing Nut	For above bolt	Hardware Str.	$ .02
5	Washers	For above bolts	Hardware Str.	$ .01
1	Copper Burnishing Wheel	2"	Hardware Str.	$ .49
1	Dowel	1" x 36"	Hardware Str.	$ .65
1	Plywood	6" x 14" x 3/4"	Lumber Yd.	$ .30 sq.ft.
2	Kitchen Drain	5" diameter	Hardware Str.	$ .39

Qty.	Item	Dimensions	Source	Cost
1	Dowell	1/4" x 36"	Hardware Str.	$ .20

Tools:

Saw

Sand paper

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 them 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^{o} jig block and then drilling straight down (see diagram). Next, holes must be drilled in the reducer ring, so that they line up with the holes in the handles. It is important that the handles, when fastened to the ring, be just flush with the top edge of this ring. This is so the valve will function properly. Mark the points on the ring that will line up with holes in the handles. To do this simply put the handles in place and push a sharp object down the hole to mark on 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. This is so there will not be obstructions in the tube. Tighten up the nuts on the bolts, being sure to put washers on first. Now the handles should 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. The last thing is to put on the valve. 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 bolt, washer and ring nut. The cover (valve) should normally lie flat over top of the ring and make contact with it all the way around. The idea is that when the sampler is shoved down, the valve will rise up slightly, allowing air to escape.

But, 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.

The last bit of construction necessary is the making of the scrubber. This is simply the 1" x 36" dowel with the 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.

Finally, 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. The operator will almost certainly have to be in the water. Grasp the sampler by its handles and drive it into the bottom. Needless to say, keep your toes out of the way. Once the sampler is down in the mud, wiggle it around a bit, from side to side, and then carefully pull it out. If the sample just falls out of the tube, the bottom is too soft or you pulled the sampler 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 without disturbing or mixing it. It's a good idea to carry an extra valve with you because it might tear or dry out and crack.

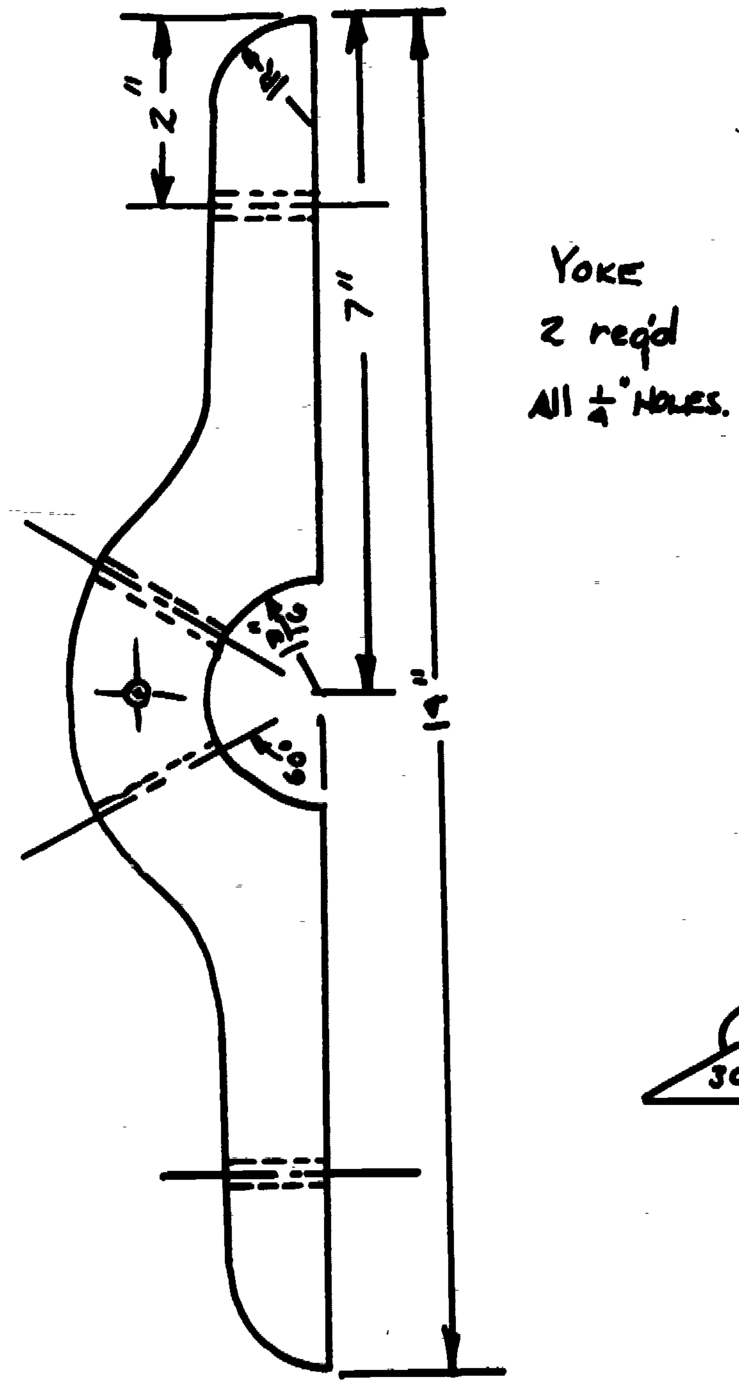
V. Problems:

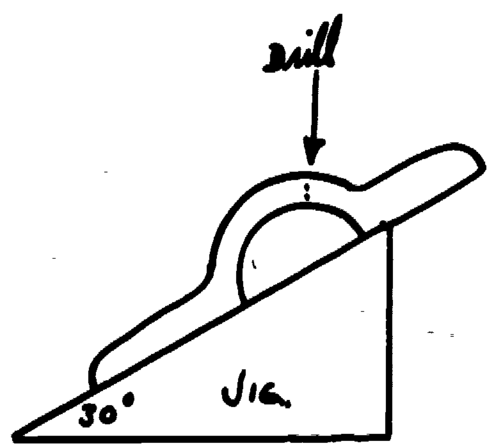
The main limitations of this device are that it cannot be used in rocky bottoms or bottoms that are so fine that the sediments will not compact and stay in the tube.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. I, Institute for Environmental Education, Second Edition, 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. The type of soil and its moisture content can tell many things about the nature of the water that is filling the nearby water body. The core sampler as it is described here is fairly tricky to make, though not to use. It is not recommended for people who have not had some experience in light metal working. A drill press is almost absolutely necessary. This design should cost about $3.50.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
3 pcs.	Sink drain pipe that fit together to make one unit (see text)	2 ft. X 1 1/2" diam. X 1/16" thick	Hardware store	$0.80/pc.
1 pc.	Maple or other hardwood	10" X 3" X 1"	Lum. yd scrap pile	$0.00
4	Bolts	3/16" X 1 1/2"	Hardware store	$0.40
4	Nuts for bolts		Hardware store	$0.01
1 pc.	Old Hacksaw blade (see text)		Scrap	$0.00

Materials:

Qty.	Item	Dimensions	Source	Unit Price
5	Bolts	1/8" X 1/2"	Hardware store	$0.01
5	Nuts for bolts		Hardware store	$0.01
1	Hose clamp	2" diam.	Hardware store	$0.35
1	Dowel	5/8" X 36"	Hardware store	$0.50

Tools:

Hacksaw

Sabre or small hand saw

Drill press with 3/16", 1/2" and 1 1/2" bits

Screw driver

Pliers

Sandpaper

Shellac

Paint brush

Goggles

III. Procedure

This core sampler is designed around a length of pipe, that 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 brass that had been chrome-plated, but any pipe of roughly the same dimensions would suffice. The upper piece should have a lip on it, but this is not essential. An extender of about five inches fits tightly onto the end of the first piece, and another extender pipe of seven inches 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 the most difficult to attach. The teeth consist of a piece of an old hacksaw blade that is cut to the right length, bent into a circle and inserted inside the open end of the pipe. The problem is that some types of hacksaw blades will break rather than bend into such a tight circle. So, you must carefully, gently 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 not tempered. They will tend to bend rather than break. Goggles should be worn when doing this testing. After inserting 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. This is 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 a 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. Now tighten up the clamp on the joint between the two pipes.

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.

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.

Allow the core sample to reach the hose clamp, and then stop to clear the tube. 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, one must clear the tube of contents and then redrill the hole until the desired depth is reached. If the sample falls apart when leaving the tube, try to tap the core onto a flat surface before clearing the tube.

V. Problems

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

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. This activity-oriented Environmental Guide is the result of cooperative efforts of High School students, teachers, scientists, and technicians. The activities are divided into four chapters: Hydrologic cycle, human activities,

ecological prospectives and social and political factors. It has many activities which can be used as examples or as a basis for other activities.

TERRESTRIAL CORE SAMPLER

E. The Polluchie--Deep Water Sampler

I. Introudction

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 mesolimnion 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, is durable and is very similar to commerical models, but can be made for literally a tenth the cost.

II. Materials and Tools

Materials		Source	Cost
1.	1-piece plastic (P.V.C.) plumbing pipe, I.D. 2", L. 2 feet	Plumbing supply	$ .63/foot
2.	2-solid rubber balls, diameter about 3 inches	Toy store	$ .25 each
3.	1-piece surgical tubing, 2 feet		
4.	1-standard 1/4 in. I.D., Lab tubing, 6 in.	Scrap from lab	$ .00
5.	1-brass needle valve (for 1/2 in. pipe) or automotive radiator drain valve	Plumbing supply house	$1.29
6.	1-hose clamp to fit pipe	Hardware store	$ .31
7.	2-eye bolts, 4 in. x 1/4 in.	" "	$ .10
8.	2 nuts for eye bolts	" "	$ .02
9.	8-washers for eye bolts	" "	$ .01
10.	2-wing nuts for eye bolts	" "	$ .04

	Materials	Source	Cost
11.	1-length 1/2 in. threaded steel rod, 4 inches	Hardware store	$ .49 (for three feet)
12.	1-piece steel flat stock 6" x 3/4" x 1/8"	Scrap from metal shop	$ .00
13.	1-same piece flat stock or brass 2" x 3/4" x 1/8"	"	$ .00
14.	1-piece steel or brass, etc., 1-1/2 x 3/4" x 1/8"	"	$ .00
15.	1-brass or aluminum bolt (release pin), 1/8" x 2"	Hardware store	$ .01
16.	2-brass or aluminum nuts for above bolt	"	$ .01
17.	2-nuts for the 1/4" threaded steel rod (activator rod)	"	$ .02
18.	1-wing nut for the rod	"	$ .04
19.	String	Scrap	$ .00
20.	1/4" woven nylon line, 3 feet	Hardware store	$ .05/foot
21.	1-piece heavy steel pipe O.D. 1 inch by 6 inches	Scrap	$ .00
22.	Rust proofing paing	Hardware store	

* All costs are per units not total

Tools:

1. Hacksaw
2. Half round second grade file
3. Sturdy vice
4. Hammer
5. Electric hand drill or drill press with 3/8", 3/16", 1/4" bits.
6. Tap of the correct size for the needle valve
7. String
8. Knife
9. 1/4" screw driver

10. Pliers
11. Rust-proofing paint
12. Paint brush
13. Needle nose pliers
14. Tape Measure

III. Construction 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 messanger that is dropped down the rope holding the sampler, when the desired depth has been reached.

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 inch piece of flat stock into a "U" with right angle corners, 2 inches on each side. Then drill a 3/8 inch hole through both sides of the piece about 3/4 of an inch from the bottom side of the "U" (see diagram). Through one side of the "U", drill another 3/8 inch hole, 3/4 inch from the first and directly opposite it. On the other side drill a 3/16 inch hole. This piece of stock is the body of the trigger mechanism. The side with the two 3/8 inch holes will be the top or upper side, and the one with the 3/8 inch and 3/16 inch holes is the lower.

Drill two 3/8 inch holes in one of the two inch pieces so that they correspond to the 3/8 inch holes in the top of the trigger piece. In the 1-1/2 inch piece, drill one 3/8 inch and one 3/16 inch hole corresponding to the holes on the bottom of the trigger piece. Next take the brass bolt (release pin) and file the final 1/2 inch of it to a point. This pin holds the cocking lines and they must be able to slide off of it easily when the messenger releases the pin. The final piece of the trigger mechanism is a 4 inch length of 1/4 inch steel rod. If you can find this length of brass or aluminum threaded rod, or a bolt, use it--it won't rust. Next, assemble the trigger mechanism. On one end of the steel rod, put a nut, the two inch steel plate, (using the 3/8 inch hole) and another nut. Now put the rod through the two 3/8 inch 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 inch steel plate throught the 3/8 inch hole, with two nuts (one above, one below). Secure the release pin in the 3/16 inch hole in the lower plate, with the two brass nuts, so that the pointed end will stick up through the 3/16 inch hole in the trigger piece. Tighten the nuts of the upper plate so that the 3/8 inch hole in the plate lies just above the outer 3/8 inch hole in the top of the trigger piece.

Next, the trigger must be adjusted. The th aded rod should be able to move freely up and down through the holes in the trigger piece, so that, when the rod is down as far as it can go (with the top plate's bottom nut resting right on the trigger piece), the release pin should not be protruding through the hole in the trigger piece into the inside of the "U". And, when the rod is up 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 of an inch above the trigger piece's bottom leg. 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 in at least two ways. Either, by using the proper tap, and tapping a threaded hole in the pipe, and then screwing in the valve, or by drilling a slightly oversized hole and fastening the valve in with a nut on the inside. Drill a 1/4 inch 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. The piece of surgical tubing (it needn't be surgical tubing, just some kind of strong, elastic tubing or cord), is passed through the body tube and fastened securely through one of the ball's eye bolts. It is then stretched fairly much and secured 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 able to be stretched enough so that the balls can be pulled out of the tube about six inches. 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. There are pieces of 1/4 inch braided nylon cord that are formed into loops and 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. The upper loop is then taken up and hooked over the release pin, when the threaded rod assembly is up as far as it can to. The loops must be made the right lengths to accomplish this. When the sampler is cocked, the balls should be 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 inch rope through the 3/8 inch 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 have been put on the rope already. 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, 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. Problems

If you've made your sampler well, no water should come out of the valve when you open it. This is because the balls seal the ends so well that no air can enter the tube to replace the water. Therefore, the top ball must be moved slightly to let some air in. If the messenger is too light, it won't move the upper plate; if it is too heavy, it will bend or break it.

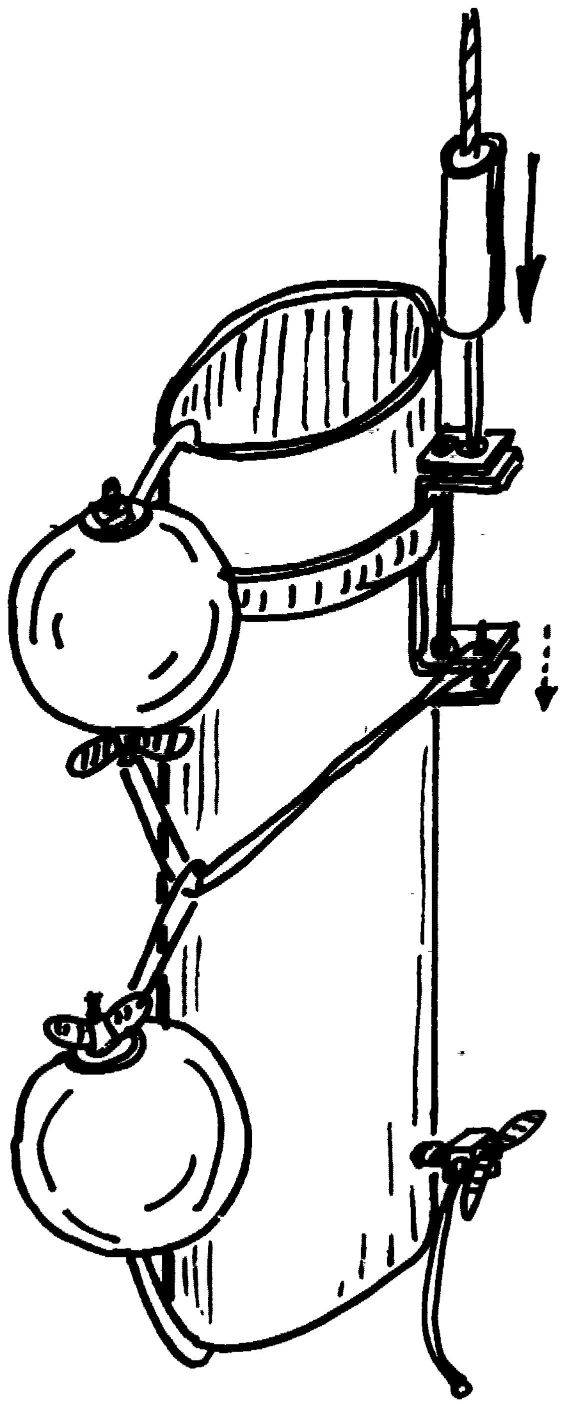
VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. I, Institute for Environmental Education, Second Edition, May, 1971, Pg. 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, Pg. A1-143. This discusses briefly the use of deep water samplers in Plankton analysis.

The Polluchie



F. DO 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 be used as a carrier for 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 physical abuse. The box can be made by almost anyone with basic carpentry skills or by anyone under the supervision of a person having the necessary skills. The price of the unit would run about $2.00.

II. Materials and Tools

Materials:

Qty.	Item	Dimension	Source	Cost
1	Plywood	16" X 42" X 3/4"	Lumber Yard	30¢/sq.ft.
1	Dowel	36" x 3/4"	Hardware St.	50¢
40	4 Penny Box Nails	1"	Hardware St.	20¢

Tools:

Power or hand saw

3/4" drill bit

Electric drill

Hammer

Wood glue

Sand paper

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 and then take one of the 12-3/4 X 4" boards and cut slots 2" deep leaving a 2-3/4" tab between the slots (see diagram). Then take the (2) 15" X 7-3/4" boards and drill a 3/4" hole with center 1" in from the end and 3-3/8 in from the sides. Drill a hole at these dimensions into both boards. Cut each of the (6) 6-1/4" X 4" pieces, in the following manner: make a 2" deep slot starting 2-3/4" in from the 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.

Using the "Center Strip", place the 6 boards, you've just finished cutting, into it, such that the slots of each of the boards slide into the slots of the center strip. You should now have 3 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 to be used to place the sides of the box on. Glue and nail on the dividers to the 12-3/4" X 7-3/4" board. Glue and nail on the (2) 12-3/4" X 4" sides of the box so that 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 6 compartments 2-3/4" X 2-3/4" and 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 to do 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. When this is done, 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 tip. In the 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.

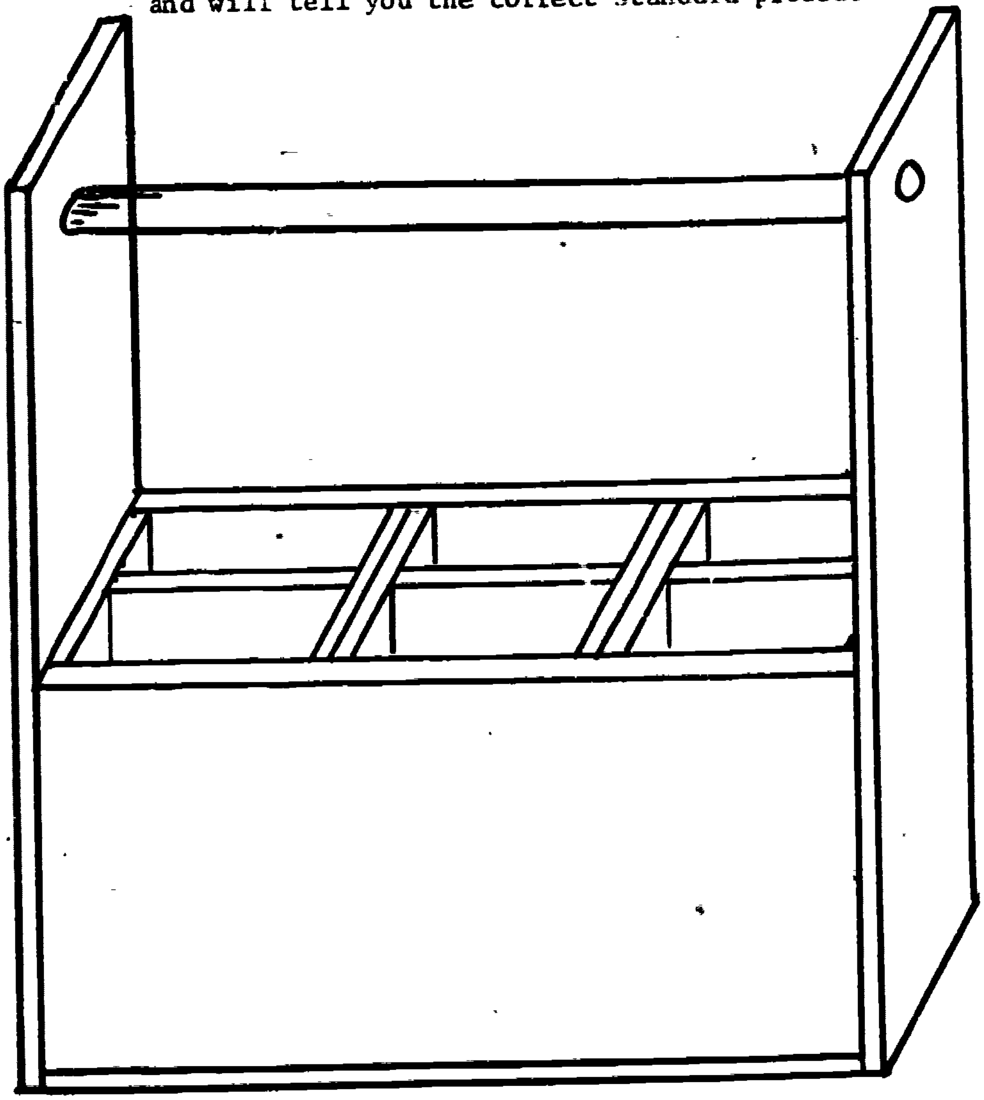
V. Problems:

If chemicals are spilled on the box, they 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, 2nd Edition, The Institute for Environmental Education, Cleveland, Ohio, 1971, Vol. II. This gives an excellent step by step procedure for doing the 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

1. Introduction

The transect dredge is used to collect samples of mud or other soft sediments from the bottom of a pond, lake or river. it is dragged (towed) along the bottom and cuts and collects the sediments along one thin strip, or transect. This is particularly useful when studying the life in the bottom, because most life does exist in the upper thin stratum.

When making this dredge, you will be working almost entirely with sheet metal. Sheet metal work requires some skill. An experienced individual in sheet metal work should act as a supervisor on this project. However, little skill is required in using the dredge to collect samples. The cost of construction is approximately $6.00.

II. Materials and Tools

Materials:

Qty.	Item	Dimension	Source	Unit Price
1	straight length galvanized sheet metal heating duct	5" diam. X 24" X 1/32"	Hard.store	$0.49
1 pc.	aluminum flat stock	1" X 3/16" X 48"	Hard.store	$2.99/8ft.
3	eyebolts	1/4" X 2"	Hard. store	$0.10
6	Nuts for eyebolts		Hard.store	$0.02

Qty.	Item	Dimensions	Source	Price
1	Snap swivel		Hard.store	$0.55
2	Hose clamps	3"	Hard.store	$0.40
1 pc.	Window screening	8" square	Scrap	$0.00
6 ft.	Nylon cord	1/4"	Hard.store	$0.40
12	Round head bolts	1/4" X 1/2"	Hard. store	$0.02
12	Washers for above bolts		Hard. store	$0.01
12	Nuts for above bolts		Hard.store	$0.01
1	Float		Scrap	$0.00

Tools:

Tin shears

Hack saw

Electric drill or drill press

Second grade flat file

Knife

Hammer or Mallet

Paint and brush

III. Procedure

The section of duct will be the main body of the sampler. The theory of operation is simple. The tube is towed or pulled along the bottom where it gathers the sediments in the back of the tube.

Cut a length of aluminum stock the length 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", evenly spaced, holes in the collar. Now bolt the collar onto the outside 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 out. Place them as low to the surface of the tube as possible. This side, which is shown in the diagram is "the top". Turn the tube over and drill a 1/4" hole about six inches from the back end and opposite the two eyebolts on top. Put the other eyebolt in and fasten it like the others. the next step is to put on "the fins" or stabilizers. These prevent the dredge from rolling over when cutting along the bottom. Cut two pieces of aluminum 15" long. At a point three inches 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 should be mounted sticking straight out from each side, near the back. In other words, one on each side spaced 90° away 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. The next step is to "rig the rigging". Take about five feet 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 ten feet 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 eyebolts. 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 either 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, pull it straight up. This insures the collecting of sample without too much danger of its washing out. From the shore, coil the lines and heave it 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

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

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. This activity oriented Environmental Guide is the result of cooperative efforts of high school students, teachers, scientists, and technicians. The activities are divided into four chapters: Hydrologic Cycle, Human Activities, Ecological Perspectives and Social and Political Factors.

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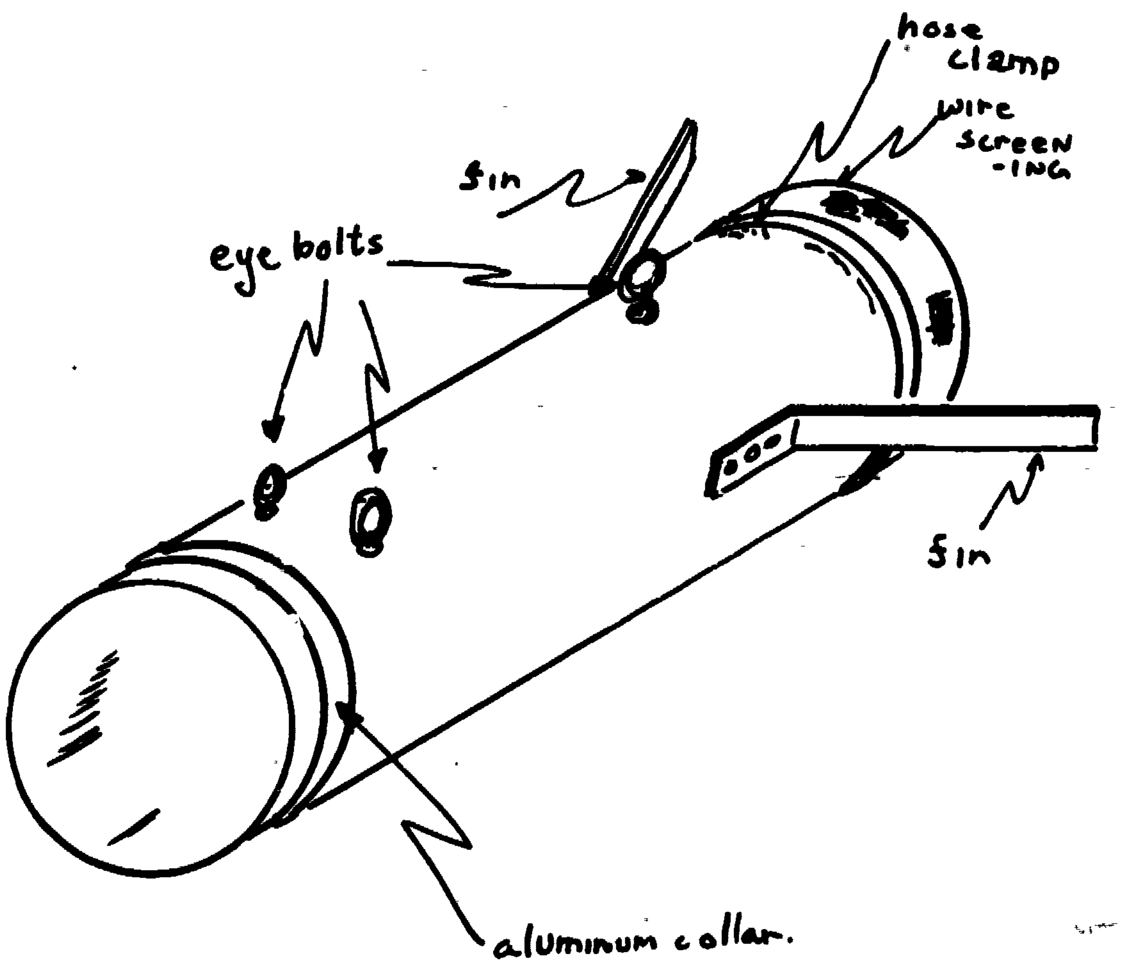


H. Drying Oven

I. Introduction

These plans are for an oven, used to dry samples of soil, bottom sediments, and macroinvertebrates to achieve their dry weights. It is designed to reach only the moderately high temperatures needed for drying samples. For this reason, it can be built from plywood, with its inner walls covered with ceramic tile. It is heated with a light bulb. This oven is fairly complex. It has some simple electrical wiring and consequently is recommended for people with some knowledge and skill with tools, wood, and wiring. It is fairly expensive for projects in this book, costing about $20.00. It is still far cheaper than anything one could buy from a commercial supplier.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 lb.	Repair Grout		Bldg. Sup.	$0.79
1 qt.	Adhesive		Bldg. Sup.	$1.89
1	Replacement cord		Hard.store	$0.99
1	Exterior Light Socket		Hard.store	$0.40
1	Red light bulb	75 Watt	Hard.store	$0.39

Qty.	Item	Dimensions	Source	Price
1	Interior Light Socket		Hard.store	$0.45
1	Exterior Wall Switch		Hard.store	$0.59
1	Junction box	5" diameter	Hard.store	$0.35
5 ft.	Electrical wire		Hard.store	$0.05/ft.
1	Electrical tape		Hard.store	$0.35
2	Nuts and Bolts	1" X 1/8"	Hard. store	$0.06
1	Sash lock		Hard.store	$0.90
2	Hinges	1" total width	Hard.store	$0.50
6sq.ft.	Tile	1/2" X 1/2"	Bldg. Sup.	$0.89/ft.^{2}
1	Bulb (Flood)	150 Watt	Hard.store	$1.40
9sq.ft.	Plywood	4-1/2' X 2' X 1/2"	Lumber yd.	$0.25/ft.^{2}
1	Staples, insulated		Hard.store	$0.15
30	4 penny box nails		Hard.store	$0.13
10	4 penny finish nails		Hard.store	$0.02
11	Wood screws	1/8" X 1/2"	Hard.store	$0.04
1	Thermometer	110°C	Scientific Supply Co.	$2.00
1	Drying rack	11-1/2" X 11-1/2"	Hard.store	$0.79

Tools:

Power saw

Jig saw

Screwdriver

Hammer

Power drill

Putty knife

Knife

Sand paper

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" X 13", and two pieces 12-1/2 X 4". These will be the legs. The front, back and sides of this oven are to be set upon 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 3/8" holes in the top piece to allow the heat to escape. You probably should make about 10 of them, but some may need to be covered if your oven does not get hot enough. Next you are ready to 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. First 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"; therefore; one of the panels will just fit. The top panel will also just fit with its tile panel centered. You will notice that the sides and door will all have to have their 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 has 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 4 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 to set the rack on to hold the samples.

You need not wait for the epoxy to dry fully or the grout to be applied before putting the oven together. Nail the back and sides to the bottom, and then to the top, and finally together. Next mount the door on its hinges with small wood screws. The door is designed to sit flush with 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. Now mount the legs on the bottom, flush with the edges of the box. They are mounted to to the box with small blocks of wood on the inside and nailed to both box and legs. In the authors' version an ornamental pattern was cut in each of these leg pieces, but this is not necessary.

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 side of the box. The two bulbs (heat and pilot bulbs) should be wired in parallel, with the switch turning them both off. With this hook up one can easily tell when the oven is on. 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 rests. 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, first mass a shallow dish. Into this dish place your sample. Place the dish onto the drying rack in the oven and allow to 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 pre-massed dish and allow to dry. The bio-mass of the dehydrated macros is the total mass minus the mass of the dish.

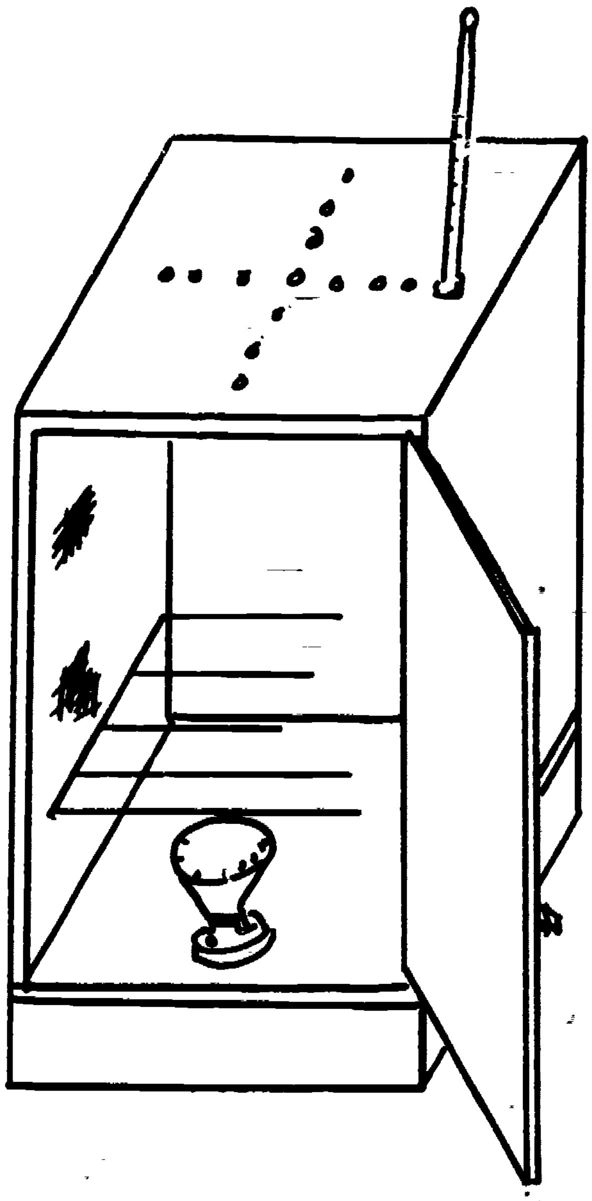
V. Limitations

From the safety standpoint, the first eight hours of operation should be under close supervision. In this way the wiring and other components of the box may be checked out while in actual operation. Swelling due to absorption of water from the samples may make the door stick. A little bit of sand paper used judiciously should loosen the door. Inasmuch as 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 upon the drying rack is not desirable. If the 150 watt bulb is not sufficient for your drying purposes, try higher wattages. However, the life of the bulb may be reduced by the high temperatures.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. This activity-oriented Environmental Guide is the result of cooperative efforts of High School students, teachers, scientists, and technicians. The activities are divided into four chapters: Hydrologic Cycles, Human Activities, Ecological Perspectives and Social and Political factors. It has many activities which can be used as examples or as a basis for other activities.

Drying Oven



I. Fish Measuring Board

I. Introduction

Introduction

Fish measuring boards are very useful when doing fish studies relative to productivity and growth rates. The fish measuring board is a flat board with three raised edges that fish can be placed on for quick measuring. It is marked off in inches or centimeters, whichever you prefer, and is essential if you are handling and measuring large numbers of fish.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Wood	1" X 9" X 24"	Scrap	$0.00
1 pc.	Wood	1/4" X 2" X 42"	Scrap	$0.00
6	Nails, 4 penny box		Scrap	$0.00

Tools:

Saw

Hammer

Wood file

Shellac

Paint Brush

Sand Paper

III. Procedure

Cut the 1/4" strip into three pieces, two - 9" long and one-24" long. These pieces should be fastened to the ends and to one side (the back) so as to make a raised edge around these three. The fish will be placed on the board, nose (or mouth) against one edge. The length will then be read at the tip of its tail. File or saw grooves in the board at inch or centimeter intervals. Label them, by painting them on or stamping them with metal dies. Preserve it from mud and fish slime with several coats of water-proof finish.

IV. Use

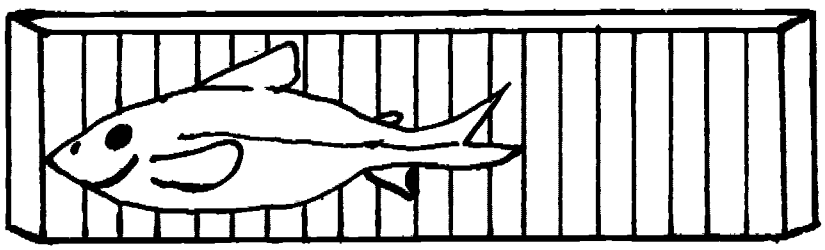
When you get a fish, slap it down on the board, push its head up flush with the lower end, and read the measure at the tip of its tail. Generally, fish are measured by rounding <u>down</u> to the next lowest whole figure. In other words, if fish "X" is almost 6 inches long, but not quite, it is recorded as being 5 inches long. This method is good because it does not presume more accuracy than can be obtained by just slapping the fish down there 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 sufficient numbers of measuring boards. Since fish metabolism rates are lower at reduced temperatures, colder times of year are better than warmer times.

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

J. Fish Tank

I. Introduction

Large aquaria and terraria are often useful for conducting lengthy observations of fish and other wildlife. Homebuilt aquaria are not only more inexpensive than those available for purchase, but 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, that 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 and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	3/4" plywood (marine)	92" X 18" X 3/4"	Lum.Yd.	$0.40/ft.^{2}
1 pc.	Glass 1/4" thick	13" X 24"	Hard.st.	$0.80
	Silicone glue		Hard.st.	$3.99/tube
	Epoxy paint (blue)		Hard.st.	$2.49/qt.
104	Wood screws	1-1/2" long	Hard.st.	$0.02

Tools:

Saw

Electric drill with bit to lead the screws

Sand paper

Screwdriver

Paint brush

III. Procedure

Cut two pieces of the plywood, to the following size: two 35-1/4" X 17-1/4", and two of them to 17-1/4" X 17-1/4". These are the front and back, and the ends. The bottom is a piece 18" X 36", cut out of the 3/4" plywood also. The only other piece is a brace, 2" X 18" X 3/4" that will support the front and back. In one of the larger pieces, cut a rectangle, 9" X 20", centered in the middle of the piece. 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 this 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. These screws should all be started by drilling holes to make the work easier and to keep the wood from splitting. Apply a billet of the glue, sealing all the inside corners. When all this has throughly 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 because 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.

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.

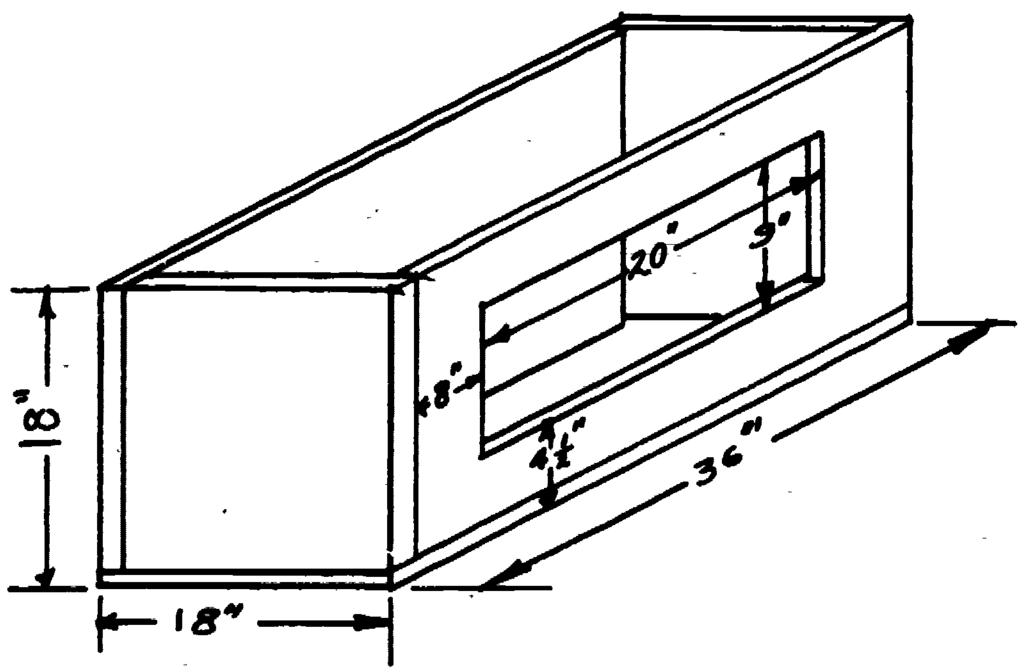
V. Limitations

If thin materials are used, the tank will normally develop leaks. Once the epoxy paint has been mixed, the wood must be painted rapidly due to the fact that epoxy dries extremely 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 1 Draft

K. Flow Meter

I. Introduction

In any study of a stream or river, one important parameter to know is how much water is flowing downstream at any given time or at any point on the stream. The characteristics of the flow are important in such considerations as the danger from floods. The rate of flow is important to the life in a stream. Current is a very important factor in any aquatic habitat. For these reasons flow measurement should 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 this by the rate of flow, found by timing a float, For more details on this procedure, see the Bibliography for the reference. 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 adpatation 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 and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Bottle	about 1/2 liter with wide (2") mouth	Scrap	$0.00
1	2-hole stopper for this bottle		Scientific	$0.10
1	Test tube	about 1/2" I.D. X 4" long	Scientific Supply Hse.	$0.10
1	Medicine Dropper		Drug store	$0.10
1	Plastic Sandwich Bag		Scrap	$0.00
1 pc.	Plastic fishtank tubing	2 ft.	Pet store	$0.05/ft.
1	Small, light float		Scrap	$0.00
1	Graduated Cylinder	250 ml.	Borrow	$0.00

Tools:

Small triangular file

Electric drill with 1/2" bit

Knife

Bunsen Burner, or alcohol lamp

Inside calipers

Goggles

III. Procedure

Cut the test tube to make an open tube, 2" in length. Use the 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 bend the glass tube into a right angle, at its mid-point. When it has cooled, push the pointed end down into the other hole in the stopper. Fasten the piece of tubing to the other end of 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 all the open end is sticking out. Now carefully push the cutoff 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 down 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. To do this, measure the inner diameter with the inside calipers. Then use the formula $A = \pi r^2$ 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 then put 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. This procedure should be done several times at the same point, and at several points at any one stream side, and the results averaged.

V. Limitations

The primary limitation of this device, is that it cannot be used in slow moving streams. This is 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, 2nd Edition, Institute for Environmental Education, Cleveland, Ohio, 1971, Vol. II. pg. Al. This is the 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, pg. 5, 6. This discusses the original design, and has a drawing of it.

Gessner, F., Hydrobotanik I. Energiehaushalt, Veb. Deutsch Ver. Wissensch., Berlin, 1955, 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

L. The Hester-Dendy Sampler

I. Introduction

The Hester-Dendy is a device used for studying the macroinvertebrate life that inhabits the bottoms of streams and lakes. It is an artificial substrate upon which these macroinvertebrates will attach themselves and grow. 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 students may assemble and use the Hester-Dendy.

II. Materials

1. 9" X 12" X 1/4" hardboard (a hard composition material often used in building). This may be obtained as scrap from a lumber company. The scraps should be 3" wide.

2. 10 square inches of 3/8" hardboard to be cut into 1" squares.

3. 1/4" X 6: eyebolt, wing nut, and two washers, source-hardware store, cost - $0.15.

III. Construction

Cut ~~the 1/4"~~ hardboard into 10 three-inch squares and cut the 3/8" hardboard into 10 one-inch squares. Drill 1/4 inch holes in the center of all the squares. Assemble the sampler by sliding one of the one inch squares onto the eyebolt, and then add one of the three-inch squares. Continue this alternating procedure until you have added 8 more of the one inch squares alternating with 8 of the three inch squares. Then place the tenth 3 inch square on the bolt right after the ninth 3 inch square, thus making a very narrow crack into which some types of microscopic organisms may crawl. Finally, place the tenth one inch square on the bolt, put on a washer, and tighten the plates together with a wing nut.

IV. Use

For any investigation, place all samplers in flowing water or else 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. (If this is not done, 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 or to 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 attempt to show the affects of an effluent on the benthic macroinvertebrates, place samplers upstream and downstream from the point at which the effluent enters. Samplers should be placed on both sides of the stream, and for the 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 three inch square at a time. This will make them easier to count and identify. (This writer 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 would give an indication of the productivity of the water.

Bnethic collections often consist of large amounts of debris. Various procedures may be followed to separate the organisms. This separation may be done by hand picking. It is best done on a white enameled tray using light touch, limnological forcepts. Screening is one of the most practical means of separation. The sample may be dumped on the screens, and then spearated by pouring water over it to wash away the mud and debris. Another method is to place the sample in a bucket or tub and then add water. The mixture is swirled vigorously, and the supernatant is poured through the screen. The residue should be examined for heavier forms which did not float up. A variation of this method is to pour a salt or sugar solution into the bucket. The mixture is stirred well, and the supernatant is poured through the screen (save it for re-use). The denser-than-water solution effects the separation of organisms from the debris. A solution of 2-1/2 lbs. of sugar per gallon of water is considered to be optimum for most samples.

Preservation of samples can be achieved 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.

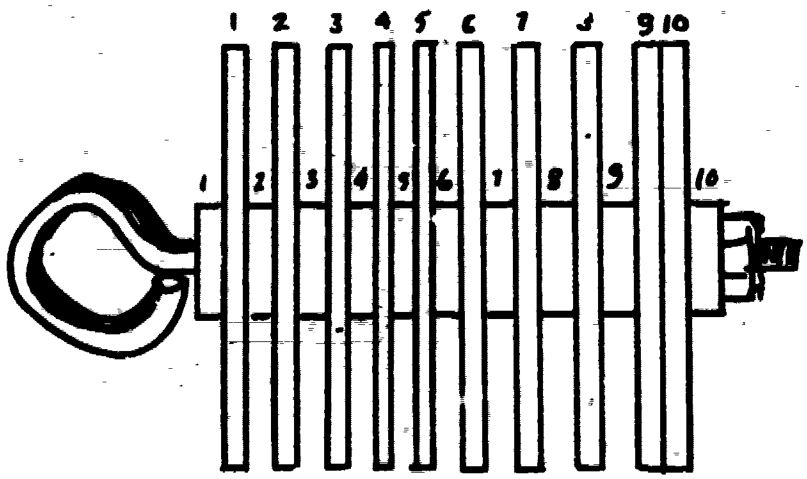
V. Bibliography

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.

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

MacKenthum, Kenneth M., The Practice of Water Pollution Biology, United States Department of the Interior, FWPCA, 1969, Pg. 62-63. This book has a brief reference to its use and briefly discusses its application.

The Hester-Dendy Sampler



M. IDOD Box

I. Introduction

In testing the water quality of a stream, you will want to conduct tests which show the stream's ability to support life. Since the life in any given body of water is intimately tied with the dissolved oxygen, tests for the oxygen uptake of the water should be made. In the Immediate Dissovled Oxygen Demand (IDOD) test one places a sample of water into a dark place and after a standard length of time, tests for the amount of dissolved oxygen in that sample. The test shows the amount of dissolved oxygen taken up by the chemical and/or organic pollutants and other non-photosoythetic constituents in the water sample. This project is simply a box which can be used as a dark locality in which to store the sample for the "dark period" of the test. Basic carpentry skills are all that must be known to make this box. It will cost about $.60 if you have to buy all the wood.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
	Wood-1/2" plywood or pine	4-1/2' X 9" X 1/2"	Lumber yard	$0.25/sq. foot
24	Nails	4 penny box nails	Hardware	$0.25

Tools:

1. Saw

2. Hammer

3. Sandpaper

4. Glue

III. Procedure

Cut the 4-1/2' X 9" X 1/2" in the following manner:

1 piece 9" X 8"; 2 pieces 8" X 8-1/2"
2 pieces 9-1/2" X 8"; 1 piece 10" X 9"

and on the left over piece of wood cut out 2 small (1-1/2" X 1-1/2") squares. Start with the 9: X 8" piece as the bottom. Place along the 9" side one of the 9-1/2" X 8" pieces of wood and thereby leaving a 1/2" overhang on one end and on 8" high box. Glue and nail the 2 boards together. On the other 9" side, attach in similar fasion the other 9-1/2" X 8 board, but leaving the 1/2" overhang on the diagonally opposite corner to the first one. You should be able to place the 2, 8-1/2" X 8" boards on the 8" side of the bottom board to make the box flush on all sides. The height of the box is a constant 8".

The last piece, a 10" X 9" board, is to be used as the top. First mark 4 lines such that they are 9/16" away from all sides of the board. Accurately place the 2, 1-1/2" squares in the 90° angles at the corners. The squares should be in opposite corners. These will prevent the top from sliding off when in use. Nail the squares into place making sure that the nails are less than 1" long. The lid should have some "play" in it, but not much. Finally, cut from a piece of black felt, 2 pieces 8" X 7-1/2"; 1 piece 9" X 7 1/2" and 1 piece 9" X 15-1/2". Secure the 2 pieces of 8" X 7-1/2" piece on one of the longer sides. Attach the last 9" X 15-1/2" piece on the last 9" X 7-1/2" side and thereby leaving an 8" flap which will go over the top of the IDOD bottles. The bottom IS NOT to be covered with felt!

IV. Use

This box is a dark place to put your filled 300 milliliter dissolved oxygen sample bottles when running an IDOD test. To run this test, see the reference in the Bibliography.

V. Limitations

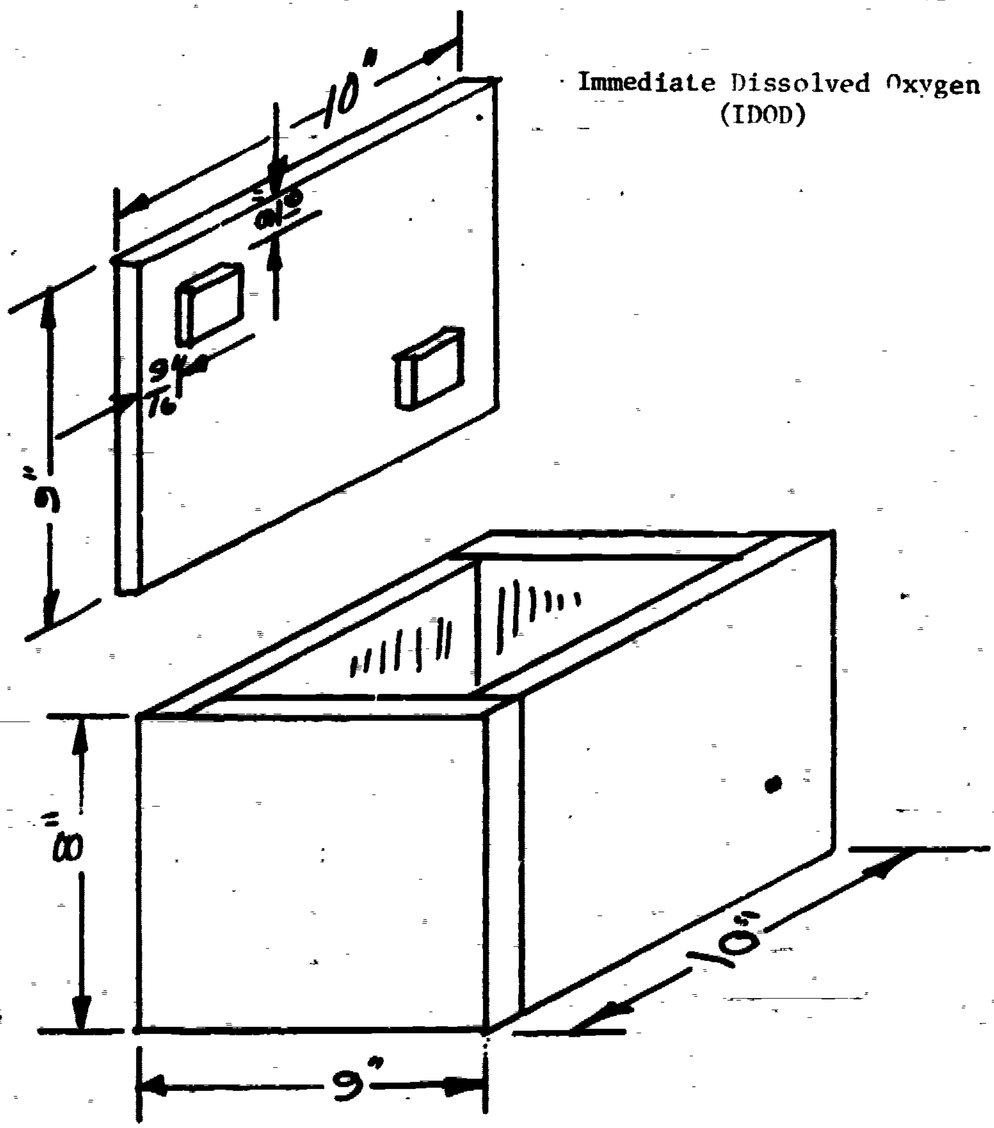
You may want to put padding in your box to keep the bottles from rattling, if you are planning to carry the box.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Envrionmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. This activity-oriented Environmental Guide is the result of cooperative efforts of high school students, teachers, scientists, and technicians.

The activities are divided into four chapters: Hydrologic Cycle, Human Activities, Ecological Perspectives, Social and Political Factors. It has many activities which can be used as examples or as a basis for other activities.

Immediate Dissolved Oxygen Demand (IDOD)



N. Louvered Instrument Shelter

I. Introduction

The louvered instrument 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. It should cost about $20.00.

II. Materials and Tools

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.	Hard.store	$0.65/pr.
4	Louvered shutters	21"x8"x 1"	Lumber yd.	$2.29
12	Screws for hinges		Hard.store	$0.00
1	Hook and eye		Hard.store	$0.05
32	Wood screws	2" long	Hard.store	$0.02

Tools:

Saw

Electric drill and bit to lead the wood screws

Sandpaper

Tools: (Cont'd.)

Screwdriver

Paint and paint brush

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 predrill 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 out 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 begin collecting data on a daily basis.

V. Limitations

One major limitation may be that the shutters are hard to come by. If you happen to know a carpenter or cooperative shop teacher, he may be able to come up with some alternative louvered sides. If not, you could consider small holes in solid sides. But these will not be very rain-proof. A larger over-hang on the roof might remedy that problem.

VI. Bibliography

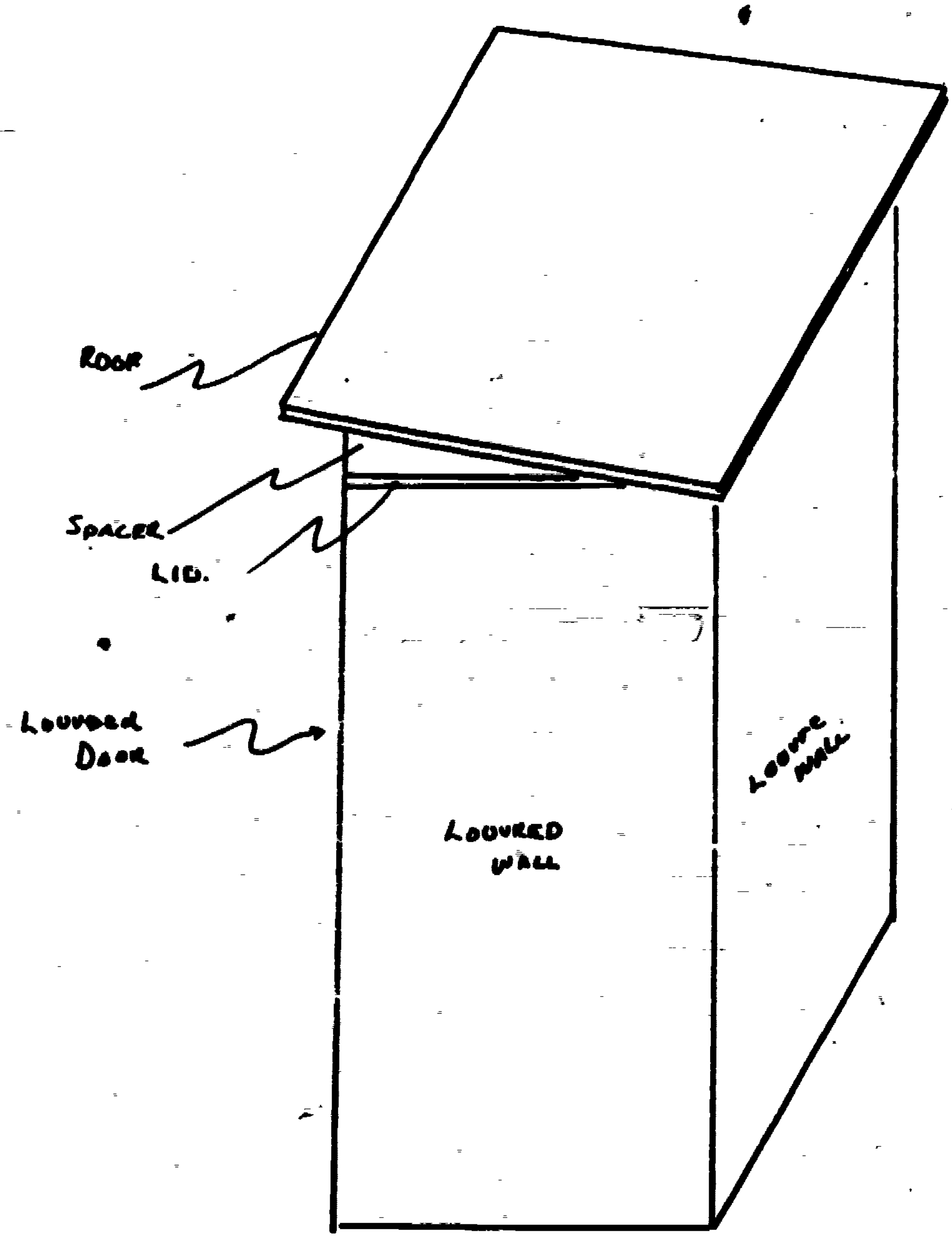
Cleaning Our Environment - The Chemical Basis for Action,

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 by a committee of the American Chemical Society in hopes of boosting the technical awareness of those legislators, adminis-

trators and others who must deal with the environment in some way, but who do not come into direct contact with the pertinent science and technology of the field. The focus is strongly on chemistry, chemical engineering, and the related disciplines. Areas discussed are: the air environment, water environment, solid wastes, and pesticides.

Storin, Diane, Investigating Air, Land, and Water Pollution, Pawnee Publishing Co., Inc., One Pondfield Road, Bronxville, N. Y., 1971. This fairly short field investigation book is quite good as far as it goes. It contains a good air quality investigation section, which instructs students to work with common household materials and common chemistry lab equipment tc study local air quality. Short solid waste and water quality sections are also included. Recommended for high school level.

Louvered Instrument Shelter



O. Mapping Table

I. Introduction

A map, upon which sites and sources of pollution can be located, is a valuable tool for use 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. Being simple to construct makes it available to anyone who needs such a device. The table can be made with or without a tripod stand. Without the stand, the table can be placed upon a trash can (or other suitable object) for use. The cost of the table without stand is around $6.00; with stand it runs about $9.00.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Plywood	2' X 5' X 1/2"	Lumber yd.	$1.50
3	Bolts	3" X 5/16"	Hard.store	$0.10
3	Wing nuts for above bolts		Hard.store	$0.05
2	Washers above bolts		Hard.store	$0.02

Materials: (Cont'd.)

Qty.	Item	Dimensions	Source	Unit Price
3	Dowels	36" X 1"	Hard.store	$0.70
3	Nails, 6 penny		Scrap	$0.00
1	Circular level	1"		$3.20
1 pc.	Pine	2" X 19" X 10"	Lumber yd.	$0.50
2	Square nuts for 5/16" bolt		Hard.store	$0.02
2	Hinges, door	3-1/4"	Hard.store	$1.20

Tools:

Power Saw

Power drill with 5/16", 1/2" and 1" bits

Screwdriver

Hammer

Chisel

Sandpaper

Water proof finish

Paint brush

30^{o} jig made from wood.

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. This leaves a smooth surface on top. The actual table top will be the 24" X 32" piece. On the unfinished side of the top piece (24" X 32") place the lower plate (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, 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 come down upon the lower piece in a flat manner. Next, drill two holes in the 18" X 26" piece such that they are each 6" away from the centerline of the board, and 1-1/2" from the end of the board. These holes should be drilled using a bit slightly smaller than the square nuts. The holes should then be chiseled to half their depth to fit the nuts. 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. Next 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 place a 5/16" X 3" steel bolt into each of the square nuts. Their round heads should have the bad side of the table top, resting on them. Next destroy the threads on the last 1/2" or so and then place the wing nut on the end and screw as tightly upon the banged-up threades as possible. Then bang up the threads on the end of the wing nuts so they cannot come off. These are the levelers for the table, and except for the stand, the table is completed and can be varnished. The construction of the stand needs a 30° jig. This can be made out of scrap wood.

Take the 10" X 10" X2" 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. Drill the holes 1" away from each apex of the triangle. Nail one 6 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 corresponding hole in the block, secure 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 shore line 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 the plumb line or carpenter's level, make sure the table is horizontal. To do this, rotate the table around on the tripod or other base, and also change the angle of the top by screwing the two adjustor screws in or out. By simply performing those two steps, the table should be able to be leveled, almost anywhere.

(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 inches from point A on the sketched base line. This would give a scale of "1 inch equals 10 feet."

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

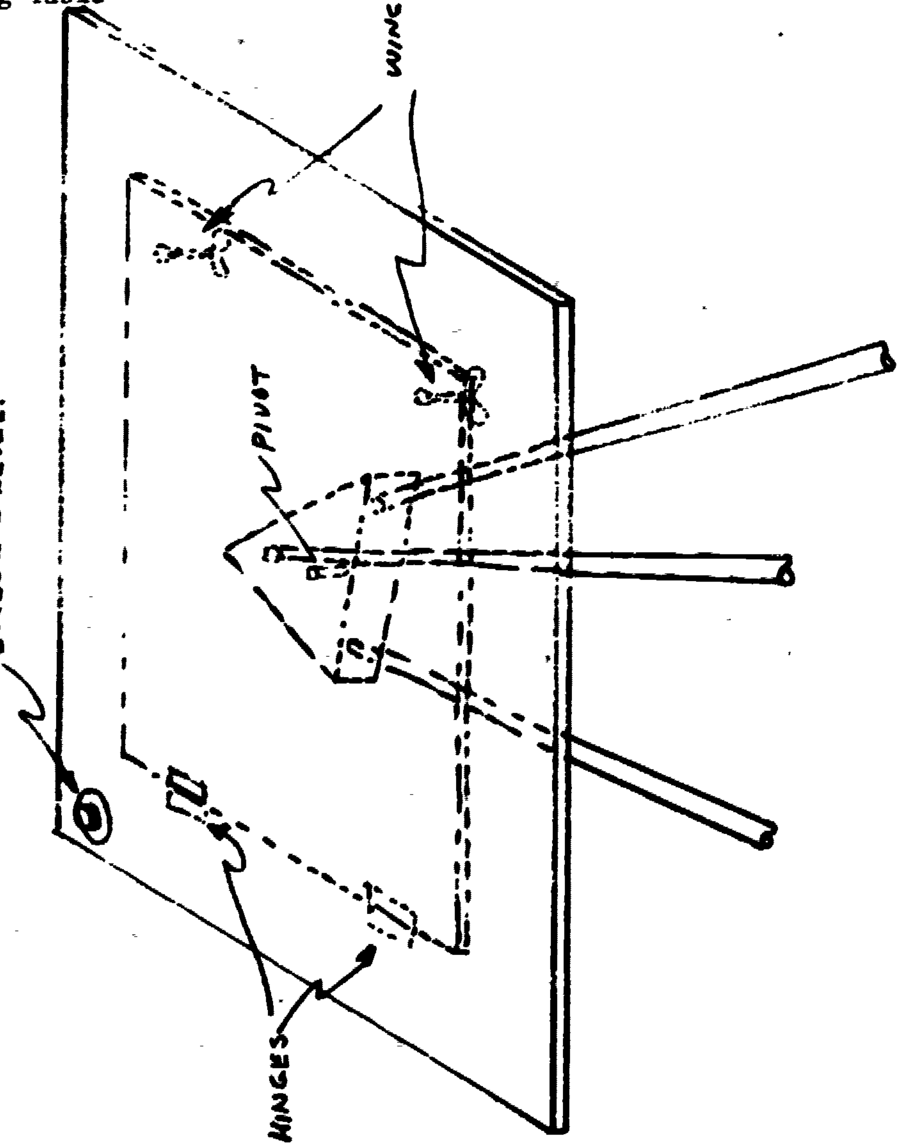
V. Problems

In really rough terrain, it may take a little more adjusting and/or arranging of the table to get it level than is discussed in step 3. This is a good place for on the spot improvising.

VI. Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Environmental Educaiton, 8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. This activity-oriented Environmental Guide is the result of cooperative efforts of high school students, teachers, scientists, and technicians. The activities are divided into four chapters: Hydrologic Cycle, Human Activities, Ecological Perspectives, and Social and Political Factors. It has many activities which can be used as examples or as a basis for other activities.

Phillips, E. A., Field Ecology, D. C. Heath Co., Boston, Mass., 1964. An excellent introductory book to ecology and field biology. Suited for high school and college students.


WING NUTS
PIVOT
BULL'S EYE LEVEL
HINGES

P. Flat-bottomed Dip Net

I. Introduction

A long-handled net like the one described here, is an important tool in almost any aquatic investigation. It can be used for catching minnows and small fish, as well as macroinvertebrates. Because of its flat bottom, it is 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 the macroinvertebrate population by placing it right on the bottom, and kicking up the bottom upstream from the net. In this way the macros will be washed downstream, and lodge in 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 and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Broomstick	Diam. 1 inch	Hard.store	$0.50
1	Piece aluminum flatstock	3/16" X 1" X 48"	"	$2.69 for 6 ft.
1	Hose clamp	Diam. approx.2"	"	$0.29
3	Bolts	1/4" X 2"	"	$0.02
3	Nuts for above bolts		"	$0.01

Qty.	Item	Dimensions	Source	Price
6	Washers for above bolts		Hard.store	$0.01
1	Piece tent poplin	24" X 45"	Fabric store	$1.29/yd.
1	Piece mosquito netting	30" X 36"	Fabric store	$0.69/yd.
	Nylon thread			

Tools:

Metal working (or other sturdy) vice

Hacksaw

Flat second grade file

Electric hand drill with 1/4 inch bit

2-"C" clamps, at least 3 inch

Large screw driver (1/2")

Medium screw driver (1/4")

Hammer

Pliers

Large fabric scissors

Yard stick

Pins

Sewing machine

Large needle

Awl

Thimble

Nylon thread

III Construction Procedure

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

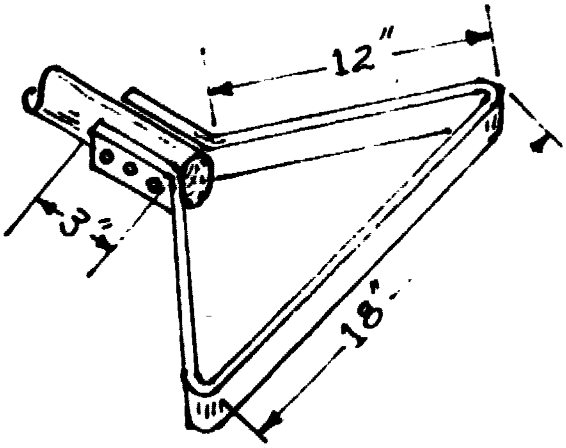


Figure 1. Net Frame

Clamp the net frame to the broomstick handle and drill a 1/4 inch hole through the center of the 3" strips and the broomstick. Secure 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: First cut the poplin into two pieces, 12 inches by 45 inches. These pieces will be layed on top of each other, and fastened to the frame. The net itself will be fastened to the poplin. Line the pieces up on top of each other, and fold them in half, width-wise, making a four layer 6 inch by 45 inch strip.

Sew a double seam along the entire length of the 4 layers, 2 inches from the fold. Once this is done, the poplin should have a 2 inch wide tube running down one edge, and the remaining 4 inches 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 inches on one side, and 21 on the other. Next measure in 3 inches from a 20 inch side and mark this point on both the 21 inch sides.

The netting should be cut on each side, from this point 3 inches in on the 21 inch sides, to the mid-point of the far 20 inch side. In other words, the final product should be a rectangle, 20 inches by 3 inches, with a triangle with a base of 20 inches and a height of 18 inches tacked onto it. Cut two more pieces of netting. These should both be triangles with bases of 14 inches and heights of 18 inches, with rectangles 14 inches by 3 inches 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 three inch base rectangles are placed between the layers of poplin, with two on each side. Then all four layers of poplin are sewed several times, anchoring the netting in the poplin. Now, the net should be put on the frame. Slide the frame through the 2 inch 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, the ends of the poplin must be sewed by hand.

IV. Use

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

V. Problem

The major weak spots of any net are at the joint between the frame and the handle, and at the covering of the frame, where most of the wear and tear takes place. 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, 1971, Pg. A1-133, A1-134. This reference discusses the use of this type of net for collecting benthic organisms (macroinvertebrates).

Q. Plankton Net

I. Introduction

The plankton net is one of those musts for any aquatic biology investigation. It is designed to filter the larger planktonic (free-floating, microscopic) life forms out of the water. It is towed or pulled 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 extensive rinsing of the outside of the net. It can be used for quantitative studies, if a calculation of the amount of water that passes through is made.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1	Piece ¼" copper tubing	¼" X 27¼	Plumbing supply store	$0.30/ft.
1	Piece fine netting or light cloth (see text)	28" x 18"	Fabric store	$0.25
3	Grommets	¼" I.D.	Hardware store	$0.01
1	Piece nylon cord	1/8" X 36"	" "	$0.05/ft.
1	Very small funnel		" "	$0.25
1	Piece thin rubber tubing	3" long	Scrap	$0.00
1	Clothespin (spring type)		Scrap	$0.00

Qty.	Item	Dimensions	Source	Price
1	Large fishing swivel		Scrap	$0.00
1	Small stoppered vials or baby food jars		Scrap	$0.00
1	Piece tent poplin or canvas	28" X 6:	Fabric store	$1.19/yd.

Tools:

Sturdy vice

Hammer

Hacksaw

First grade flat file

Large fabric scissors

Sewing machine

Pins

Yard stick (tape measure)

Epoxy or plastic cement

Grommet tool

Nylon thread

III. Construction Procedure

Begin by bending the 27¼ inch 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 inch from the fold. Now cut the netting to make a cone about

18 inches deep. This should then be sewn 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 on to the hoop. The rest of the seam must now be sewed, including the ends of the hoop cover. If desired, the ends of the tubing can be soldered together, before the cover is sewed. At the tip of the net, cut an opening slightly smaller than the mouth of the funnel. Epoxy the funnel into this opening, pointing out (away) from the hoop. The piece of tubing should be thin-walled and flexible. Stretch it over the end of the funnel, and fasten it there, if necessary. Seal off the tube with the clothespin.

Fasten the 3 grommets in the cover, just behind the hoop, equally spaced around it. Cut the cord into one foot lengths, and tie one 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

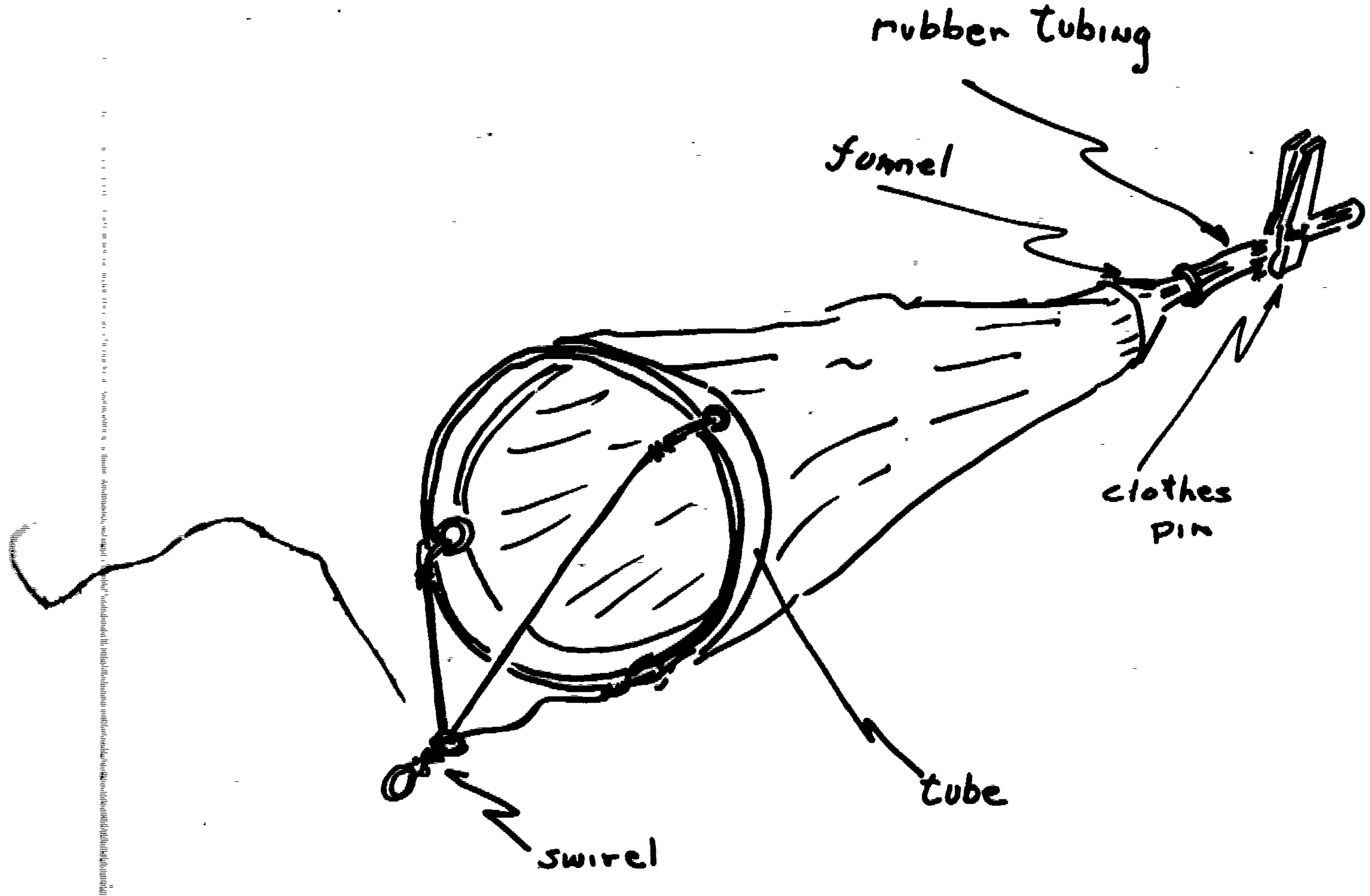
Fasten a tow line to the net, and pull it through the water. If you desire quantitative results, make note of how far the net is being towed. This can be done by towing at a given speed for a given time and then calculating: distance = speed X time.

To remove the plankton from the net, rinse down the sides of the net thoroughly from the outside. This can be done by splashing water onto it. As you 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 down the net, and tipping the funnel, thereby concentrating the plankton on the net right around the funnel. When you finally reach the very bottom of the net, rinse it thoroughly, splashing the water through the net and into the funnel, collecting the plankton there. This last bit of water containing most of the plankton from the net, 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. It is: .04 square meters.

V. Problems

To begin with, plankton nets of any kind can only filter out a certain percentage of the plankton present. This is because many are too small to be caught in a net. Just how many this is depends on where you sample. Obviously, the method of calculating volume of flow through the net is not very accurate. 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 water from passing through freely. The "standard" Plankton net uses a no. 0 mesh, which has 34 meshes to the inch. A fine net uses no. 12 cloth, and has 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 34 mesh type. Buy scraps of light cloth from fabric stores, and check them out for mesh size and thickness.

Plankton Net



R. Stationary Plankton Net

I. Introduction

The stationary plankton net is really not a net at all. It is more correctly a sieve. But it serves the prupose of a plankton net, and so it is called one. The concept is that a water sample is poured through this "net with legs", and the larger planktonic life forms are filtered out on a small piece of fine netting. Most plankton nets are designed to be towed through the water, collecting plankton as the water passes through them. But very often it is not possible or practical to tow the net either because no boat is available, or because the body of water is not suitable. The stationary net is designed to be used at these times. The net is not put in the water at all, but instead is set on the bank and the water is brought to it in a bucket. Using this net has the added advantage of allowing accurate measurement of just how much water has passed through the net.

II. Materials and Tools

Materials:

Qty.	Materials	Dimensions	Source	Unit Price
1	Large plastic funnel	8" across the top	Automotive supply co.	$0.69
1	Piece aluminum flat-stock	3/16" X 1" X 72"	Hardware store	$2.69

Qty.	Materials	Dimensions	Source	Price
1	Hose clamp	Diameter about 2"	Hardware store	$0.25
6	Bolts	1/4" X 3/4"	"	$0.01
6	Nuts for above bolts		"	$0.01
1	Scrap light, fine mesh ployester fabric	2" X 2"	Fabric store	$0.10
1	Small plastic cup or tube	1 to 2" Diameter 1" long	Scrap	$0.00

Tools:

Sturdy vice

Hammer

Hacksaw

Second grade flat file

Electric hand drill or drill press with 1/4" and 1/8" bits

1/4" screwdriver

Pliers

Knife

Scissors

Plastic cement

Yardstick

III. Construction Installation

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 seven inch lengths of the aluminum. At a point 3 inches from one end of each leg (or four inches from the other end), make a groove straight across the piece, 1/16 of an inch deepwith a hacksaw. Then make a bend at this groove such that the leg forms an angle of 315 degrees. With the hacksaw cut on the <u>inside</u> of the angle. Next, drill two 1/4 inch holes in the three inch 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 degrees apart around the funnel, thus making the legs equidistant from each other (see diagram).

The only other thing that must be done is the mounting of the small net below the mouth of the funnel. The procedure for this will depend largely upon the exact dimensions of your funnel and of your tube or cup. If your funnel is similar to the one used in the prototype, and if 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.

IV. Use

The stationary plankton net can be conveniently nested inside a bucket when not being used. When it is used it is lifted out, set on the ground, and a precise volume of water is poured through it 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 fully passed through the net, loosen the hose clamp, and remove the net cup. Carefully rinse, with a wash bottle, into a small container. This process will remove almost all the plankton caught in the net. This rinse water can then be microscopically examined for numbers or types of plankton.

V. Problems

If the netting is too thick, or dense, water may not pass through freely. If this occurs, a lighter material must be obtained. One possible material to use as a last resort is nylon stocking. It is not ideal because its meshes are larger, but it may be suitable.

VI. Bibliography

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

Needham, J. G., and Needham, P. R., A Guide to the Study of Fresh-Water Biology, Holden-Day, Inc., San Francisco. A good field reference book.

Fresh Water Algae of the United States, Albert Smith, 2nd Edition, McGraw Hill Book Company, New York, 1950. A very good, all-around reference, with key, as well as technique discussion.

S. Rain Gauge

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 quite naturally into one important aspect of the hydrologic cycle, rain. A study of a stream and its watershed must necessarily include data on the amount and frequency of rainfall. The rain gauge is the elementary, yet all-too-important piece of equipment for this kind of study.

This rain gauge is simple, fun to make and should be accurate if carefully made. Sixth graders could handle the construction, probably with some assistance in cutting the bottle. They will certainly be able to take daily readings from it. The gauge should cost no more than about 50 cents.

II. Materials

Qty.	Item and Dimensions	Source	Unit Price
1	Bottle, see text	Glass Re-cycling Ctr.	$0.00
1 pc.	3/4" plywood or pine or anything 8" X 30"	Lumber yd. or scrap	$0.50
8	4 penny box nails	Scrap	$0.00

III. Tools

Saw (a power saw would be best)

Hammer

Sandpaper - coarse and fine

Glue

Small triangular file

Jigsaw or sabre saw

Bottle cutter

Electric drill and large (about 1-1/4") bit

Graduated cylinder

IV. Procedure

The first thing to do is to get a bottle. This bottle will have its bottom cut off and will be inverted to catch rain. 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 mesurable amount of the gauge. Look for a clear bottle about quart size that tapers to a fairly thin neck. A quart sized soft drink bottle is suitable. 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 it. Be careful, this is tricky business. See that your bottle has a cap, or is well-sealed otherwise. Now make the stand for your rain gauge. The dimensions given are designed around a common size of quart soft drink bottle. You may have to alter a little to fit your bottle.

If you don't have a power saw, try to get a lumber yard or a friend to cut the piece of wood to 8" X 30" From there it's only 3 cuts with a hand saw and one (circular) cut with the jig saw. Cut the wood into pieces, two 8" X 9:, one 7" X 9" and the leftover is a 1" X 9" piece - save it, you'll use all of it.

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, we'll use that, too. One of the 8" X 9"'s 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:'s toge^her with glue and the 4 penny nails so that they form a right angle joint with the 8" edge of the bottom piece, meeting and 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 (the 8" X 7") directly above the bottom piece onto the back piece, forming another corner just like the one between back and base. This piece should be centered against the back piece, leaving a 1/2" space on either side. The 1 inch 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 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 gauge. Rain is measured in linear inches. That is, an inch of rain is that amount that must fall to fill any straight walled, flat-bottomed container to a depth of one inch. Since our collector is only straight walled at the top, and that is the way we want it, one inch of rain will be more than a height of one inch in the neck. Therefore, calculate the volume of water that would fill a container having the same opening as this one, but that was straight walled, to a depth of one inch. To do this calculate the area of the opening, using metric measurements, and multiply this by the metric equivalent of one inch. The resultant will be the metric volume of water that will be in the collector when one inch 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 one inch volume. These marks indicate tenths of inches. Inches and tenths of inches should be the only markings you need.

V. Use

Place the Rain Gauge in an open area away from trees or buildings, or on a roof top. Take readings of the amount of precipitation daily.

VI. Problems

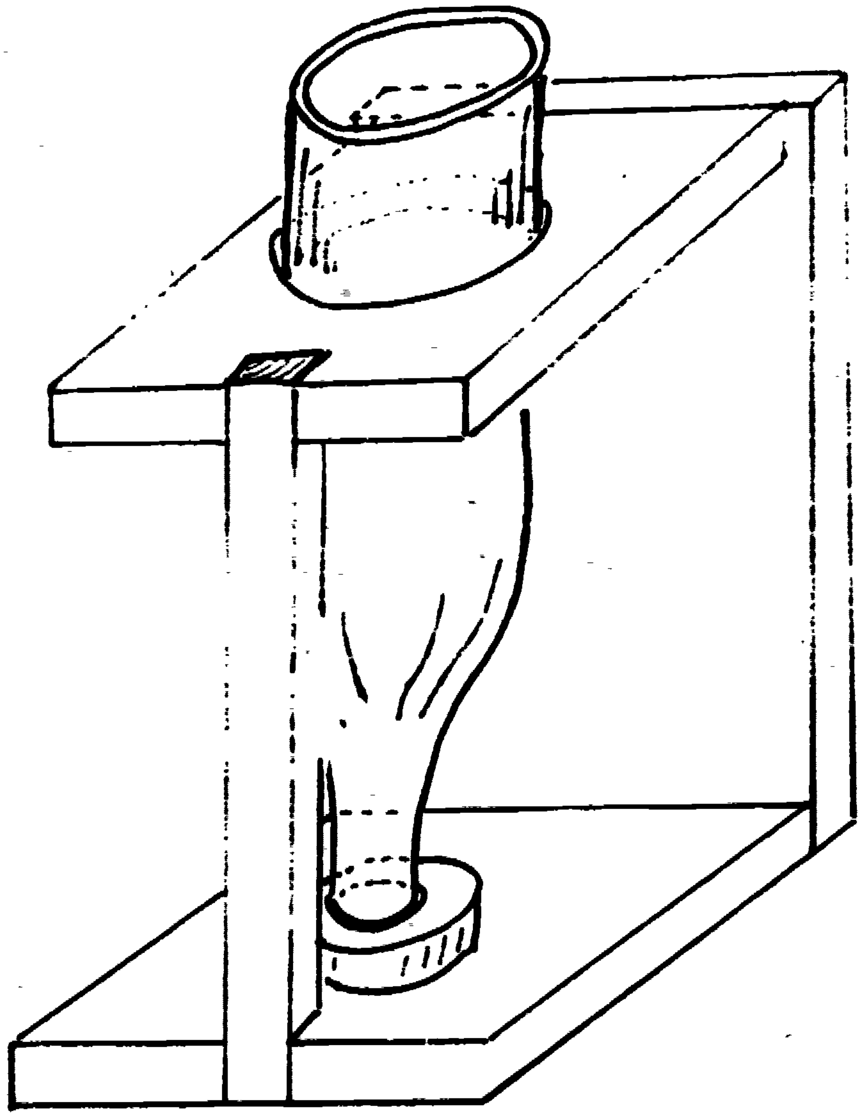
The primary limitation of this project is the accuracy of the calibration. A careful job of doing this will lead to a very successful rain gauge.

VII. Bibliography

Odum, Eugene P., Ecology, W., B. Saunders Co., Philadelphia, Pa., 1971. Contains a discussion of the importance of rain fall in the environment.

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

A Rain Gauge



T. Secchi Disk

I. Introduction

The Secchi disk is used to measure turbidity. Turbidity can be caused by various inputs, 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. The major material is a fifty foot line that can be used for other pieces of equipment. It can be made by anyone and is simple to use.

II. Material and Tools

Materials:

Qty.	Item	Dimensions	Source	Cost
1	Nylon Line	1/4" X 50'	Hardware st.	$0.05/ft.
1	Beaver Board	20 cm X 20 cm	Scrap	$0.00
1	Eye Bolt	1/4" X 2"	Hardware st.	$0.05
2	Washers	For above bolt	Hardware st.	$0.01
1	Wing nut	For above bolt	Hardware st.	$0.02
1	Pipe	1" X 6"	Scrap	$0.00
1	Enamel	Black (Pint)	Hardware st	$0.75
1	Enamel	White (Pint)	Hardware st.	$0.75

Tools:

Power saw

Power drill

Placement clamp

Screwdriver

Paint brush

Masking tape

Indelible marking pen

1/4" drill bit

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 a disk with a different dimension than another 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. Then using the masking tape, edge the lines of 2 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 onto 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

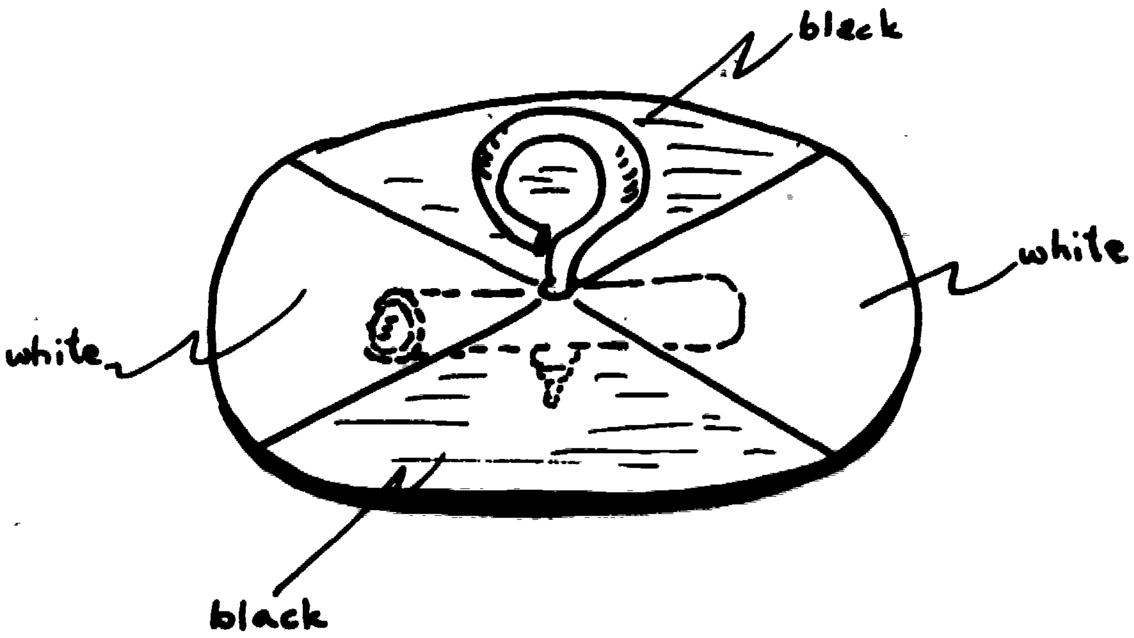
The range of the Secchi disk goes from a few centimeters to over 40 meters. To record the readings of any one site first lower the disk and record depth of disappearance. Then lower the disk below the recorded point and then slowly raise it. Record the depth at which the disk first becomes visible. Average the 2 readings for the final measurement.

V. Problems:

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

VI Bibliography

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



U. Hand Seine

I. Introduction

The hand seine is the basic tool for sampling the nekton populations in streams and ponds. The nekton are defined as the macroscopic free-swimming organisms. 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 their states. In Pennsylvania for instance, a permit is required for use of <u>any</u> seine larger than four feet square. This seine is just that size.

This seine can be made by anyone with almost no tools, and can be used by anyone. However, the success in catching organisms will be determined by the amount of skill and practice involved. This seine should not cost over $4.00.

II. Materials and Tools

Materials:

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

Tools:

Hnad saw

Knife

Electric hand drill with 1/4" bit

III. Procedure

Cut the broomstick to five foot lengths. Drill 2, 1/4" holes through each pole, one, an inch from one end, and another one in each pole, four feet above the first. These holes will be used to fasten the netting securely to the poles. The top edge of the seine (the float line) will be attached to the poles by the holes 11 inches from one end. And 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 kind of net for catching small fish. Move slowly, sudden movements of yourself or the net may frighten your prey. Try to herd the fish up against the bank or into a corner. 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 probably should check your state fish and game ordinances to find out what laws might 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, Second Edition, Volume II, Institute for Environmental Education, 1971, p. A1-145, 146. A brief discussion of basic nekton collection techniques.

V. Separating Sieves

I. Introduction

A set of separation sieves is used for separating particles of different sizes. In particular, sieves are used to divide samples of soil or sediment into several different sizes. 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 when studying the composition of stream sediments or of soils. This set of sieves has a large range of mesh sizes, but not too many gradations within the range. This is because it is difficult to find screening of many different types locally. Therefore, this set of separation sieves will give 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. The set should not cost more than $3.60.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
1 pc.	Hardware cloth 1/8" mesh	7" X 7"	Hard. store	$0.33/ft.^{2}

Qty.	Item	Dimensions	Source	Price
1 pc.	Hardware cloth	1/4" mesh 7" X 7"	Hard. st.	$0.35/ft.^2$
1 pc.	Hardware cloth	1/2" mesh 7" X 7"	"	$0.35/ft.^2$
2	3/4" Dowels	3/4" X 36"	"	$0.30
1 pc.	1/2" plywood	12-1/2" X 48"	Lumber yd.	$0.25/ft.^2$
48	4 penny box nails		Hard. st.	$0.25
2 pc.	1/2" plywood	12" X 12"	Lumber yd.	$0.25
48	Small staples		Hard. st.	$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 4 sieves so that they can sit on top of each other and be 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" out 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 16 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 of each of the hardware cloths, and of 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 having 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. These 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 problem with this set of sieves is that the range of sizes has so few gradations, and that there are no sizes below 1/16" where many of the particles will fall.

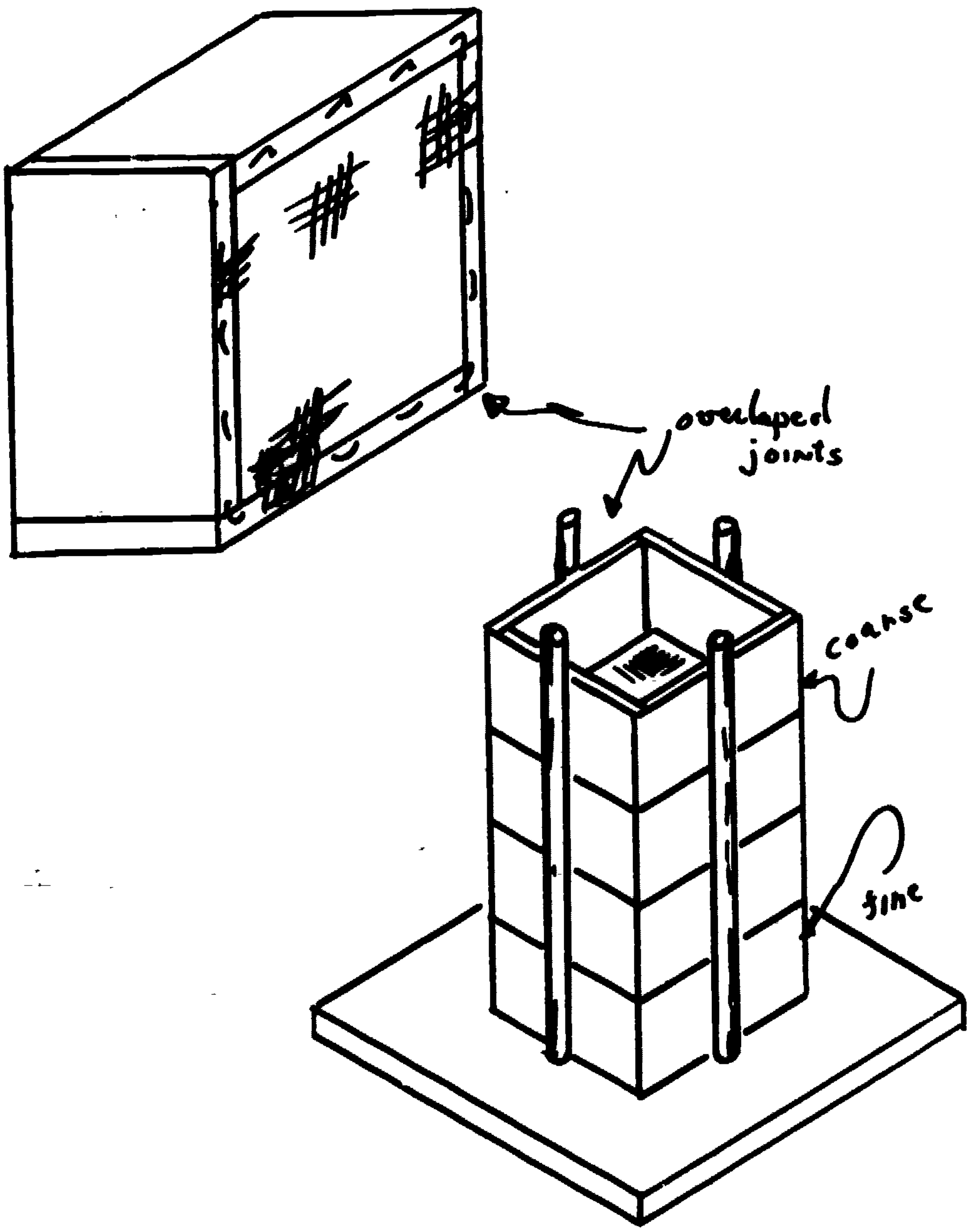
VI. Bibliography

Managing Our Environment, A Report On Ways Agricultural Research Fights Pollution, U. S. Dept. of Agriculture, Superintendent of Documents, Government Printing Office, Washington, D. C. 20402, April 1971. Excellent background source. Covers problems of sediment, animal wastes, plant nutrients, sewage, pesticides, plant residues, recyc. ing, erosion, control methods. Good for grades 5 and up.

Proceedings of the National Conference on Sediment Control. U. S. Department of Housing and Urban Development, Washington, D. C. 20410, May 1970, Presents a collection of papers on the problem of sediment and erosion. Provides a wealth of valuable information. Readable by students from grade 6 upward.

Science and Improving Our Environment, How Agricultural Research Prevents Pollution, U. S. Dept. of Agriculture, Superintendent of Documents, U. S. 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



W. 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 clear 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 well 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 female student who sews, would probably be glad to help you make the net part of this sampler.

II. Materials and Tools

Materials:

Qty.	Item	Dimensions	Source	Unit Price
9 ft.	Aluminum flat stock	1"X 3/16"X 96"	Hard. st.	$2.99
8	Right angle corner braces	3/4" wide	"	$0.10
32	Aluminum bolts	1/4" X 1/2"	"	

Materials: (Cont'd.)

Qty.	Item	Dimensions	Source	Unit Price
32	Aluminum nuts for above bolts		Hard. st.	$0.01
2	Aluminum bolts	1/4" X 1"	"	$0.04
4	Nuts for above bolts		"	$0.02
2	Brass hinges,overall open width not more than 2"		"	$0.80/pr.
12	Brass nuts and bolts for hinges		"	$0.05
1	Small can with plastic top	3" diam. X 5"	Scrap	$0.00
1	Hose clamp	3" diameter	Hard. st.	$0.40
1 pc.	Fiberglass Window screening	26" X 104"	Hard. st.	$0.14/ft.^{2}
1 pc	Heavy canvas	50" X 8"	Fabric st.	$1.00/yd
1 pc.	Seam binding	1" wide X 8" long	Fabric st.	$0.50

Tools:

Hacksaw

Second grade flat file

Electric hand drill or drill press with 1/4" and 3/16" bits

Screwdriver

Pliers

Heavy fabric scissors

Sewing machine

Rust proofing paint, paint brush

III. Procedure

Begin by cutting eight one-foot lengths of the aluminum, and one ten-inch piece. The eight one-foot pieces will be bolted together to form two squares, each one foot square. One of these squares will sit on the bottom, the other will be mounted at right angles to the first, and will 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. Other right angle 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 ten-inch 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 five inches 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 and 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 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.

Now it's time to make the net. Cut four pieces of 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, tacked on to 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 it 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 like you did the second. And finally the fourth side should be added. Now, 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 will be fit inside the tube by sliding the tube around the frame. But first, sew the net securely between the two extra flaps of canvas. Do this by plading 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 four foot 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, and 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. Cut the bottom out of it and stick it into the opening in the end of the net, and fasten it there with the hose clamp. Now cut small holes in the canvas and put the hinges and brace back on this upper frame.

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 position. Then set it in a stream in a rift, or riffle. 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, by hand to dislodge all benthic organisms. The current should then carry them into the net. A stiff vegetable brush is often useful, especially if the bottom materials are covered with moss. When bottom materials are picked which are free from macroinvertebrates, the sampling is finished. Before removing the sampler from the water, the bottom should be "fanned" with the hand to kick up any macroinvertebrates which may have fallen straight down rather than being carried into the net. Now 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 the can fills with water, tip it and pour the water out of it through the net. Then, wash the organisms back into it. When you think that 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. Finally, 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. However, because of the durability, ease of handling, and economy of the window screening, the authors feel that the loss of organisms through this netting is outweighed by its positive attributes. However, you may want to use a smaller netting if you are concerned with very high levels of quantification.

VI. Bibliography

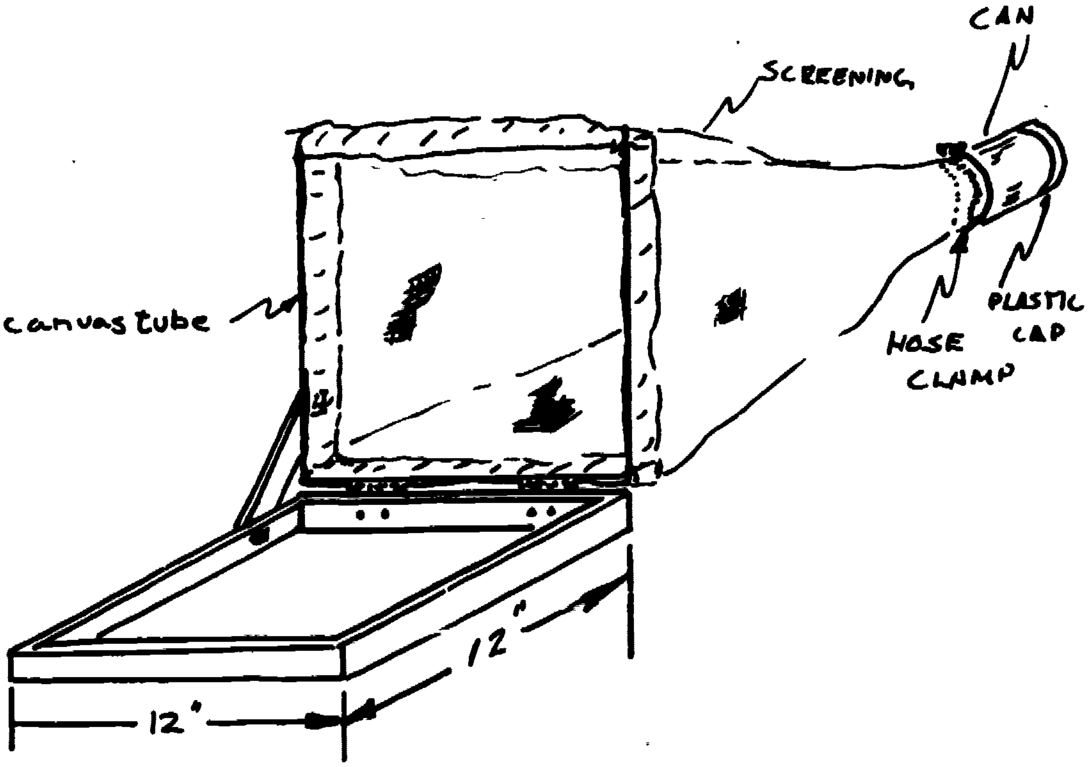
A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, 1970. This activity-oriented environmental guide is the result of cooperative efforts of high school students, teachers, scientists, and technicians. The activities are divided into four chapters: Hydrologic Cycle, Human Activities, Ecological Perspectives and Social and Political Factors. It has many activities which can be used as examples or as a basis for other activities.

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 Ed., APHA, AWWA, WPCF, American Public Health Association, 1740 Broadway, New York, N. Y. This reference discusses the Surber and other macroinvertebrates sampling devices.

Chapter 1 Draft

The Surber Square Foot Sampler



CHAPTER 2

Chapter 2 Water Quality Kits Draft

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 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 relaible as an indicacion 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 include physical, chemical, macrobiological and microbiological factors. This chapter groups the water quality tests into the above mentioned categories.

The chapter discusses three water 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 system or intermediate

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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.

level is designed for use by students in about the eighth or ninth grades. The third or advanced system may be used by students from grade nine upward. The kits vary not only in the quality of results which may be obtained, but in the diversity 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 One, complete with detailed construction instructions. Any test or method not discussed in Chapter One can be found described, or its reference given in Vol. II of A Curriculum Activities Guide to Water Pollution and Environmental Studies (the Guide). Anyone interested in implementing any of the plans discussed here, is urged to adapt them to his own needs and interests.

II. Basic Kit

The basic kit investigates three of the four main water quality parameters. The first parameter deals with the physical aspects of the body of water. Measurements of volumetric flow can be obtained by using a float, some rope, a meterstick and a watch. An in-depth discussion of the procedures involved can be found in Volume II, A Curriculum Activities Guide to Water Pollution and Environmental Studies. Another facet of the physical nature of water quality deals with the temperature of the water. This is a simple, yet vital test, which can be done using a thermometer. A reading of the air temperature should also be taken at each testing site.

The second parameter to be covered is the chemical content of the water. Three important yet simple chemical tests are dissolved oxygen (DO), pH and total phosphates. The DO, the amount of dissolved oxygen present, gives an indication of the ability of the stream to support life. The pH value indicates the hydrogen ion activity. The total phosphate test is useful in showing the amount of this nutrient in the water. For further references about these tests, see Vol. II of the Guide. These tests can either 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. In this section, a hand dip net is recommended to gather the aquatic organisms. With the nets, students are able to collect samples of the macroinvertebrate life as well as some fish. 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 areas, - physical, macrobiological and chemical - can be either 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 safely secured. The chemical tests contain some potentially harmful materials so it is imperative that a safe place be made for them.

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

III. Intermediate Kit

The Intermediate Kit covers the 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 commercial 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 to test for the basic life quality factors.

The biological testing, as in the Basic Kit, is concerned with collection of certain types of organisms in the water, so that they may be analyzed and interpreted. A long handled dip net (Ch. 1 - P), and a Hester-Dendy (Ch. 1 - L), are again recommended. In addition, the Surber sampler (Ch. 1 - W), is a very good piece of equipment, and can easily be handled at this level. The Surber will also allow quantitized data such as biomass, and population densities to be taken, something the dip net cannot do. At this level the plankton, or microscopic, free floating life, can also be studied quite easily. All that will be needed to do this is a plankton net (Ch. 1 - Q), and a microscope with slides and cover slips. With this equipment, such measurements as the 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, and the one not covered in the basic system, is the microbiological. It is concerned with finding the types and numbers of bacteria present in a body of water. For the Intermediate level, a test for the total coliform bacteria present is recommended. This test is relatively simple, is an excellent introduction to microbiological studies, and teaches "sterile technique" safely and effectively. This test is the standard bacteriological test for water quality, and used to set Public Health standards. The equipment and supplies needed for this test can be obtained from the Millipore Corporation. The initial cost 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 which 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 doing the total coliform test are given in Volume II of the Guide.

When taking the Intermediate system into the field, it is a good idea to have everything well-packaged. Cardboard boxes have an amazing ability to dissolve when wet, and good sturdy, permanent boxes not only protect, but they help to keep things organized. As mentioned earlier, a box for each major parameter is a good idea. Everything should probably not be in one kit, because it will be big, and it will cause confusion when 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. For this reason 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 (Chapter 1). With the flow meter and the "standard" flow procedure, comparisons of the results can be made and the best system determined.

The chemistry section should be a commercial test kit, plus several more precise tests, and equipment for different ways of testing. To be specific, a sophisticated kit is recommended. In addition, the special bottles (300 milliliter glass stoppered), burettes, and chemicals for performing the Winkler

Azide method for the determination of dissolved oxygen, are important. The Winkler method is a standard, highly accurate, and it aids in teaching titration methods. It is discussed in Vol. II of the Guide. In addition, a box for carrying the chemicals and sample bottles for this test is described in Chapter 1. The Secchi Disc for the determination of turbidity, is another useful piece. It again is a standard method and an accurate yet simple one. It is also discussed in Chapter 1. A deep water sample is often needed at this level of testing. It is used in any lake or pond study to check for variations in water quality (physical, biological, chemical) at varying depths. Another test that can be done at this level, is the determination of immediate dissolved oxygen demand (IDOD) which gives more information about the oxygen demand characteristics of water than just the dissolved oxygen test.

The biological section 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 or large net if the law permits. They can be measured on a fish measuring board. The macroinvertebrates can be sampled with: a dip net, a Hester-Dendy, a Surber, a dredge, and a corer, all of which are described in Chapter 1. The microscopic life can be sampled with plankton nets and with benthic algae substrates. These substrates are for studying the benthic,or bottom dwelling algae.

The microbiological tests in the Advanced Kit should go one step further than the Intermediate Testing Kit by sampling for fecal coliform, fecal streptococci and total bacteria. Pieces of equipment needed would be a constant temperature water bath for the fecal colony counts and a good incubator for the 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 the fedal coliform count to the fecal strep count is used as an indicator of the kind of organism the waste came from. For example, when the ratio exceeds "4" the polluting organism is probably man. The total bacteria test gives a diversity reading on the types of organisms present. For further information concerning the nature and procedural aspects of the tests, see Vol. II of the Guide.

The advanced section would probably best be separated into kits. Each kit could contain one of the four main parameters of testing. By using this method, the students could work in groups and eliminate the need for one, overly-large kit. The Advanced Kit should by no means be taken to be the peak of water testing equipment. Rather it should serve as a sounding board from which the students could go on with further studies in the field.

For example, if an individual wished to do a study on thermal pollution, he needn't carry all the advanced equipment around with him. Instead he might want to place just certain pieces of testing equipment in a pack he could carry on his back.

For more sophisticated or longer range studies, some of the heavier equipment might be placed in a trailer which could then be easily towed to the site.

In conclusion, water testing kits should be made to fit the job requirements. This does not mean that one needs the Advanced Kit for every water testing site. On the contrary, once the students are familiar with the techniques, they should make the decision whether or not they need certain pieces of equipment. They could over-stock their testing kits for what they wished to do.

V. Bibliography

1. Physical parameter test references:

A Curriculum Activities Guide to Water Pollution and Envi -

ronmental Studies, 2nd Edition, Institute for Environmental Education, 1971, Cleveland, Ohio, Vol. II, pp. A1-196 to A1-200. This section gives a detailed account of the timed float-flow determination method.

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

2. Chemical parameter test references:

A Curriculum Activities Guide to Water Pollution And Environmental Studies, 2nd Edition, Institute for Environmental Education, 1971, Cleveland,Ohio, Vol. II, Appendix I. The first third of this appendix discusses, in detail the important chemcial tests.

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

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

3. Biological parameters test references:

A Curriculum Activities Guide to Water Pollution and Environmental Studies, 2nd Edition, Institute for Environmental Education, 1971, Cleveland, Ohio, Vol. II, Appendix I.

The last third of this appendix describes important biological tests.

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

4. Microbiological parameter test references:

A Curriculum Activities Guide to Water Pollution and Environmental Studies, 2nd Edition, Institute for Environmental Education, 1971, Cleveland, Ohio, Vol. II, Appendix I. The second third of this appendix gives all the 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. This is the "Bible" for bacteriological identification and culture methods.

Millipore Corporation, Bedford, Ma., 01730. This company has many excellent technical manuals and application procedures relating to aquatic bacteriology.

CHAPTER 3

Running a comprehensive water quality study program t... a great deal of equipment, but fortunately much of it can be obtained locally. This chapter outlines the equipment requirements to run a comprehensive water quality study program. The tables are broken down according to the following topics: measuring devices, scientific equipment, tools, resource materials, supplies, containers, and glass and miscellaneous items.

Each of the tables has columns related to the use of the items mentioned, the abbreviations in the use 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. The chapter references are abbreviated as follows: H for Hydrologic Cycle, EP for Ecological Perspectives, HA for Human Activities and SP for Social and Policital factors.

The third column entitled Age Range refers to the age of student who can make use of 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 be obtained through special sources peculiar to the school system, I.E., local business and industry, community organizations or institutions of higher learning.

Table 3-1, Measuring Devices, lists those things which will be required to make individual measurements. Items which 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 on this list there is 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 types 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. The process of obtaining the various types of maps related to water studies usually leads to the other collateral resource documents.

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 to carry out 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. In Volume II, the chemicals are listed as they appear as ingredients to make up standard solutions and as the standard solutions and reagents. They may be ordered either way by consulting Volume II. The supplies listed in 3-5 should be considered to be back up materials much in the same way that tools are. The exception being that the supplies are expendable.

Table 3-6 lists Containers and Glass. 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 required for collection purposes. Those items used for scientific 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 items that did not easily fit into other categories. However, 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 scope of equipment and materials that will be needed to begin a program. The lists also point out that the carrying out of a program without huge expenditures of money is possible.

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	Hardward store
Light meter	B,P	H,EPHA	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

The codes used in the second third columns are explained on page 148.

Table 3-2 Scientific Equipment

Item	Use	Guide Ref. Chapter	Age Range	Local Source
Aerator	B	EP	7-18	Pet shop
Balance (±0.1gm)	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 samp.	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	-----

Table 3-2 (cont'd.)

Item	Use	Guide Ref. Chapter	Age Range	Local Source
Microscope (HP)	B	EP,HA	10-12	-----
Millipore kit	C	EP,HA	12-18	-----
Movie equipment	B,C,P	SP	10-18	Photography shop
Petersen 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
Winkler set up	C	EP,HA	12-18	-----

The codes used in columns 2 and 3 are explained on page 148.

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	EPHA	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

Table 3-3 (Cont'd.)

Item	Use	Guide Ref. Chapters	Age Range	Local Source
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

The codes in columns 2 and 3 are explained on page 148.

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
Topo maps	B,C,P	H,EP,HA,SP	10-18	Federal Government (Interior)

The codes used in columns 2 and 3 as explained on page 148.

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	Food 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	Hardeare store
Masking tape	B,C,P	H,EP,HA	7-18	Hardware store
Paper towels	B,C,P	H,EP, HA	7-18	Food 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	Food 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

The codes used in columns 2 and 3 are explained on page 148.

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, 1000 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

Table 3-6 (Cont'd.)

Item	Use	Guide Ref. Chapter	Age Range	Local Source
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	-----

The codes used in columns 2 and 3 are explained on page 148.

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 repellant	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

The codes used in columns 2 and 3 are explained on page 148.

CHAPTER 4

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

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

Tables 4-1 and 4-2 list manufacturers and suppliers, respectively. The Field column refers to B for Biology, C for Chemistry, and P for Physics. Dealing directly with manufacturers cuts out the middleman and usually results in good service when required. In the area of kits and associated refills this is an important consideration.

Catalogues may be obtained from each manufacturer and supplier listed. The phone number listed will enable a person with questions to make contact easily. In many cases regional offices are maintained and a sales representative will be glad to visit your operation.

Compare prices of similar stock items since prices do vary from catalogue to catalogue. When purchasing a kit be sure to consider refills and maintenance (batteries, etc.) costs also. Consider the utility of the kits also, 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 susceptability to damage, water and dirt. If a kit can't be kept from so being damaged frequently, 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.

A final recommendation is to get advice of experienced teachers. Experienced teachers often attend meetings or run workshops. They may become known to the reader 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 Company (515) 232-2533	Box 907 Ames, Iowa	C	Kits, reagents
Koslow Scientific Co. (201) 861-2266	7800 River Road North Bergen, N. J. 07047	C	Kits, heavy metals
LaMotte Chemical Products Company (301) 778-3100	Chestertown, Md. 21620	B,C,P	Excellent kits and literature
Millipore Corporation (617) 275-9200	Bedford, Ma. 01730	B,C	Excellent bacteriology equipment & literature
Novo Enzyme Corporation (914) 698-7001	1030 Mamaroneck Av. Mamaroneck, N. Y. 10543	B	Enzyme experiments, kits
Oceanography Unlimited (201) 779-2313	108 Main Stree 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

MANUFACTURER	ADDRESS	FIELD	REMARKS
American Chemical Society (202) 737-3337	1155 16th St., N.W. Washington, D. C. 20036	B,C,P	Lab guide - a catalogue of catalogues
Beckman Instruments, Inc. (714) 871-4848	2500 Harbor Blvd. Fullerton, Cal.	C,P	High quality lab equipment
Carolina Biological Supply Company (919) 584-3771	Burlington, N.C. 27215	B	Specimens, AV Equipment
Central Scientific Co. (312) 277-8300	2600 S. Kostner Av. Chicago, Ill.	B,C,P	Broad line, good service
Damon Corporation (617) 449-0800	115 Fourth Ave. Needham Heights, Ma. 02194	B,C	ESCP, Kits
Eduquip, Inc. (617) 298-0160	1220 Adams Street Boston, Ma. 02129	B,C,P	Supplies from other manufacturers, kits
Fisher Scientific Co. (412) 562-8300	711 Forbes Ave. Pittsburgh, Pa.	B,C,P	Broad line
Forestry Suppliers, Inc. (601) 359-3565	Box 8397 Jackson, Miss	B,C,P	Broad line of outdoor equip.

Table 4-2 (Cont'd.)

MANUFACTURERS	ADDRESS	FIELD	REMARKS
Jewel Industries (312) 622-6622	5005 W.Armitage Av. Chicago, Ill. 60639	I	Aquaria-Terraria
Macalaster Scientific Company (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	Excellent activities
NASCO (414) 563-2446	901 Janesville Ave. Fort Atkinson, Wis. 53538	B,C,P	Broad line
National Wildlife Federation (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, Ma. 02543	B	Marine specimens
Sargeant-Welch Scientific Company (312) 677-0600	7300 North Linder Skokie, Ill 60076	B,C,P	Broad line
Science Kits, Inc. (716) 87 6020	777 E. Park Drive Towanda, N. Y. 14150	B,C,P	Kits

Table 4-2 (Cont'd.)

MANUFACTURERS	ADDRESS	FIELD	REMARKS
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