Chapter 7

Stream and Pond Field Trip

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Introduction

Streams and ponds are important ecosystems that offer good opportunities for comparative studies of biological communities. For streams, comparisons can be made on the basis of stream size, current velocity, degree of pollution, or habitat degradation. For ponds, community differences can be examined in relation to pond size, likelihood of winterkill, presence or absence of fish, and permanency. Aquatic habitats are particularly fascinating to students because many will have had little exposure to aquatic organisms. This is because, unlike terrestrial organisms, aquatic organisms live in an environment that is not readily accessible to us. Thus, sampling aquatic environments requires specialized equipment. This exercise uses equipment commonly used to sample aquatic environments and aquatic organisms. Equipment can be purchased from The Wildco Wildlife Supply Company, 301 Cass St., Saginaw, MI 48602, (517) 799-8100. Commercially-made sampling gear is often expensive but in many cases there are inexpensive home-made alternatives; some examples are given in Appendix A.

A major problem in studying aquatic systems is learning to identify the different groups of aquatic organisms. Although many students have some familiarity with fishes, students are less likely to be familiar with the many types of invertebrates that dominate aquatic environments. To avoid the frustration inherent in identifying unknown organisms, it is better to work at a fairly broad taxonomic level (e.g. identifying organisms to order such as mayflies, stoneflies, amphipods, etc.) and to use statistical approaches that do not require fine-scale identification. Examples of general taxonomic keys are found in Eddy and Hodson (1961), Merritt and Cummins (1984), and Thorp and Covich (1991).

Objectives

1. Measure important habitat features that influence the types of aquatic organisms present.
2. Demonstrate the use of various types of gear to sample the aquatic organisms in a stream and beaver pond complex.
3. Characterize biological communities from different habitats.
4. Use the information collected to understand how abiotic factors influence the types of organisms found in various aquatic habitats.

Materials

Measuring Abiotic Factors

Tape measure
Meter stick
Current meter (or an orange and a stopwatch)
Water sampler (van Dorn sampler or home-made equivalent)
Benthic dredge (or a shovel)

Sampling the Biota

Plankton tow net (or home-made equivalent)
Benthic dredge (or a shovel)
Kick net sampler (commercial or home-made)
Seine
Sorting pans and forceps

Methods

Measuring Abiotic Factors

1. Begin by observing the sites that are going to be sampled and note the general habitat conditions. What type of land-use is apparent that might influence aquatic organisms. Are there any signs of pollution or degradation? What is the condition of the riparian zone?

2. Identify the particular habitats that are going to be sampled. Measure a 20-m section of each habitat type and mark the upstream and downstream boundaries. On each side of the stream measure the length of the stream bank that is eroded (non-vegetated).

3. At 5-m intervals along the study reach place the tape measure across the stream to create a transect. At 10 equally-spaced intervals across the transect measure water depth, current velocity (if a current meter is available), and note the type of substrate present (1 = muck, 2 = sand, 3 = gravel, 4 = cobble, 5 = boulders, 6 = bedrock), and the type of vegetation present (1 = no vegetation, 2 = submerged vegetation, 3 = floating vegetation, 4 = emergent vegetation). Students should also note whether they are in a riffle, run, or pool habitat.

4. If no current meter is available, measure average reach velocity by timing how long it takes an orange to float through the reach.

Sampling the Biota

1. Benthic invertebrates can be quantitatively sampled by taking a kick sample or by using a dredge. Kick samples work best where there is current to wash the dislodged insects downstream into a collecting net. Students can use either a Surber sample or a home-made version consisting of a metal frame placed in front of an aquarium net. Stir up the sediments within the sampling area and collect the invertebrates in the net. A dredge sample works best in soft sediments where there is minimal current or when one wishes to sample in deep water. The sediments should be passed through a sieve to separate the invertebrates from the bottom silts. To reduce processing time one can pick out all the invertebrates seen in the sample within a

standardized amount of time (e.g., 10 minutes). This avoids having to bring large amounts of sediment back to the laboratory. Benthic invertebrates can be preserved in 70% ethanol.

2. Zooplankton (tiny invertebrates such as water fleas *Daphnia*) are easily sampled with a plankton net. A home-made net can be constructed from a coffee can and an old nylon stocking (see Figure 7.1). When the net is towed through the water, it filters all the zooplankton from a column of water having a width equal to the diameter of the net and a height equal to the distance the net was towed. Thus, quantitative data (number of zooplankton per cubic meter) are easy to calculate. Although researchers use formalin to preserve zooplankton, 70% ethanol (which is less noxious) can also be used.

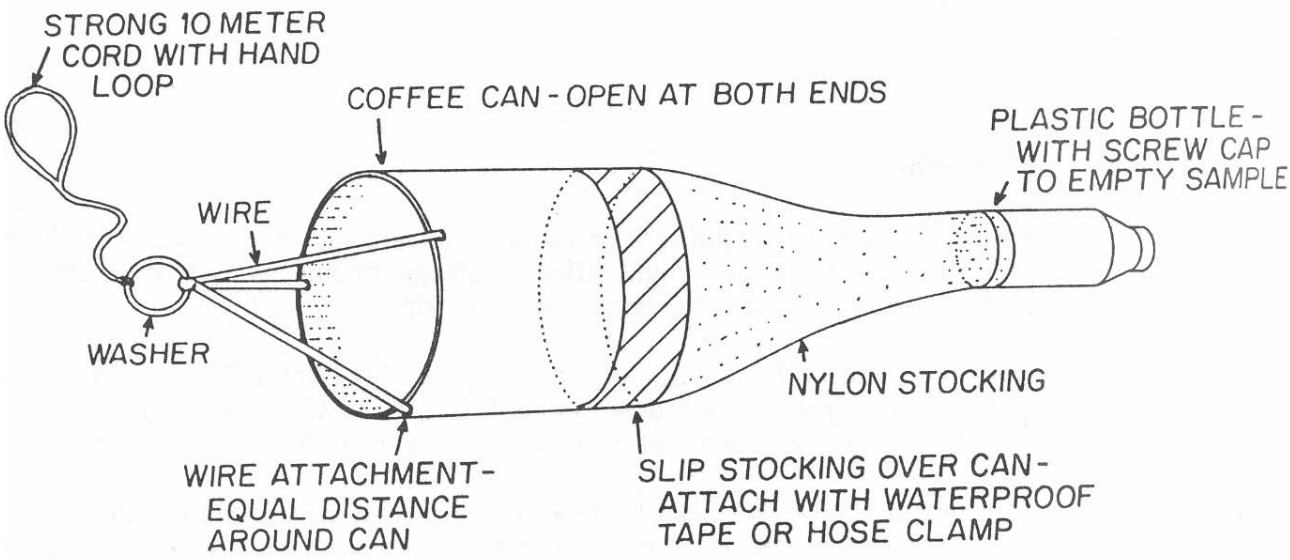

Figure 7.1. A home-made plankton net. By pulling the net through the water, small organisms will be filtered and collected in the botto m portion of the net. The sample can be retrieved by simply unscrewing the cap and allowing the sample to collect in a vial.

3. A water sample (for chemical analysis) can be collected at any depth with a van Dorn sampler or its home-made equivalent (Figure 7.2). Deep ponds and lakes stratify in summer with cold water at the bottom. In productive waters, the bottom waters may lose their oxygen and thus comparison of surface and deep water samples is an interesting exercise.

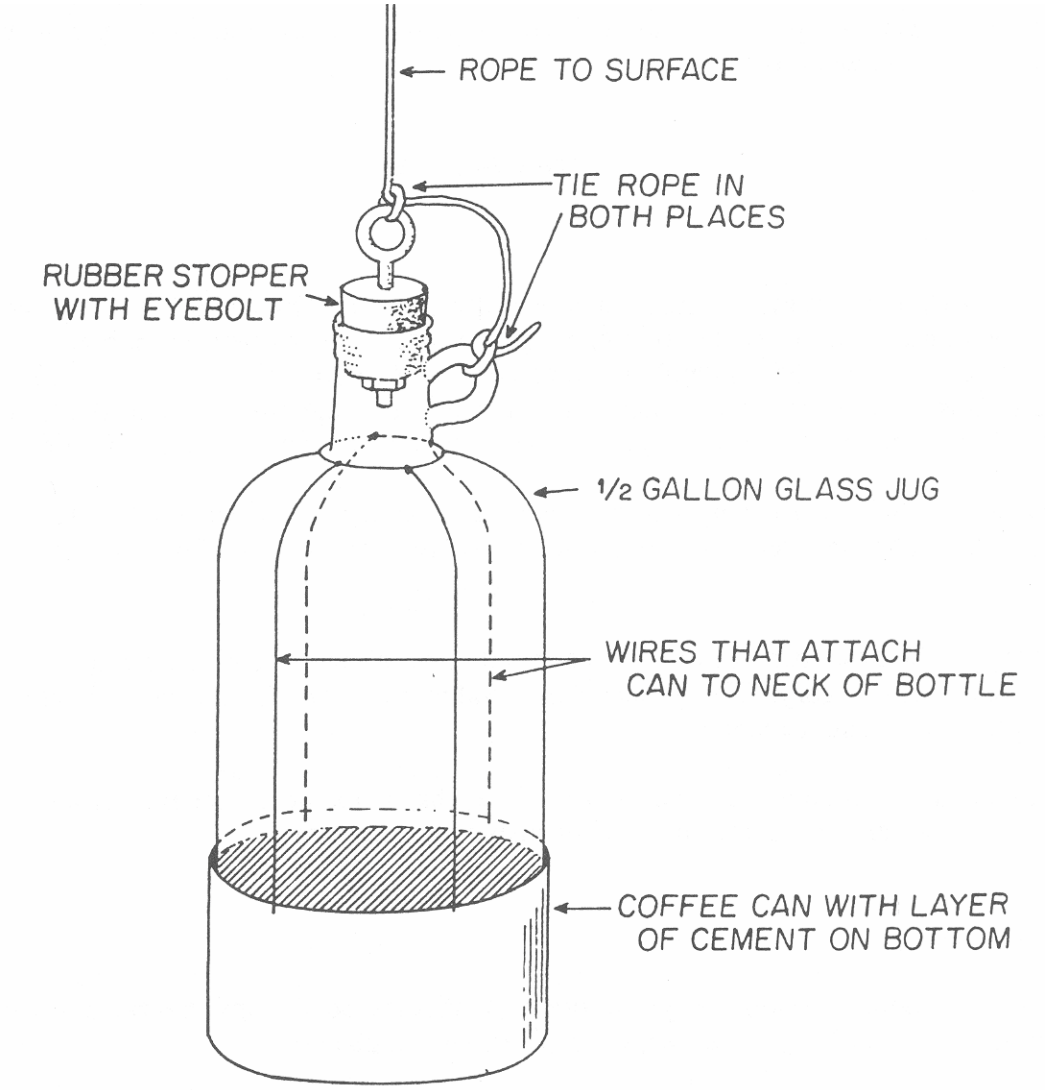

Figure 7.2. A simple water sampler that can be used to collect water from any depth in a pond or lake. The coffee can is weighted by pouring cement in the bottom. The bottle can then be lowered to any depth and a sharp tug on the line is used to dislodge the cork. The bottle then fills with water from that depth and this water remains in the bottle as the apparatus is lifted back to the surface. Further details are in Lind (1985).

4. Fish are easily sampled with seines (check with the state or provincial natural resource management agency to see if permits are required). Quantitative data can be obtained by seining a known area of lake shore or stream reach and expressing fish abundance as the number of fish per square meter of surface area. Population estimates for each species can be made by repeatedly seining the same area and keeping track how many fish are caught with each pass. See below for details on the "depletion method" of estimating population size. Fish

can also be sampled very effectively with electrofishing equipment but such gear is expensive and requires a permit by the natural resource management agency.

Data Analysis

Abiotic Factors

1. The proportion of degraded streambank is easily calculated by adding up the length of bank that is eroded and dividing by the total bank length of the study reach (remember to consider both sides of the stream). Mean depth and mean current velocity are estimated by taking the average of all transect-point measurements. The proportion of the stream reach that is riffle, pool, or run habitat is estimated from the proportion of the transect points that fall into each habitat type.

2. Measures of habitat diversity can be obtained by applying a Shannon-Weiner Diversity Index (H') to the substrate, depth, current velocity, or vegetation data. The formula is:

$$H' = -\sum (p_i \bullet \ln p_i)$$

where p_i is the proportion of the transect points that fall into the *i*th substrate (or depth, velocity, or vegetation) category. The greater the H' value, the more diverse the habitat as measured by that particular habitat feature.

3. Histograms comparing the distribution of depths, velocities, substrate types, and vegetation categories are another useful method of displaying the data.

Biotic Factors

1. Using the general taxonomic keys provided, identify the benthic invertebrates collected into major groups (e.g., mayflies, stoneflies, caddisflies, snails, clams).

2. Begin by plotting the abundance of the common taxa in bar graphs. Are there major differences in the types of organisms found in the different stream reaches?

3. Species richness is the total number of species or in our case, taxonomic groups, present. In general, healthy communities tend to have more species than degraded communities. Does species richness differ among the stream reaches?

4. Diversity is a measure of both the number of species and their relative abundances. The Shannon-Weiner Diversity Index can be used as a measure of community diversity where p_i now represents the proportion of the *i*th species in the community. Does diversity differ between stream reaches?

5. Another measure of diversity is the Sequential Comparison Index (SCI) which is useful because it does not require taxonomic identification of the organisms. Details are provided in Lind (1985). The procedure is to randomly arrange the organisms in your sample in a straight line. Then begin at one end of the row of organisms and examine them one at a time. Decide if each organism is different from the previous one, if so count this as the start of a "run." If the organism appears similar to the previous one, continue on in the same "run." The more diverse

a sample is, the higher the number of "runs" you will encounter. The Sequential Comparison Index is then calculated as:

$$SQI = \frac{number\ of\ runs}{number\ of\ organisms}$$

6. Depletion methods are used to estimate the number of fish in a stream reach. The basic principle is that the catch will decline in a linear fashion as more and more fish are caught (and removed) from the population. Eventually, catch is zero when all fish have been caught. By plotting catch per stream reach as a function of cumulative catch, the total population estimate will be the *x*-intercept. The following data illustrate the method:

Seine or electrofishing pass per number	*Number of fish caught in stream reach*	*Cumulative catch*
1	20	0
2	11	20
3	4	31
4	1	35

The plot of catch per stream reach versus cumulative catch has an *x*-axis intercept of 38, which is the estimated number of fish originally present in the stream reach (Figure 7.3).

Assignment

The assignment should include a presentation of the abiotic data and the biological data collected for each stream reach. Students may plot the abundance of particular taxonomic groups in relation to the habitat factors measured. Community indices such as the Shannon-Weiner Diversity Index or the Sequential Comparison Index should also be examined in relation to habitat conditions. All graphs should have clearly labelled axes and a self-explanatory legend. The emphasis is on comparing the stream reaches to understand how abiotic differences contribute to differences in community composition. Students may consult additional references to get a better grasp of the biology of particular taxonomic groups in order to understand why they dominate in certain habitat types.

At the University of Wyoming we often compare two stream reaches that differ mainly in water depth and current velocity related to beaver impoundment: a beaver-impounded section of stream and a free-flowing section of stream. The comparative approach can also be used to contrast other types of aquatic environments; examples include polluted versus unpolluted streams, ephemeral versus permanent streams, headwater versus downstream reaches, pools versus riffles within a reach, temporary versus permanent ponds, shallow versus deep ponds, or surface versus bottom waters within a stratified lake.

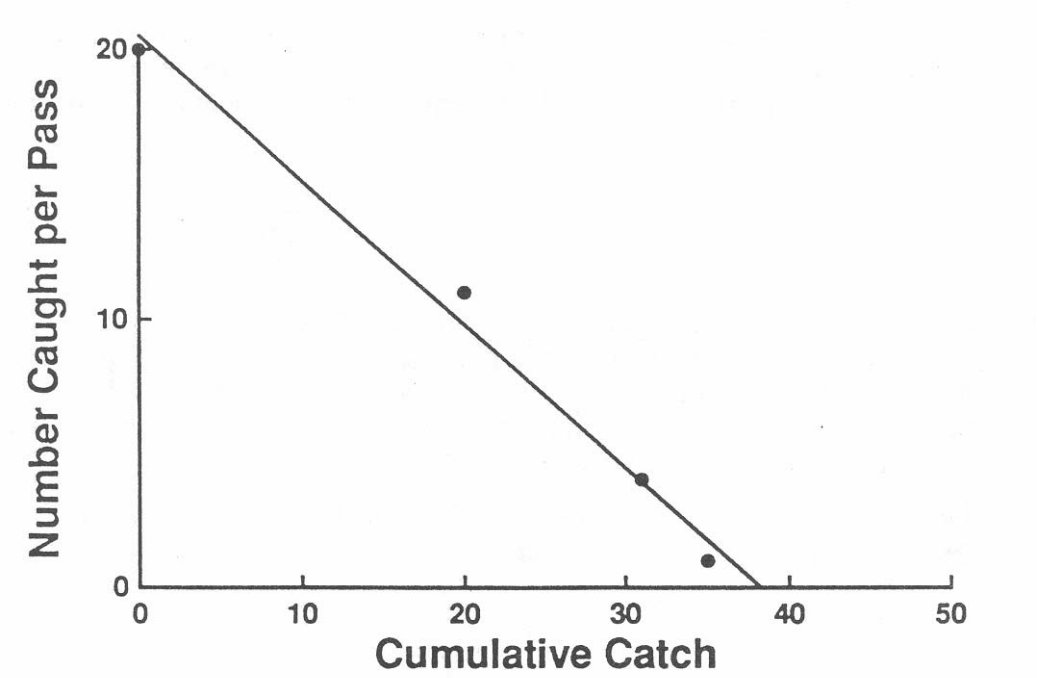

Figure 7.3. Plot of catch per seine haul versus cumulative catch of all previous seine hauls. The regression equation is $y = 20.52 - 0.54x$. The x-intercept equals 38 and is the estimated total number of fish present in the stream reach.

Literature Cited

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APPENDIX A
Materials for Collecting and Observing Aquatic Organisms

Catalogue Item	**Inexpensive Alternatives**
Minnow seine	Large dip net from pet store
Plankton net	Coffee can, tape, wire, nylon stocking (see Figure 7.1)
Dredges	Garden hoe or shovel
Surber kick sampler	Fine mesh net held downstream of wire frame held on stream bottom
Sieve	Window screen nailed over wood frame or frying pan splatter screen
Sorting pans	Tin baking pans painted white inside
Current meter	Time how long it takes an orange to float through a known distance
Binocular dissecting scope	Hand lens
Probes and forceps	Pins and tweezers
Collecting jars and ethanol preservative	Small screw cap jars, rubbing alcohol