Introduction

The Chicago Academy of Sciences is dedicated to promoting science literacy for all citizens so that each may reap the benefits of full participation in the intellectual, economic, and civic life of our society. With support from the Illinois Department of Conservation's Small Project Program, the Academy developed and presented 90-minute workshops in water quality monitoring and river ecosystems for the general public throughout the spring of 1995. During the program, participants of all ages conducted standard water tests for phosphates, nitrates, pH, and dissolved oxygen. They discovered relationships among these parameters by observing actual river dynamics in our stream table and, perhaps most important, they learned several ways to get involved with local agencies to assist with their ongoing efforts. This project was a city-wide invitation to learn how to participate in the preservation of our watershed.

Materials and Methods

The classes were held in our Water Works Lab at the Nature Museum of the Chicago Academy of Sciences. Water Works is an exhibit, laboratory classroom, and research laboratory all in one room, designed to provide learning opportunities for a variety of audiences. It is open to the public as part of our museum, and features several hands-on manipulative experiences for our visitors.

Water Works helped us in teaching the public about our natural resources during the workshops. It features two very special water exhibits and equipment with which our volunteers helped workshop participants gain a better understanding of river environments. The first is a living replica of the Chicago River, near East LaBagh Woods on Foster and Cicero on the city's northwest side. The model brings a section of the river to our visitors, providing opportunities for them to make observations of the life cycles in an aquatic environment they might not make otherwise. During the workshops, it also served as a source for water samples to be obtained for biological, physical, and chemical water quality testing right in the laboratory.

The second special exhibit is a 4 x 8-foot stream table where workshop participants investigated with river dynamics to understand how rivers are formed and how they continue to change. They explored first-hand the results of natural erosion and flooding, and simulated natural conditions with various levels of the nutrients we measured. Using a variety of toys (pipes, plastic pavement, root systems, trees, walls), participants could see the effects of human development and intervention as they altered the landscapes or removed vegetation to change the speed or direction of the flowing water.

Test kits for phosphates, nitrates, pH and dissolved oxygen similar to those used by local monitoring agencies were used during the workshops. These tests are simple to perform and provide accurate, reliable results. Most involve only four or five steps to complete, and were a good choice for public audiences. The test kits were purchased from the HACH Chemical Company, from Ames, IA.

Other materials purchased for the project were: gloves, goggles, testing manuals, resource books, thermometers, magnifiers, supplies for fish tanks, nametags, and film supplies to document the classes. No equipment was purchased with a value over $100.00.

Quarterly reports dated January 1, and April 1, 1995 were submitted describing the status of the project and the updated plans for its continuation. Prior to beginning teaching, as noted in those reports, volunteer opportunities were selected (Attachment 1) so they could be given out to every participant following the class and an operations manual for the lab was completed (Attachment 2) to facilitate the use of the lab by volunteers and staff. Both of these efforts added to the success and the smooth implementation of the project.

The actual 90-minute program was developed using a constructivist philosophy. With learners of all abilities and interests coming in to the classes, it was necessary to begin with what they already knew about the subject and build upon that. The class outline (Attachment 3) demonstrates our effort to tap prior knowledge and prior experience with the Chicago River before presenting information. Participants gained experience during the hands-on testing before discussion questions like "Where do nitrates come from?" or "Why do we test for pH?" were posed.

The class outline was revised based on the first few sessions. More content detail and sample responses to questions which were not anticipated prior to beginning the workshops were added during a short piloting phase. The class outline contains the goals, the room set up, and the lesson plan in a format which can be readily understood and used by many of the Academy's staff and volunteers. Having this product is important because we hope that these informal workshops can be continued even after Illinois Department of Conservation support ends in June. Now that the class has been developed, our plan is to keep making them available to many audiences.

The objectives for our project, as written in our proposal, were to:

1) Offer a series of 8-10 90-minute water quality monitoring workshops for the general public, free of charge and scheduled once or twice per month. The primary focus of the workshops will be to teach people how to conduct standard water monitoring tests to provide reliable results, and give them an introduction to river ecology and stream dynamics.

2) Promote involvement in local community organizations such as The Friends of the Chicago River, OpenLands, Nature Conservancy, and Friends of the Fox River. Our goal is to have at least 50% of workshop participants volunteer for action projects following their training. After all, it is the participation in these community service projects which makes their learning during the workshop relevant and contributory.

The Water Monitoring Workshops were received very well. Our outreach educators offered the programs to families of K-8 students in many inner-city schools in which they work, especially those involved with our Ecological Citizenship program on the northwest side of the city. Fliers (Attachment 4) were also sent to many agencies with which the Academy of Sciences has partnered with in the past, such as Friends of the Chicago River, Project OpenLands, Palos Restoration Project, Chicago Housing Authority, Families Building Community, AmeriCorps/National Service, The Nature Conservancy, and Sierra Club.

In addition, a news release was sent out to the media on January 20, 1995, and 7 different announcements about the upcoming courses were placed in at least 27 different papers (Attachment 5). The class was also advertised in our Academy newsletter, *Nature's Notes*, for the December/January, the February/March, and the April/May/June issues. It appeared in the resource menu of the Chicago Systemic Initiative, The Prairie University Catalog, and the newsletter of the Palos Restoration Project, among others.

Once the classes were implemented, a second news release was written and submitted for publication (Attachment 6). Recently, two outside authors have also come in and interviewed staff and have written articles about the Water Works Lab and the public programming. When they are published, copies will be forwarded to the Department.

The Academy still plans to produce a brochure about the lab/exhibit. However, the brochure has been delayed because the museum is changing locations and as of June 4, 1995, will be moving to a new space. Once the new address is confirmed and the museum is settled in, information about the Lab as a resource will be distributed.

Results

Our first objective was met, as ten workshop sessions were scheduled and offered to the public. Dates for the workshops were February 21, February 25, March 24, March 25 (two sessions), April 8, April 22, May 13, May 20 (two sessions). Two dates for workshops were changed: January 21 was advertised before the first news release went out, and was canceled due to lack of response; June 10 was rescheduled due to availability of the Water Works Lab. Extra dates or sessions were added as the project continued, depending upon the numbers of participants who pre-registered.

Our second objective was met as well, with over 50% of workshop participants volunteering for action projects following their training. There were 60 participants who attended (four individuals took it twice, with different groups) during the 10 sessions (Attachment 7). Of those who attended the workshops, 50 individuals are involved in further educational and restoration efforts. The participants will continue to be tracked to determine the level of their involvement throughout the coming year, but the results are already encouraging.

The following breakdown shows the way the class information will be used by the participants:

- 11 are going on to teach river monitoring in a formal situation (in a school classroom with students)
- 1 is going to teach in an informal setting (teaching other volunteers about it)
- 15 were members of the FOCR Canoe team
- 13 are involved in AmeriCorps/National Service
- 8 are using the information for science projects, and will pass it on by doing and presenting school projects
- 2 will be working with the Academy to present more of these workshops in the future
- 10 were individuals who wanted to learn more, but as far as we know, have not yet volunteered at one of the agencies

Note: There is some overlap in this breakdown, as some participants fit into more than one category. The numbers will not add up to the total participants.

Discussion

In retrospect, this was a difficult class to facilitate because it was never the same class twice. Each session was unique because each group of people had its own set of questions about the Chicago River, and a different purpose for learning about water quality monitoring.

The class was not a lecture; it provided a very real opportunity for people to do science and to practice their skills in ways that suited them best. As the list above demonstrates, the participants are involved in a wide variety of educational efforts, and it was necessary to let them guide the direction of the class in order to meet their specific needs. Being this flexible makes for a better class, but it means that our volunteers have to be well prepared, and confident in the subject matter, in order to facilitate the sessions.

Our staff will work closely with the two participants who have expressed an interest in continuing to present the program. We have a list of many more people who are interested in attending a workshop or sponsoring a session with our assistance at their own sites. It should be a very busy summer. This small project may be completed, but its influence is likely to be just beginning.

Unfortunately, although the 10 sessions were registered to capacity and there was a waiting list for most of them, everyone who registered did not follow through and actually attend their scheduled workshop. At the first class, for example, only 3 people out of the 15 who registered actually came. This is a very common problem with free workshops and one we have experienced before. We tried to limit it by calling people before the class to reconfirm their place in the class, but it did not seem to make a difference. In the future, perhaps these sessions would work better by charging a small 'materials fee' so that participants will have some investment in it, or by announcing it in the museum and presenting a more spontaneous class session without pre-registering.

As difficult as it was to be prepared for the possible exploration of a variety of water quality topics at each class, it was exciting to be part of this project. Those who attended seemed to get a lot out of the experience; many participants stayed after the class time to ask more questions or practice with the testing. That is a good sign that they became engaged in the topic. Some even called back in the weeks following to ask more questions, or to get connected to a volunteer agency. Others were working on their science fair projects and were using the Academy as a resource. If for no other reason, this project was a success because it reached individuals who had not known that our Water Works Laboratory was available for their use, and introduced them to a whole new variety of water-related volunteer opportunities. We look forward to sustaining the new partnerships we have formed in the coming months.

Attachments

1. Volunteer opportunities
2. Operations Manual for the lab
3. Class outline and selected content
4. Class fliers to advertise the program
5. News release and printed articles announcing the award of $1,000. from the Wildlife Preservation Fund
6. Second news release about the first few workshops
7. Sign-in sheets from the classes
8. 5-10 photographs and slides of the class (in first package only)

Attachment 1: Volunteer opportunities

Opportunities to Get Involved in Water Quality Monitoring and River Clean-Up

Riverwatch
Friends of the Chicago River
Bill Koenig, volunteer coordinator
312/939-0490
407 South Dearborn, Suite 1580
Chicago, IL 60605

Volunteer Network
Friends of the Fox River
Patrick Reese
708/741-1124
P.O. Box 1478
Elgin, IL 60121

Shorekeepers
Lake Michigan Federation
Sophia B. Twichell, program coordinator
312/939-0838
59 East Van Buren Street, Suite 2215
Chicago, IL 60605

Swamp Squad Wetlands Monitoring Project
Sierra Club
Adam S. Weinberg
312/431-0158
506 South Wabash #505
Chicago, IL 60605

River Rescue
Friends of the Des Plaines River
708/296-6359
P.O. Box 1162
Des Plaines, IL 60017-1162

Great Lakes Beach Sweep
John G. Shedd Aquarium
312/939-2426
1200 South Lake Shore Drive
Chicago, IL 60605

Volunteer Stewardship Network
The Nature Conservancy
79 West Monroe, Suite 900
Chicago, IL 60603

Urban Greening Program
OpenLands
Julie Sacco, volunteer coordinator
312/427-4256
220 South State Street, Suite 1880
Chicago, IL 60604-2103

Other Volunteer Opportunities
Calumet Prairie Restoration in south east Cook County
For information call Marlene Nowak 708/333-3642

Des Plaines River Valley Volunteers in west Cook Couty
For information about workdays and walking tours, contact Sue Osborne 708/848-5928

DuPage Volunteer Stewardship Group
For information call Mary Ann Skvara 708/246-9561

Friends of the Fen
For information contact Melanie Manner 708/888-4426

Palos Restoration Project in southwest Cook County
For information call Julie Sacco at 312/247-2606

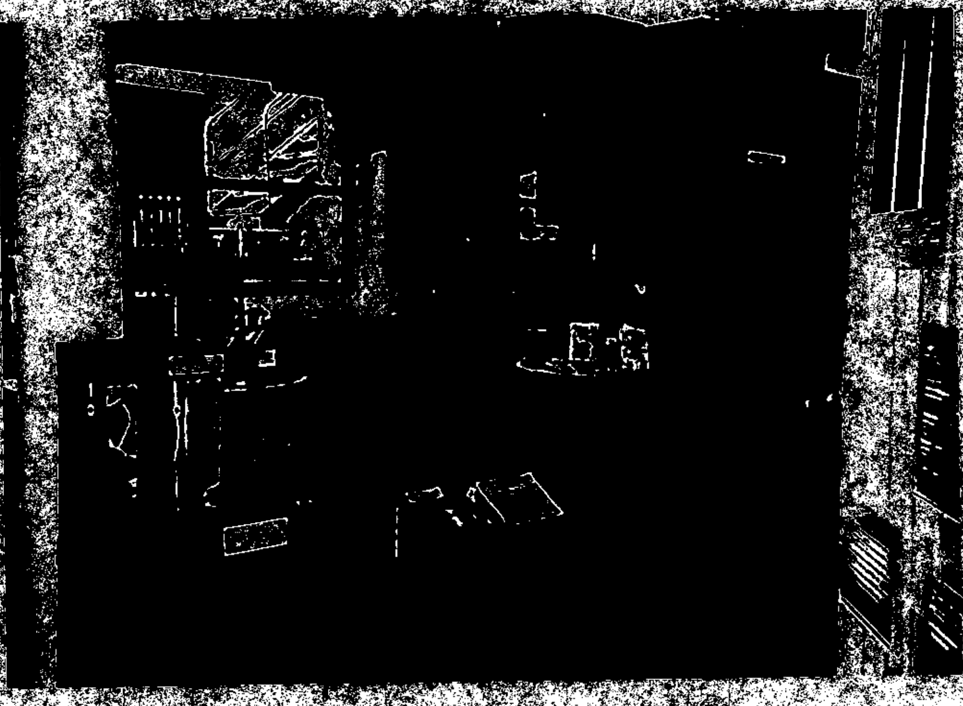
The Chicago Academy of Sciences • The Nature Museum

Attachment 2: Operations Manual for the lab

Chicago Academy of Sciences

Water WORKS

The Water Works Lab Operations Manual

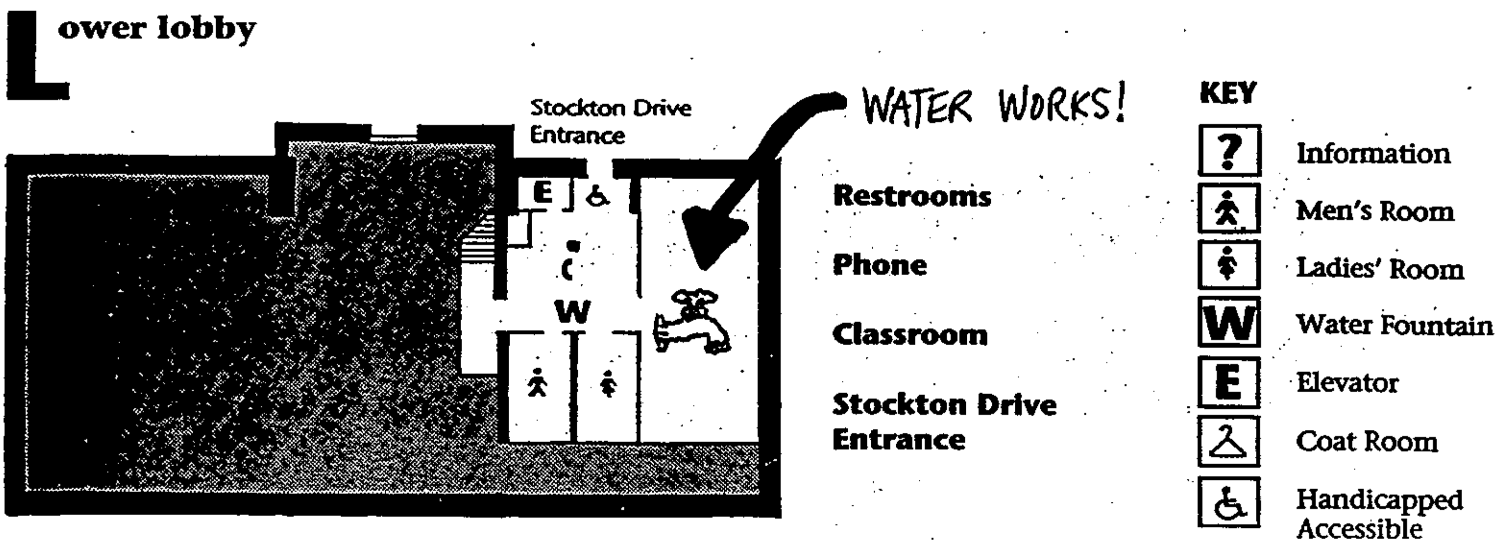


by Jaime Bina

I. Welcome to the Lab

Water Works is a "hands-on/minds-on" exhibit, laboratory classroom, and research laboratory at the Chicago Academy of Sciences where visitors can learn first-hand the effects of natural processes and of human impact on the Chicago River. In the exhibit, there is a replica of a section of the north branch of the Chicago River, a stream table, authentic sampling and lab testing equipment for water quality monitoring, information on current topics such as zebra mussels and waste water treatment, and an on-line computer for networking and entering data.

When entering through the main door of the Academy of Sciences' Museum, the Water Works Lab is in the lower level, by the washrooms. Visitors can get to the lab by taking the stairs at the right of the coal forest, or by taking the elevator near the auditorium to the basement floor.



The lab is open when the museum is open, from 10 am to 5 pm, daily. It functions as an exhibit (Scenario A) where visitors can look, touch, and explore the different stations around the room. At certain times, usually on weekends and during the summer, the lab has volunteers or staff who set up the tables to do more advanced chemical, biological, and physical testing. The staff also perform stream table demonstrations for interested visitors (Scenario B).

The lab was designed with three goals in mind:

1) to be a "hands-on/minds-on" exhibit for visitors
2) to offer visitors the opportunity to learn content skills for water quality management and stream dynamics appropriate to their level and interest.
3) to be a fun, inviting, and dynamic environment.

All of our exhibit components, as well as staff interactions, should reflect these goals as closely as possible.

II. Opening the Lab

If you are the first person to arrive in the morning, follow these steps to prepare the Lab for visitors:

1. Unlock the main door to the exhibit. Put down the door stop so that the door stays open.

2. Turn on the light switch, which is located to the left of the door. The lights are on when the switch is in the "down" position and off when the switch is in the "up" position.

3. Check The River to make sure that nothing is out of place; remove dead fish and plant roots as necessary. Also, check the four square black tanks scattered around the room. Remove any dead fish and excess of up-rooted plants; see that the air hoses are not plugged. Make sure the pumps are running smoothly and there are no problems. You do not have to feed the fish or zebra mussels in these tanks when you open the room.

4. Straighten the books at the Sources station. It does not matter if they are standing or laying flat, but they should always be neat so that visitors will respect them and leave them in a neat arrangement. The small sign which says, "Look at Our Sources but Do Not Remove from the Lab!" remains in the center of the table and should be stuck with a 2" x 2" piece of tape. Leave a couple of chairs around the table to encourage visitors to sit and read.

5. Check the computer to be sure it is covered with its plastic cover, the chair is pushed in at the table, and that the table is neat.

6. Check the gray supply cabinet to be sure the handle is locked. The keys are kept on a small hook behind the grid wall to the left of the gray cabinet. If the water bath or oven are on, check in the Communications Log to see if there is a test in progress so that you don't turn them off if someone has left them on for a reason, or so that you *can* turn them off if someone has turned them on for *no* reason.

7. Check the pump at the front of the stream table to see if it is cracked. Check the small blue tank on the floor to see if there is too much sand in the bucket or by the hose intake. Try drawing water through the hose to be sure it isn't clogged. If it is clogged, get a screwdriver (in the supply cabinet) and unclasp the hose so you can dump the sand out, and try again drawing water through it. You can clean the tools in the buckets near the window, or leave them in the sand. Wipe the table and nearby pole/fire extinguisher down if sand is all over it, and sweep around the tables if there is sand nearby. You can move the sand away from the drain and arrange it at the top in a meandering fashion, but it isn't necessary. We want it to look inviting for the visitors who walk to the door.

8. If anything has been taken off of the walls or has fallen on the floor overnight, hang it back up on the wall. A mop and a bucket are located in the back hallway if needed.

9. The goggles cabinet and the corrosive cabinet should always be locked unless a volunteer is in the room with visitors. Check them to be sure they are not open. As mentioned, some of the Water Works supplies are located in the back hallway. The door leading to the hallway can only be opened from the other side; the staff do not have a key. Please check to be sure the door is locked before the museum is open, unless you are remaining in the lab to work with visitors. In that case, you may keep it unlocked and use it as your access to the back hallway -- for supplies -- as you need them during the day.

10. Clean the table tops at the stations and arrange the Scenario A or Scenario B materials as shown in sections X, XI, XII, XIII, and XIV of this manual.

III. Supply Cabinets

Gray Supply Cabinet

The supply cabinet is the gray cabinet that is to the right of the door. The key to that cabinet is kept behind a gridwall at the right of the cabinet. You need to gently push the gridwall and you will see a hook. On that hook are the keys to the cabinet. In that cabinet is kept all the material used during classes, and to that cabinet the materials should be returned when you have finished using them. It is very important to keep that cabinet closed and locked at all times because that cabinet is also the place where the video/microscope is kept.

Corrosive Materials

There is a special cabinet across the room from the supply cabinet labeled "Corrosive Materials". It contains the corrosive materials for the Lab, such as alcohol and other chemicals used in laboratory operations. The visitors are not allowed to take or experiment with any of these materials unless there is trained staff supervising the Lab. The cabinet is to be kept locked at all times!

Goggles Cabinet

Above the Corrosive Materials Cabinet there is a white cabinet where the safety goggles are kept for experimenting with chemicals. The visitors can use the safety goggles if there is an experiment going on with chemicals and there is somebody trained helping them; otherwise, this cabinet should be kept closed. After goggles have been used and replaced in the cabinet, turn the black knob on the upper right side to sterilize them with UV light for 8-10 minutes.

IV. Communications Log

There is a Communications Log hanging on the door inside the supply cabinet. If there is an experiment going on with the water bath or oven, it should be noted here; otherwise, the equipment will be turned off. If there is something missing or if there is any damaged equipment, it should also be noted here at the beginning of each day. Any materials needed in the operation of the Lab can be requested by making a note in the Log.

The time when the fish are fed and by whom should be written either in the Log or on a separate feeding log so that it can be tracked.

Communication is important, especially since all those involved in the operation of the Lab are spread around many areas. Please take time to write things down and share information.

V. River Simulation

This river is alive. It simulates an actual section of the North Branch of the Chicago River, near *LaBagh Woods.* The river includes native Illinois plants and animals and functions as a source for sampling for a number of the biological, physical, and chemical water monitoring tests.

The water is recycled by a pump that processes 1000 gallons of water per hour. It should run 24 hours/day without a problem. Check periodically to see that it is not getting overheated or is not making abnormally loud sounds. If it is, or if the river simulation starts to overflow; unplug the pump (the plug is located at the bottom of the white pillar between the river section and the orange collection tank), write it on the communications log so others will know why it is unplugged, and tell the Lab Supervisor about it. Do not lift the three white pipes that bring the water from the river into the orange container. They will lose their suction, or prime, if they are lifted out of the water. The river has enough oxygen to sustain itself for a short period of time while the pump is repaired. In the river simulation there are small green plants. They are often floating around. These plants should be put with their roots into the rocks because they could get into the pump and damage it. By continually replanting them they eventually will develop roots and stay planted. If anybody did any experiments with the river water and touched it, it is necessary, for health reasons, for them to wash their hands.

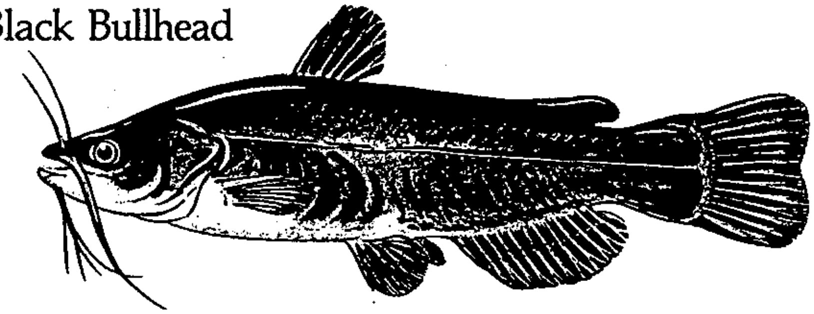
The water must be kept at a level of 4.5 inches. The water level can be measured on a submerged ruler near the pump at the west end of the River. If it is very low, water can be added from the red River Water containers in the back hallway. If the water from these containers is finished or is about to be finished, notify the Lab Supervisor. The water is brought from *LaBagh Woods* , near the intersection of Cicero and Foster. The water must be kept at no higher than 70 degrees F but no lower than 45 degrees F. The temperature can be measured on a submerged thermometer next to the ruler by the pump. Both the water level and the temperature should be recorded regularly in the communications log.

Life in the Chicago River

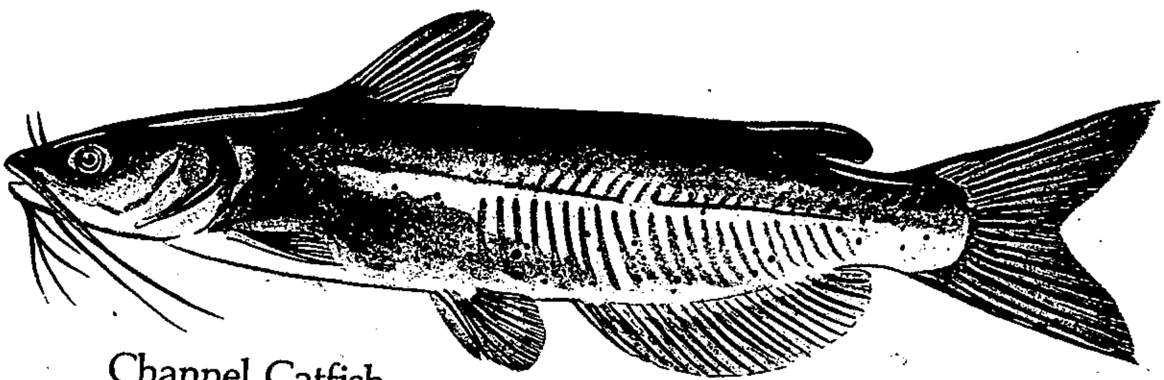
The life in the Chicago River consists of about 55 species of fishes besides the small animals like worms and bacteria that live in there. Some of these fishes are:

BULLHEADS: Are found in ponds and sluggish streams throughout North America. Like other catfish, bullheads have a smooth, scaleless skin and a sharp spine in the top (dorsal) fin and in each side (pectoral) fin. Chin whiskers, or barbells, are sensory organs that aid fish in finding food, primarily small bottom animals. Bullheads and other catfish feed mostly at night or in roiled waters; their eyes are small. Most common is Black Bullhead. Yellow Bullhead inhabits clearer water than Brown or Black. All are good to eat. Average size is 0.5 to 1.0 pounds; 12 inches long.

Black Bullhead

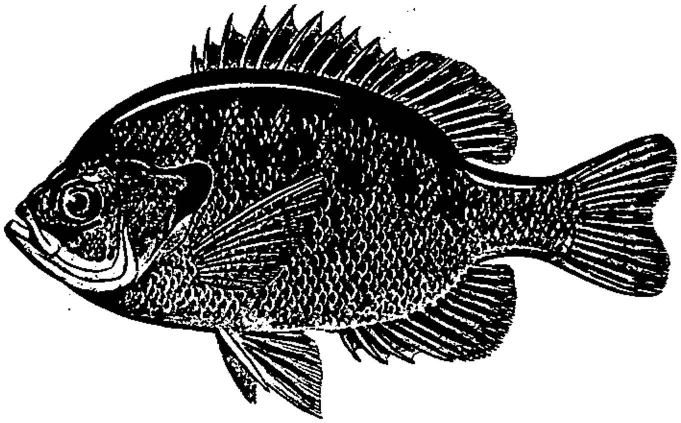


CHANNEL CATFISH: Is primarily stream dweller, but it lives in lakes and has been stocked in ponds. Tail fin are deeply notched. Spotted young are commonly called "fiddlers." Catfish are edible and have firm flesh, especially when from cold waters. Range in size from 2 to 4 pounds.



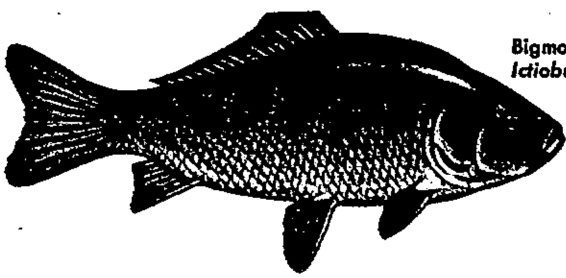
Channel Catfish

BLUEGILL SUNFISH: Are widely distributed as a result of stocking in farm ponds and other waters. Bluegills eat insects, crustaceans, and other small animals. A large female may lay more than 60,000 eggs at one spawning, but only a few of them of the many young survive. Length 8 to 12 inches; occasionally may weight as much as 1 pound. Look at small sign on top of tank for more interesting information.



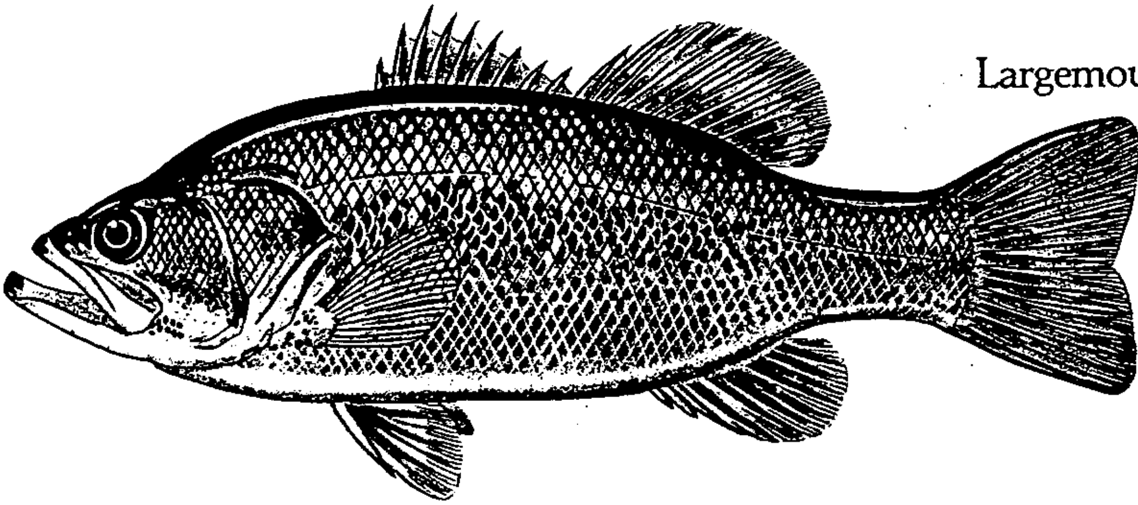
Bluegill

BUFFALO: Belong to the sucker family, with some 60 species in North America. Most are bottom feeders, eating mollusks, insects, and plants. In a stream or river mouth is directed upward, not down as in suckers. Bigmouth Buffalo can grow to 65 pounds, although are usually smaller.



Bigmouth Buffalo
Ictiobus cyprinellus

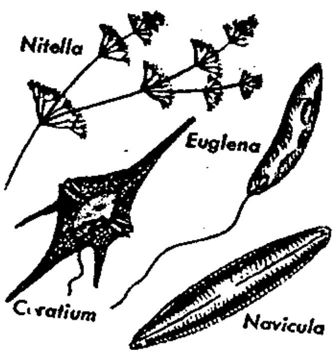
LARGEMOUTH BASS: A large member of the sunfish family, is common in ponds, lakes, and sluggish streams throughout central and southern North America. It preys on smaller fishes. Look at small printout above tank. The Largemouth Bass averages 2 to 4 pounds, but in the South grows to more than 18 pounds.

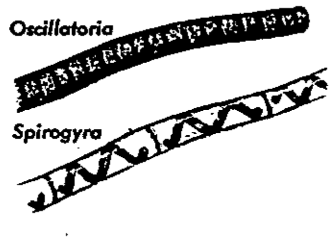


Largemouth Bass

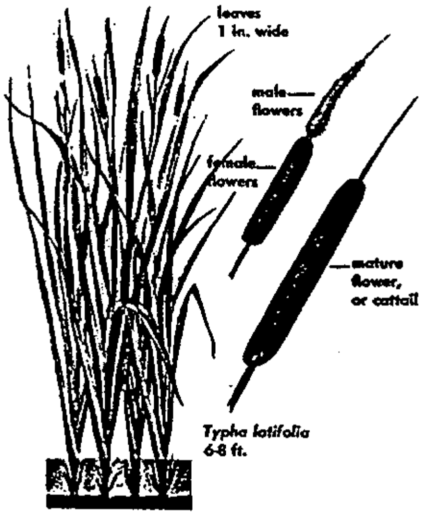
ALGAE: Are very simple plants, believed to be the first forms of life to appear on the Earth. The individual plants range in size from single cells to the mats of stoneworts resembling dense growths of higher plants. The single cells of some algae are joined together to form chains or filaments. Other single-celled algae swim like one-celled animals. Algae are found in all natural waters--even in hot springs. They contain chlorophyll and often other pigments.

Algae form the broad base on which the food pyramids in ponds and lakes are built. In manufacturing food, algae release oxygen, increasing the amount dissolved in the water. When overabundant, however, their decay may deplete the oxygen and cause "summerkill" of aquatic plants and animals.

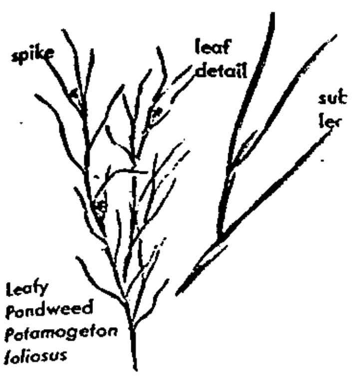


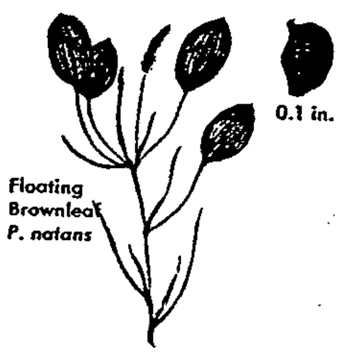


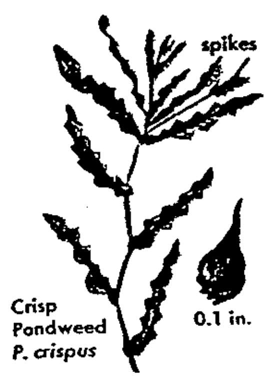
CATTAILS: Are common in marshes and ditches and along shallows of lakes, ponds, and slow streams. The long slender leaves reach a height of 6 to 8 feet. The flower stems, usually shorter than the leaves, bear two masses of flower parts. Cattails spread by their wind-borne seeds and also by their starchy underground root-stocks. There are twelve species in N. A.



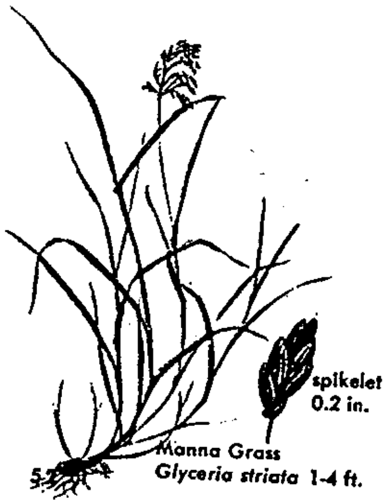
PONDWEEDS: Are the largest family of truly aquatic seed plants. They are perennials, growing mainly in cool regions. More than 60 species grow in fresh water ponds and lakes and some even in brackish and salt water. Several kinds of ducks feed almost wholly on pondweeds. The dense underwater growths of pondweeds provide cover for fishes, snails, and other animals. Ponweeds survive the winter by using food stored in their underground stems and tubers. Tubers also break off and grow into new plants. In summer, heavy growths of some ponweeds may interfere with boating, fishing, and swimming. Most fresh-water ponweeds have spike-like flowers; leaves usually alternate along the stem. Our river has some Leafy Ponweeds (Potamogeton foliosus). Its leaves, all submerged, are thin and tapelike with flower spikes in axils. It is fruit keeled.



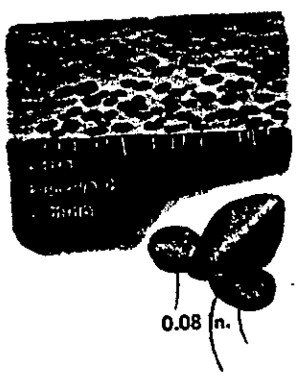


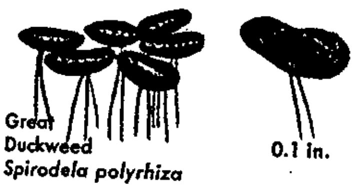


TRUE GRASSES: Include only a few aquatic species, difficult to identify. Their two-ranked (2 rows on stem), parallel-veined leaves have sheaths loosely encircling round hollow stems. They have flowers in spikelets. Our river has Manna Grasses (Glyceria striata). These are perennial plants with tall stems growing from rhizomes, or rooted stems. There are about 10 species of Manna Grasses.

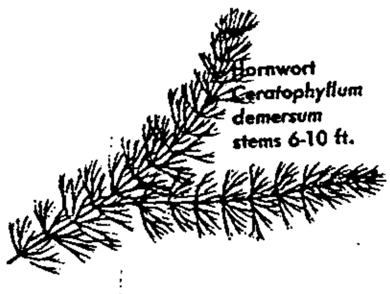


DUCKWEEDS: Tiny floating herbs, are a favorite food of waterfowl. About 25 species of these smallest of the seed plants are known. Tiny flowers, rarely produced, grow out of the leaflike body, which lacks true leaves and stems. Reproduction is mainly vegetative, by a division of the plant body. There are some of these plants living in our Lab. They are floating on the top of the Zebra Mussels tank.

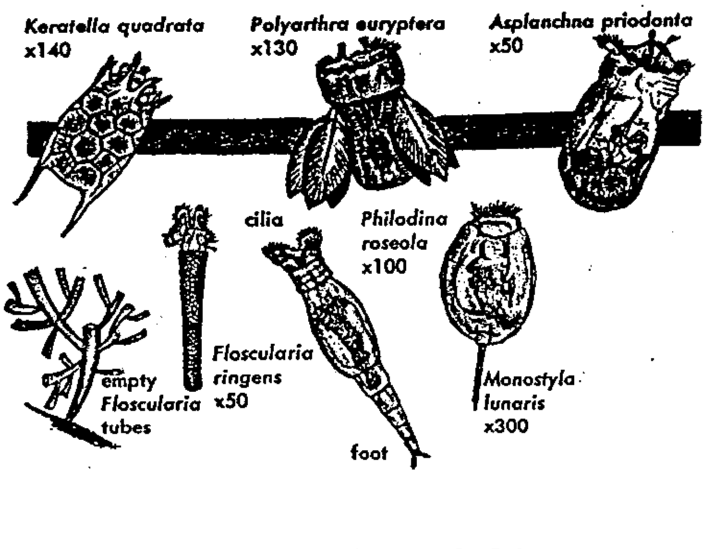




HORNWORT OR COONTAIL: Grows beneath the surface in quiet waters throughout N. A. Its branched leaves, brittle and crowded foward tip, are arranged in whorls around a slender stem. Hornwort's flowers are pollinated underwater. The seeds, eaten by waterfowl, have a tough covering. We have some of these in the Panfish tank.



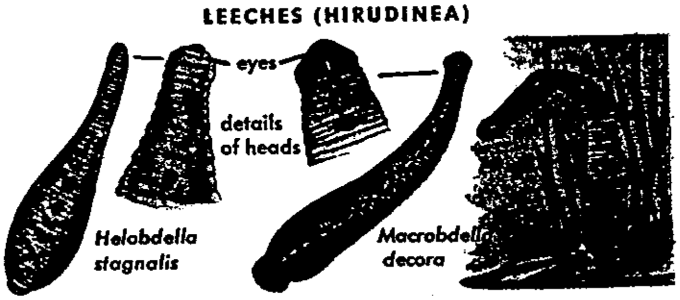
ROTIFERS: (wheel animalcules) are found in all types of quiet waters. Rotifers are tiny, many of them microscopic and sometimes mistaken for one-celled animals. Their name refers to the rotating movement of the hairlike projections (cilia) on the front of the body. At the rear is a base, or foot, that secretes a "glue" by which the rotifer attaches to objects. The 1,700 known species are widely distributed. Some live in the shore zone; others are part of the floating plankton. Some feed on algae; others pierce plant stems and suck out the juices. Many are predaceous. Rotifers, in turn, are the food of worms and crustaceans. Some rotifers secrete a gelatinous covering and remain dormant for months if the pool in which they are living dries up.



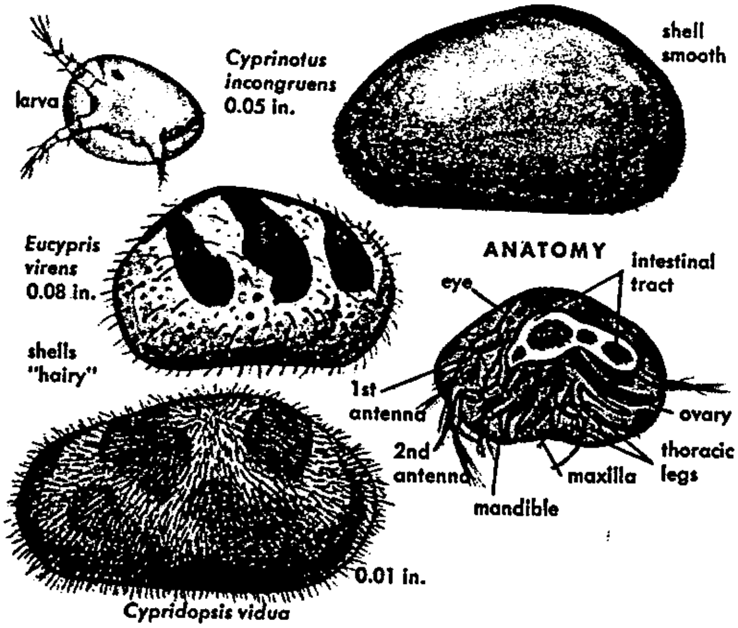
WORMS: Are animals belonging to several major unrelated groups that share a generally similar shape. These include the flatworms and also smaller groups. Segmented worms (Annelida) are the earthworms, mainly dwellers; leeches, found primarily in fresh water; and sandworms, mainly marine. A few species of earthworm group live in fresh-water ponds and lakes. Some are abundant in decaying vegetation or in floating masses of algae. Others feed on organic matter as they burrow in the bottom mud.

Leeches are flattened, segmented worms, often abundant in calm, shallow, warm waters in which the bottom is cluttered with debris. They are seldom found in acid waters, and they survive the drying up of pond by burrowing into the bottom mud. Leeches shun light. They move by "looping"—alternately attaching the mouth sucker and tail sucker to the surface. Some kinds are graceful swimmers. Bloodsucking leeches have well-developed jaws, in contrast to those of scavenger and carnivorous species.

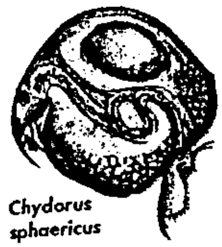
LEECHES (HIRUDINEA)

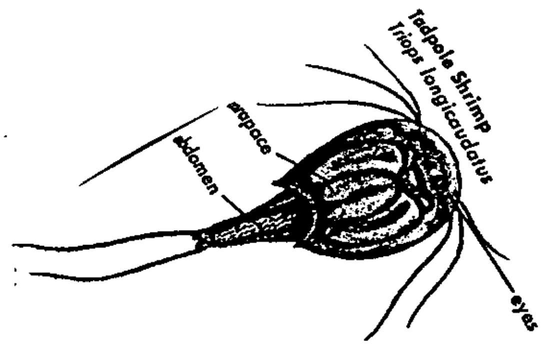


SEED SHRIMPS: (Ostracoda), usually less than 0.1 inch long, are bivalved (clamlike) crustaceans found in fresh waters of all types. They are specially common in mats of algae or other vegetation and also in mud on pond bottoms. Many of the some 150 N. A. species are brightly colored. Some have dark patterns on their valves. Their two pairs of antennae are protruded from between the shelves when opened and, with other appendages, aid in swimming. Eggs are laid on plant stems and in debris. The males of many species are unknown; the females lay fertilized eggs that develop into larvae. A larva, or nauplius, is quite different from the adult and goes through several stages before reaching maturity. Seed shrimps are scavengers. They are eaten by small fishes.

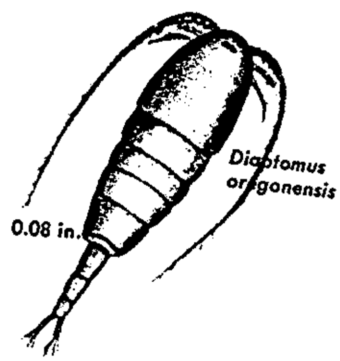


WATER FLEAS: (Crustaceans—Cladocera), abundant in all kind of fresh water, swim jerkly by means of the enlarged second pair of antennae. Water fleas eat algae, microscopic animals, and organic debris swept into their mouth in current of water created by the waving of their legs. In turn, they are eaten in great numbers by small fishes. In some species the shape of the female's head changes seasonally.

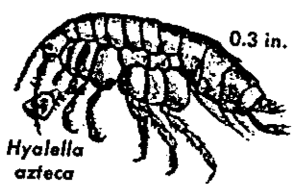




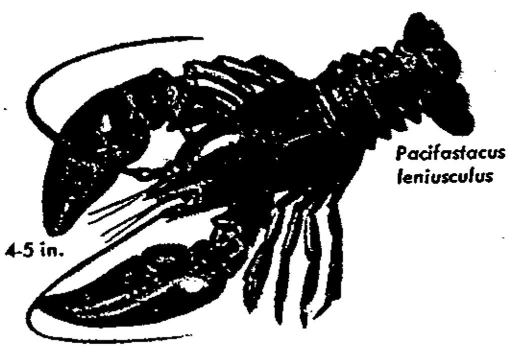
COPEPODS: (Copepoda) are small crustaceans (about 0.1 inch long) found everywhere in shallow waters and in open-water plankton of pond and lakes. Some cling to vegetation and are found even in damp debris above the waterline. A few kinds, such as *Argulus*, are parasitic on fishes and other aquatic animals but seldom cause much harm. During the breeding season, one or two egg sacs develop on each female. The young pass through five or six nauplius stages before maturity. Copepods feed on algae, bacteria, and organic debrils. They are food themselves for larger animals, though not as important as food for fishes as are water fleas. There are three groups of free-living copepods.



SCUDS: (Crustaceans—Amphipoda), also called Side-swimmers, are widely distributed in ponds and are found even in the deep waters of large lakes. Flattened sidewise like fleas, scuds usually live close to the bottom or among submerged objects; they avoid light. Some, such as *Gammarus*, grow to about 0.5 inches long, but most scuds are much smaller. They are scavengers on plant and animal debris; and in turn, they are eaten by fishes that feed among plants or off the bottom. Scuds are the intermediate hosts for tapeworms and other parasites of frogs, fishes, and birds.

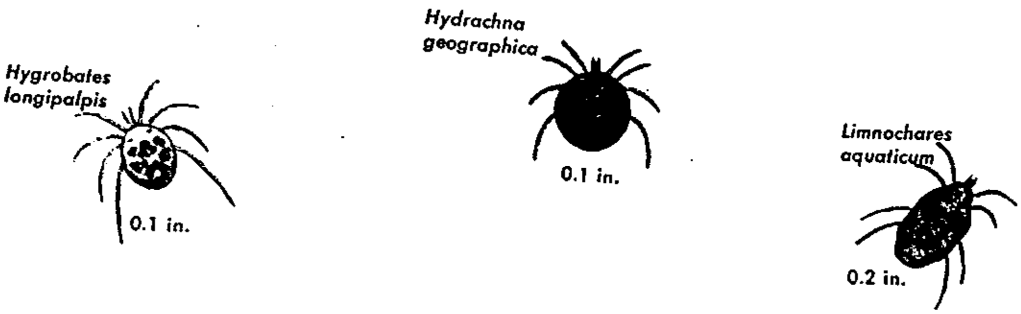


CRAYFISH: (Decapoda), are crustaceans relatives of marine crabs, lobsters, and shrimps. They have a carapace over head and thorax and five pairs of walking legs, the first pair with large pincers used in holding and tearing food. More than 200 species of crayfish live in N. A. Some species are found only in ponds, others in streams, and still others in wetlands in burrows that can be identified by their above-ground "chimneys" made of mud balls from the digging. Crayfish usually hide in burrows or under objects during the day. They are active at night. Their food consists mainly of plants, though they will eat animal food when available. The female carries the fertilized eggs attached to appendages (swimmerets) on her abdomen. Young crayfish pass trough three stages (instars) before becoming adults. Crayfish shed, or molt, their hard exoskeleton as they grow.



DRAGONFLIES: (Odonata) are also called Mosquito Hawks or Devil's Darning Needles. About 400 species occur in N. A. Dragonflies hold their wings in a horizontal position when at rest. The nymphs are dull-colored, awkward-looking creatures with large chewing mouthparts covered by a scooplike lip (labium). They feed on insect larvae, worms, small crustaceans, or even small fishes. In turn, they are an important food of many larger fishes. Dragonflies mate in flight. Females deposit their eggs in the water, in floating plant masses, in sand, or in holes cut by the females in plant stems. Some species complete their life cycle from egg to adult in three months; others may take up to five years and pass through many nymphal stages before becoming adults. Transformation from nymph to adult (imago) takes place on a piling, on a plant stem sticking out from the water, or on some similar object. The nymph's outer skin splits lengthwise on the upper surface and the adult emerges. It must wait for its wings to dry before it can fly.

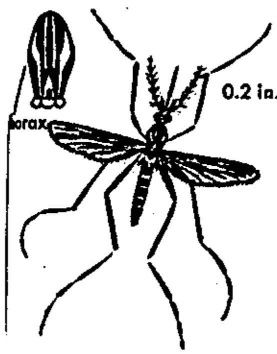
WATER MITES: Have eight legs, as do ticks, scorpions, and other members of the same arthropod group—Arachnida. Water mites, usually no more than 0.2 inch long, live with the floating plankton or in wet vegetation along shores. Each species is usually restricted to a particular habitat. Water mites feed on worms, small crustaceans, and insects; some are parasites. A few swim; others crawl about on plants or rocks; all surface to get air.



MOSQUITO: Larvae, or wrigglers, range from 0.2 to more than 0.5 inch long. They differ from other fly larvae in that their head is larger than the remainder of the body. Mosquito larvae eat microscopic plants and animals or organic debris filtered through brushes that surround their mouth. They breathe through gills at the end of the abdomen. Larvae usually rest at surface, but wriggle downward if disturbed.

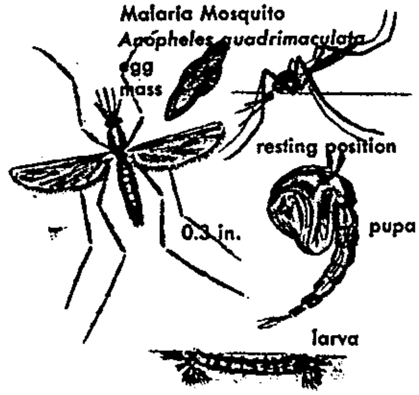
Mosquito pupae, commonly called tumblers, are also aquatic. Unlike those of the larvae, their head and thorax are fused into one unit, and they breathe through tubes in their thorax. In contrast to the pupae of most other insects, they are active and can swim by using their leaflike tail appendages.

Only the female mosquitoes are bloodsuckers. Many require a meal of blood before they are able to lay their eggs. Some kinds of mosquitoes transmit diseases, such as malaria and yellow fever. The males feed on nectar and ripe fruit. Mosquitoes survive winter and periods of drought in the egg stage, hatching as soon as conditions are favorable. About 120 species of mosquitoes occur in N. A.



Yellow Fever Mosquito
Aedes aegypti

Malaria Mosquito
Anopheles quadrimaculata



VI. Stream Table

The dynamics of a stream can be explored at this station. Variables such as velocity, vegetation, shape, and the effects of the human activities can be manipulated to study the impact they have on the river. The Stream Table offers many inquiry-style experiences.

The Stream Table consists of a table with sand and a hand pump. The table is very versatile. It can be used to demonstrate the erosion of water, the formation of rivers, lakes, and others bodies of water, and how these affect the landscape. Visitors can pump water into the table, form rivers with the sand, and enjoy. There are some instruments on the table that the visitors may use to form their rivers. It's O.K. for them to use their hands. If they do use their hands, they can wash them in the container on the nearby table that says "Rinse hands". Rinsing hands must be done in this way so that the pipes of the washrooms don't get sand inside them. We decided not to leave paper towels near the containers where visitors are supposed to wash their hands, because of the large generation of waste and because they are often left all over the lab and museum.

The sand for the table is bought by bag from a local hardware store. There are more bags of sand in the back hallway. If you think that more sand is needed, notify the Lab Supervisor or someone from Exhibits before adding it. The sand must be washed many times before using, due to the large amount of dust per bag.

Once per week the sand should be emptied out of the blue bucket and returned to the top of the table. Sometimes it smells and needs to be rinsed well before dumping back with the rest of the sand. It does not have to be changed frequently, as long as new sand is added every now and then. The water should be changed regularly, too. You can dump the old water outside and fill the blue bucket using the hose from the men's bathroom (before the museum is open) or another smaller bucket carried from the sink in the back hallway. Using a dolly from beneath a garbage can helps in this process because the blue bucket can be heavy when filled with water and sand.

If the pump on the stream table is broken, take out the sign from the supply cabinet that says, "Station under repair," and tape it over the pump. Write it on the Communications Log and tell the Lab Supervisor about it. The visitors are not allowed to use the pump of the stream table if it is damaged.

In Appendix A, there is a demonstration lesson with the stream table for you to use. With practice, the demonstration can be very enjoyable for both visitors and yourself.

VII. Fish Tanks

There are 3 tanks of fishes and one of zebra mussels in the laboratory.. The fishes are fed Brine shrimp which are kept in the top part of the refrigerator in the back hallway. The shrimp should be distributed proportionally with the size and number of fishes living in each tank. The fish are fed once a day and you must make sure that some shrimp reaches all the fishes, even the ones that live near the bottom. Sometimes the shrimp runs out, but there is back up food if this happens in the gray cart in the back hallway. This must; however not occur; tell the Lab Supervisor if the shrimp is running out.

The hour the fish are fed, as well as the name of the person who did it, should be registered in the Communications Log inside the supply cabinet. There is not much danger of the fishes dying if they are not fed for short periods; in fact, many times the fishes are not fed one or two days during the weekends, but they should be fed regularly so as to maintain a healthy routine for all fish. If two or more fish are "not getting along with each other," the main thing to do is give them food if they have not already been fed.

Small nets for fish are kept in the gray supply cabinet. **Be sure not to use equipment for the zebra mussels with the fishes.**

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VIII. Zebra Mussels Tank

Zebra mussels are small animals, usually no larger than a fingernail. The typical juvenile mussel has a two double-shelled shape. The period of largest egg production of the zebra mussels is, in the Lake Erie, between early May and October. A fully mature female mussel may produce several hundred thousand eggs for season. Eggs are fertilized outside the mussel's body and within a few days develop into free-swimming larvae called **veligers**. Veligers remain suspended in the water for three or four weeks. If they don't settle onto firm objects in that time period they die. Those that find a hard surface quickly attach themselves to it with a tuft of fibers known as **byssus**, or byssal threads, from a gland in the foot. The byssus protrudes through the two halves of the shell. Mussels grow rapidly, nearly an inch in their first year, adding another one-half to one inch their second year. A zebra mussel becomes sexually mature within a year.

The zebra mussel is now well established in all of the Great Lakes and they are spreading into river systems outside the Great Lakes, including the St. Lawrence, Hudson, Illinois, Mississippi, Ohio, and Tennessee Rivers. Ultimately, zebra mussels will colonize most lakes and rivers in Canada and the United States.

Equipment for handling the zebra mussels is kept in the hallway and should never be used with the fish in the black tanks or in the river because the zebra mussels will spread!!!

The zebra mussels are fed small pinch of powdered larvae every couple of days. The powder is kept in a can on the gray cart in the back hallway. Be sure to register when you fed them in the communications log.

Zebra mussels in the Great Lakes: The invasion and its implications

OHSU-FS-045
by *Fred L. Snyder, David W. Garton, and Maran Brainard*, Ohio Sea Grant College Program.
1990. Revised 1991 & 1992.

The Great Lakes Sea Grant Network is a cooperative program of the Illinois-Indiana, Michigan, Minnesota, New York, Ohio, and Wisconsin Sea Grant programs. Sea Grant is a university-based program designed to support greater knowledge and wise use of the Great Lakes and ocean resources. Through its network of advisory agents, researchers, educators, and communicators, the Great Lakes Sea Grant Network supplies the region with usable solutions to pressing problems and provides the basic information needed to better manage the Great Lakes for both present and future generations. This publication was produced by Ohio Sea Grant for the Great Lakes Sea Grant Network. Sea Grant is in the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce.

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Zebra mussels (*Dreissena polymorpha*) were first discovered in the Great Lakes in 1988. Within one year, zebra mussels had colonized the surfaces of nearly every firm object in Lake Erie. Numerous populations of zebra mussels are now well established in all of the Great Lakes and are spreading into river systems outside the Great Lakes, including the St. Lawrence, Hudson, Illinois, Mississippi, Ohio, and Tennessee Rivers. Zebra mussels have been reported in several inland lakes, including Lake Wawasee in Indiana, Indian Lake in Ohio, Kentucky Lake and Dale Hollow Reservoir in Kentucky, and Balsam, Rice, and Big Bald Lakes in Ontario. Ultimately, zebra mussels will colonize most lakes and rivers in Canada and the United States.

Questions about zebra mussels abound but finding answers is much more difficult. What follows are answers to some of the more commonly asked questions about zebra mussels.

Close-up of a zebra mussel shows the tuft of byssal threads used for attachment. Particles on the ends of the threads are debris.

The invasion

Zebra mussels have been in western and central European waterways for nearly 200 years. However, comparing the Great Lakes to European lakes won't predict the impact on any Great Lake with accuracy. Europe's industries and commerce developed on water bodies already populated with zebra mussels. *Dreissena* arrived in North America to find industrialized, plankton-filled Great Lakes that supports multi-million dollar sport and commercial fisheries.

Dreissena polymorpha is a native of western Russia, near the Caspian Sea. Canals built during the late 1700s allowed the mussels to spread throughout eastern Europe. During the early 1800s, canals were built across the rest of Europe. The canals made bulk shipping much easier but also allowed rapid expansion of the zebra mussels' range. By the 1830s the mussels had covered much of the continent and had invaded Britain.

The successful introduction of zebra mussels into the Great Lakes appears to have occurred in 1985 or 1986 when one or more transoceanic ships discharged ballast water into Lake St. Clair. The freshwater ballast, picked up in a European port, contained zebra mussel larvae and possibly juveniles. Alternately, adult mussels may have been carried in a sheltered, moist environment, such as a sediment-encrusted anchor or chain. Being a temperate, freshwater species, they found the plankton-rich Lakes St. Clair and Erie to their liking.

The zebra mussel

The mussel's reproductive cycle is one key to its rapid spread and high abundance. Egg production starts when the water temperature warms to about 54° (12°C), usually early May in Lake Erie, and continues until the water cools below 54°, generally in October. In Lake Erie, spawning (the release of eggs and sperm) peaks during July and August at water temperatures above 64° (20°C). A fully mature female mussel may produce several hundred thousand eggs per season.

Eggs are fertilized outside the mussel's body and within a few days develop into free-swimming larvae called veligers. Veligers remain suspended in the water for three to four weeks, drifting with the currents. If they don't settle onto firm objects in that time period, they die, and the vast majority actually suffer this fate. Those that find a hard surface quickly attach themselves and transform into the typical, double-shelled mussel shape, and are then considered to be juveniles. A zebra mussel becomes sexually mature within a year. Mussels grow rapidly, nearly an inch in their first year, adding another one-half to one inch their second year. European studies report mussels may live four to six years, but in Lake Erie three years seems to be the maximum life span and the average is much less.

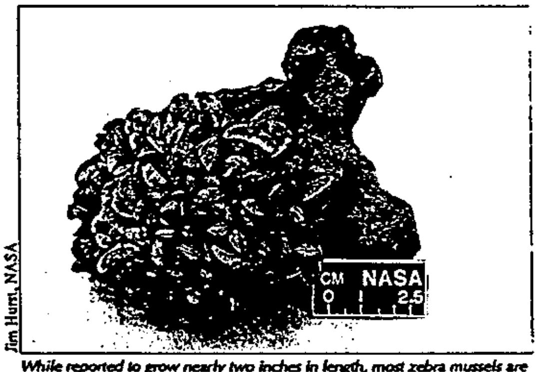
Zebra mussels generate a tuft of fibers known as a byssus, or byssal threads, from a gland in the foot. The byssus protrudes through the two halves of the shell. These threads attach to hard surfaces with an adhesive secretion that anchors the mussels in place. Small juveniles can actually break away from their attachments and generate new, buoyant threads that allow them again to drift in the currents and find a new surface.

Any firm surface that is not toxic can be colonized by zebra mussels. Rock, metal, wood, vinyl, glass, rubber, fiberglass, paper, plants, other mussels—the surface need only be firm. Beds of mussels in some areas of Lake Erie now contain over 30,000, and sometimes up to 70,000 animals per square meter.

Zebra mussel colonies show little regard for light intensity, hydrostatic pressure (depth), or even temperature when it is within a normal environmental range. Colonies grow rapidly wherever oxygen and particulate food is available and water currents are not too swift (generally less than six feet per second). Thus, colonies are rare in wave-washed zones except for sheltered nooks and crevices. In most European lakes the greatest densities of adult mussels occur at depths ranging from 6 to 45 feet.

Zebra mussels also colonize soft, muddy bottoms because hard objects deposited in or on the mud, such as pieces of native mussel shells, act as substrate (base) for settling veligers. As a few mussels begin to grow, they in turn serve as substrate for additional colonization. In this way, extensive mats of zebra mussels can form on soft lake bottoms.

The free-swimming veligers usually reach their greatest abundance at depths of 10 to 23 feet and usually do not descend below the thermocline, into the lower colder heavier oxygen-poor water. Veligers are the life stage most sensitive to low temperature. Juveniles are more sensitive to low temperature than adults. All life stages are sensitive to low levels of dissolved oxygen, particularly as temperature increases. Some juveniles migrate by drifting from shallow habitats occupied in late summer to deeper waters during winter.



While reported to grow nearly two inches in length, most zebra mussels are the size of a fingernail. Tiny zebra mussels (juveniles) readily attach to older ones, causing colonies to grow rapidly to depths of several inches.

Biological and ecological concerns

The feeding method of zebra mussels points to one of the growing concerns in regard to aquatic food chains. Each adult mussel is capable of filtering about one liter of water per day. Nearly all particulate matter, including phytoplankton and some small forms of zooplankton, are removed. Literature reviews suggest that zebra mussels eat mostly algae, but select primarily the 15-40 micrometer size range for consumption. Instead of passing any uneaten phytoplankton back into the water, mussels bind it with mucous into pellets called pseudofeces. Pseudofeces are ejected and accumulate among the shells in the colony. Thus, zebra mussels can remove significant amounts of phytoplankton from the water. Phytoplankton are the food source for microscopic zooplankton, which in turn are food for larval and juvenile fishes, and other plankton-feeding forage fish supporting sport and commercial fisheries. This competition for phytoplankton, the base of the food chain, could have a long-term negative impact on Great Lakes fisheries. Other Great Lakes fisheries less dependent upon plankton as a food base may experience fewer impacts from zebra mussels.

Recent studies in Lake Erie have examined the relationship between seasonal populations of zooplankton in areas with very high zebra mussel densities. Other studies suggest that detritus, small particles of organic matter, also may have a significant role in zebra mussel feeding. Observations of the effects of zebra mussel filtration upon the food base for fish communities are still inconclusive.

Researchers as well as boaters have noted greatly increased water clarity in Lake Erie between 1989 and 1991. Shallow embayments are being recolonized by rooted, aquatic plants since turbidity no longer shades them out. A significant part of this change in clarity has been attributed to the filtering activities of zebra mussels.

Biologists were also concerned about zebra mussel colonies covering rock reefs. Most rocky areas in Lake Erie are almost completely covered with mussels several inches deep. In laboratory observation, the accumulation of pseudofeces in these beds creates a foul environment. As waste particles decompose, oxygen is used up and the pH becomes very acidic. Such poor environmental conditions potentially could hinder normal egg development of reef-spawning fish (walleye, white bass, and smallmouth bass). Results of initial American and Canadian studies indicate eggs and fry of walleye develop normally on mussel-covered reefs.

Zebra mussels are known to be intermediate hosts for a number of parasites that can also infect fishes and birds. While the European experience with *Dreissena* has not indicated a major problem with diseases or parasites, it merits further observations in North America.

Native North American mussels (family *Uniodidae*) have suffered as a result of encrustation by zebra mussels. Zebra mussels readily settle on live native mussels, sometimes several thousand zebra mussels are found on a single native mussel. In Lakes St. Clair and Erie heavy fouling by zebra mussels has severely reduced populations of native mussels. Some native mussel species are more tolerant to fouling than others, but even for these "resistant" species, zebra mussel encrustation leads to reduced energy reserves and leaves them vulnerable to other environmental stressors. In addition, a number of native mussel species are very rare and are officially listed as endangered species. As zebra mussels spread, biologists are concerned that populations of native mussels will decline, and perhaps some of the rarer species may be completely eliminated.

Industrial, commercial, & recreational concerns

The zebra mussels' proclivity for hard surfaces located at moderate water depths has made water intake structures, such as those used for power and municipal water treatment plants, susceptible to colonization. Since 1989, some plants located on the shorelines of Lake Erie have reported significant reductions in pumping capabilities and occasional shutdowns due to zebra mussel encrustment.

Several approaches to zebra mussel control on intake structures have been examined, including prechlorination, preheating, electrical shock, and sonic vibrations. Control methods that currently appear most feasible include prechlorination, ozone, potassium permanganate injection, and sand bed filtration. Prechlorination has been the most common treatment used to date; but it also raises concerns about the toxicity of chlorinated compounds to other aquatic organisms.

Zebra mussels are very sensitive to high temperatures. Researchers have obtained 100 percent mortality after five hours at 90°F, but after only 15 minutes at 104°F. Other reports show minor variation around these figures, but clearly indicate that heat can be an effective control for zebra mussel infestations. It is, however, difficult to safely apply heat to large underwater structures.

Recreational industries along Lake Erie have been impacted by zebra mussels. Unprotected docks, breakwalls, boat bottoms, and engine outdrives were rapidly colonized during 1989. There had been numerous reports of boat engines overheating due to cooling water inlets being clogged by colonies of zebra mussels. Boaters need to make frequent inspections of these areas in the future. Boats painted with approved antifouling paints containing copper have been effective in resisting zebra mussel attachment. However, copper-based paints corrode aluminum. Paints containing slow-release polymers of tributyltin (TBT) are also effective. However, these paints are banned in Michigan and restricted in other states. For more information on approved antifouling paints, contact your state's Department of Agriculture.

Beaches are also affected by zebra mussels. By autumn of 1989, extensive deposits of zebra mussel shells could be seen on many Lake Erie beaches. The extent of these deposits varied with successive periods of high wave activity. Sharp-edged shells accumulating along swimming beaches could be a hazard to unprotected feet.

Zebra mussel control

Lakewide control of zebra mussels is simply out of the question. After two centuries of infestation, the European community hasn't been able to develop a chemical toxicant for lakewide control that isn't deadly to other aquatic life forms.

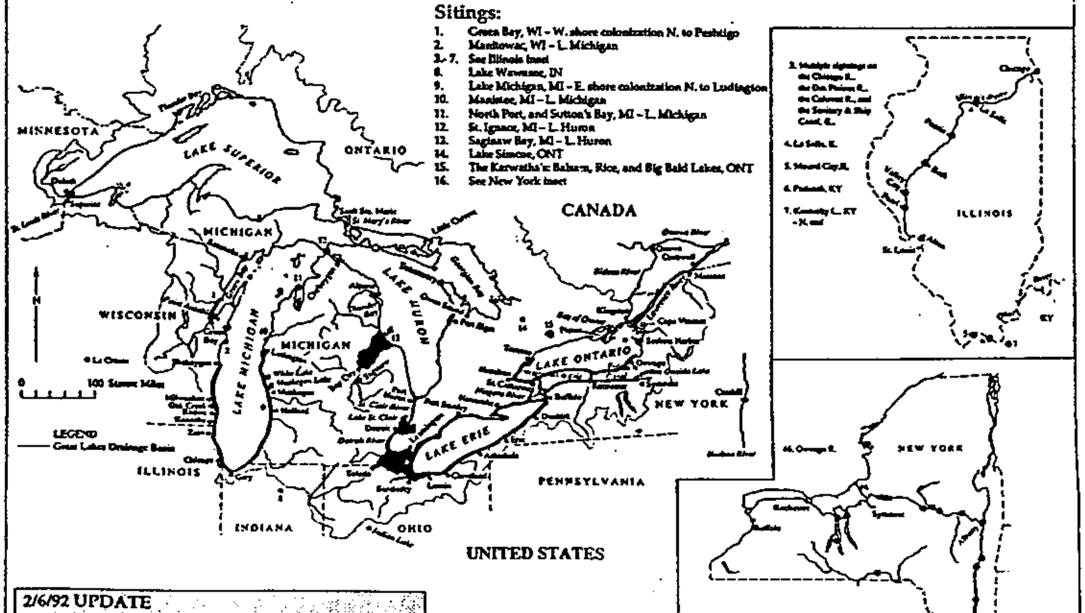
In some parts of Europe, large populations of diving ducks have actually changed their migration patterns in order to forage on beds of zebra mussels. The most extreme case occurs in Germany's Rhine River, which hosts high densities of zebra mussels. Overwintering diving ducks and coots were seen to consume up to 97 percent of the standing crop of mussels each year, although high mussel reproduction rates replenished the population each summer.

In North America, the most likely duck species that might prey on zebra mussels are scaup, canvasbacks, and old squaws. Populations of these species are quite low, in fact, canvasbacks are so rare they are a totally protected species. In the Great Lakes, diving ducks are migrating visitors, pausing only

Range of the zebra mussel in North America as of 26 November 1991

Compiled by New York Sea Grant with information from: Empire State Electric Energy Research Corp., Fisheries and Oceans Canada, Illinois-Indiana Sea Grant, Michigan Sea Grant, Minnesota Sea Grant, Ohio Sea Grant, Ontario Hydro, Ontario Ministry of Natural Resources, US Army Corps of Engineers, US Fish & Wildlife Service, Wisconsin Sea Grant.

Note: The Kenosha (WI); Cheboygan (MI); Indian Lake (OH); and Ottawa (ONT) sitings were all on "movable substrates" (boats, barges, driftwood, etc.) and DO NOT INDICATE COLONIZATION AT THIS TIME.



2/6/92 UPDATE

Zebra mussels were discovered at Indiana and Michigan Electric Company's plant in Rockport, Indiana located to feed during north- and southward migrations. However, Canadian researchers have documented increasing numbers of migrating ducks around Pt. Pelee (western Lake Erie), and these ducks were observed to be feeding heartily on zebra mussels. In southern Lake Michigan, zebra mussels encrusting an underwater power plant intake have attracted flocks of greater and lesser scaup. Unfortunately, some became confused and were pulled into the intake pipe and drowned. The stomachs of these dead scaup were full of zebra mussels. Therefore, North American waterfowl do feed on zebra mussels, whether or not this predation will have an impact on zebra mussel population remains to be seen.

Some fish species are likely to include zebra mussels in their diet, but research is needed to determine which species will act as predators and how many mussels they can eat. Freshwater drum, or sheepshead, are known to feed substantially on zebra mussels, and yellow perch have been seen to feed on juvenile zebra mussels, particularly when the mussels are detached and drifting.

One novel approach to controlling zebra mussel populations is by disrupting the reproductive process. As mentioned earlier, zebra mussel eggs are fertilized externally, therefore males and females must release their gametes (sperm and eggs) simultaneously. After release, zebra mussel sperm remain viable for only a short time; perhaps only a few minutes. Disrupting the synchronization of spawning by male and females will effectively reduce the numbers of fertilized eggs, and hence fewer zebra mussels will be found in the next generation. Researchers are currently studying the environmental cues and physiological pathways that coordinate spawning activity in zebra mussels.

Second species of Dreissena *discovered*

European (mostly Russian) literature describes several species of mussels in the genus *Dreissena* based on morphology, physiology, and geographic distribution. It was thought only one, *Dreissena polymorpha*, had been introduced into North America.

However, a second species of *Dreissena* has been discovered in North America. Its identification has not yet been confirmed but it is morphologically and genetically different. Its shell is rounder and squatter in shape than *D. polymorpha*. It is present in much lower numbers than *D. polymorpha* and is more common in Lake Ontario than in Lake Erie.

The prodigious filtering of water by zebra mussels may increase exposure risk to humans and wildlife to organic pollutants (PCBs and PAHs). Early studies have shown that zebra mussels can rapidly accumulate organic pollutants within their tissues to levels over 300,000 times greater than concentrations in the environment or can deposit these pollutants in their pseudofeces. The fate of the chemicals depends in part on the suitability of the food source. These pollutants found in algae and sediments are persistent and can be passed up the food chain. Any fish or waterfowl consuming zebra mussels will also accumulate these organic pollutants. Likewise, human consumption of fish and waterfowl from areas with zebra mussels could risk increased exposure to these same pollutants. The implications for human health are unclear.

Spread to inland waters

Zebra mussels can spread to other inland waters either as veligers transported in water, or as adults attached to boat hulls, engines, and fish cages, or on any number of other items. Veligers attached to boats don't survive drying but they can survive in any residual water source. Waterfowl and other wildlife also may transport zebra mussels, carrying veligers and/or adults in wet fur or feathers.

Adult zebra mussels are very hardy, and with their shells closed, can survive drying for several days. In moist environments, they can survive out of the water even longer.

Before transferring a boat from a zebra mussel infested waterbody to inland waters, wildlife agencies urge boaters to clean boat hulls, trim tabs, outdrives, and outboard lower units or to leave the boat out of the water for 10 to 14 days. Live wells and bilges can be disinfected with one part chlorine bleach to 10 parts water for several hours. *This solution should not be discharged into lakes or streams due to its toxicity to aquatic life.* An effective alternative is to coat all boat and engine surfaces exposed to water with approved antifouling paints. Do not paint the inside of live wells or bait wells. For more information for recreational boaters, request the publication *Slow the spread of zebra mussels, and protect your boat too*, FS-054, from Ohio Sea Grant.

Veligers can be transported very easily in water used in live bait containers. Minnows or crayfish used or collected in lakes containing zebra mussels should be transferred to well water or aged chlorinated tap water before carrying them to other bodies of water.

Most authorities consider the spread of zebra mussels across North America to be a certainty. The southward spread probably will be limited by average summer water temperatures above 81°F. The northward spread might be limited by soils deficient in calcium or by summer water temperatures below 54°F. This region extends from the East Coast to the West Coast and from Canada to the southernmost states.

The zebra mussel is now a permanent part of the Great Lakes environment. Increased support for research is needed to gain understanding of its effects upon the lakes' ecosystems and industries, economic implications, natural predators, spawning activity, and pollutant uptake. Theoretically, zebra mussel populations should peak a few years after initial infestation and then decline, depending upon predation and on each lake's carrying capacity. There is little doubt that the zebra mussels' impact will be felt by great numbers of people who use the Great Lakes.

Role

Roles of agencies in the Great Lakes include:

- U.S. Fish & Wildlife–monitor and research
- Coast Guard–regulatory activities
- Great Lakes Environmental Research Lab, NOAA–research
- Great Lakes Fishery Commission–research
- Great Lakes Commission–policy development and coordination
- Sea Grant–research, education, and technology transfer

For other publications, newsletters, conference and workshop announcements, or for advice from a local expert, contact the Sea Grant program or state natural resources management office nearest you.

Illinois/Indiana Sea Grant Extension	708/818-2901
Michigan Sea Grant	313/764-1138
Minnesota Sea Grant Extension	218/726-8106
New York Sea Grant Extension Zebra Mussel Clearinghouse	800/285-2285
Ohio Sea Grant	614/292-8949
Wisconsin Sea Grant	608/263-5371

Safe use of zebra mussels in classroom and laboratories

by *Thomas G. Coon,*
Department of Fisheries and Wildlife
Michigan State University
13 Natural Resources Building
East Lansing, MI 48824

The Great Lakes Sea Grant Network is a cooperative program of the Illinois-Indiana, Michigan, Minnesota, New York, Ohio, and Wisconsin Sea Grant programs. Sea Grant is a university-based program designed to support greater knowledge and wise use of the Great Lakes and ocean resources.

Through its network of advisory agents, researchers, educators and communicators, the Great Lakes Sea Grant Network supplies the region with usable solutions to pressing problems and provides basic information needed to better manage the Great Lakes for both present and future generations.

Sea Grant is a program in the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce

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Michigan Sea Grant
University of Michigan
4113 I.S.T. Building
2200 Bonisteel Boulevard
Ann Arbor, MI 48109-2099
313/764-1138

Ohio Sea Grant
The Ohio State University
1314 Kinnear Road
Columbus, OH 43212-1194
614/292-8949

Zebra mussels (*Dreissena polymorpha*) were accidentally introduced into North American waters in the mid-1980s. Since that time, they have spread throughout the Great Lakes region and into the Mississippi River basin. They have attained considerable notoriety because they are extremely prolific and move into new regions fairly quickly, but most importantly because they clog water intakes and plumbing systems and foul boat hulls, docks and other submerged surfaces.

Several fact sheets on the biology and control of zebra mussels are available from Sea Grant offices. See the references at the end of this fact sheet or contact the nearest Sea Grant office for more information.

Some of the features that make zebra mussels a nuisance also make them interesting for use in the classroom. Adult mussels can be kept alive easily in a simple aquarium system for at least several days, and they readily exhibit interesting facets of animal behavior, physiology and ecology.

However, zebra mussels are not native to North American waters and they can be a costly nuisance. Because of this, it is important to use extreme caution when using them for class instruction. It is imperative that classroom use not result in the release of live mussels—either adults or larvae—into lakes, streams or plumbing systems, either by accident or by intent.

To understand the basis for control measures, it is important to understand a few aspects of zebra mussel biology, specifically, their means of transport and their tolerance of adverse conditions. Adult zebra mussels attach themselves to hard substrates such as rocks, other mussels, logs, boat hulls and the inner walls of pipes with secreted fibers called byssal threads. It is when these attached mussels accumulate (up to hundreds of thousands per m^2) that they become a nuisance to industries, municipal water suppliers, power plants and other water users. Adult mussels can survive being detached from their substrate, and they can crawl along the substrate to find new attachment sites. In fact, adult mussels will readily detach themselves from a substrate, crawl to another substrate and reattach.

The primary means of dispersal for zebra mussels is not the movement of adult mussels, however. Rather, zebra mussels spread as their planktonic larvae are carried by water currents into previously mussel-free habitats. Though this passive transport can only occur downstream in rivers, it assures broad dispersal of mussels within a lake basin.

However, zebra mussels can and do move upstream and against lake currents—with human help. For example, larvae can be carried in the bilge water of boats (including pleasure craft) traveling upstream or being transported over land to upstream waters. Adult mussels attached to boat hulls, trailers, anchors or ropes can also be transported upstream by boat travel. Adult mussels, in particular, can survive out of water for days simply by closing their valves and slowing their metabolic processes.

These "opportunistic" characteristics make it imperative that people take precautions to prevent the spread of zebra mussels into waters where they could not go without our assistance. For example, zebra mussels have effectively surrounded lower Michigan by colonizing Lakes Erie, St. Clair, Huron and Michigan. However, they have only been found in a few inland water bodies. These invasions occurred when boats from the Great Lakes were transported to these inland lakes.

Even in areas where zebra mussels are established, it is important to use them with caution in the laboratory. For example, a flow-through aquarium that drains into a sink or floor drain could introduce mussels into plumbing and eventually clog the plumbing and require expensive repairs.

We recommend several preventative measures for teachers and students to follow to ensure against introducing zebra mussels into plumbing or inland waters.

First, know the current status of zebra mussels in your area. You can get this information by calling your state's Sea Grant office or natural resources agency or the zebra mussel hotline operated by New York Sea Grant.

Are zebra mussels present in the lakes or streams around your school? If mussels are not present in your area's surface waters, then you should not transport them to your lab or classroom from infested areas. Transportation across state lines is generally illegal and many states forbid transporting them anywhere within the state. If there are no mussels in your area, do not use them in your class but go to a site that is already infested to study them. In other words, confine your use of zebra mussels to field trips to areas where they are already present.

Do not bring live mussels, water that was in contact with zebra mussels or items that have been in contact with water that contained zebra mussels back to your classroom. The water may contain microscopic larvae, and items with hard surfaces may have tiny post-larval mussels attached. To avoid the risk of introducing zebra mussels to the interior waters of Michigan, Michigan State University researchers have conducted their research with live mussels at F.T. Stone Laboratory, Ohio State University's biological field station on Lake Erie.

Second, if you do use zebra mussels, water or items that have been in contact with zebra mussels in your classroom, quarantine them from contact with your plumbing system and the surface waters in your area. In other words, keep the mussels and water in closed systems.

Third, treat any items that have been in the water with mussels (such as gravel, rocks, filters, siphon tubes, plants, etc.) with a 10% solution of household chlorine bleach before using them again. This will kill any attached larvae, juvenile or adult mussels. Also, be sure to treat any water that has come into contact with mussels before disposing of it. The preferred treatment is a bleach solution (1 part full-strength bleach to 9 parts water, minimum 30 minute exposure). Alternatives include exposure to hot water $\geq 40°C$ (104°F) or hot salt water (≥ 3 parts per thousand) for at least 15 minutes or freeze samples at -18°C (0°F) for a minimum of 24 hours.

We recommend using a water-proof bin or tub to soak all items that came into contact with zebra mussels or zebra mussel water and a separate container for discarded zebra mussel water. Keep these containers away from sink and floor drains so that untreated spillage does not escape down the drain. At the end of each day, treat both containers with chlorine bleach or hot water as prescribed above. This will kill any remaining larvae, juvenile or adult mussels. Overnight exposure is more than long enough to kill remaining mussels, as long as concentrations are appropriate. You may want to place several live adult mussels into the treatment water to verify that your treatment is adequate to kill zebra mussels.

Fourth, dispose of any treated water very carefully. Do not pour chlorinated water or salt water directly into a lake or stream—this is toxic to resident organisms. You may likely pour the treated water down your drain, but use caution. Large volumes of chlorinated water may cause problems for your wastewater treatment facility. Check with the facility's operators to see if they have any special concerns or suggestions.

Fifth, know where your drain goes. Some floor drains go directly to a storm sewer or open body of water. It's best to avoid these. Passing the treated water through a wastewater treatment plant further ensures that no mussels survive your treatment efforts.

The only other appropriate way to dispose of treated water is to pour it over very porous (sandy) soil—far from a surface water body or storm sewer.

Zebra mussels and other exotic organisms can be effective teaching tools for a variety of biological topics. However, careless use of any exotic species will likely result in an undesired, costly lesson—both in terms of potential repairs and in terms of adverse ecological effects on your local aquatic ecosystems. To avoid this, use any exotic species with caution and take all necessary precautions to prevent release of live exotics into aquatic or terrestrial ecosystems!

For information about Sea Grant's work on zebra mussels, contact the Great Lakes program nearest you. If you are interested in another area of the country, ask for the phone number of any of the 23 coastal Sea Grant programs.

Illinois-Indiana Sea Grant Program
University of Illinois, 65 Mumford Hall, 1301 West Gregory Drive, Urbana, IL 61801, 217/333-9448

Michigan Sea Grant College Program
4113 IST Building, 2200 Bonisteel Boulevard, Ann Arbor, MI 48109-2099, 313/764-1138

Minnesota Sea Grant College Program
1518 Cleveland Avenue North, Suite 302, St. Paul, MN 55108, 512/625-6781

New York Sea Grant Institute
Hartwell Hall, SUNY College at Brockport, Brockport, NY 14420-2928, 716/395-2638 or 800/285-2285

Ohio Sea Grant College Program
The Ohio State University, 1314 Kinnear Road, Columbus, OH 43212-1194, 614/292-8949

Wisconsin Sea Grant Institute
ES 105, UW-Green Bay, Green Bay, WI 54311-7001, 414/465-2795

IX. Sources Table

The books on this table should be neatly arranged. It doesn't matter if they are standing or laying flat, but they should be kept neatly arranged so that the visitors respect them. On the table there should be a sign that says; "Look at Our Resources but Do Not Remove from the Lab!". All the books should be labeled inside with the logo of "Chicago Academy of Sciences." There should always be chairs near the table so that the visitors can sit and read. When you are working in the lab, encourage them to do so.

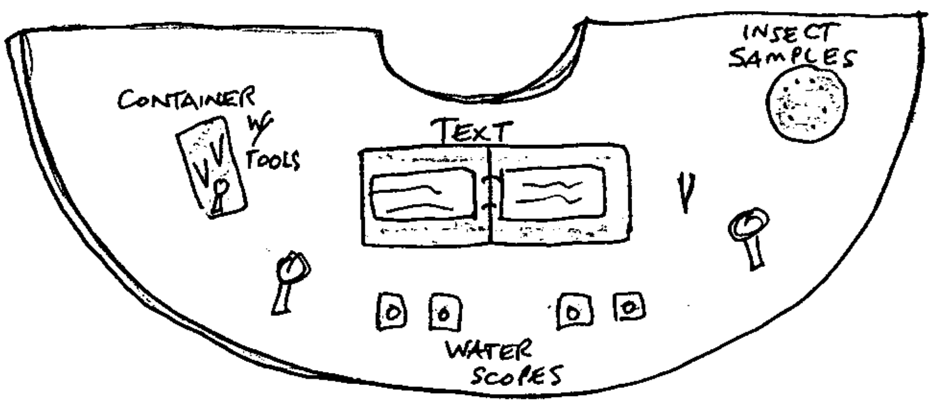
Depending on supply, there may be a variety of state and national publications available at this station for distribution. This table, and all tables should be clean and look presentable.

X. Microscopes Table

Macro and micro organisms can be explored at this station. Specimens can be viewed through hand lenses and water microscopes. The river section provides live samples of aquatic plants and benthic, or bottom dwelling organisms, for viewing.

The microscope table consists mainly of small plastic microscopes in which the visitors can examine the Chicago River Water. Those should be on the table, maybe with some water in them already. This table also has as an exhibit, a container with small dissected River insects and a magnifying glass to observe them. There is also another microscope; this one, bigger, is inside the supply cabinet. You can take it out if you want, just remember to put it away in the supply cabinet as it was.

The monitor and the Microscopic Camera can be brought out when staff are in the Lab. The Microscopic Camera, when connected to the monitor, will magnify anything that is on a right line to it, and it will pass these images to the monitor. Because of the fragility and cost of these objects, they are used only when staff are present. The monitor is kept in the back hallway and the camera in the supply cabinet; for this reason, it is very important to keep the supply cabinet locked!



DIRECTIONS FOR SETTING UP THE MICROSCOPIC CAMERA

1. Go to the back hallway. There you will find the monitor and the base for the microscopic camera. There may be two televisions back there at certain times. Don't get confused (the monitor looks like a television set), the monitor is to your left as you enter.

2. Take the base with you. The base has a square at the bottom. It has a long tube sticking out of the square. Going along the tube there is a black movable piece and it is on top of the monitor so you won't miss it; besides, it is about two and a half feet high.

3. Put the base on the right side of the microscopes table; you will need to move some of the materials that are on the table.

4. Get the monitor and put it to the right of the microscopes table. If you need to move one or two chairs from the Sources Table, do it; just remember to put them back when you put away the monitor.

5. Plug the monitor in. You can do this in a white extension bar, on the floor, just below the microscopes table. You can plug the monitor in two different ways. There is a cable attached to the monitor; in the first one you plug that cable directly in the white extension bar. The second way is to connect the cable attached to the monitor in the extension that the monitor already has in the back; and then plug the cable of that extension in the white extension bar. The white extension bar stays where it is always.

6. Press the "POWER" button to turn on the monitor. Make sure monitor is on VIDEO 1.

7. Get the Microscopes materials kit from the supply cabinet that is next to the big microscope. Inside you will find some materials you will need.

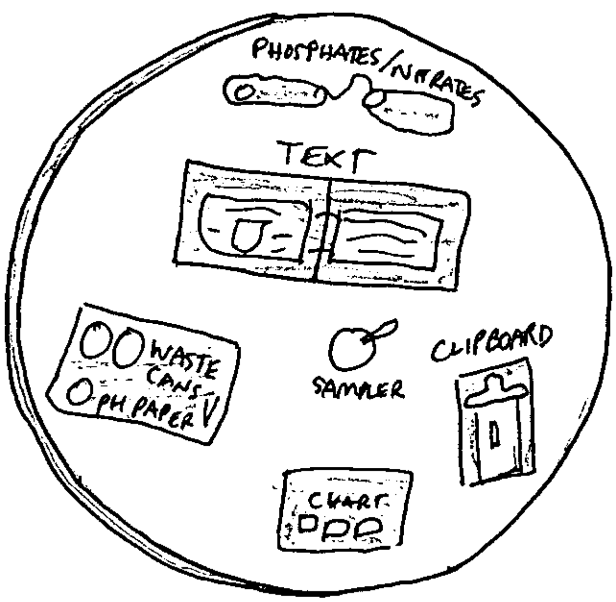
8. Find the camera inside the kit. It is a gray rectangle with a black lens. There are two small holes on this gray rectangle-like object. Find the one that is on the same side as the company sticker. Find a mounting device on the base. This device looks like a small black disk with a little piece-of-nail sticking out. Attach the camera to the mounting device by screwing the camera in the mounting device with the hole that has the sticker. You will know when it is closed because you will feel a small "crack."

XI. "What's in the Water?" Table

Phosphates and nitrates are important indicators of water quality. Excessive amounts of these substances can cause enrichment of the water and cause unusual plant growth which, in turn, will affect the oxygen levels in the water. A variety of sources are identified here. pH is also one of the major water quality tests performed at this station. Visitors can learn about acid rain and its effects, and perform pH tests using their samples or samples from our river section.

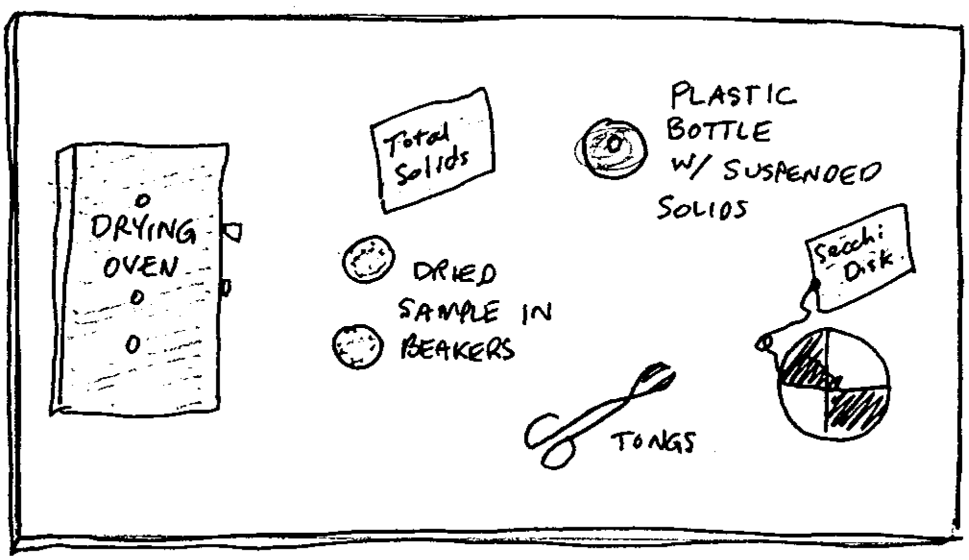
This table has information in how to find out the acidity of the Chicago River by a pH test. To do this test you only put pH paper in the water, see its color change, and then compare it to the chart in the book. pH paper is in a small bottle on the table. There is more of these paper in the supply cabinet if needed, but there must only be about 15 or 20 pieces of paper on the table; otherwise the people will waste it.

If the lab is being used as Scenario B, this table contains the tests for phosphates and nitrates as well as pH tests.



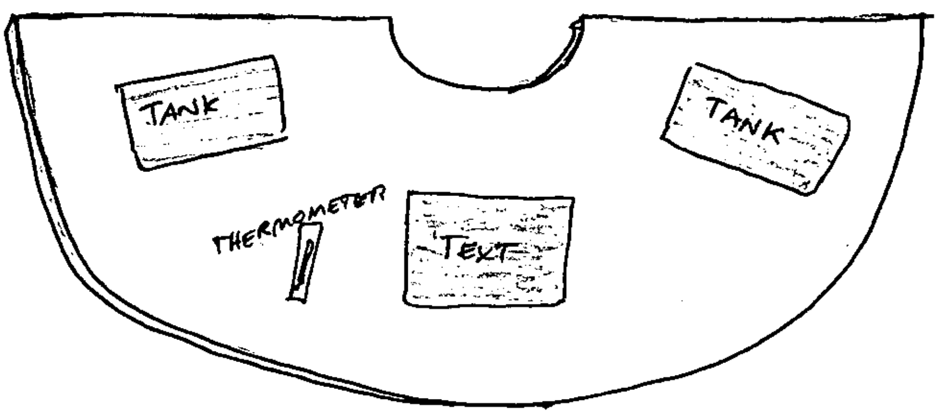
XII. Total Solids Table

Total solids (material that is suspended and dissolved in water) has a direct effect upon water clarity. An oven is available to remove the water to find the residue which is then massed. Samples of test results will be on display at this station.



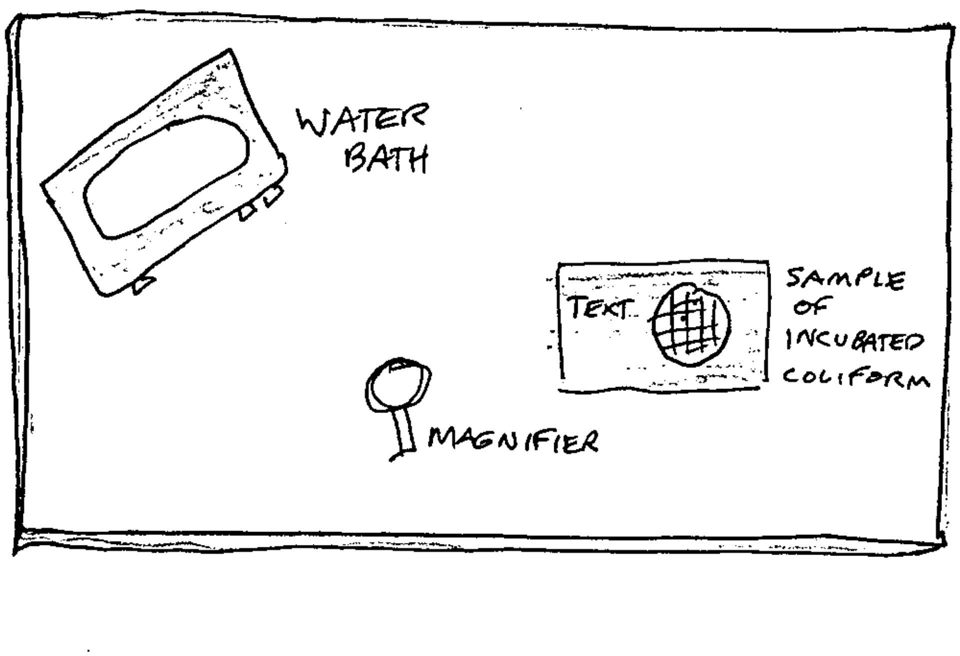
XIII. Oxygen Table

Oxygen is essential for all animal life. Consistently high levels of dissolved oxygen indicate a healthy lake or river system. Chemical tests are performed to determine the amount of dissolved oxygen in a sample of water. At this station, you can learn about these tests, take temperature readings using thermometers to see the important relationship between temperature and dissolved oxygen, and see results from samples of our own river section.



XIV. Fecal Coliform Table

Fecal coliform bacteria are an important indicator of water quality. This lab station contains the equipment needed to filter water samples to remove the coliforms and conduct the 24-hour incubation. Samples and techniques of this process will be on display.



XV. Computer

The computer in the Lab works primarily as a database where statistics about the various water experiments are stored. The computer is usually not used by visitors because to use it they have to do all experiments and calculate a WQ index, so it should have a plastic cover to protect it from dust.

Later on, we hope to purchase programs that are effective, have illustrations and attract attention so visitors can use the computer. In the meantime, the computer should be off at all times, unless somebody is doing experiments and the computer is going to be used for data entry.

After it has been on a while, a screen saver comes on, and you need a password to resume use. The password to access the computer is "RIVER."

XVI. Eye Cleaner

The eye cleaner is a green container next to the supply cabinet. Its purpose is to clean the eyes if someone gets a chemical in his or her eyes. The instructions for its use are written in the container.

Visitors keep emptying it when it is filled. For this reason, we only fill it with water on days when classes are visiting the lab and performing chemical testing.

XVIII. Water Bath and Oven

The water bath and oven should be off all the time unless somebody is doing an experiment, in which case it would be noted in the Communications Log. If the oven or the water bath or both are on, check to see if there is a note in the Communications Log about any experiment in progress. If there is none, turn them off. It is important for safety reasons that small children don't play with either the oven or the water bath. These items can be extremely hot and fragile.

XVII. Waste Management

There are three containers for Lab waste. The General Waste, the Liquid Waste and the Biohazardous Waste. Everyday waste (paper, glass, cardboard,...) is put in the General Waste. Water used during experiments and with or without chemicals in it, is thrown in the Liquid Waste container. Biohazardous waste includes used disposable gloves and waste from the fecal coliform experiment.

You won't have to deal with the Liquid Waste or the Biohazardous Waste; those are emptied on a regular basis by the Education Staff. You need to empty the General Waste in the big iron outside garbage can everyday at the beginning of the day and later in the day if there is already a lot of waste. It is important to throw the waste away, because if not, an odor may develop!

If by any chance you need paper towels or trash bags, and they are not inside the gray cabinet, go to the back hallway and get them. They are in a supply room in the back of the refrigerator.

XIX. Phone Numbers

In addition to the Lab Supervisor, the following individuals may be able to answer questions and help you out:

Ken	Education	extension	3064
Michelle	Education	extension	2034
Doug	Education	extension	2015
Tim	Exhibits	extension	3024
Admissions	Desk	extension	2025

There is no telephone in the lab. You can use the extensions upstairs at the front desk or downstairs, through the hallway at Joel's desk.

XX. Closing the Lab

1. Check to be sure the River level is normal, and that the pump does not sound abnormally loud. Remove any trash which might have entered the stream. Remove any sampling equipment and return it to the appropriate table, or to the gray supply cabinet.

2. Straighten the books at the Sources station. Arrange the chairs at the table.

3. Check the computer to be sure is off, and covered with its little plastic cover and that the chair is pushed in at the table. This station is not used as part of the exhibit yet.

4. Check the gray supply cabinet, in the corner by the plants, to be sure the handle is locked. Read the Communications Log if there is a question about missing equipment or equipment being used.

5. Clean the table tops at the stations and straighten the Scenario A materials.

6. Make your sand/pump checks on the Stream Table and set it up for use the next day. Wipe it down so that it is clean.

7. If you see any paper towels left around the room, please use the trash can marked General Waste to dispose of them. Sweep the floor. Empty the Trash in the General Waste container.

8. Turn off the lights in each of the four square black tanks located around the room.

9. Turn off the light switch for the overhead lights, which is located to the left of the door. Close the main door to the exhibit.

Appendix A

Stream Table Demonstration

This demonstration will:

- alert audiences to the fragile nature of our rivers and give them an increased awareness and sensitivity to water-related environmental issues
- provide audiences with hands-on experience with river dynamics (velocity, vegetation, shape, and effect of human activity on rivers)
- give audiences a basic knowledge of geologic vocabulary and river features
- encourage audiences to further explore variables on their own

<u>Materials</u>
stream table, sand, tools, toothpicks, polyfil

<u>Time Allotment</u>
one 20-minute session

<u>Advanced Preparation</u>
Put all of the sand in the stream table up in the top half of the table. Make an S-shaped meandering stream prior to group's arrival. Place toothpicks and polyfil on the banks of the first two bends.

Throughout the lesson, encourage visitor participation by allowing them to manipulate the stream and direct the discussion. Discussion and information should be based on interest level and background of the audience.

<u>Procedure</u>
Tap Prior Knowledge

1. This table shows us stream dynamics on an easy-to-see basis. Does anyone know what *dynamics* means? That's right. It means changing. A river changes its course and its speed or velocity, sometimes naturally, sometimes as a result of human interaction.

2. The course of a river is formed by natural forces, most of the time. What role does a river or stream play in changing its own course? What is *erosion*? What happened last summer in the Midwestern United States? The large amount of rain last summer caused the Mississippi to overflow its riverbanks. As a result, the river changed.

Introduce Activity

3. This is a basic meandering stream. The *source* of the river is here. (Point to the place where the water comes out of the pipe.) We have four bends in the river here. (Point to the four bends.) Streams and rivers all have drainage patterns. On level land, they create these S-shaped curves called *meanders*. This is the *mouth* of the river. (Point to the part where the water is opening out into the table.) The place at which the water flows into another body of water is called the mouth. This could be considered Lake Michigan, the backwater of the Illinois River, or the Mississippi River. Streams and rivers all have drainage patterns. On level land, they create these S-shaped curves called meanders.
4. The first two bends up here are protected areas. These are areas with trees and root systems holding the banks. We demonstrate this by using toothpicks for trees and polyfil pillow stuffing for root systems. What do you think will happen to these four bends? Will the water flowing along cut the banks at the same rate?

5. Have someone begin pumping water slowly. The water is flowing down, carrying *sediment*. Sediment is any loose material including sand, mud, gravel, etc. washed off by erosion and carried. There is no *delta* formed yet. Where would the delta be? It is a deposit formed as the river dumps its load. It is at the mouth of the river. Point out a photo of the Mississippi delta, if on the wall. Normally, the Mississippi carries about 600 million tons of rock particles each year. Last summer, I believe that amount was much higher.

6. As the water runs, you can see very quickly what happens to the banks that are unprotected. Note that erosion takes place more slowly on the far side of the bend. The points that are formed are called *point bars*. As the land is worn down one of these meanders may meet another to form a lake. Perhaps it will be a long curved lake called an *oxbow lake*.

7. Here pools and riffles are formed naturally, creating a great variation of habitat in the river system. In *pools*, it is quiet. The water isn't running as quickly. These are the preferred spots for many forms of aquatic life, and it is where decomposition takes place. The velocity of the current is slow enough to allow part of the load to settle down. Many people fish in these quieter pools because they know there will be many fish there. The turbulent **riffles** have a different chemistry, velocity, and depth.

8. As it meanders, the river dissipates energy. If it straightens (let students try it) or breaks through, the water will travel at a greater speed. If the depth is increased or decreased (let students try it), the speed will also change. These factors affect the types of plants and animals which live in the river.

9. You can see the delta forming by now.

Assessment

Assess understanding by posing open-ended questions.

- What would happen if we built a dam along our stream or river? You can specify a point along the river or have them show you a location.

- What is a sign of a mature river? It would be a river which had formed several meanders and had varied habitats within its system, perhaps.

- How would the slope of the river affect its dynamics?

- If you wanted to measure the amount of change along a meandering stream, how might you do it? They might position one post on the inside of the bend, and position several posts along the outside, and measure the changes along the banks.

Appendix B

Background Information

We depend on our rivers to provide clean and healthy water for recreational usage, municipal water supply, fisheries and wildlife habitat, water sources for irrigating cropland, scenic vistas, and to meet daily industrial demands. It is for these reasons, and many more, that citizens need to understand clearly what rivers mean to the quality of our lives. The impact of changing water quality in our local rivers over time is significant. We must recognize the names and responsibilities of organizations and agencies concerned with preventing degradation of our watershed areas and our waterways. It is also important for us to take some of the responsibility ourselves. Learning about the river and water quality monitoring is a step towards this responsibility. In addition to the chemical and biological tests, it is important to look at rivers systems. What flows into it? How is the land around it being used? We should look at the river from multiple perspectives: not just as scientists, but as artists, sociologists, economists, and politicians.

The following background information and timeline is based on information published by the Chicago Historical Society, Illinois Bell Educational Relations, the Chicago Sun-Times, and the Metropolitan Water Reclamation District of Greater Chicago. It is published in the Science Explorers' *Children of the River* curriculum.

History of the Chicago River

Over the centuries, the Chicago River has nurtured a great variety of life. Many Native Americans made its region their home, for the area was rich in wildlife, fish, and plant life.

The name of the Chicago River, and of the city itself, comes from an Indian word, but its various spellings and definitions have not been agreed upon by historians. Some say that Checagou was an adjective signifying "great" or "powerful." Others hold that it was an Indian word for an onion-like plant that grew along the banks of the river.

The Illiniwek, or Illinois, Indians who inhabited the area included bands of Kaskaskia, Cahokia, Tamaroa, Peoria, Michigamea, and Moingwena, among others. It was the Illiniwek name which, with some influence of the French explorers who dropped the last two syllables and added "ois," gave the Lake of Illinois (future Lake Michigan), the Illinois River, and of course the state of Illinois, their names. The original Indian name referred to "many men."

After DuSable explored the area and set up for trading, the first permanent settlers began to arrive. More and more people came to this swampy region and soon Chicago became a city. It didn't take long before the river and its inhabitants felt the impact of so many humans.

Soon the Chicago River became dirty and, as a result, it contaminated Lake Michigan. At that time, the river flowed directly into the lake. Something needed to be done because many people were getting sick. Many died as a result of drinking the dirty and contaminated lake water.

The engineers from the Chicago Sanitary District figured out a way to reverse the flow of the Chicago River away from Lake Michigan. This engineering feat, completed in 1900, changed the Chicago River and its surrounding environment forever.

Time Line for the Chicago River

1673 Father Jacques Marquette and explorer Louis Jolliet locate a place for a small canal to connect the Chicago and Des Plaines Rivers with the Illinois River. This would enable boats to go directly from Lake Michigan to the Gulf of Mexico.

1779 Jean Baptiste Point DuSable establishes a trading post on the north bank of the Chicago River.

1795 General Wayne forces Indians to cede huge tracts of land in the Midwest. This land includes six miles at the mouth of the Chicago River.

1804 Fort Dearborn is situated at what is now the south end of Michigan Avenue bridge.

1812 Indians ambush settlers at Fort Dearborn as they attempt to flee during very tense times on the frontier.

1818 Illinois becomes the 21st state of the Union.

1825 The Erie Canal opens, creating a new water route between Chicago and the East. Meanwhile, the Illinois and Michigan Canal Company is incorporated.

1830 James Thompson, surveyor, plots out the town of Chicago. It is bounded by Madison, Kinzie, State and Desplaines Streets. This is done so plots of land can be sold to finance construction of the new canal.

1832 Sauk warrior, Black Hawk, and his men wage war to regain their homelands, but are defeated. All of Illinois is now open for pioneer settlement.

1836 Work on the new canal begins.

1837 Chicago is incorporated into a city, with a population of 4,170.

1839 Chicago's role in the export trading business begins as the ship *Osceola* leaves with 1,678 bushels of wheat.

1848 The Illinois and Michigan Canal opens, linking the Atlantic Ocean with the Gulf of Mexico.

1855 Ellis Sylvester Chesbrough, engineer, develops a plan to raise sewers in the city high enough for wastewater to flow into the Chicago River. This has two results. The first is that virtually all city streets and many buildings need to be raised, some by as much as 12 feet. The second is that the city's water supply is now in danger of becoming contaminated (see 1885).

1856 Ice floes keep wiping out Chicago's wooden bridges. The first iron pivot bridge is built at Rush Street. Several years later, it swings open with a herd of cattle standing on it. The animals stampede and the bridge falls into the river.

1871 Great Chicago fire burns in a large section of downtown. The flames leap over the river, to the horror of thousands who had been watching the holocaust from the "safe" side of the stream.

1885 A six-inch rain hits the city, filling the Chicago River and causing sewage to flow far out into Lake Michigan. The city's drinking water is contaminated and 80,000 people die from typhoid, cholera, and dysentery.

1889 The Sanitary District of Chicago is created to protect the city's water supply.

1892 Construction of the Chicago Sanitary and Ship Canal begins. It is a 28-mile passage west of Chicago to reverse the flow of the Chicago River, via the Illinois River, in order to prevent further contamination of Lake Michigan. The canal opens in 1900.

1910 Locks are installed in Willmette Harbor. Water Reclamation Plants open in Stickney, Skokie, and Calumet.

1920 The Michigan Avenue Bridge becomes the world's first double-deck trunnion bascule bridge, spanning the Chicago River at Chicago's most important crossing.

1922 Locks are installed in Calumet River.

1927 Construction of the LaSalle Street Bridge and Bridge Houses begins. This trunnion bascule bridge is 86-feet wide and 242-feet across and is supported by pony trusses.

1928 At a cost of $9 million, the South Branch of the river is moved 1/4 mile west to make room for a railroad terminal and expansion of downtown Chicago.

1938 Chicago River Locks installed to control the amount of water diverted where the river meets Lake Michigan.

1955 The name of the Chicago Sanitary District is changed to the Metropolitan Sanitary District of Greater Chicago after services were expanded. It is later changed again to the Metropolitan Water Reclamation District of Greater Chicago.

1979 The Friends of the Chicago River organizes to promote education and preservation of the Chicago River.

1984 The Environmental Protection Agency decides that the Metropolitan Water Reclamation District no longer needs to add chlorine to all waste water treatment.

1985 The Tunnel and Reservoir (Deep Tunnel) Project begins operation. The first 31 miles is used to hold storm water until it can be treated, saving the river from harmful run-off.

1992 O'Hare Water Reclamation Plant opens in Des Plaines.

1992 Chicago's Loop is flooded when more than 134 million gallons of Chicago River water flows into a ruptured underground freight tunnel. The water fills sub-basements and basements in more than 50 office buildings.

Stream Dynamics

Many factors control the course and the life of a river. Some of them are natural, such as rain and temperature. Others are the result of human interaction or engineering, such as pollution and the construction of dams or locks. For example, when natural barriers are removed from a river's banks, high levels of phosphates and nitrates from fertilizers and animal wastes can be carried by the watershed run-off into the river. This leads to a process called eutrophication, or an increase in plant life in the aquatic environment. More plant growth may result in slower running water and the stagnation of the river, which in turn reduces the dissolved oxygen content of the water, making it a less hospitable environment for the plant and animal life in it. Some industries pollute not with chemical, but with thermal, discharges. Higher temperatures decrease the ability of the water to hold oxygen and, like the eutrophication process, will affect a river's ability to sustain life.

Erosion takes place as a result of forces like wind and glaciers. The most effective tool of erosion is water. Streams of running water wear away rock and move sediments downstream. The results of this erosion are evident in our environment. The Mississippi River, for example, carries about 600 million tons of rock particles each year. This sediment is deposited at the mouth of the river, in the Gulf of Mexico, creating the Mississippi Delta which can be seen in aerial photographs. The Grand Canyon, also, was formed after millions of years of water running through it. The erosion process is a powerful component of the natural rock cycle.

Appendix C

Water Quality Monitoring

There are nine standard water quality tests that are used in water quality monitoring. Together, they give a Water Quality Index where each test is weighted based on its relative importance. The following descriptions for these water quality parameters were taken from the Field Manual for Water Quality Monitoring by Mark K. Mitchell and William B. Stapp.

DISSOLVED OXYGEN

Dissolved Oxygen is essential for the maintenance of healthy lakes and rivers. The presence of oxygen in water is a positive sign; the absence of oxygen a signal of severe pollution. Rivers range from high levels of dissolved oxygen to those with very low dissolved oxygen levels, practically destitute of aquatic life. Most aquatic plants and animals need a certain level of oxygen dissolved in water for survival. Fish and some aquatic insects have gills to extract life-giving oxygen from the water. Some aquatic organisms like pike and trout require medium to high levels of dissolved oxygen to live. Other aquatic organisms like carp and catfish flourish in waters of low dissolved oxygen. Waters of consistently high dissolved oxygen are usually considered healthy and stable aquatic ecosystems capable of supporting many different kinds of life.

Much of the DO in water comes from the atmosphere. Waves on lakes and slow moving rivers and tumbling water on fast-moving rivers act to mix atmospheric oxygen with the water. Algae and rooted aquatic plants also deliver oxygen to water through photosynthesis. In lakes and impounded rivers, rooted aquatic plants are more abundant than in rivers with significant current. From morning through afternoon hours, then, DO levels rise because of photosynthesis. Late in the afternoon, oxygen levels are highest. As the sun sets, photosynthesis stops, but plant and animal respiration continues to use oxygen. Just before dawn, DO levels are at their lowest.

The build-up of organic wastes or wastes from once-living plants and animals (in the form of sewage, urban and agricultural runoff from rain and melting snow carrying organic wastes into the water, fertilizers that stimulate extensive growth of algae and other aquatic plants, discharge from food processing industries, meat packing plants, and dairies) and from the feces of animals contributes to changes in DO levels. Water temperature and the volume of water also affect DO levels. Gases, like oxygen, are more easily dissolved in cooler water than in warmer water.

Dissolved oxygen is measured by adding two chemicals to a sample of water and titrating a third chemical into the solution.

DOING THE DISSOLVED OXYGEN TEST

Materials

- Container to sample river water
- Waste containers
- Dissolved oxygen kit with chemicals
- Thermometer

1. Remove the stopper and immerse the DO bottle beneath the river's surface. Use gloves to avoid contact with the river.

2. Allow the water to overflow for two to three minutes (this will ensure the withdrawal of air bubbles).

3. Make sure no air bubbles are present when you take the bottle from the river.

4. Add the contents of pillow # 1 and pillow # 2.

5. Insert the stopper, making sure no air is trapped inside, and shake vigorously to fully mix. Be very careful not to splash the chemical-laden water; *wash your hands if you contact this water.* If oxygen is present in the sample, a brownish-orange precipitate will form (floc). If air bubbles form after the first shake, discard the dissolved oxygen sample and begin again.

6. Allow the sample to stand until the precipitate settles halfway. When the top half of the sample turns clear, shake again, and wait for the same changes.

7. Add pillow # 3 to sample and shake. The precipitate will dissolve and the water will turn yellow.

8. Pour sample to the top of the measuring tube; pour the contents of the measuring tube into the square mixing bottle. *Do this one more time.*

9. While swirling the sample, use the dropper to add the titrant (sodium thiosulfate) to the prepared sample--*count* each drop of titrant added. *Count* the number of drops needed to change the sample from yellow to a clear solution. Hold the bottle against white paper to see the color change accurately. Each drop equals 0.5 mg/liter of Dissolved Oxygen.

10. Use a thermometer to measure the temperature of the water sampled. Use the charts in the Water Testing Manual to determine the % saturation.

BIOCHEMICAL OXYGEN DEMAND

Biochemical oxygen demand is a measure of the quantity of oxygen used by microorganisms in the aerobic oxidation of organic mater. Organic matter is fed upon by aerobic bacteria that require oxygen. In this process, organic matter is broken down and combined with oxygen. The input of nutrients, such as phosphates and nitrates, into the water stimulates plant growth. Eventually, more plant growth leads to more plant decay. Nutrients, therefore, can be a prime contributor to high biochemical oxygen demand in rivers.

Biochemical oxygen demand is measured by filling two glass-stoppered bottles (one clear and one black) with water. A dissolved oxygen test is done first on the water in the clear bottle. After five days of incubation at room temperature, a DO test is done on the water in the black bottle. The BOD is the difference between the two results.

DOING THE BIOCHEMICAL OXYGEN DEMAND TEST

MATERIALS:

One clear stoppered DO bottle
One black stoppered DO bottle
Gloves

1. Fill two glass-stoppered DO bottles (one clear and one black) with sample water, holding them for two or three minutes between the surface and the river bottom. If sampling by hand remember to use gloves.

2. Prepare the clear sample bottle according to the directions for the dissolved oxygen test. Determine the DO value for this sample in mg/l.

NOTE: *Ensure that the water sample is retained to the lip of the BOD bottle. This layer of water will prevent evaporation during the five days from pulling water from inside the bottle, leaving an air bubble.*

3. Place the black sample bottle in the dark and incubate for five days at 68°F (20°C). This is very close to room temperature in many buildings. If there is no incubator, place the blackened sample bottle in a "light-light" drawer or cabinet.

4. After five days, determine the level of dissolved oxygen (in mg/l) of this sample by repeating steps four through ten of the DO testing procedure.

5. The BOD level is determined by subtracting this DO level from the DO level found in the original sample taken five days previously:

BOD=mg/1DO (original sample)-mg/1DO (after incubation)

FECAL COLIFORM BACTERIA

Fecal coliform bacteria are found in the feces of humans and other warm-blooded animals. These bacteria can enter rivers through direct discharge from mammals and birds, from agricultural and storm runoff carrying mammal and bird wastes, and from sewage discharged into the water. Fecal coliform bacteria by themselves are not pathogenic. Pathogenic organisms include bacteria, viruses, and parasites that can cause diseases and illnesses. Fecal coliform bacteria naturally occur in the human digestive tract, and aid in the digestion of food. We test for FC bacteria because if counts are high (over 200 colonies in 100 ml water) there is a greater chance that pathogenic organisms are present as well. Pathogens are relatively scarce in water; this makes them hard and time-consuming to monitor directly.

Cities and suburbs can contribute human waste to local rivers through the sewer system. Heavy rains may cause fecal coliform to enter the river water from illegal sanitary sewer connections into the storm sewers in separate sewer systems or in filled-to-capacity combined sewer systems. That is why it is important to note the weather conditions on the days before a fecal coliform measurement.

Fecal coliform bacteria are measured by incubating a sample in a water bath and counting the colonies after 24 hours.

DOING THE FECAL COLIFORM BACTERIA TEST

Materials

- Container to sample river water
- Petri dish with pad
- Broth in a glass ampoule
- Alcohol and Alcohol burner/Matches
- Filter with grid
- Filtration system
- Pipette or graduated cylinder
- Tape or ziploc baggies/Marker
- Tweezers
- Waste container
- Magnifier

1. Turn on the water bath. Set dial to 44 degrees and allow it to preheat.

2. Open one of the petri dishes with the absorbent pad inside (Note: we buy the dishes with the pads already inside; the directions in the manual are different for steps 1 and 2). Use an ampoule breaker if needed, and drain the contents of one broth vial onto the pad. The broth is liquid food for fecal coliform bacteria. Put the top on the petri dish and set aside.

3. Sanitize forceps by holding them above the alcohol burner for a few seconds. Do not put them down after sanitizing.

4. Unscrew the top half of the filtration system and place a sterile filter paper on top of the filtration system's membrane with forceps, grid side up. Be sure the filter lies completely flat with no wrinkles.. Screw on the top half of the filtration system to the bottom half.

5. Before taking a sample, use a pipette to rinse the filtration system with a small amount of distilled water. Add the water through the hole in the top of the system. (there should be two or three rubber stoppers on top of the filtration system, and one hole without a stopper.

6. Determine the desired volume of water (in ml) to be tested based upon the water source (We use 1 ml). Place the pointed end of the pipette into the water to be sampled and lower into the water until the desired sample size, as shown by volume markings on the side of pipette, has been drawn into the pipette. A rubber bulb attached to the top of the pipette may be required to obtain the desired volume. The ideal number of fecal coliform colonies is 20-60 on a petri plate. This range reduces the effects of colony crowding on sheen or color development.

7. Place the end of the pipette into the open hole on top of the filtration system, and release the water sample into the funnel.

8. With the filtration system level, use the suction pump and draw all of the sample and distilled water through the filter while swirling so that the number of bacteria adhering to the upper filtration system is reduced. (warning: be careful when pushing

the plunger back into the syringe; you want to avoid pushing air back into the filtration unit and forcing the filter off the membrane.) Draw the water through the filter until it appears dry.

9. Unscrew the top half of the funnel, and carefully remove the filter with the sanitized forceps.

10. Open the top of the petri dish, and slide the filter across and into the dish, with the grid side up. Enclose the petri dish in a waterproof bag (to avoid leakage) and then put into the water bath. Dishes may also be sealed with waterproof tape (freezer tape) to avoid leakage. *Be sure to record the date, site, and volume of sample on the frosted part of the petri dish.*

11. Petri dishes should be incubated within 30 minutes of filtering the sample; this will ensure heat shock of any non-fecal coliform organisms. Incubate for 24 hours (±2 hours) at 44.5°C. (Temperature must be maintained within a range of ±0.25°C of 44.5°C.) Petri dishes should be inverted during incubation to avoid condensation. *Please wash your hands after this test*

12. After incubation, carefully count the bacterial colonies on the filter, using a magnifying glass (10x) or unaided eye. You might want several people to verify the bacterial count. Each bluish spot is counted as one fecal coliform colony. Cream or gray-colored colonies are non fecal coliform. Fecal coliform colonies should be examined within 20 minutes to avoid color changes that occur with time.

13. *It is important to report the highest fecal coliform value rather than an average value.*

pH

Water contains both H+ (hydrogen ions and OH- (hydroxyl) ions. The pH test measures the H+ ion concentration of liquids and substances. Each measured liquid or substance is given a pH value on a scale that ranges from 0 to 14. Pure, deionized water contains equal numbers of H+ and OH- ions and is considered neutral (pH 7), neither acidic or basic. If the sample being measured has more H+ than OH- ions, it is considered acidic and has a pH less than 7. If the sample contains more OH- ions than H+ ions, it is considered basic and has a pH greater than 7. It is important to remember that for every one unit on the pH scale, there is approximately a ten-fold change in how acidic or basic the sample is. For example, the average pH of rainfall over much of the northeastern United States is 4.3, or roughly ten times more acidic than normal rainfall of 5.0-5.6. Lakes of pH 4 (acidic) are roughly 100 times more acidic than lakes of pH 6.

In the US ., the pH of natural water is usually between 6.5 and 8.5, although wide variations can occur. Increased amounts of nitrogen oxides (NOx) and sulfur dioxide (SO2), primarily from automobile and coal-fired power plants emissions, are converted to nitric acid and sulfuric acid in the atmosphere. These acids combine with moisture in the atmosphere and fall to earth as acid rain or acid snow. If limestone is present, the alkaline (basic) limestone neutralizes the effect the acids might have on lakes and streams. The areas hardest hit by acid rain and snow are those downwind of urban/industrial areas and do not have any limestone to reduce the acidity of the water.

pH is measured by comparing the color of the sample to a standardized chart after adding a chemical to it.

DOING THE pH TEST

Materials	Sampler to get river water (yogurt container)
	Distilled water for rinsing vials at end
	cube with vial and chemical (or pH paper)
	waste containers

1. Rinse the empty test cube with the water sample. Fill the tube to the mark with the water sample.

2. Open one Phenol Red Indicator Pillow. Add the contents of the pillow to the cube. Cap and invert several times to mix.

3. Match the color of the sample to the closest color in the cube to obtain the pH of the water sample.

TOTAL PHOSPHATES

Phosphorous is an essential element for life; it is a plant nutrient needed for growth, and a fundamental element in the metabolic reactions of plants and animals. Plant growth is limited by the amount of phosphate available. Cultural eutrophication is an enrichment of the water, usually by phosphates, from human activities. It is characterized by extensive algae growth, the water becomes a pea-green color, and rooted plants become very dense. Water in the advanced stages of eutrophication can become anaerobic (without oxygen). The diversity of life able to survive in the water is limited.

Total phosphate includes organic and inorganic phosphates. Organic phosphate is a part of living plants and animals. It is attached to organic matter composed of once-living plants and animals. Inorganic phosphates include the ions bonded to soil particles, and the phosphates present in laundry detergents. Phosphates come from several sources: human wastes, animal wastes, industrial wastes, and human disturbance of the land and its natural vegetation.

DOING THE TOTAL PHOSPHATES TEST

MATERIALS

- Sampler to get river water
- Distilled water for rinsing vials at end
- Phosphate cube with vial and chemical waste containers

1. Rinse the empty test cube with water to be tested. Fill to the mark with the water sample.

2. Open one PhosVer® 3 Phosphate Reagent Powder Pillow. Add the contents of the pillow to the cube. Cap the cube and invert several times to mix.

3. Wait one minute, but no longer than two minutes, for color development.

4. Match the color of the sample to the closest color in the cube to obtain mg/L phosphate.

NITRATES

Nitrogen is an essential plant nutrient required by all living plants and animals for building protein. In aquatic ecosystems, nitrogen is present in many different forms. As aquatic plants and animals die, bacteria break down large protein molecules into a final product ammonia. Ammonia is then oxidized by specialized bacteria to form nitrites and nitrates. Because nitrogen, as ammonia and nitrates, acts as a plant nutrient it also causes eutrophication. As mentioned above, eutrophication promotes more plant growth and decay, which in turn increases the biochemical oxygen demand. Inadequately treated sewage water, faulty septic systems and runoff from land where fertilizers and animal wastes are present are common sources of nitrates.

DOING THE NITRATES TEST

MATERIALS

- Sampler to get river water
- Distilled water for rinsing vials at end
- Nitrate cube with vial and chemical
- Waste containers

1. Rinse the empty cube with water to be tested. Fill to the mark with the water sample.

2. Open one NitraVer® 5 Nitrate Reagent Powder Pillow. Add the contents of the pillow to the cube. Cap the cube and shake vigorously for exactly one minute.

3. Wait for one minute to allow color development.

4. Match the color of the sample to the color on the cube to obtain the mg/L nitrogen (NO_3 as N).

TOTAL SOLIDS

This water quality measures dissolved solids and suspended solids in the water. Dissolved or inorganic materials include calcium, bicarbonate, nitrates, phosphates, iron, sulfur, and other ions found in a water body. A constant level of these materials is essential for the maintenance of aquatic life because the density of total solids determines flow of water in and out of organisms' cells. Suspended solids include silt and clay particles from runoff, plankton, industrial wastes, and sewage. High concentrations of total solids cause lower water quality and water balance problems for individual organisms. Low concentrations may limit the growth of aquatic life, or restrict some organisms from surviving in the water.

A sample of water is evaporated in an oven overnight to measure the amount of total solids in the water.

DOING THE TOTAL SOLIDS TEST

MATERIALS

- Beakers
- Pot holders or tongs
- Scale-sensitive to 0.000g
- Thermometer for oven
- Graduated cylinder
- Container to sample river water
- Waste container

1. Turn on the oven and allow it to preheat. There is no mark on the dial, so it is set with trial and error to 103 degrees. Keep checking the thermometer until it is right.

2. Clean a beaker (a 300 ml beaker provides greater surface area) and dry in the 103°C oven for one hour.

3. Remove beaker from heat with tongs and allow it to cool, then weight with a sensible balance (to the nearest 0.001 gram). *Do not touch the beaker with bare hands because body moisture will be transferred to it, thereby changing its weight.* Use tongs, if available, or pads or gloves.

4. Using a pipette or graduated cylinder, measure a 100 ml sample from your sampling container and transfer into the beaker. If sample has been sitting, swirl the sample water before measuring out the 100 ml.

5. Place the beaker with the sample in a 103°C oven overnight to evaporate the liquid and dry the resulting residue. Allow the beaker to cool, then reweigh it. *Remember: don't touch the beaker with your hands.*

6. Subtract the initial weight (in grams) of the empty beaker from the weight of the beaker and residue to obtain the increase in weight, or the weight of the residue.

$$\frac{\text{Increase in weight in gm}}{\text{Volume in milliliters (ml)}} \times \frac{1000 \text{ mg}}{1 \text{ gram}} \times \frac{1000 \text{ ml.}}{1 \text{ liter}} = \text{mg/l}$$

TEMPERATURE

The water temperature of a river is very important because many of the physical, biological, and chemical characteristics of a river are directly affected by the temperature. For example, the amount of oxygen that can be dissolved in the water depends on how cold or warm it is. The rate of photosynthesis by algae and larger aquatic plants is affected by temperature. More plants grow and die. As plants die, they are decomposed by bacteria that need oxygen. The metabolic rates of organisms is affected by temperature. The sensitivity of organisms to toxic wastes, parasites, and diseases is also affected.

Temperatures can be changed by thermal pollution, from industries or runoff from hot surfaces. People may impact river temperature by cutting down trees that help shade the river from the sun. Direct sunlight is a major factor in the warming of rivers. People may also contribute to warmer water by causing soil erosion along the river bank. Erosion adds to the amount of suspended solids carried by the river. A large amount of suspended solids turn the water turbid or very cloudy. This cloudy water absorbs the sun's rays which warms the water. Temperatures are measured in two locations along a river: the test site and one mile upstream. By discovering river reaches that undergo rapid temperature changes, we can begin to discover the sources of thermal pollution.

DOING THE TEMPERATURE TEST

MATERIALS: Rope
Thermometer

1. At the site where the other water quality tests are being performed, lower the thermometer four inches below the water surface.

2. Keep the thermometer in the water until a constant reading is attained (approximately two minutes).

3. Record your measurement in Celsius.

$$°C = \frac{(°F - 32.0)}{1.80}$$

$$°F = (°C \times 1.80) + 32.0$$

4. Repeat the test approximately one mile upstream as soon as possible.

5. Subtract the upstream temperature from the temperature downstream using the following equation:

temp. downstream - temp. upstream = temp. change

6. Record the change in temperature.

TURBIDITY

Turbidity is the result of suspended solids in the water that reduce the transmission of light. Turbidity can be understood as the relative clarity of water. Suspended solids are varied, ranging from clay, silt, and plankton, to industrial wastes and sewage. Turbidity may be the result of soil erosion, waste discharge, urban runoff, abundant bottom feeders like carp that stir up bottom sediments, or the presence of excess nutrients that result n alga growth. Turbidity may affect the color of the water, from nearly white to red-brown, as well as green from algal blooms. At higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Waters become warmer as suspended particles absorb heat from sunlight proportionate to the concentration of particles.

DOING THE TURBIDITY TEST

MATERIALS: Secchi Disk/rope

1. Lower the Secchi disk from a bridge, boat, or dock into the water until it disappears. It is important that the disk travels vertically through the water and is not "swung out" by the river current. Note the number of feet/inches on the chain or rope.

2. Drop the disk even farther (until it disappears) and then raise it until you can see the disk again. Note the number of feet/ inches on the chain.

3. Add the results of step 1 and step 2 and divide by two. This is your turbidity level using the Secchi disk.

General Materials

Goggles
Gloves
Clock for timing tests
Waste containers
Containers to sample river water
Towels for drying equipment/spills

Materials for dissolved oxygen

Dissolved oxygen kit with bottles and chemicals
Thermometer

Materials for total solids kit

Beaker
Pot holders or tongs
Scale-sensitive to 0.000g
Thermometer for oven
Graduated cylinder

Materials in fecal coliform kit

Petri dish with pad
Broth in a glass ampoule
Alcohol and Alcohol burner/Matches
Filter with grid
Filtration system
Pipette or graduated cylinder
Tape or ziploc baggies/Marker
Tweezers
Magnifier

Materials in pH kit

Distilled water for rinsing vials at end
cube with vial and chemical (or pH paper)

Materials in nitrate kit

Distilled water for rinsing vials at end
Nitrate cube with vial and chemical

Materials in phosphate kit

Distilled water for rinsing vials at end
Phosphate cube with vial and chemical

Materials in microscope kit

Video microscope with 2 cables and AC
Slides
Pipette

- RiverWork Projects. This is real work being done by volunteers along the river. It could be re-establishing floodplain vegetation along the North Branch, or helping the Chicago Botanic Garden restore the Skokie River through their property, or it could be cutting buckthorn on an island in the Skokie Lagoons, or repairing an eroding riverbank along the South Branch. Whatever it is, it means sore muscles, dirty fingernails and satisfied smiles.

1994 is off and running and already things are happening. Several teachers, whose students have been monitoring water quality for some time, and monitoring experts and scientists from local agencies recently formed the RiverWatch Leadership Committee. They will be working to assure quality testing standards and methods throughout the watershed as well as finding ways to unify all of the monitors on the Chicago River system. The Chicago Academy of Sciences, one of our valued RiverWatch partners, has established a permanent river monitoring exhibit called Water Works. The Academy and Friends will be holding river monitoring training this spring and summer.

Adopt-a-Reachers will have new River Patrol Reports and Incident Logs to aid their valuable work. The Great Chicago River Rescue Day, May 15, promises to be a big success with full participation by the Forest Preserve District and other city and local agencies and, especially, all of you. Skokie River restoration in the Botanic Garden will require intensive volunteer effort all spring and summer.

The river needs you. No matter whether you can help once a year or once a week, your energy will make a difference. Call us at 312/939-0490 and we'll be happy to put you to work.

Attachment 3: Class outline and selected content

WATER QUALITY MONITORING WORKSHOP

Audience: Families and museum visitors, all ages
Length of program: 90 minutes
Maximum number of participants: 15

Project Objectives:
1) Offer a series of 8-10 90-minute water quality monitoring workshops for the general public, free of charge and scheduled once or twice per month. The primary focus of the workshops will be to teach people how to conduct standard water monitoring tests to provide reliable results, and give them an introduction to river ecology and stream dynamics.

2) Promote involvement in local community organizations such as The Friends of the Chicago River, OpenLands, Nature Conservancy, and Friends of the Fox River. Our goal is to have at least 50% of workshop participants volunteer for action projects following their training. After all, it is the participation in these community service projects which makes their learning during the workshop relevant and contributory.

Set up for the class:
1) Arrive about 45 minutes prior to the class time. Post the two "closed" signs which are in the class folder. The first goes at the front door of the museum, by the admissions desk, and the second goes by the door to the Water Works Lab Exhibit. These will let visitors know that the lab will be closed for the class and when it will be closed. Give a copy of the sign-up sheet to the person working at the front desk so that he or she will admit our participants free of charge. There should be no charge to attend this workshop.

2) Set up an easel and a flip chart in the lab for recording results. Take out the bin with the cotton and toothpicks from the supply cabinet for the stream table demonstration and set it out of the way on the blue corrosive cabinet. Get 15 folding chairs from the lower level classroom and set them up at the tables. Remove all of the exhibit materials from the tables and clean the tables well. Each table should have a bottle of distilled water and some paper towels. The cart should have all the test kits, disposable gloves, results charts, and markers. The goggle cabinet has the goggles (keys are on the wall to the left of the gray supply cabinet). The class folder has name tags. That is everything you will need.

3) Note: If it is Saturday, the room tends to be busy with visitors and it is necessary to do this preliminary set up while they are still playing with the stream table, etc. You can shut the door half way to discourage new visitors from coming in as it gets close to the starting time. We would like to keep the room open as much as possible so don't close the door all the way until after your participants have arrived and the class is actually starting. Be at the door to greet people who have signed up and tell others to come back to visit at the end time.

The class:

1) Welcome everyone to the Chicago Academy of Sciences. Ask how many have been here before. Our museum here in Lincoln Park is the oldest in the city. We specialize in the natural history of the Chicago area. We have lots of programs for teachers, students, and the public. This is our Water Works Lab. It is set up to learn about water monitoring. We have real water from the Chicago River here in our sampling station. It was taken from LaBagh Woods, at Foster and Cicero, which is where we go to do our sampling. Does anyone know that area? We are going to use this water to do our tests today.

2) Ask the participants to think about what experiences they have had with the Chicago River (or other rivers) and what they can remember about it. Go around the room informally. During this time, many adults will share their memories of hanging out on its banks as a youngster and they will recall how it smelled. Many people say they drive over it downtown and that is as close as they have been. Get an idea of where the participants are coming from. If necessary, use the map on the wall and let people show where they live, work, and play, etc. Tell them that the Academy has been involved in water monitoring for several years now... we have teachers and students who monitor sites along the river, we collaborate with The Friends of the Chicago River on clean up and canoe projects, and we are the leaders of a museum and National Park partnership which is giving people all over the country the skills to keep track of quality in all types of water.

3) Tell participants to sign in on the sign-in sheet and pass it around. If everyone has not arrived, you can do this towards the end of the class, just don't forget. Tell them that this class is sponsored by the Illinois Department of Conservation. The Department's Illinois Wildlife Preservation Fund is supported by donations from taxpayers on the state income tax form. Thanks to them, we received some money to buy materials to offer these sessions. We are grateful.

4) Ask if anyone has ever done any testing. We are going to start with a phosphate test. Pass out the phosphate cubes to the groups at the tables. Each table can get a cube or if there are only five people, each person can have a cube. Group according to size and according to families, etc. Model and follow the directions for the test.

* Fill the vial with water, up to the line where it says mg/l.
* Open 1 packet of chemical and put it in the water.
* Shake for 1 minute. Have everyone time separately using the clocks on the wall.
* Compare the color of the water to the colors on the scale.
* Record the results on the flip chart. Discuss why results may be different: vials not clean enough, didn't use all the pre-measured chemical, didn't have exact amount of water, etc. This reliability is important when testing. What is the average of all the tests?

5) When the test is finished, empty the vials out into the yellow Liquid Waste bucket and rinse with distilled water. Discuss what phosphates are. It is important that you try to do the test first, and then talk about what it means. Of course, you can respond to questions as they come up, and they most likely will come up before the test is completed. Ask where they have heard the word phosphates before. Phosphates come from detergents mostly, but also from human wastes, animal wastes, industrial wastes, and the removal of vegetation which promotes runoff. It is an essential element for life. It is a nutrient that naturally controls plant growth. The more phosphates you have, the more plant growth you will have. Excess amounts can cause extensive algae growth and algae blooms, which changes the entire aquatic environment so that it can support much less diversity of life.

6) We want the phosphate level to be less than 0.1 mg/l. Tell them that the average concentration of total phosphates in the Chicago River has been between .68 and .86 mg/liter. These typical results were obtained from the Metropolitan Water reclamation District on Erie Street. They have researchers who regularly sample and test the water for exactly the same tests we are doing today. Volunteers who do testing with organizations like Friends of the Chicago River and Friends of the Fox River, etc. help them by sampling a greater area.

7) Repeat the testing procedure with the nitrate test.

* Fill the vial with water, up to the line where it says mg/l.
* Open 1 packet of chemical and put it in the water.
* Shake for 1 minute. Have everyone time separately using the clocks on the wall.
* Compare the color of the water to the colors on the scale.
* Record the results on the flip chart.
* Clean and rinse materials.

8) Nitrates come from animal wastes, runoff, and poorly functioning septic systems. Fertilizers are a common source of nitrates. Like phosphates, they control the growth of plants. What is the average of the tests for nitrates? Write it on the flip chart. We would like to see this result be less than 10 mg/l. The average result in Chicago River is between 2.83 and 3.72 mg/l.

9) At this time, ask the participants how plant growth might affect the environment. Visualize one of the fish tanks in the room as it grows fuller and fuller. How would that affect the water flow? It would move more slowly. What would the temperature do? It would rise. Now, what is the relationship between temperature and the amount of gas a liquid can hold?

10) After they squirm for a few seconds, have them think about soda pop. When it is cold, the carbon dioxide in it is high. There are many bubbles, much fizz. As it warms, however, it can hold less CO_2. It goes flat. The same is true for water. When it is cold it can hold much more oxygen than when it is warm. This is a very

important thing for us to remember. Where do trout like to live? Where it is cold because it is high in dissolved oxygen. Trout need a lot of oxygen...catfish do not.

11) Go over to the stream table and do the stream table demonstration. The entire demonstration is written out separately and is in the class folder. Use this demo to show how water runs differently and creates different environments. How things change and how we can affect those changes. What happens if we build a parking lot there? What happens if we take down those trees?

12) Go back to the tables and do the dissolved oxygen test. Explain that this is the most important test to do if you can only do one. DO is a good indicator of a river's quality. Mention the importance of sampling away from rapidly moving water as that is what introduces oxygen into the water.

* Remove the stopper and fill the bottle with water.
* Add the contents of pillow #1 and #2.
* Insert the stopper and shake to mix.
* Let the sample sit, then shake, and let it sit again until the floc settles below the white line.
* Add the contents of pillow #3.
* Pour to the top of the measuring tube, then into the square mixing bottle. Do this again.
* Use the dropper to add the titrant one drop at a time, while swirling. Count the number of drops.
* Divide by 2. That is the number of mg/l.
* Clean and rinse materials.

13) Record the results on the flip chart. Discuss the results. The average DO has been about 8.4 mg/l in the Chicago River.

14) Do the pH test, if you have time. The procedure is the same as the phosphate and nitrate tests. Otherwise, invite the participants to come back to the lab and do the test because pH paper is always available in the lab. Note that the average acidity of the Chicago River is between 7.5 and 7.8.

15) Wrap up the class by distributing the list of volunteer opportunities and telling them more about what they can do as citizens. Answer questions. Replace the goggles in the cabinet and put all gloves and chemical packets in the white Biohazardous Container. Return all kits to the cart. Remind participants to wash their hands in the restrooms before they continue with their visits.

<u>Returning back to normal:</u>

16) Put away the stream table demo materials in the supply cabinet. Turn on the goggle cabinet to disinfect the goggles (the timer will shut off by itself). Clean up the tables and put the exhibit materials back in place. Take down the signs and put them in the class folder, along with the sign in sheet. Leave them on the class cart. Put the cart in the back hallway and lock the door.

Attachment 4: Class fliers to advertise the program

FREE WORKSHOP!!
at The Nature Museum

WHAT'S IN YOUR WATER??

How much do you know about the quality of the water that flows through our city?

With funding from the Illinois Wildlife Preservation Fund, the Chicago Academy of Sciences is pleased to offer a free and informal 90-minute exploration of the Chicago River.

YOU CAN:

- **Roll-up your sleeves and experiment with *stream dynamics*!!**
- **Test the pH, Phosphate and Nitrate levels of the river!!**
- **Learn about the River and how you can play a part in its restoration.**

WHEN?
Saturday afternoons, from 1:30-3:00 pm
Choose from the following dates:

February 25 *March 25*
April 8 *April 22*
May 13 *May 20*
June 10

WHERE?
The Chicago Academy of Sciences
The Nature Museum
2001 North Clark Street

HOW?
Call 312-549-0775 to register
Families Welcome!!

Water WORKS

Attachment 5: News release and printed articles announcing the award of $1,000. from the Wildlife Preservation Fund

FOR IMMEDIATE RELEASE: January 20, 1995
CONTACT: Katherine Weber (312) 549-0606, ext. 2061

Chicago Academy of Sciences Invites Public to Test Chicago's River Water

How much do you know about the water flowing through our city? Roll up your sleeves and join The Chicago Academy of Sciences in monitoring one of our greatest natural resources--the Chicago River. With funding from the Illinois Wildlife Preservation Fund, the Academy is offering free weekend workshops on water quality monitoring and river ecosystems in its hands-on *Water Works* laboratory.

The 90-minute sessions will focus on the ecology of the Chicago River and will introduce four standard water quality tests. Children and adults can perform tests monitoring pH, phosphate, nitrate, and oxygen levels. Chicago River water samples will be used, or participants may test their own water from home.

"Our workshops for school groups and teachers have led many to become volunteers helping to restore and preserve the river," says Ken Rose, Academy curriculum specialist. "With the support of the Wildlife Preservation Fund, we're excited to bring these workshops to the public."

Participants can also experiment with river dynamics at the stream table or explore river ecology up close. Our living replica of the Chicago River is complete with native plant and animal species. Most importantly, families can learn what they can do to protect our natural watershed.

Participants may choose one of 7 sessions held Saturdays from 1:30 - 3 pm on February 25, March 25, April 8, April 22, May 13, May 20, June 10 at the Nature Museum of the Chicago Academy of Sciences. The museum is located at 2001 N. Clark St. (at Armitage) in Lincoln Park. Classes will be limited to 25; please call (312) 549-0775 to register.

-- MORE --

The workshops are funded by donations to the Illinois Wildlife Preservation Fund on the state income tax form. The Fund was established by the Illinois legislature as a means for all citizens to voluntarily support wildlife and native habitats with a portion of their tax refund.

Founded in 1857, the Chicago Academy of Sciences is dedicated to promoting scientific literacy for all citizens and to advancing scientific knowledge. The Nature Museum of the Chicago Academy of Sciences features exhibits on environmental issues and the natural history of the Chicago area. The Academy brings science outreach programs to Chicago Public Schools; hosts science workshops for teachers; and offers lectures, field trips, weekend workshops, and other special programs for children and adults. The Academy's International Center for the Advancement of Scientific Literacy conducts research on the public understanding of science in this country and throughout the world. Programs at the Chicago Academy of Sciences are made possible in-part through the generous support of the people of Chicago through the Chicago Park District.

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News articles: Total circulation

name of newspaper, date	circulation
Daily Herald, January 24, 1995	
Carpentersville, IL	3270
Wheaton, IL	6460
Lisle, IL	6180
West Chicago, IL	1920
Lombard, IL	3260
Wooddale, IL	6650
Barrington, IL	3340
Mount Prospect, IL	14,060
Bartlett, IL	8120
Lake Zurich, IL	5120
Algonquin, IL	1890
Rolling Meadows, IL	3680
Palatine, IL	10,340
Hoffman Estates, IL	15,490
Buffalo Grove, IL	9510
Carol Stream, IL	4000
Des Plaines, IL	5390
Arlington Heights, IL	14,250
Libertyville, IL	5650
Chicago North Community News, January 25, 1995	49,000
Chicago Weekly Reporter, January 25, 1995,	13,000
Lawndale News, February 2, 1995	15,000
Chicago Crusader, February 4, 1995	57,000
Momento, February 11, 1995	20,000
Brighton Park Life, February 23, 1995	28,000
Chicago Sun-Times, February 24, 1995	1,000,000

NEWSCLIP
312/751-7300

CHICAGO NORTH-N.W.
COMMUNITY NEWS
CHICAGO, IL
PUBL. WEDNESDAY
CIRC. 49,000

JAN 25, 1995

Workshops slated on Chicago River quality

The Chicago Academy of Sciences is offering free weekend workshops on water quality monitoring and river ecosystems in seven sessions slated for 1:30 to 3 p.m. Saturdays starting Feb. 25 at the Nature Museum of the academy, 2001 N. Clark St.

The 90-minute sessions will focus on the ecology of the Chicago River and will introduce four standard water quality tests. Children and adults can perform tests monitoring pH, phosphate, nitrate and oxygen levels. Chicago River water samples will be used, or participants may test their own water from home.

Participants may choose one of the sessions set for Feb. 25, March 25, April 8, April 22, May 13, May 20 and June 10. Classes will be limited to 25.

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For more information, call 312-549-0775.

NEWSCLIP
312/751-7300

LAWNDALE NEWS

CICERO, IL
PUBL. THURSDAY
CIRC. 15,000

FEB 2, 1995

Chicago Academy of Sciences invites public to test Chicago's river water

065

How much do you know about the water flowing through our city? Roll up your sleeves and join The Chicago Academy of Sciences in monitoring one of our greatest natural resources-the Chicago River. The Academy is offering free weekend workshops on water quality monitoring and river ecosystems in its hands-on Water Works laboratory.

The 90-minute sessions will focus on the ecology of the Chicago River and will introduce four standard water quality tests. Children and adults can perform tests monitoring pH, phosphate, nitrate, and oxygen levels. Chicago River water samples will be used, or participants may test their own water from home.

Participants can also experiment with river dynamics at the stream table or explore river ecology up close. Our living replica of the Chicago River is complete with native plant and animal species. Most importantly, families can learn what they can do to protect our natural watershed.

Participants may choose one of 7 sessions held Saturdays from 1:30-3 pm on February 25, March 25, April 8, April 22, May 13, May 20, June 10 at the Nature Museum of the Chicago Academy of Sciences. The museum is located at 2001 N. Clark St. (at Armitage) in Lincoln Park. Classes will be limited to 25; please call (312) 549-0775 to register.

The workshops are funded by donations to the Illinois Wildlife Preservation Fund on the state income tax form. The Fund was established by the Illinois legislature as a means for all citizens to voluntarily support wildlife and native habitats with a portion of their tax refund.

Founded in 1857, the Chicago Academy of Sciences is dedicated to promoting scientific literacy for all citizens and to advancing scientific knowledge. The Nature Museum of the Chicago Academy of Sciences features exhibits on environmental issues and the natural history of the Chicago area. The Academy brings science outreach programs to Chicago Public Schools; hosts science workshops for teachers; and offers lectures, field trips, weekend workshops, and other special programs for children and adults. The Academy's International Center for the Advancement of Scientific Literacy conducts research on the public understanding of science in this country and throughout the world.

NEWSCLIP
312/751-7300

CHICAGO CRUSADER

CHICAGO. IL
PUBL. THURSDAY
CIRC. 57.000

FEB 4. 1995

Chicago Academy of Sciences invites public to test Chicago's River water

How much do you know about the water flowing through our city? Roll up your sleeves and join The Chicago Academy of Sciences in monitoring one of our greatest natural resources–the Chicago River. With funding from the Illinois Wildlife Preservation Fund, the Academy is offering free weekend workshops on water quality monitoring and river ecosystems in its hands-on Water Works laboratory.

The 90-minute sessions will focus on the ecology of the Chicago River and will introduce four standard water quality tests. Children and adults can perform tests monitoring pH, phosphate, nitrate and oxygen levels. Chicago River water samples will be used, or participants may test their own water from home.

"Our workshops for school groups and teachers have led many to become volunteers helping to restore and preserve the river," says Ken Rose, Academy curriculum specialist. "With the support of the Wildlife Preservation Fund, we're excited to bring these workshops to the public." 0625

Participants can also experiment with river dynamics at the stream table or explore river ecology up close. Our living replica of the Chicago River is complete with native plant and animal species. Most importantly, families can learn what they can do to protect our natural watershed.

The museum is located at 2001 N. Clark St. (at Armitage) in Lincoln Park. Classes will be limited to 25; please call (312) 549-0775 to register.

NEWSCLIP
312/751-7300

DAILY HERALD

PALATINE, IL
PUBL. DAILY
CIRC. 10,340

JAN 24, 1995

Democrat's remark steels GOP stance on voter fraud

How touchy are Republicans when it comes to expanded voter registration problems?

They leaped all over a wisecrack made by former Democratic National Chairman David Wilhelm, who recently told a gathering in Chicago how his newborn baby had already been registered to vote seven times for the upcoming Chicago mayoral election.

"That's exactly what we're worried about," says Mark Gordon, an aide to Senate President James "Pate" Philip. "Chicago's reputation when it comes to voter fraud scares us and we don't want to pass anything that would make it easier for them."

Illinois is being sued by the federal government because Republicans in the Legislature refused to pass laws bringing the state into compliance with a registration program approved by Congress.

■ ■ ■

What next, Republicans against tort reform?: Former state Rep. Vickie Moseley of Springfield, one of the many Democrats knocked out of state government by the Republican takeover, keeps herself busy these days with a political action committee of her own making.

Called "Democrats for Life," it promotes one of Moseley's pet causes — opposition to legalized abortion by trying to encourage the many Democratic lawmakers who support a woman's right to abortion to switch their stance.

"I firmly believe there is good within the Democratic Party," Moseley tells us.

■ ■ ■

Waterworks: Remember when Chicago Mayor Richard J. Daley said that someday we would be able to go fishing in the Chicago River during lunch?

Well, the Chicago Academy of Sciences is now offering free weekend workshops on water quality monitoring and river ecosystems so dedicated anglers can decide whether they want to eat what they catch. But, alas, Friends of the Chicago River say the river's denizens need not worry about becoming someone's dinner. They're still too contaminated for that.

■ ■ ■

Medicine man: Eliot Cowan brings his Plant Spirit Medicine movement to the Chicago area Wednesday and Thursday. Cowan is trying to revive lost Indian healing practices using native plants and combine them with Chinese practices. He has been working with Huichol Indian shamans in Mexico and will speak at Triton College in River Grove and Ohashiatsu Chicago in Evanston.

■ ■ ■

Dial M for mayhem: The Jerky Boys are in town in advance of the Feb. 3 opening of their film, "The Jerky Boys." Queens pranksters Johnny Brennan and Kamal Ahmed previewed the trailer of their film and signed autographs at Planet Hollywood. On Tuesday, the two become authors with the debut of their book, "The Jerky Boys, the Book," adorned with a sticker reading: "This book may be offensive. Got a problem with that?"

Written by Greg Tejeda and Marcy Kreiter of UPI.

NEWSCLIP
312/751-7300

BRIGHTON PARK LIFE

CHICAGO, IL
PUBL. THURSDAY
CIRC. 28,000

FEB 23,1995

Weekend Workshops On Water Quality

The Chicago Academy of Sciences, 2001 N. Clark st. is offering free weekend workshops on water quality monitoring and river ecosystems in its hands-on "Water Works" laboratory.

The 90-minute sessions will focus on the ecology of the Chicago River and will introduce four standard water quality tests for pH, phosphate, nitrate, and oxygen levels. Chicago River water samples will be used, or participants may test their own water from home.

Participants can also experiment with river dynamics at the stream table or explore river ecology up close. The Academy's living replica of the Chicago River is complete with native plant and animal species.

Participants may choose one of 7 sessions held Saturdays from 1:30-3 p.m. on Feb. 25th, March 25th, April 8th, April 22nd, May 13th, May 20th or June 10th. Classes will be limited to 25 persons. Call (312) 549-0775 to register.

NEWSCLIP
312/751-7300

MOMENTO

CHICAGO, IL
PUBL. THURSDAY
CIRC. 20,000

FEB 11, 1995

***

Roll up your sleeves and join **The Chicago Academy of Sciences** in monitoring one of our greatest natural resources-the Chicago River. The Academy is offering free weekend workshops on water quality monitoring and river ecosystems in its hands-on "Water Works" laboratory.

The 90-minute sessions will focus on the ecology of the Chicago River and will introduce four standard water quality tests. Children and adults can perform tests monitoring pH, phosphate, nitrate and oxygen levels. Chicago River water samples will be used, or participants may test their own water from home.

Participants also can experiment with river dynamics at the stream table or explore river ecology up close. The living replica of the Chicago River is complete with native plant and animal species. Most importantly, families can learn what they can do to protect the river.

Participants may choose one of seven sessions held Saturdays from 1:30 to 3 p.m. Feb. 25, March 25, April 8 and 22, May 13 and 20 and June 10 at the Nature Museum of the Chicago Academy of Sciences 2001

NEWSCLIP
312/751-7300

CHICAGO SUN-TIMES

CHICAGO, IL
PUBL. DAILY
CIRC. D-518,094
S-497,526

FEB 24, 1995

Get a 'Taste of Black History'

MUSEUMS

By Lynn Voedisch

065

To celebrate Black History Month, the **Jane Addams Hull House Association's Parkway Community House** will serve African foods from 3 to 5:30 p.m. Sunday. "From Africa to America: A Taste of Black History" will feature such foods as fufu, an African yam dish. Employees of the center will be cooking all the foods based on family recipes.

The annual event, at 500 E. 67th St., also will feature traditional music, dancing, singing, a children's play and a keynote speaker. Admission is free. Proceeds from food sales will benefit the community house programs.

For more information, call (312) 493-1306.

FREE LECTURE: Artist Ann Hamilton will discuss her silent "performance" installations at 6 p.m. Tuesday at the Rubloff Auditorium of the **Art Institute of Chicago**, Michigan at Adams. Hamilton uses natural materials along with hand-crafted objects and barely audible soundtracks to create evocative, allegorical settings.

Hamilton's work will be shown at the Americas Exhibition, which opens on March 11. For more information, call (312) 443-3624.

GOING WILD: Ways to attract more wildlife to your backyard will be just one of the topics addressed at the "Prairie, Woodlands & Wetlands" seminar at **Garfield Farm Museum** in LaFox. Running from 8:30 a.m. until noon and 1 to 4:30 p.m. Saturday, the seminar will teach participants how to restore and manage prairie, woodlands and wetlands.

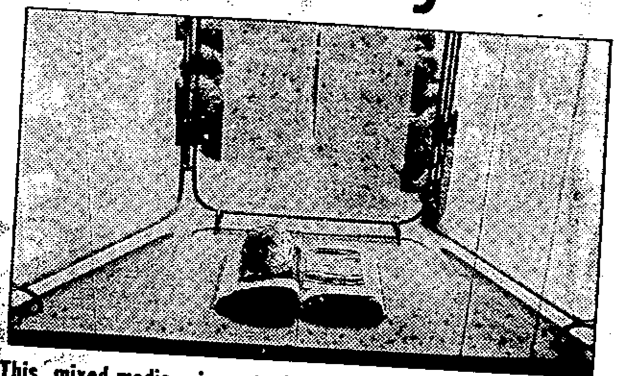
Reservations are required; call (708) 584-8485. The fee is $15.

Garfield Farm, a living historic farm and inn museum, is five miles west of Geneva on Garfield Road, just off Illinois 38.

RIVER ECOLOGY: The **Chicago Academy of Sciences** is offering free weekend workshops on water-quality monitoring and river ecosystems in its Water Works laboratory. Sessions will be held from 1:30 to 3 p.m. on Saturday, March 25, April 8, April 22, May 13, May 20 and June 10 at the Nature Museum of the academy, 2001 N. Clark.

The 90-minute sessions will focus on the ecology of the Chicago River. Children and adults will be able to perform tests monitoring pH, phosphate, nitrate and oxygen levels.

Classes will be limited to 25. For registration information, call (312) 549-0775.



This mixed-media piece typifies the work of artist Ann Hamilton, who will lecture on her silent "performance" installations Tuesday at the Art Institute of Chicago.

SPRING DREAMS: In anticipation of warm weather, the Chicago Botanic Garden will present a gardening lecture on "Getting Ready for Spring" from 1 to 5 p.m. Sunday. Experts from the Wisconsin/Illinois Lily Society, North Shore Iris and Daylily Society and the Midwest Daffodil Society will lead an hourlong slide show and lecture covering the fundamentals of growing these plants.

Refreshments will be served.

The Chicago Botanic Garden is on Lake-Cook Road one-half mile west of the Edens Expy. in Glencoe. Admission is free; parking is $4 per car.

For more information, call (708) 835-5440.

Spring Wild Flowers. Two-hour stroll along the trails at Camp Sagawau with a naturalist to learn about ephemeral flora and enjoy their delicate beauty. Su Apr. 30, 1:00 PM.

Laughing Squaw Sloughs Hike. Two-hour hike into the wetlands created by kettles during glaciation, now a rich environment for aquatic plants and animals. Plan to get your feet wet. F May 5, 10:30 AM. Meet at the Horsetail Lake parking lot 1/4 mile north of 123rd St. on the east side of 104th Ave.

Wild Flower Key. Two-hour mini course in the identification of spring wild flowers using the Flower Finder by May Watts. Flower Finders are available for use for free. They may also be purchased at the time of the program. Sa May 6, 1:00 PM.

Search for Birds. An extended all-day bird hike visiting many nearby Forest Preserves for a variety of habitats, possibly seeing 100 or more species. F May 12, 7:30 AM-2:00 PM.

Nature Sketching for Beginners. Two-hour program designed to give the budding naturalist the ability to record your observations visually, drawing what you see with pencil sketches. This is part one in a series of four nature art programs. Sa May 13, 1:00 PM. Cost: $3 (Free with your own materials).

Spring on the Prairie. Two-hour guided hike around the Sagawau prairie restoration, one of the first restorations in the Chicago area. Learn the history of the prairie and identify the plants which are spectacular and change weekly. Sa May 20, 1:00 PM.

Birds of the Grassland. Two-hour hike visiting local open grassy areas to observe the territorial behavioral and mating activity of those species requiring large areas of undisturbed grasslands. F May 26, 10:00 AM.

Tree Key. Two-hour program using the Tree Finder by May Watts. This mini course in tree identification will help you identify trees by their leaves. Tree finders may be used or purchased at the time of the program. Sa May 27, 1:00 PM.

CHICAGO ACADEMY OF SCIENCES
2001 N. Clark Street
Chicago, IL 60614
(312) 549-0607

Requirements: Preregistration required for field trips; call (312) 549-0775. Van departs from the Academy unless otherwise noted.
Fees: $non-members ($members).

Bald Eagles of the Mississippi River. The best time for viewing bald eagles along the Mississippi River. In addition to witnessing the large number of majestic eagles wintering at the Savannah Army Depot, search for geese, hawks, ducks, and woodpeckers. Trip leader: Anderson. Sa Feb. 18, 6:00 AM-6:00 PM. $39($33).

Do You Know What's in Your Water? A series of weekend workshops in Water Quality Monitoring and River Ecosystems in its new laboratory, Water Works. During each 90-minute session, you will learn how to conduct standard water quality monitoring tests on samples of water taken from our river. Workshops held once a month, Jan. through June. To register call (312) 549-0775 MWF 2:00-4:00 PM.

Nature Explorations Volunteers. Volunteers are needed to teach hands-on school programs which encourage children to explore wildlife, habitats, the environment, and much more. A great opportunity to get involved in the community, learn about the natural history of Chicago, and have fun while doing it. Full training is provided. Contact Jill Koski, Volunteer Coordinator (312) 549-0606, ext. 2026.

Target Population:	Families
Dates:	April 1 and April 8, 1995
Hours:	9:00 a.m.- None
Fee:	None
Description:	Travel to the forefront of a new frontier in zoo biology: increasing the activity and interest levels of animals by including "behavior enrichment devices" (BEDs) in innovative exhibit designs. Discover how zoo curators and animal keepers apply behavioral science and engineering to animal management. A stipend of $8 per hour will be issued to Chicago Public School teachers who successfully complete this workshop. Stipends are made possible through the Chicago Public Schools Bureau of School-Base Teacher Support. ESEA Title II.

Program Name:	ARCHEOLOGY TEACHERS' WORKSHOP		
Organization:	Center for American Archeology		
Address:	P.O. Box 366 Kampsville, Il 62053-0366		
Coordinates:	250 miles South		
Contact Person:	Harry Murphy/Brenda Nord		
Phone:	618/653-4316		
Fax	618/653-4232		
Target Population:	Science & Social Studies/History 3-12		
Start Date:	Week 1 August 7	Week 2 August 14	Monday Through Friday
End Date:	Week 1 August 11	Week 2 August 18	
Hours:	All week (M-F) Full days		
Fee	$200.00		
Credit (if applies):	Promotional Credit		

Program Name:	WATER QUALITY MONITORING WORKSHOP
Organization:	The Chicago Academy of Science
Address :	2001 North Clark Street
Building/Room:	Water Works Laboratory
Coordinates:	2000 North
Contact Person:	Jo-Elle Hardiman, CAS Education Dept.
Phone:	312-549-0606 ex 034
Fax:	312-549-5199
Target Population:	General Public - Parents and children - all ages
Start Date:	Saturdays (April 8, April 22, May 13, May 20, June 10)
Hours:	1:30-3:00 p.m.
Fee	none
Description:	15 people in each session With funding from the Illinois Wildlife Preservation Fund, the Academy is pleased to offer a series of weekend workshops in Water Quality Monitoring and River Ecosystems in its new laboratory, Water Works. During each 90 minute session, you will learn how to conduct standard water quality monitoring tests on samples of water taken from our river. You can explore river ecology and stream dynamics using our hands-on stream table and, perhaps most important, you can find out how to get involved with volunteer agencies like the Friends of the Chicago River so that you can play an important role in the preservation of our watershed. The time is right to get involved!

FIELD NOTES

PALOS RESTORATION PROJECT

Vol. 5, No. 1.9
Winter 1995

PALOS WILL MISS YOU, ANDREA SARRIS

In December, our friend and Palos steward of Katydid Prairie, passed away. Andrea had been ill for a while and was diagnosed with cancer. During the course of treatment, transfusions were necessary and several Palos volunteers responded by donating blood. Sincere thanks to everyone who helped Andrea through the rough times in the one way they could.

Diane Sarris, Andrea's sister, invites all volunteers to attend a memorial service at Katydid Prairie on April 30 (which would have been Andrea's birthday), followed by a workday at that site.

Date:	*Sunday, April 30*
Time:	*1 p.m. to 4 p.m.*
Place:	*Katydid Prairie*
	95th & Willow Springs Road

Joe Neumann, steward of Ashburn Prairie, wrote the following in Andrea's memory.

Andrea's Poem
by Joe Neumann

The wild rose is an expectation
A butterfly yet to be born
A forming foaming star
A dreamer waiting to awaken
The wild rose is a thing that seems to pass too soon

On this dreary December day
Rose hips are for smearing between fingers
And casting to chilled soil
Knowing that June has always been
And will always be--
And that June holds the petals of the wild rose

As a token of the Palos volunteers' affection for Andrea, Joe presented Diane with a few rose hips and a lovely framed photo of a wild rose along with his poem. We all miss you, Andrea.

NATURAL GARDENING IN THE WINTER
by Rory Nelson

In winter's cold and short days, the garden becomes less of a priority, even to the most dedicated gardeners. I find myself looking at the garden rather that being out in it. This prompts some interesting observations . . .

Have I planned for the little "vistas" that are part of my daily routine? Each morning as I open the blinds, I am greeted with the dried pods of Marsh Milkweed (*Asclepia incarnata*), still delicate and beautiful. The milkweed leans a bit on its neighbor, tall and graceful Maiden Grass (*Miscanthus sinensis "Gracillimus"*). Although not a native, the Maiden Grass fits the low-maintenance and durability criteria for inhabitants of my garden, while providing incredible seed heads and great camouflage for the garage. Below these two plants are the remains of Brown-eyed Susan (*Rudbeckia hirta*), still strong and upright and ready to catch the morning frost. We tend to plan the garden as it is viewed from the street or patio; but these mini-compositions created for my window views are a great pleasure through the indoor months.

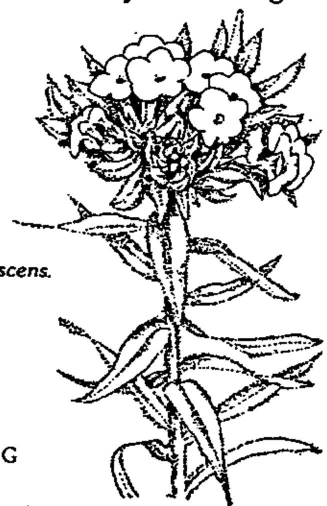
Yet another consideration are the structural elements left in the garden after the leaves fall. In choosing trees and shrubs for the garden, most of us think first of the flowers or autumn colors. What about branching structure and bark interest? These are the factors that are visible for a good part of the year, and they deserve equal attention. Every day as I go in and out of my front door, I walk by a young Pagoda Dogwood (*Cornus alternifolia*). Native throughout the upper midwest and northeast, this small understory tree is lovely during the growing season. But its real drama is in the delicate, distinctly horizontal branching structure of the tree, and its smooth, reddish bark. I also appreciate the clusters of purple-red berries in late summer, which would persist into late autumn if they weren't so quickly stripped clean by the local birds.

Better known from southern Illinois, pumpkin ash (*Fraxinus tomentosa*) bears *tomentum* (short, soft, matted or tangled hairs) on its young stems and buds.

You can tell the difference between a leaf-blade of silky wild rye (*Elymus villosus*) and other native wild ryes with your eyes closed. The silky, *villous* (long, soft, straight) hairs on the upper leaf surface are virtually unmistakable to the touch.

Finally, let's consider a pair of species with common names that reflect a fine distinction in hariness. Other than habitat, it is the *canescent* (dense, fine, downy) hairs of *Lithospermum canescens* that differentiate it from *L. croceum*. That is, canescence differentiates hoary puccoon from hairy puccoon.

Our local flora abounds with similar examples. You might contemplate the "wooly" sedge that used to go by *Carex lanuginosa* (now *C. pellita*); lanuginose means woolly. Or consider *Pentstamon hirsutus*, a species partial to dolomite prairies, told in part by the *hirsute* (coarse, stiff, straight) hairs on its stem and bearing the evocative common name of hairy beard tongue.



HOARY PUCCOON *Lithospermum canescens.*

Recommended Reading

The Fourth Edition of *Plants of the Chicago Region*, by Floyd Swink and Gerould Wilhelm, 1994, Indiana Academy of Sciences, includes an illustrated glossary. (Binomial nomenclature in this article was derived from the Fourth Edition.)

Plant Identification Terminology (An Illustrated Glossary), by James G. Harris and Melinda Woolf Harris, 1994, Spring Lake Publishing, contains more than 1,700 illustrations of botanical terms, as well as dichotomous keys to several groups of related terms, and definitions for more than 2,400 taxonomic terms.

Spring Annual Meeting And Pot Luck Party Just Around The Corner

Plan to join us at our annual meeting and pot luck dinner party on:

Saturday, March 4th
4:30 p.m. - 9:30 p.m.
Hinswood Club House

A terrific program is planned, featuring a presentation on the Joliet Arsenal and efforts underway to make it a natural areas site. Carl Glassford of Openlands Project is working to convince Illinois legislators that 2,000 of the Arsenal's acres should be held safe from development. His slide show features some of the 348 native plants, wetlands, prairies, forests, and rare animals that call the Arsenal home.

Bring your family and friends to the party.--it will be a great time getting together. For more information and directions to the party site, call Marge Keller at 708/852-6075.

What's In Your Water?

How much do you know about the quality of the Chicago River? The Chicago Academy of Sciences offers a free 90-minute exploration of the Chicago River where participants will:

- Roll up their sleeves and experiment with stream dynamics
- Test the pH, phosphate and nitrate levels
- Learn about the Chicago River and how to take part in its restoration

Offered one Saturday each month through May, call the Chicago Academy of Sciences for more information at 312/549-0775. Families welcome!

1995 Fall Burn Season Nears

As soon as the snow melts, we think about controlled burns. With four years of experience now, we've learned a lot about using fire as a management tool. *Burn Coordinator, Steve Bubulka, has updated the burn phone tree. To make sure you're on it, call him at 708/424-3178.*

Attachment 6: Second news release about the first few workshops

FOR IMMEDIATE RELEASE: April 13, 1995
CONTACT: Ken Rose (312) 549-0606, ext. 3064

A New Look at the Chicago River at the Chicago Academy of Sciences

"This is fascinating! I never thought of it that way before!" realizes Wendy Brawn, a Lincoln Park resident and recent participant in one of the Chicago Academy of Sciences' free weekend workshops on water quality and the Chicago River.

Wendy and her fellow classmates have just finished changing the physical characteristics of their own handmade river model in a 4 x 8-foot stream table and have discovered for themselves a complex relationship between the model ecosystem and four standard water quality tests that they have already performed. "I never saw the connection between pollutants, water temperature and oxygen levels, river dynamics, and ultimately, river life, until now. I will never look at the river the same way again."

Held in the *Water Works* laboratory at the Nature Museum of the Chicago Academy of Sciences, these informal introductory experiences have been very popular for all ages. "Each class has had a different focus so far, " says Ken Rose, Academy curriculum specialist and facilitator for the 90-minute classes. "Every time, a different group of people comes in with a specific question they would like to see addressed, and we go off investigating in a new direction as a result. It is exciting for all of us, and we all get something out of the learning experience. I, personally, have learned a great deal about the Chicago River and about water quality by tapping into the diverse experiences of the participants."

This project was funded by the Illinois Department of Conservation, Natural Heritage Division, from contributions to the Illinois Wildlife Preservation Fund. The remaining classes, held on Saturdays from 1:30 to 3:00 PM throughout the spring, are filled to capacity. This is a wonderful indication that many individuals and families in the city want to get involved in protecting Chicago's fragile watershed. Those wishing to be on a waiting list for the classes are invited to call (312) 549-0775 as soon as possible.

The Academy hopes to continue these opportunities for public water monitoring programs throughout the summer and fall, so watch for more dates to be announced soon!

Attachment 7: Sign-in sheets from the classes

Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
FEB 21/23, 1995

	name of participant	phone number
1.	Bill Crater	
2.	Jane Healy	
3.	Greg Williams	
4.	Angel Martin	
5.	TOM KINSELLA	
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, February 25, 1995

name of participant	phone number
1.	
2. Janet Knaett	929-1398
3. Natalie Holden	935-4260
4. BILL EYRING	743-1635
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Friday, March 24, 1995

name of participant	phone number
1. [illegible]	373-9956
2. Lena Witherspoon U.S.D.A./AMERICORP	373-9956
3. Christine Mallett U.S.D.A. Americorp	373-99[illegible]
4. [illegible] Belle	
5. Michael Thomas USDA	FRESH Prince
6. Lawrence [illegible]	
7. April Stegner U.S.D.A	
8. [illegible] Miller	
9. Tina Spencer USDA	
10. William Payne "	
11. Jesse Payne "	
12. Edna Wilson U.S.D.A	
13. Ralph Owens USDA	
14.	
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, March 25, 1995 130-300 PM

	name of participant	phone number
1.	Lori B. Mott	312 509-0438
2.	Carla Molinaro	312-221-0076
3.	Louise Lunak	642-7011 x2038
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, March 25, 1995 3-430 PM

name of participant phone number

1. Nasreen Khan
2. Wisam Blan
3. Yousaf Malhance
4. Rabah Hafeez
5. Jaani Malhance
6. Tariq Hafeez
7. P.K. Hafeez
8. Rubina Hafeez
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, April 8, 1995

	name of participant	phone number
1.	Richard Raskin	(312) 938-0380
2.	Cynthia Raskin	(312) 929-0614
3.	Frank Rechtsen	
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, April 22, 1995

name of participant	phone number
1. Peter Greene	488-6592
2. Michelle Matthews	643-9005
3. Kirkland Williams	1-800-570-6961
4. Wendy Brown	472-8029
5. T. SANDERS	(312) 994-3118
6. H. THORNTON	(312) 285-7370
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, May 13, 1995

	name of participant	phone number
1.	Vernecia Rogers	278-9155
2.	Heather Smith	728-8143
3.	Susan Gordon	486-7799
4.	Ruth Brazobitz	
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop
Saturday, May 20, 1995

	name of participant	phone number
1.	Paula Weber	769-2862
2.	Archie Jackson	373-~~[illegible]~~ 9956
3.	William Payne	373-9956
4.	Lawrence Davis	221-2561
5.	Jamie Gallagher	(708) 459-1561
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Sign Up Sheet
for
IDOC Water Quality Monitoring Workshop

Saturday, May 20, 1995
Session II

name of participant		phone number
1. Chiz Weinman		312/ 549-6529
2. Geoff Haban		312-549-0606 x3071
3. Jason Sheperis		(312) 847-3416
4. Joyce Li		(312) 944-5189
5. Charley Jenkins		(312) 247-8394
6. Peter Deene	USDA	(312) 373-9856
7. Michael Thomas	U.S.D.A	(312) 707-1449
8. Sammy Bawsley	USDA	(312) 373-9856
9. KIRKLAND WILLIAMS		~~312~~) 1-800-570-6941
10. Gerald Newell		(312) 264-5597
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Attachment 8: 5-10 photographs and slides of the class