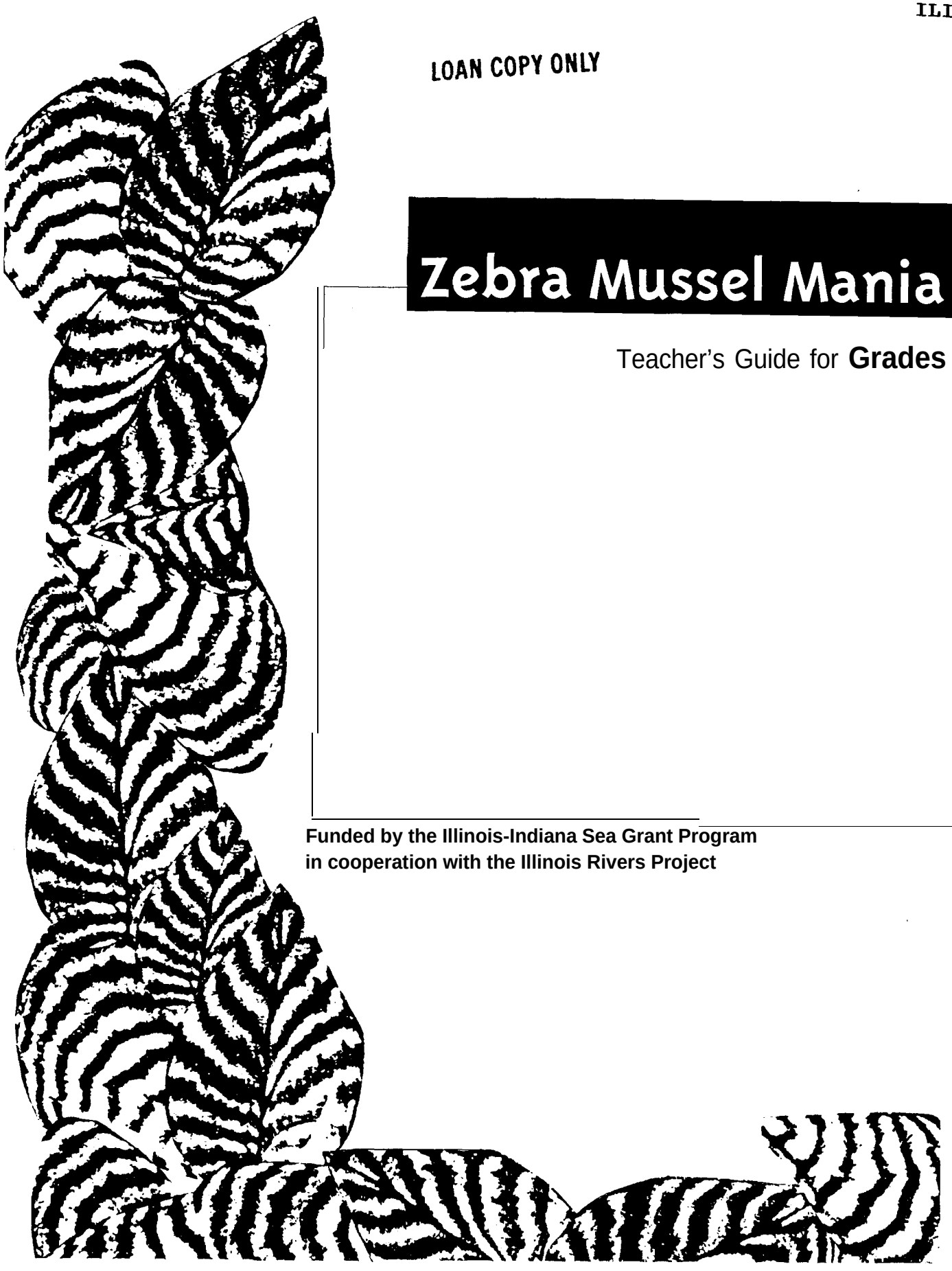

Zebra Mussel Mania

Teacher's Guide for **Grades 5 and 6**

Funded by the Illinois-Indiana Sea Grant Program
in cooperation with the Illinois Rivers Project

Teacher's Guide for **Grades 5 and 6**

Developed by:

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The Zebra Mussel Traveling Trunk was modeled after the Math and Science Hands-On (M.A.S.H. kit) concept developed at Educational Service Center #16 Belleville, Illinois, and Southern Illinois University at Edwardsville

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Virginia Polytech Institute and State University

All About Zebra Mussels activity sheet
Illinois Department of Conservation

Don't Pick Up Hitchhikers! Stop the Zebra Mussel! poster
New York Sea Grant Institute

Exotic Aquatics fact sheets
Bell Museum of Natural History

Great Lakes Sea Grant Network
Exotic Species Graphics Library
Michigan Sea Grant College Program

Nonindigenous Species fact sheets
Programs in the Great Lakes Sea Grant Network and
Mercury Marine, Division of Brunswick, Inc.

Rulers
Illinois American Water Company

Spiny Water Flea Specimen
Minnesota Sea Grant Program

Stop the Invaders poster
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ACTIVITIES

ACTIVITY SHEETS

Sea Grant
ILLINOIS - INDIANA

The Illinois-Indiana Sea Grant Program is a joint federal and state program administered through Purdue University, West Lafayette, Indiana. and the Unwersity of Illinois at Urbana-Champaign. The University of Illinois and Purdue University are affirmative action/equal opportunity employers.

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The Zebra Mussel Traveling Trunk at a Glance

Introduction

- This section is written to provide you with a quick overview of the major curriculum elements around which the Traveling Trunks were designed. In cooperation with the Illinois Rivers Project, the Minnesota Sea Grant College Program, and the University of Minnesota Bell Museum of Natural History, the Illinois-Indiana Sea Grant Program developed this educational resource kit. The Zebra Mussel Traveling Trunk and accompanying curriculum guide, Zebra Mussel Mania, were specifically created to provide teachers, environmental educators, natural resource agencies, and Cooperative Extension Service youth educators with a set of tools to teach 5th and 6th grade students about zebra mussels and the array of problems commonly associated with these and other exotic species. The Trunks were modeled after the Math And Science Hands-on (M.A.S.H.) kit concept developed by Educational Service Center #I6 in Belleville, Illinois, and Southern Illinois University at Edwardsville.

Scope and Sequence

- This kit is developed around fundamental themes in science that can be matched to concepts covered in most textbooks. Students explore these central themes as they complete ten developmentally appropriate, process-based activities.

Benchmarks

- The Traveling Trunk was developed by Illinois, Indiana, and Minnesota educators primarily to assist classroom teachers in meeting the educational needs of their students. As a result, each investigation's instructional guidelines focus on information in Benchmarks *for Science Literacy, Project 2061* (American Association for the Advancement of Science). These guidelines include the basic concepts and fundamental skills across the curriculum: science, mathematics, social studies, language arts, fine arts, health, and physical education. The trunk activities were carefully selected to prepare students to meet or exceed these benchmarks. Each of the ten activities is prefaced with specific goals and objectives to be met upon completion of the exercises that comprise the activity.

Science Process Skills

- The activities in the kits address the science process skills necessary for students to utilize when learning science: observation, measurement, classification, inference, prediction, communication, formulation of hypotheses, experimentation, and interpretation of data.

Cooperative Learning

- The instructional approach utilized in this curriculum allows students to work in cooperative groups. It is recommended that the size of your cooperative groups not exceed four students. Many educational benefits occur when students work together in groups to investigate and solve problems. Cooperative learning more closely resembles the way individuals work together to solve problems in the real world. Another important reason for the use of cooperative groups is to make the acquisition, costs, and management of materials reasonable for the classroom teacher.

Language Arts

- Students read about, talk about, and write about the exciting science activities they are doing. This additional use of language along with the science investigation reinforces students' understanding of the scientific principles being explored. The trunk includes its own science-related publications and an additional list of resources.

Mathematics

- Many of the science investigations result in an opportunity for the students. to apply mathematics skills in a variety of ways. Students are encouraged to quantify their observations with metric measurements and to record and report those observations with charts, tables, and graphs. Often times students will need to apply mathematical operations to solve problems or answer questions.

Alternatives in Assessment

- The activity assessment provided in this guide can be used to determine students' understanding of the major concepts dealt with in the trunk. Unit tests utilize a variety of different question formats such as fill in the blank, short answer, etc. The lesson assessment may be given in a pre-post type format in order to: (1) determine the increase of students' understanding as a result of this unit, and (2) clarify students' prior skill and knowledge of the direction instructions should take. The trunks also include a performance-based assessment that gives the teacher the opportunity to observe what students actually can do with the science concepts and skills they have learned.

Packing List of Materials for Zebra Mussel Traveling Trunk

ITEM	#/KIT	SUPPLIER	COST/KIT
16 to 18 gallon Rubbermaid 'Tote" container with lid	1	Discount Store	$7.00
Aluminum cookie pan	**4**	Discount Store	$4.00
Cottonbails	1 bag	Discount Store	$1.00
Cup, measuring **Cups, plastic**	1 **8**	Discount Store Discount Store	$- $0.50
Fact card master sheet for Clue Game	1	Illinois-Indiana Sea Grant	$0.50
Fact cards for Clue Game*	**4** sets	Illinois-Indiana Sea Grant	**$4.00**
Food pyramid transparency	1	Illinois-Indiana Sea Grant	**$0.50**
Funnel (use top of 2-liter bottle)	—	Self-supplied	
Game pieces, Web of Life Game	150 blue 150 red	Illinios-Indiana Sea Grant	$3.00
Gravel, Arkrolyte	2 bags (5 lb. each)	Garden/Landscape Suppliers	$4.00
Information brochures on six exotic species	8 sets	Illinois-Indiana Sea Grant	$4.00
Life cycle chart, freshwater mussel	4	Illinois-Indiana Sea Grant	$4.00
Life cycle chart, zebra mussel	4	Illinois-Indiana Sea Grant	$4.00
Metric ruler	8	Discount Store	$4.00
Mussel shells, assortment	4 bags (13 ea.)	Illinois Rivers Project	$16.00
Name tags for Web of Life game	33 name tags	Illinois-Indiana Sea Grant	$12.00
Nonindigenous species information cards*	4 sets of 6	Illinois-Indiana Sea Grant	$10.00

***The starred materials are found** *in plastic bags marked for each group.*

ITEM	#/KIT	SUPPLIER	COST/KIT
Posters:			
Wetlands: Water, Wildlife, Plants and People	1	Illinois-Indiana Sea Grant	$3.50
Exotic Species Poster	1	Illinois-Indiana Sea Grant	$8.00
Water: The Resource That Gets Used for Everythlng	1	Illinois-Indiana Sea Grant	$3.50
Groundwater: The Hidden Resource	1	Illinois-Indiana Sea Grant	$3.50
Groundwater and Land Use in the Water Cycle	1	Illinois-Indiana Sea Grant	$3.50
National Wildlife and Scenic River System	1	Illinois-Indiana Sea Grant	$3.50
The Water Cycle: Nature's Recycling System	1	Illinois-Indiana Sea Grant	$3.50
America's Pearly Mussels	1	Illinois-Indiana Sea Grant	$3.50
Shell button set*	**4**	Illinois Rivers Project	$5.00
Shell Classification Game	**4**	Illinois-Indiana Sea Grant	$20.00
Spoons, plastic	**8**	Discount Store	$1.00
Video (all 3 on one tape) Mussel Menace...Zebra Mussels and You: Zebra Mussels: Help Save America's Pearly Mussels	1	Illinois-Indiana Sea Grant	$20.00
Vldeo The Sea Lamprey Battle Continues	1	Great Lakes Fishery Commission	$-
Vinyl tubing, 1.4 m long, 2.5 cm diameter, with screen	**4**	Plumbing Supply and Hardware Store	$30.00
Zebra mussel filter model	**4**	Illinois Rivers Project	$5.00
Zebra mussel shells	1 **bag**	Illinois Rivers Project	$5.00
		Total	$194.00

* *The starred materials are found in plastic bags marked for each group.*

Cooperative Learning: Classroom Management Techniques

1 In order for your students to complete the activities successfully, it is essential that they know, and follow, the ten rules for group work:

- move into groups quietly, without bothering others
- use quiet voices
- stay with your group
- everyone does a job
- everyone shares the work
- no one is bossy
- everyone shares materials
- everyone shares ideas
- take turns talking
- care about others' feelings

2 Initially avoid competition between groups. This can be accomplished by carefully selecting groups in a variety of manners-randomly (i.e., by birthdays), by students' abilities, or by allowing students to choose the groups for themselves. It is important to note, however, that if the final technique is used to form groups, the students must be made aware that, if their group does not perform adequately or productively, alternative selection methods will be employed (i.e., teacher selection).

3 Clearly define the task to be done.

4 Be sure a "product " is connected with the group activity.

5 In setting time limits, allow too little time rather than too much time for the group to finish.

6 Each person in the team should play an active role. Regular rotation of roles should occur to give each student the opportunity to play a different role. Roles students can have are:

Principal Investigator: This person keeps the group members on task and makes sure the activity is understood by all and is completed. Any questions will be immediately clarified with the teacher.

Materials Manager: This person obtains all supplies the group needs. If the group is large enough, a second Materials Manager can be assigned to be responsible for returning materials to the supply area and having the group clean up its work area.

Recorder/Evaluator: This person writes down responses that team members have formulated. This student notes how well group members perform their responsibilities, contributing to the overall performance and outcome of the group.

Reporter: This person writes down the group's conclusions and reports to the class. The reporter may also need to record the group's data on a class graph or chart. If the group is large enough, two Reporters can be assigned-one to record conclusions and chart data, the other to present their findings to the class.

7 Follow the Five C's of group work in order to have a safe and FUN science activity:

CAUTION: Laboratory group work requires caution in every part. Safety instructions should be followed and a safety checklist should be implemented before each activity.

COOPERATE: To ensure successful group work, each member must cooperate with the other members of the group.

CONTRIBUTE: Each member must make an effort to contribute to the group.

CONTROL: Group work requires control over our body movements, voices, and actions. To avoid chaos in the classroom, control must be practiced by each member of the group.

CLEAN UP: Each group member must do his or her part to clean up after the activity. Students must make sure the work area is clean and all materials are put away.

8 The culmination of a group activity should be a time of sharing and evaluating how well members worked together as well as examining each group's end results or products.

Quick Reference Glossary

Definitions in this Glossary are intended for teacher use and quick reference,

- **action project -** taking what is learned and making a plan for bringing the issue to the attention of the local community and society in general

- **aquatic vegetation –** the plant life that exists in a freshwater environment

- **area –** the measure of the surface of a solid; a part of any surface; a particular zone

- **ballast water -** the water carried in a boat or ship to give stability

- **biological diversity** - variety of life

- **bivalve –** any mollusks, including mussels and clams, having a shell consisting of two valves hinged together

- **brainstorm -** the unrestrained offering of ideas or suggestions by all members of a group seeking a solution to a problem

- **byssal threads –** a tuft of filaments, chemically similar to silk, secreted by various bivalves, especially mussels, used to attach the mollusk to the substratum

- **centimeter (cm) –** a metric unit of measure equal to 1/100 meter (about the width of your finger)

- **common name –** the familiar name used by everyday people to refer to any species

- **community –** a group or unit that lives together

- **congregate –** a gathering or assemblage of people or things

- **data –** facts, figures, or information from which conclusions can be drawn

- **degradation –** sedimentation in aquatic areas that affects the quality of the water; the lowering of land surfaces by erosion

- **dispersal -** to break up and scatter in various directions

- **dissolved oxygen -** the oxygen freely available in water; vital to fish and aquatic life for respiration; dissolved oxygen has been accepted as the single most important indicator of the ability of a body of water to support aquatic life

- **diversity –** variety

- **documentary –** a motion picture, television program, or other presentation that shows or analyzes news events or social conditions with little or no fictionalization

- **ecosystem -** the interacting system of a biological community and its non-living environmental surroundings

- **estimate –** to judge or determine generally, but carefully, the size, value, or cost of an item

- **exotic species -** the organisms that are foreign, not native, to a particular location

- **extrapolate -** to arrive at a conclusion or result by hypothesizing from known facts or observations

- **filtration –** a treatment process for removing solid matter from water by passing the water through sand or a man-made filter

- **flow restriction –** anything that restricts or slows water flow; for example, zebra mussels restrict flow in a water pipe, and weeds restrict flow in a canal

- **food chain –** a sequence of organisms, each of which used the next lower member of the sequence as a food source

- **food web –** all the individual food chains in a community

- **glochidia –** the parasitic larval stage of freshwater mussels that infests the gills of many fishes

- **habitat –** the place where a population lives and its surroundings, both living and non-living

- **indigenous species –** organisms that are native to a particular area or region
- **infestation -** to overrun or inhabit in large numbers, as to be parasitic in or on a host
- **intake -** the place fluid is taken into a pipe, e.g., intakes for water treatment plants and power industries
- **introduced species –** a population placed into a particular area or region the species is not native to
- **larval fish –** an immature, free-swimming stage of a fish
- **life cycle –** the series of changes in form undergone by an organism in development from its earliest stage to the recurrence of the same stage in the next generation
- **liter (L) –** a metric unit of liquid measurement; it is equal to 1.06 quarts
- **maximum -** the greatest number, degree, or quantity
- **millimeter (mm) –** a metric unit of measure equal to one thousandth of a meter; 10 mm equals 1 cm
- **minimum -** the smallest number, degree, or quantity
- **mollusk –** members of the phylum of invertebrates that include bivalves, snails, and squids
- **molluscicide –** a chemical substance that poisons mollusks
- **mother of pearl -** the hard, pearly internal layer of certain bivalve shells, such as abalone and the three ridge mussel
- **native species –** species that naturally occur or live in a particular area or region
- **nonindigenous species –** species that are not native to a particular area or region

- **nutrient –** any substance assimilated by living things that promotes growth
- **organic detritus –** dead animal or plant materials or debris
- **organic matter -** carbon-based waste compounds produced by living plants or animals
- **parasitize –** to obtain benefit from another organism at that organism's expense
- **percentage –** a given part or amount in every hundred
- **phytoplankton –** microscopic plants that float in the water and are eaten by aquatic animals
- **population –** a group of interbreeding organisms of the same kind occupying a particular space
- **population density -** the quantity or number of a species per unit, as of an area
- **predator -** an animal or organism that lives by feeding on other animals
- **predict -** to determine in advance what will happen
- **prey –** an animal used for food by another animal
- **public information –** knowledge or information that is open to and for the use and benefit of all people
- **public involvement –** action taken by members of a community in response or conjunction with a particular issue or project
- **quantify –** to determine or express the amount of something; to measure
- **questionnaire –** a written or printed form used in gathering information about a subject; it consists of a set of questions to be answered then submitted to a group or organization
- **salinity –** a condition in which salt is part of a solution; the amount of salt in water

- **sampling -** the process of taking a small amount of an item or object for testing or analysis
- **sedentary –** remaining or fixed in one spot
- **sediments –** soil, sand, and minerals that settle at the bottom of a body of water
- **siphon –** an opening through which water enters and leaves an object, such as a mussel; some species can use this activity as a means of propulsion; also a means by which a liquid is transferred from one object to another, such as to siphon water into a bottle
- **smallmouth bass –** a North American fish found in cool, clear, fresh waters
- **submerge –** to completely immerse in water
- **substrate –** the ground or other solid material on which an animal moves or is fastened
- **turbidity -** when the amount of material such as silt or organic matter in the water reduces its clarity
- **univalve –** a mollusk possessing only one shell, such as a snail
- **veliger –** a zebra mussel larvae
- **ventral line –** a longitudinal line along the lower side of a zebra mussel
- **water clarity –** a condition in which the water is unclouded
- **zooplankton –** microscopic aquatic animals eaten by larger aquatic animals

Agencies and Officials

Staff members from the following agencies can be contacted to speak to your class about problems faced by the agency that relate to the activities in this guide. Representatives also may be able to discuss how they are solving problems caused by zebra mussels and other nonindigenous species. For addresses and or phone numbers, consult your local phone directory or contact your local or school library.

- **State Sea Grant Program**
- **State Natural History Survey**
- **State Water Survey**
- **State Department of Conservation/Natural Resources**
- **U.S. Army Corps of Engineers**
- **Soil Conservation Service**
- **State Department of Transportation**
- **Power Company**
- **Municipal Water Treatment Facility**
- **Biology Department of a University or College**
- **Museum**

Goals and Objectives

Goals

- To provide scientifically based education about zebra mussels for fifth and sixth grade students.
- To provide teachers with an interactive teaching tool and curriculum on zebra mussels and other nonindigenous species.
- To build students' critical thinking skills and scientific literacy.

Objectives

After completing Zebra Mussel Mania, students will be able to:

1 Record the observations they have made on nonindigenous species and describe their impact on the local ecosystem and industries.

2 Record observations of zebra mussel characteristics and be able to describe concerns about their arrival in North America.

3 Make inferences based on facts about zebra mussels.

4 Demonstrate the ability to differentiate between freshwater mussels and zebra mussels.

5 Measure and graph the length of the ventral side of a sample of zebra mussels.

6 Construct a model to simulate how zebra mussels filter large quantities of water.

7 Use a model to predict the rate of flow of water in a pipeline.

8 Calculate the number of zebra mussels in a given area.

9 Demonstrate critical changes in a native river ecosystem due to the introduction of zebra mussels.

10 Apply prior knowledge to design a community action project.

Setting the Stage for Learning

1 **Cooperative Learning Groups -** All work in this unit is meant to be done in groups of two to four students. The importance of helping each other and sharing must be stressed. It is helpful if both individual and group goals are set by the teacher and students.

2 **Inquiry-Discovery Method –** Very little of this material should be TOLD to the students. They should learn by completing the activities in the unit. This provides students with valuable experiences and skills along with learning the content in the unit.

3 **Play Time –** Allow time for students to appreciate Zebra Mussel Mania materials in a nonstructured, informal environment before, during, and after the activity.

4 **Material Storage –** Allow zebra mussels and other materials to dry out before returning to packages and to the trunk. This will avoid a mold problem.

5 **Unit Introduction -** To find out students' prior knowledge about zebra mussels, let the children brainstorm. First, place the words zebra mussel on chart paper or butcher paper. List all the words the students give you. Remember, when brainstorming, all words are accepted. Then, form a semantic map by putting the words under different categories. Words that have nothing to do with zebra mussels will naturally be discarded. Finally have the students write their own definition of a zebra mussel.

6 **Zebra Mussel Journal -** Students will keep a daily journal of their research about zebra mussels. This journal can also include usage of the unit vocabulary words as well as any questions they may have. Use pocket folders or construction paper to create journals, and have students decorate the journal by drawing zebra mussels. You can reproduce pictures from the guide for a journal cover. Use the journal master page provided to make appropriate number of copies for each student.

7 **Creative Writing -** The zebra mussel journal sheet decorated with a zebra mussel border can be used for creative writing activities, including reports, letters, brainstorming ideas, poetry, essays, etc. Use this with any language arts activity.

8 **Resource Materials –** A Sea Grant resource material list has been provided. Three videos (on one tape) are included in this curriculum, which supports Activity Two, Looking at the Zebra Mussel Menace. Many other resource materials can be obtained from the Illinois Rivers Project and state agencies such as the Department of Natural Resources, Bell Museum of Natural History in Minneapolis, Minnesota, Natural History Survey, State Water Survey, Department of Natural Resources, power plants and water treatment facilities. (See packing list of materials for supplier of included resources.)

9 **Expanding Bulletin Board –** Use materials in the kit to prepare bulletin boards. Other materials can be obtained by contacting the previously mentioned agencies.

10 Learning Strategies – You are encouraged to use the following strategy(s) to introduce any lesson in this unit.

- **KWL strategy** suggests that you ask each student to identify "what you know about the topic" **(K),** "what you want to know about the topic" **(W),** and after the lesson, "what you learned" **(L):** .A section on the KWL sheet can be used to indicate what the student is still confused about. Students fill out the first two columns before the activity and the last two after completing each activity. See Student KWL, page 16.

- **Mapping** is a technique for visually organizing material. Place a concept word in the middle of the board or butcher paper and let the children give you category words and phrases that fit with your word:

11 Attitude Survey – The attitude survey is optional. See page 17.

12 **Safety –** Go through the safety rules found in back pocket. Other safety rules may pertain if you go on a field trip.

Student KWL Strategy

- Activity
- Student Name
- What I know
- What I want to know
- What I learned
- What I am confused about

Student Attitude Survey

Zebra Mussel Mania

Name

Date

Directions: Please read each of the following statements carefully. Put a check mark by each statement that you agree with.

-1 I would rather study science than any other subject.

- 2 Science is of great value.

- 3 I really enjoy science.

- 4 Science is boring.

- 5 I love to study science.

- 6 Science is a waste of time.

- 7 Science will benefit only the smart kids.

- 8 I have no desire to learn about science.

- 9 Science classes are profitable to everyone who takes them.

- 10 Science is practical.

— 11 I like science experiments.

— 12 Science experiments are dumb.

— 13 Science teaches me to think.

- 14 Science is of benefit to me.

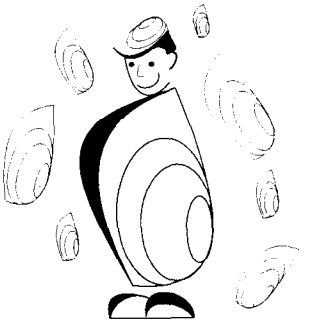
— I5 I hate science.

You may write any additional comments about science that you feel are important.

Zebra Mussel Mania

Teacher's Guide for **Grades** 5 **and** 6

Activities

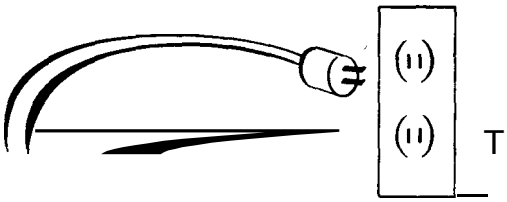


ACTIVITY ONE:	ALIEN INVADERS
TIME:	(3) 45-minute lessons
SCIENCE PROCESS SKILL:	Communicating
SCIENCE CONCEPT:	Nonindigenous species have an impact on native populations.
BENCHMARKS:	Students should: Learn a lot about plants and animals by observing them closely. Care must be taken to know the needs of living things and how to provide for them in the classroom. Know that changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. Keep a notebook that describes observations made. Carefully distinguish actual observations from ideas and speculations about what was observed. The notebook should be understandable weeks or months later. Buttress their statements with facts found in books, articles, and databases, and identify the sources used.
OBJECTIVE:	Students will record observations on species and describe the impacts of these introduced species.

1

WHAT YOU OUGHT TO KNOW

Nonindigenous animals and plants that have been introduced to a specific area may have tremendous impacts on a native habitat. Species that are introduced intentionally or accidentally may change the habitat so much that native species - may have little chance of survival. Introduction may occur through natural means, such as through currents and floods, or by attaching to animals and birds that move from one location to another. However, humans frequently are the primary transporters of these alien invaders.



WHAT'S THE CONNECTION?

TO LANGUAGE:
Write poetry, a rap, or a skit about the "evils" of nonindigenous species.

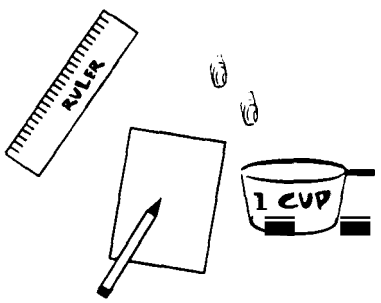
TO ART:
Prepare a zebra mussel folder/journal.
Design and display posters locally.

TO SOCIAL STUDIES:
Map out the areas of infestation by any of the nonindigenous species.

WORDS OF WISDOM

Ballast water, biological diversity, degradation, dispersal, exotic species, habitat, indigenous species, infestation, native organisms, nonindigenous species, prey, predator, turbidity, zooplankton (see also glossary on page 7)

RESOURCES AT THE READY



Zebra mussel journal
Research on Exotic Species Record Sheet 1.1
Paper
Information cards and fact sheets on:
zebra mussels, ruffe, purple loosestrife,
spiny water flea, sea lamprey, and
Eurasian water milfoil
Other background information for teachers
(in the black portfolio)
Video: The Sea Lamprey Battle Continues

GETTING YOUR ACT TOGETHER

Read the resource materials and become familiar with the_ materials to facilitate cooperative learning groups. The class should be divided into cooperative working groups of 3-5 students, with one or more groups given the species represented in the materials. Using the provided journal master sheet (see p. 14, no. 6), prepare a zebra mussel journal for each student (or each working group). The students will be using this journal throughout the traveling trunk study.

TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

DAY 1-2

1. Introduce students to the concept of alien invaders. Ask them what they know about animals and plants that have been introduced to America and that are not native. List on a piece of newsprint, or the board, what they know about alien invaders or exotic organisms. Communicate that the students will be concentrating on recent invaders, focusing on one in particular.
2. The teacher, or working groups, should choose a species to research.
3. Using the laminated exotic species information cards, students will find the following information: species description, method of introduction, means of spread, impact on native species, and interesting facts pertinent to their research (who, what, when, where, why, and how).
4. Using their newly acquired information, students will prepare an oral presentation. The presentation may be supplemented with materials in the kit or may include posters or other student-made materials. If the species can be obtained locally (through your University's biology department or a natural resource management agency), arrange for specimens to be brought into the classroom.

DAY 3

5. Write the following statements on the board and have the students copy them in each journal, leaving space for answers. Repeat this six times (pages) with the species name supplied each time. Another option is to reproduce Record Sheet 1.1.

   NAME OF SPECIES:

   SCIENTIFIC NAME OF SPECIES:

   DESCRIPTION OF SPECIES:

   METHOD OF INTRODUCTION:

   HOW THE POPULATION SPREADS:

   IMPACT ON NATIVE SPECIES:

   INTERESTING FACTS:

6. Students will present to the class findings from the information researched.

7. As each presentation is made, students will take notes in their journals, filling in the appropriate data and information. Questions can be asked by students to complete any missing information.

8. With student discussion and input, make a list (on newsprint or on the board) of what students now know about each alien invader. Compare the lists and identify differences and similarities. Use the webbing technique to show relationships within the information.

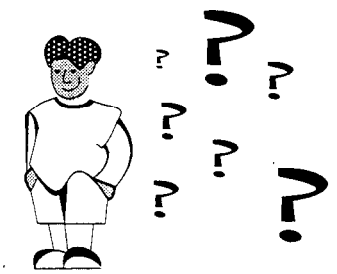
WHAT DID YOU LEARN??

As each student listens to the presentations, he/she should have recorded the required information in the journal. The reports should reflect the information presented in the poster materials. The students' lists made in their initial fact-finding activity should now be much longer. Did everyone add information to the list?

WAIT, THERE'S MORE. . .

- Have the class make additional reports on other alien invaders or exotic species. These include carp, dandelion, English sparrow, rabbits in Australia, starling pheasant, rainbow trout, and others.
- Ask a local Cooperative Extension Service educator, wildlife biologist, or natural resource manager to discuss nonindigenous (exotic) species with the class.
- Consult books such as *Protecting Endangered Species* by Felicity Books (Usborn Publishing Company, 1SBNO-7460-0608X). This book shows impacts of other introduced species and explains what has happened to native species when new species have been introduced.

ACTIVITY TWO:	**LOOKING AT THE ZEBRA MUSSEL MENACE**
TIME:	(2) 45-minute lessons
SCIENCE PROCESS SKILL:	Observing, measuring, and communicating
SCIENCE CONCEPTS:	Zebra mussels have identifiable and observable characteristics. Zebra mussel history and concerns can be identified from a video.
BENCHMARKS:	Students should: Know that changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. Judge whether measurements and computations of quantities such as length, area, volume, weight, or time are reasonable in a familiar context by comparing them to typical values.
OBJECTIVE:	Students will record observations of the zebra mussel. Students will be able to describe concerns about the zebra mussel's arrival in North America.

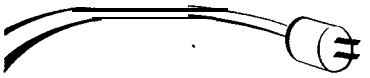


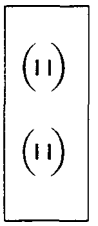
WHAT YOU OUGHT TO KNOW

A zebra mussel is a bivalve mollusk. It is a fingernail-sized clam with yellowish or brownish shells marked in wavy bands. Female zebra mussels can produce 30,000 to 1,000,000 eggs per year. These eggs develop into free-swimming larvae (called veligers) that quickly begin to form shells. After approximately three weeks, zebra mussels attach to hard surfaces called substrates. These are surfaces such as rocks, gravel, metal, crayfish, native mussels, and each other. They attach to these surfaces by using their byssal threads. Byssal threads have a strong adhesive that will dry under water and even adhere to Teflon.

Zebra mussels filter plankton from the water. Adult mussels can filter up to one liter of water per day. Diving ducks and freshwater drum eat zebra mussels. However, zebra mussels reproduce at such a rapid rate they cannot be controlled by this method alone.

The activities in Day 1 allow students to observe the characteristics of the zebra mussel. Observations are made by using the five senses. Some observations are: shiny inside, two shells per mussel, and 2 cm in length. Caution students not to make inferences, such as meat is inside the shell, unless they can see it. During Day 2 students will identify some of the environmental, recreational, and industrial problems caused by zebra mussels.





WHAT'S THE CONNECTiON??

TO LANGUAGE:
Write letters to request information about zebra mussels from organizations listed on the Agencies and Officials sheet, page 12. You and the students will need this information for use in Activity Ten. Write a physical description of the zebra mussel in the journal.

TO MATHEMATICS:
Estimate the number of zebra mussels that will occupy a 100 ml space.

TO ART
Construct a mosaic of the zebra mussel by using construction paper.

TO SOCIAL STUDIES:
Using a world map, trace the spread of zebra mussels over time.

WORDS OF WISDOM

Ballast, byssal threads, bivalve, ecosystem, exotic, molluscicides, salinity, substrate, veliger (see also glossary on page 7)

RESOURCES AT THE READY

Videos (combined onto one tape) -

"Mussel Menace...Zebra Mussels and You" (15:35)

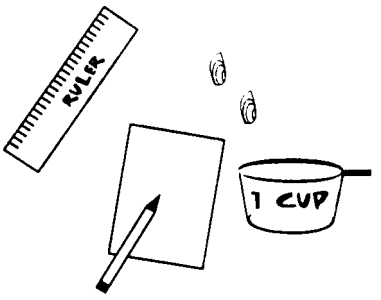
"Zebra Mussels" (30:00)

"Help Save America's Pearly Mussels" (30:00)

Newsprint sheets

Zebra mussel journal

For each working group:



Metric ruler

Zebra mussel shells (100 ml)

Measuring cup

Zebra Mussel Observation Sheet 2.1

Zebra Mussel Menace Record Sheet 2.2

Group folder

GETTING YOUR ACT TOGETHER

Prepare the materials in a folder for each cooperative group. On newsprint, make up a summary sheet for each of the day's activities. The summary sheets should be titled "Zebra Mussel Observation Sheet" and "Zebra Mussel Menace Record Sheet." Preview the first two videos described in the resources section.

TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

DAY 1

1. Show the video “Mussel Menace...Zebra Mussels and You.” The second video, “Zebra Mussels,” is a PBS program that can be shown on this day or at a later time in the curriculum.
2. Divide students into cooperative learning groups.
3. Have each group measure 100 ml of zebra mussels. (If necessary, you could have these measured out in advance.) Before the shells are observed by the groups, have them estimate the number of mussels in the sample. Record this on the Zebra Mussel Observation Sheet 2.1.
4. Observe mussels and record observations on the Zebra Mussel Observation Sheet 2.1. You will want to support the students’ observations by offering clues to the groups as needed. Some suggestions are:

   What are the color variations?

   Ask questions about shell symmetry and bivalve construction.

   How is feel related to a particular surface that is touched?

   One side will feel sharp, another smooth.

   How many actual mussels were counted? (Record this on the data sheet.)

   Sound is not easy to observe. In order to observe sound, something must be done to the mussels.

   An obvious smell is present. Does it change when the mussels are wet?

5. Record each group’s data on your newsprint sheets. Are differences apparent? Discuss the data.

DAY 2

6. Hand out Zebra Mussel Menace Record Sheet 2.2 to each student.
7. View video again so students may complete the sheet.
8. Have the reporters summarize the data on a class chart.
9. Write group-generated answers for each question on newsprint charts.
10. Discuss and summarize the results. Each student should copy this summarized data in his/her journal.

WHAT DID YOU LEARN??

Use the group charts to generate discussion based on observations made. The students' senses should have been used to observe zebra mussel characteristics. Taking measurements of length, width, and mass also should have helped students to identify physical aspects of zebra mussels. While watching the video, did each student make notes and contribute to the total information produced by their group? Each group member should be able to answer questions based on physical observations of zebra mussels and information gained from the video. Can they answer your questions?

WAIT, THERE'S MORE. . .

Use information from the chart to have the class draw conclusions from the following questions:

1. Why are zebra mussels considered a menace?
2. How do zebra mussels affect you?
3. How did zebra mussels travel from Europe to North America?
4. How are zebra mussels transported throughout the United States?
5. What are some ways to prevent zebra mussel spread?

ACTIVITY THREE	DON'T HAVE A CLUE
TIME:	(1) 45-minute lesson
SCIENCE PROCESS SKILL:	Inferring -
SCIENCE CONCEPT:	Zebra mussels have an impact on the environment.
BENCHMARKS:	Students should: Know that, in making decisions, it helps to take time to consider the benefits and drawbacks of alternatives. Understand that, for any particular environment, some plants and animals survive well, some survive less well, and some cannot survive at all. Know that organisms interact with one another in various ways in addition to providing food.
OBJECTIVE:	Students will make inferences based on facts about zebra mussels.

WHAT YOU OUGHT TO KNOW

Zebra mussels may have negative impacts that upset the ecological balance of the Great Lakes and inland waterways. The sport fisheries in the Great Lakes are changing because of improved water clarity. The zebra mussel's amazing water filtering capacity is partly responsible for improved water clarity; but other factors such as tougher pollution laws and better technology are helping to keep the water clean. Research is being conducted to examine effects of the zebra mussel invasion on native mussel populations.

Although this activity's story, "What Happened to Lake Michigan," is fictional, the facts and basic story line are scientifically based. This is an interactive lesson where students must work together to understand the problem. The fact cards provide information and background knowledge. **NO** single fact card is sufficient to answer the questions.

WHAT'S THE CONNECTION??

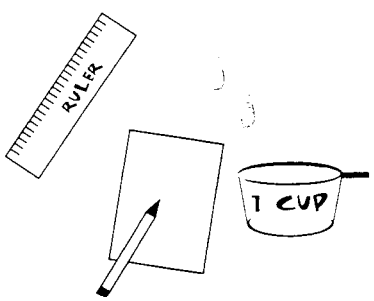
TO LANGUAGE:
Students will write their own clue game and play the new game with each other.

TO ART
Students can use the story to create and illustrate a comic book.

TO MUSIC:
Write a rap using alliteration.

WORDS OF WISDOM

Aquatic vegetation, smallmouth bass, water clarity
(see also glossary on page 7)



RESOURCES AT THE READY

FOR EACH GROUP -
Two copies of the story 3.1, "What Happened to Lake Michigan," and accompanying questions
Fact card sheet master 3.2
Observation Sheet 3.3
Laminated fact cards
Paper and pencil
Zebra mussel journals

GETTING YOUR ACT TOGETHER

Hand out the zebra mussel journals so that students can refer to their previously gathered information Provide 8 fact cards for each working group. Provide other zebra mussel literature as needed by the group.

TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

1. Divide students into cooperative learning groups. Each group will carry out the entire activity.
2. Give each group a package of materials that includes two copies of Story 3.1, "What Happened to Lake Michigan," and the related questions.
3. Distribute 2-3 fact cards per group member in every group, and request that they do not read them yet.
4. Teacher will read the story, "What Happened to Lake Michigan." At the end of the story, students in each group will take turns reading the questions.
5. Students are to silently read their fact cards and, when needed, share the information on the fact cards with their group members.
6. Record the answers to the questions on Observation Sheet 3.3 using all available information. Any answer that can be substantiated with the facts and other outside knowledge should be accepted.
7. When the groups are finished, conduct a class discussion on each question and allow each group to contribute its collective answers. Come to a class consensus when determining answers to each question.
8. Have each child record the answers to each question (reached by class consensus) in his/her journal. This information will be useful in later activities.

WHAT DID YOU LEARN??

Each group should present its answers in a class discussion of the questions. The answers should indicate that students have gained experience in finding and summarizing the information requested. Were proper inferences made?

WAIT, THERE'S MORE. . .

- Can the students adapt/modify the game by creating more information (fact) cards?
- Can they rewrite or change the story and make fact cards more locally based?
- Suggest that the modified game be used next year, or have the students teach their adaptation to another class.

"DON'T HAVE A CLUE" GAME

DIRECTIONS FOR STUDENTS

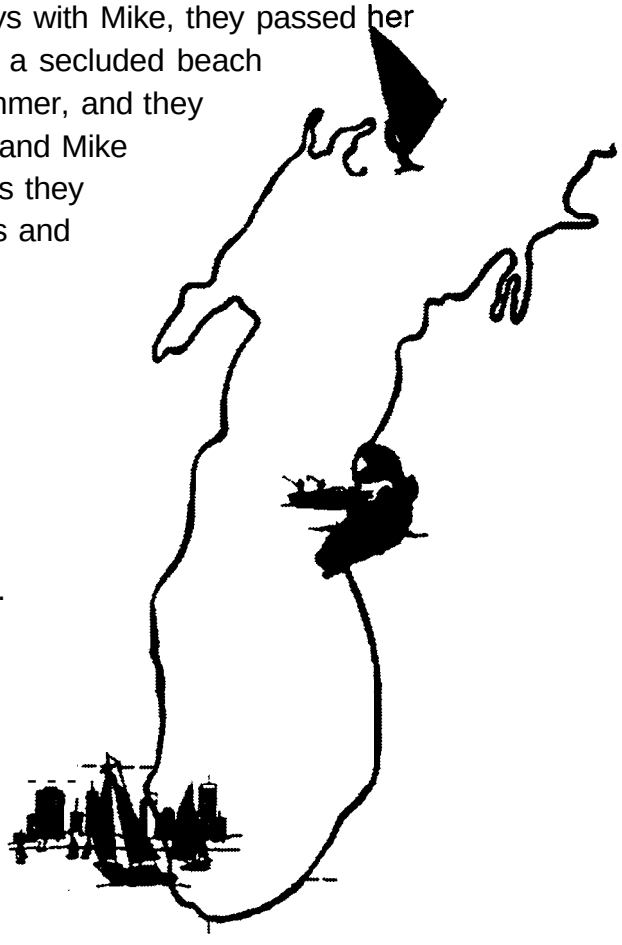
1. Each person in the group will receive several (two or more) fact cards concerning the story.
2. Listen to the story of Lake Michigan as it is read.
3. Using the facts, help your group answer the questions that follow the story. The group can take any approach to solving the problem. However, do not pass the fact cards to anyone (not even in your group) until the activity has ended. One student will read a question then refer to his/her fact cards for an answer. If that student does not have the answer, another student with the correct fact card gives the answer. The next student reads the second question, and so on until all the questions are answered.

Don't Have a Clue Story 3.1
Read by Teacher

What happened to Lake Michigan?

Melanie had grown up near Chicago, and she had spent most of her summers sailing, swimming, and fishing in Lake Michigan. Melanie moved away from Chicago in 1980. In 1993, she and her husband, Mike, moved back to her home town, where they moved into a condominium high above Lake Michigan's impressive shoreline. Melanie noticed that the water in the harbor was much clearer than when she was a child. She was surprised to see a lot of plant life in the water that she had never observed before.

One day while they were sailing, Melanie told Mike that, when she was in high school, she remembered boats coming in and out of the harbor filled with walleye and smallmouth bass. As Melanie was remembering the good old days with Mike, they passed her family's favorite vacation spot, a secluded beach where they camped every summer, and they noticed a nasty odor. Melanie and Mike also noticed that the only boats they saw on the lake were sailboats and yachts -- no fishing boats.



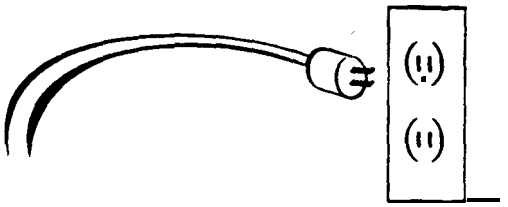
On their return trip home they stopped at Fred's Fresh Fish Shop to purchase, what else, fresh fish. Melanie was disappointed to learn from Fred, a local fisherman, that he didn't have any walleye left.

He informed her that the local fishing industry has gone through many changes. At this time, the only fresh fish he had was fish shipped in from elsewhere.

ACTIVITY FOUR	MUSSEL TO MUSSEL
TIME:	(3) 45-minute lessons
SCIENCE PROCESS SKILL:	Classifying
SCIENCE CONCEPT:	Native and introduced species of mussels must both be recognized.
BENCHMARKS:	Students should: Know that a great variety of kinds of living things can be sorted into groups in many ways by using various features to decide which things belong to which group. Understand that, for any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.
OBJECTIVE:	Students will demonstrate the ability to differentiate between native mussels and zebra mussels.

WHAT YOU OUGHT TO KNOW

Almost 300 different species of native mussels have been identified from streams, rivers, lakes, and ponds of North America. They are important, both economically and ecologically. Zebra mussels compete with native mussels for food, space, oxygen, and other necessities. Some competition may not be bad if the teams are fair; but, because zebra mussels reproduce so quickly, they often will "out compete" the native mussels (and other native organisms as well). Zebra mussels may eliminate native mussels completely from many rivers and lakes. To preserve our native mussels and control or eliminate zebra mussels, we need to be able to tell the good guys (the native mussels) from the bad guys (the zebra mussels). Several characteristics can be used to tell different species apart. Several features can be used to tell the difference between native mussels and zebra mussels.



WHAT'S THE CONNECTION??

TO LANGUAGE:
Write a constructed definition for each vocabulary word from given materials.

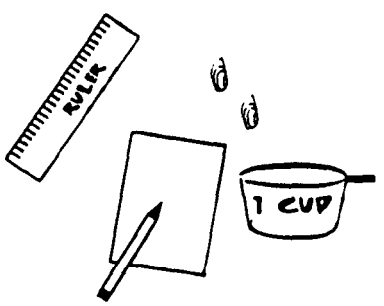
TO MATHEMATICS:
Find the differences in length of freshwater and zebra mussels.

TO ART:
Sketch the mussel of their choice. Construct a shell poster.

TO SOCIAL STUDIES:
Read about the shell industry along the Mississippi River.

WORDS OF WISDOM

Classification, diversity, glochidia, life cycle, marsupium, mother of pearl, organic detritus, parasitize, sedentary, sediments, species (native, exotic, and introduced), scientific and common names, shell species (see also glossary on page 7)



RESOURCES AT THE READY

Collection of mussel shells (4 bags)
Shell button set (2 buttons per strip)
Copies of ***Mr. Boepple's Shells*** story 4.1
Shell Classification Game 4.2
(4 game boards in poster tube)
Freshwater Mussels Life Cycle Chart
(4 posters in binder's back pocket)
Zebra Mussel Life Cycles Chart
(4 posters in binder's back pocket)
Pamphlets on freshwater and zebra mussels (8)
Construction paper or cardboard
Zebra mussel journals and pencil

TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

DAY 1-3 (THE ENTIRE CLASS)

1. Have the entire class read Mr. Boepple' s story, Story 4.1, and distribute buttons for each group of students to observe. Buttons included in the kit are made from either shells or plastic; you may want to add a few buttons of your own. Buttons on green side of strip are mussel shells; buttons on white side are made of newer plastic materials. Have the students decide which are the shell buttons. In their journals have them write a description of the shell button and the plastic button and how they can tell the difference between the two or between others in the kit.
2. Have the students discuss the story of Mr. Boepple. What were some characteristics they saw in him that made him a good business person? What were some of his characteristics that made him a bad business person? He used mussel shells for buttons. What other uses could be made for shells? Make a list of uses for shells. What changes have been made in modern medicine that would make it almost impossible for Mr. Boepple to die today with a cut foot?
3. Explain that just as they have learned to distinguish the shell button from other buttons, shells can be classified into groups by common appearances or differences. Their next task will be to classify a group of shells by common characteristics and to look at the life cycles of shells.

TEACHER DIVIDES THE CLASS INTO TWO GROUPS

GROUP 1	GROUP 2
classifies the shells	looks at the life cycle

The groups will switch activities each day so both groups will have the opportunity to do each activity.

CLASSIFYING THE SHELLS (DONE BY GROUP 1)

1. Each group should take a shell set and shell classification guide. Have each group sort the shells into groups that look alike. They will notice that the shells have numbers. The number will be used later in sorting the shells and to help learn their names. Have them write, in the zebra mussel journal, descriptions of each shell. Encourage them to use a ruler. Discuss how their shell groups were formed-by size, by color, by shape, by shell type, etc. Accept all answers in this discussion.

2. Explain that most shell keys are developed around a binary (two division) key. They are now going to classify the shells using Record Sheet 4.2, Mussel to Mussel Shell Classification Game.

3. Show students the procedure for developing the key. First have them place all the shells in one group. Place shells in the big rectangle on Record Sheet 4.2. Then, make up a good question, where the answer is either yes or no, that will divide the shells into two groups. (One questions could be: Are they snail-like?) Write the question on the line in the first big rectangle. Physically divide the shells into those two groups. Place the shells or write the numbers of the shells whose answer is yes in that rectangle; and the letters whose answer is no in that rectangle. Have the students pretend that the lines are a path on which the shells are carried to the next rectangle. Keep dividing the shells by asking new questions that can be answered by either a yes or a no until the bottom of the board has been reached.

4. When finished, have each group share their classification. Discuss how the groups vary, or are the same? Why were decisions made about the grouping? You may want to make a big classification diagram on a poster board or lay the shells flat on a piece of butcher paper.

5. Hand the groups the picture guide to Freshwater *Mussels of the Upper Mississippi River.* From your list, have them find the name of a shell, then look up information in the shell guide. Copy information from that shell guide along with names of other students researching that shell.

Life Cycles (Done By Group 2)

1. Give the students a piece of construction paper or cardboard and a shell. Have them make a list of the important information about that shell. Print it carefully. When both groups have finished the classification activity, place the shells from one set on the completed descriptions of that shell. Place the shell and information page in a display area for other classes to observe.

2. Explain to the students that internal or reproductive methods also are used by experts to classify mussels. Students should understand how freshwater mussels are classified differently from zebra mussels and many other mussels by their reproductive method. That characteristic is one reason why zebra mussels have spread so easily, with exploding populations that cause population declines in freshwater mussels.

3. Have the students collect the life cycle posters and Observation Sheet 4.6.

4. Using the life cycle charts for both native and zebra mussels, have each working group read, discuss, and record the similarities and differences of both groups of organisms. They should make notes in their zebra mussel journals and transfer the final information to Observation Sheet 4.6.

5. Have each group share their observations with the class. As they do so, make a large list on the board. With discussion, prepare a list of characteristics that will compare and contrast the two organisms. Have the students copy that information into their zebra mussel journal. They will need that information later.

6. Have each student draw in the journal the life cycle of the freshwater mussel and life cycle of the zebra mussel, and label the drawings fully.

7. Have everyone complete the Mussel Multiplication section of *All About Mussels* found in the front pocket, or use this later as part of the Post-test.

WHAT DID YOU LEARN??

You should be able to observe the students interact in groups as they classify the shells and compare and contrast freshwater mussels with zebra mussels. Each student should have the required information and drawing in the journal. Questions can be asked about the life cycle, and each group should be able to distinguish between the life cycles of native mussels and zebra mussels.

WAIT, THERE'S MORE . .

- The students can bring in other shells or mussels (including freshwater and saltwater species) to add to your collection. Are they freshwater or marine species? Have them find the names of each from shell books.
- Did you discover that 13 shells were found in the shell collection? Shell 13 is unlucky because this mussel can no longer be found alive in the Illinois River. The other shells, however, can still be found at locations along the river where they once were abundant. Can the students develop some explanations for the disappearance of that species? Find out which mussels in your region are endangered.
- Do a venn diagram comparing and contrasting zebra mussels and other freshwater mussels.

WHAT DID YOU LEARN??

You should be able to observe the students interact in groups as they classify the shells and compare and contrast freshwater mussels with zebra mussels. Each student should have the required information and drawing in the journal. Questions can be asked about the life cycle, and each group should be able to distinguish between the life cycles of native mussels and zebra mussels.

WAIT, THERE'S MORE. . .

- The students can bring in other shells or mussels (including freshwater and saltwater species) to add to your collection. Are they freshwater or marine species? Have them find the names of each from shell books.
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- Do a venn diagram comparing and contrasting zebra mussels and other freshwater mussels.

ACTIVITY FIVE	HOW BIG ARE YOUR MUSSELS?
TIME:	(1) 45-minute lesson
SCIENCE PROCESS SKILL:	Measuring and graphing
SCIENCE CONCEPT:	Zebra mussels vary in length and size.
BENCHMARKS:	Students should: Know that, when people care about what is being counted or measured, it is important for them to identify the units (three degrees Fahrenheit is different from three centimeters; three miles is different from three miles per hour). Graphically display numbers to spot patterns that are not otherwise obvious, such as comparative size and trends. Spread data out on a number line to see what the extremes are, where they pile up, and where the gaps are. A summary of data includes where the middle is and how much spread is around it. Keep records of their investigations and observations and not change the records later.
OBJECTIVE:	Students will measure and graph the length of the ventral side of a sample of zebra mussels.

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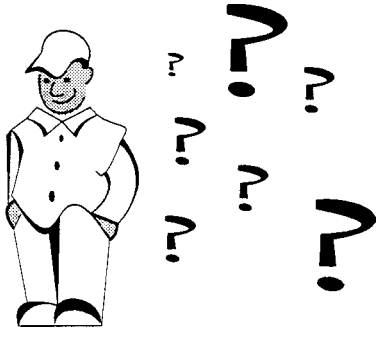


WHAT YOU OUGHT TO KNOW

Zebra mussels are found in a variety of lengths. They range in length from less than 1 mm to 45 mm or larger. Length measurements are made along the ventral side of the mussel, which is the straight edge. The enclosed Illinois Natural History Survey (INHS) sheet shows actual length data from three samples at one site on the Illinois River. The purpose of this activity is to determine the frequencies of shell lengths and to visually illustrate those frequencies by the use of graphs.

WHAT'S THE CONNECTION??

TO LANGUAGE:
Write a journal entry about the life of a zebra mussel. Have the students take the viewpoint of the zebra mussel.

TO MATHEMATICS:
Calculate the average length of the sample of shells for each group and then for the class. Calculate the percentage of the numbers for each length. Discuss other ways to graph and have the students construct a pie graph for the group sample.

TO ART
Make an enlarged drawing of a zebra mussel using the grid method.

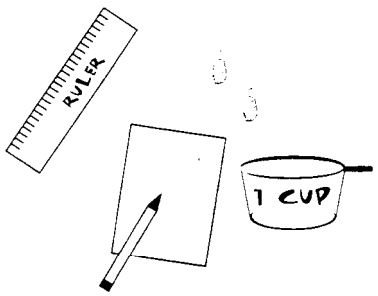
TO SOCIAL STUDIES:
Read an Illinois map to find the location of each zebra mussel sample site on the Illinois River (described in this activity). Consult monitoring agencies in your state to construct your own map of sample sites.

WORDS OF WISDOM

Centimeter (cm), data, maximum, millimeter (mm), minimum, percentage, ventral line (see also glossary on page 7)

RESOURCES AT THE READY

FOR EACH GROUP –
Measuring cup
Zebra mussel shells
Metric rulers
Graph paper
Length Frequency Chart Data Sheet 5.1
Length Frequency Bar Graph 5.2
Grid Data Sheet 5.3
Zebra mussel journal

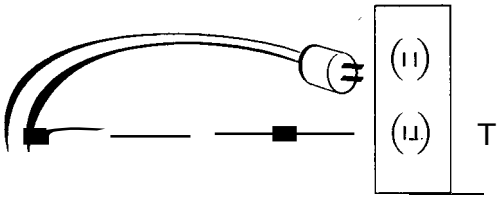


ACTIVITY FIVE	HOW BIG ARE YOUR MUSSELS?
TIME:	(1) 45-minute lesson
SCIENCE PROCESS SKILL:	Measuring and graphing
SCIENCE CONCEPT:	Zebra mussels vary in length and size.
BENCHMARKS:	Students should: Know that, when people care about what is being counted or measured, it is important for them to identify the units (three degrees Fahrenheit is different from three centimeters; three miles is different from three miles per hour). Graphically display numbers to spot patterns that are not otherwise obvious, such as comparative size and trends. Spread data out on a number line to see what the extremes are, where they pile up, and where the gaps are. A summary of data includes where the middle is and how much spread is around it. Keep records of their investigations and observations and not change the records later.
OBJECTIVE:	Students will measure and graph the length of the ventral side of a sample of zebra mussels.

1

WHAT YOU OUGHT TO KNOW

Zebra mussels are found in a variety of lengths. They range in length from less than 1 mm to 45 mm or larger. Length measurements are made along the ventral side of the mussel, which is the straight edge. The enclosed Illinois Natural History Survey (INHS) sheet shows actual length data from three samples at one site on the Illinois River. The purpose of this activity is to determine the frequencies of shell lengths and to visually illustrate those frequencies by the use of graphs.



WHAT'S THE CONNECTION??

TO LANGUAGE:

Write a journal entry about the life of a zebra mussel. Have the students take the viewpoint of the zebra mussel.

TO MATHEMATICS:

Calculate the average length of the sample of shells for each group and then for the class. Calculate the percentage of the numbers for each length. Discuss other ways to graph and have the students construct a pie graph for the group sample.

TO ART:

Make an enlarged drawing of a zebra mussel using the grid method.

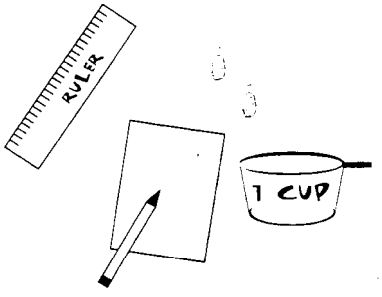
TO SOCIAL STUDIES:

Read an Illinois map to find the location of each zebra mussel sample site on the Illinois River (described in this activity). Consult monitoring agencies in your state to construct your own map of sample sites.

WORDS OF WISDOM

Centimeter (cm), data, maximum, millimeter (mm), minimum, percentage, ventral line (see also glossary on page 7)

RESOURCES AT THE READY

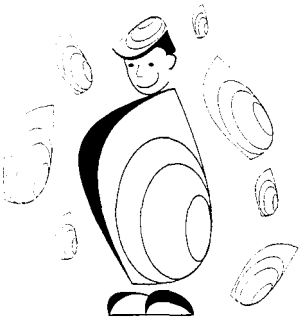


FOR EACH GROUP –

Measuring cup
Zebra mussel shells
Metric rulers
Graph paper
Length Frequency Chart Data Sheet 5.1
Length Frequency Bar Graph 5.2
Grid Data Sheet 5.3
Zebra mussel journal

GETTING YOUR ACT TOGETHER

Read the Illinois Natural History Survey Zebra Mussel Length Frequency Bar Graph 5.3 to familiarize yourself with the length frequency of live zebra mussels. This information is actual data taken from three samples along the Illinois River. You should prepare a larger summation chart of the information so that students can compare data.



TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

1. Each group should become familiar with Data Sheet 5.1, the Zebra Mussel Length Frequency Chart. On this data table students will record zebra mussel shell length, number, total, and frequency (or percentage).
2. One student from each group should measure 100 ml of zebra mussels with the measuring cup and bring them back to the group.
3. Students will measure each shell in millimeters (mm) along the ventral line and tally the number of each one on the data table.
4. Students should total the number of shells for each length by adding up the tallies.
5. Students should total the number of all shells and then compute the percentage for each length. They then can determine the maximum and minimum lengths for each sample. (Note: Teacher should note these lengths on the board.)
6. Show the students the Illinois River Data (Bar Graph 5.2). Ask them to compare their sample to that made by scientists of the Illinois Natural History Survey. Were the percentages similar?
7. Each group should construct a graph based upon their data table illustrating the percentage of each length.

8. Each group should share measurements from their data sheet on the class summary sheet. Determine the class total percentages and maximum and minimum lengths. Is there a difference between data from the different working groups? Variation could well occur, which is the reason multiple samples are used to define a population.

9. Discuss the following questions:

   a. What was the length of most of your zebra mussels?

   b. What length of zebra mussels had the fewest numbers? Why do you think this is?

   c. Give an explanation of the distribution of the lengths of the zebra mussels.

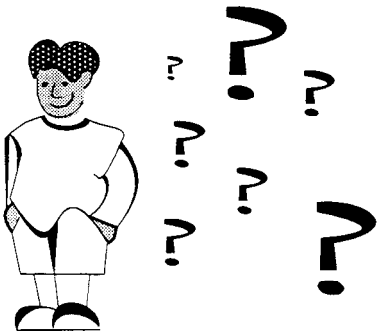
WHAT DID YOU LEARN??

Can the students accurately measure a zebra mussel? When comparing the data table to the graph, are the zebra mussel groupings accurate? Can each student complete a graph and place the variables on the proper axis?

WAIT, THERE'S MORE...

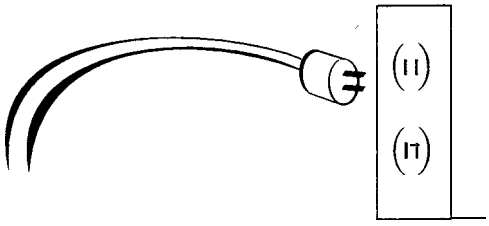
Study other species' populations: measure lengths of tree leaves, snail lengths, other shell lengths, seed sizes, dandelion flower or flower stalk sizes, heights or weights of students in class and school.

ACTIVITY SIX:	**FILTERING FOOLS**
TIME:	(1) 45-minute lesson This activity is to be done by half the class at the same time as Activity Seven is done by the other half of the class.
SCIENCE PROCESS SKILL:	Inferring and model building
SCIENCE CONCEPT:	Zebra mussels use a biological siphon to filter large quantities of water.
BENCHMARKS:	Students should: Know that scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Know that seeing how a model works after changes are made to it may suggest how the real thing would work if the same were done to it. Use numerical data in describing and comparing objects and events.
OBJECTIVE:	Students will construct a model to simulate how zebra mussels remove nutrients and particles from the water.



WHAT YOU OUGHT TO KNOW

Zebra mussels use water filtration to collect the nutrients needed to sustain life and grow. An adult zebra mussel can filter approximately one liter of water per day. A positive effect of this filtration is the increased clarity of the water filtered by the zebra mussels. However, on the negative side, the zebra mussels interrupt the food web for other life forms and change the ecosystem of the aquatic habitat. Additionally, even if the water is clearer, that does not mean the water is better.



WHAT'S THE CONNECTION??

TO LANGUAGE:
Research and write reports on another animal using filtration.

TO MATHEMATICS:
Calculate the amount of water a given number of zebra mussels can filter.

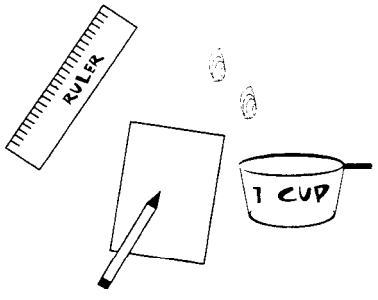
TO ART:
Design a filter that would keep zebra mussels from entering industrial pipes.

TO SOCIAL STUDIES:
List where filters are used in your home, industry, business, etc.

WORDS OF WISDOM

Filter, filtration, liter, nutrient, siphon, submerge
(see also glossary on page 7)

RESOURCES AT THE READY



FOR EACH GROUP -
Two 2-liter drink bottles, clear
(one for mixing dirt, one for 100 ml of water)
Four zebra mussel filter models for each group
(made of film canister and tubing)
Several gallons of water
Cottonballs (13)
Bucket for the waste water
Four clear plastic cups for each group
Measuring cup
Dirt (not potting soil)
Filtering Fools Data Sheet 6.1
Filtering Fools Observation Sheet 6.2
Zebra mussel journals

GETTING YOUR ACT TOGETHER

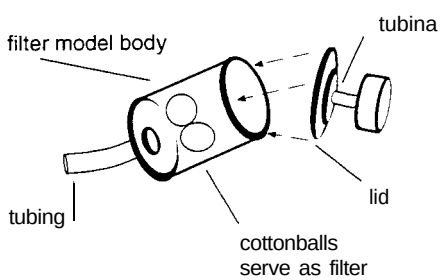
This will be a wet and messy activity. You will probably need to have a mop on hand in case of spills. You will need to have an adequate supply of water nearby, or you will want to prepare for the lesson by having the water brought into the classroom. From the cafeteria, collect buckets, pickle jars, vegetable cans, even milk jugs to use for water, cleaning up, and collecting dirty water.

NOTE: You will want to consider teaching this lesson simultaneously with Activity Seven, "All Clogged Up." Copy one data sheet per group. Practice using the "zebra mussel filter model" ahead of time so you can explain and demonstrate its use to the students.

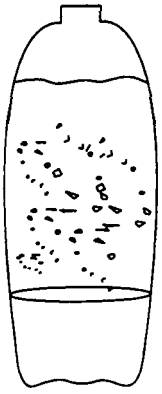
TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

1. Have students draw and label the zebra mussel filter model in their zebra mussel journals.
2. Have each group mix exactly 15 ml (1 T) of dirt with 2 liters of water. Shake to disperse the dirt (do not use potting soil).
3. Students should observe this water and record their observation under the unfiltered water category on the Filtering Fools Data Sheet 6.1.
4. Shake the 2-liter bottle well. Then add 100 ml dirty water to a clean 2-liter bottle and screw on the zebra mussel filter model.
5. Add two cottonballs to act as a filter, then secure the cap and tubing and begin the filtering action. The filtered water should be collected in a clear plastic cup. Save this water for comparison. Record the results of the filtration under the two cottonball column.

FILTER MODEL ASSEMBLY

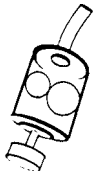


STEPS 1 - 3

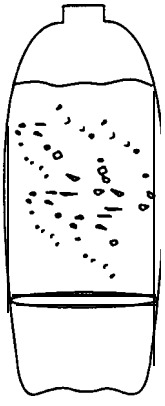


Mix 2 liters of water and 15 ml of dirt

STEP 4



. 2 cottonballs



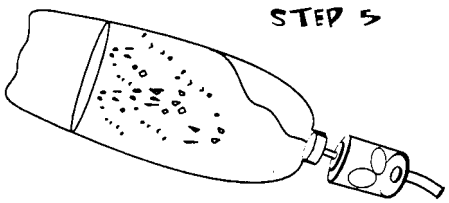
Screw the zebra mussel filter model on bottle.

Add the dirty water to a clean 2-liter bottle.

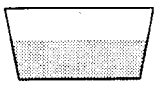
6. Save the cottonballs used in each filtration to compare the colors. Save these cottonballs on a paper towel.
7. Compare clean cottonballs with the two cottonballs used to filter the cup of dirty water.

a. Predict how the water will appear if it is filtered using four cottonballs.

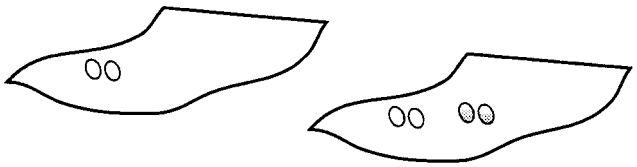
9. Repeat the activity using four, then six cottonballs.
10. Lay the cottonballs taken after filtering in order on the paper towels. Have the Reporters for each group prepare a presentation for the other groups completing Activity Seven. They should demonstrate the procedure and show the results gathered.
11. Empty the water and clean the equipment, including any spilled water.
12. Discuss with the class their results comparing the number of cottonballs with the success in filtration. The millions of zebra mussels found in rivers and lakes act in the same way as the cotton filters, except the mussels eat the food trapped in their filters. Because there are so many zebra mussels, tremendous amounts of materials can be removed from the water. One zebra mussel can filter up to a liter of water each day.
13. Have each group answer questions on the Filtering Fools Observation Sheet 6.2. Discuss the answers.



Save filtered water for comparsion.



STEPS 6-7



Repeat steps 1-7 using 4 then 6 cottonballs.

WHAT DID YOU LEARN??

Did the students complete the worksheet correctly?

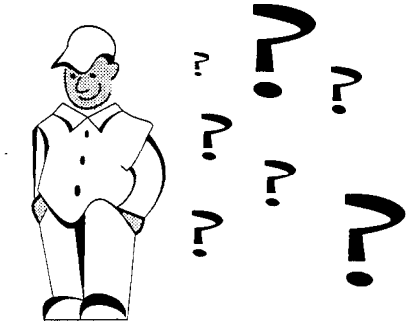
Is each student able to make some comparison of the filter model to the zebra mussel?

Can each student relate the huge number of zebra mussels to the large amount of water they are capable of filtering?

WAIT, THERE'S MORE...

- Find and display filters that are used by people.
- Research how other mussels and organisms collect food using the filtering process. Make a list of these filter feeders.
- Lake Erie and Lake Michigan have become clearer because of zebra mussels. Find out how this was done.

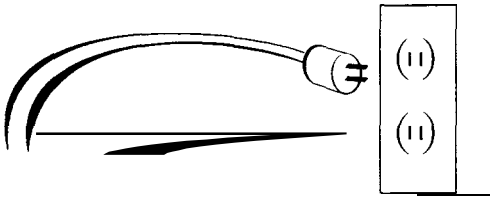
ACTIVITY SEVEN:	**ALL CLOGGED UP**
TIME:	(1) 45-minute lesson This activity is to be done by half the class at the same time Activity Six is done by the other half of the class.
SCIENCE PROCESS SKILL:	Predicting and model building
SCIENCE CONCEPT:	Zebra mussels can restrict the flow of water by congregating in water lines.
BENCHMARKS:	Students should: Know that scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Know that seeing how a model works after changes are made to it may suggest how the real thing would work if the same change were made. Keep records of their investigations and observations and not change the records later. Use numerical data in describing and comparing objects and events.
OBJECTIVE:	Students will use a model to predict the rate of flow of water in a pipeline.



WHAT YOU OUGHT TO KNOW

Zebra mussels are gathering on water intake lines of the power companies and water treatment plants along rivers and lakes. The resulting economic impact to these companies is very serious and costs thousands of dollars for clean-up and repairs. Have students brainstorm problems that might occur if these industries and water utilities were unable to easily draw incoming water. This activity shows students how the flow of water through a pipe can be reduced by zebra mussels. Students will be estimating the rate of water flow in a pipe when colonized by zebra mussels.

Each tube used by the students represents one of the multiple tubes present in the cooling system of a power plant. When the pipes are clean, the water moves through quickly and in known amounts. As soon as zebra mussels come into the pipes, water flow is reduced. The more mussels in the pipes, the less water is allowed to pass through. If the cooling process is stopped, the power plant could overheat and a shutdown could occur.



WHAT'S THE CONNECTION??

TO LANGUAGE:
Write a newspaper account of a nuclear power plant being shut down because of a water flow shortage.

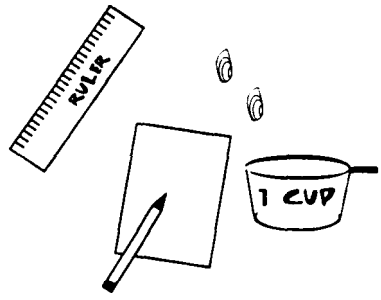
TO MATHEMATICS:
Estimate the rate of flow of a 5-liter bucket draining through a 4 cm hose, 8 cm hose, etc.

TO ART
Use straws and aquarium tubing to build a water or power plant structure.

TO SOCIAL STUDIES:
Locate your area's water plant and power plant on a map.

WORDS OF WISDOM

Congregate, flow restriction, intake lines, siphon
(see also glossary on page 7)



RESOURCES AT THE READY

EACH GROUP WILL NEED-

One 2.5 cm inside diameter, vinyl tubing, 1 m long
with attached screen (see drawing)
2-liter bottle (4) (teacher collected)
Gravel
Ruler
Buckets (2) (teacher collected)
Clean-up equipment and water-holding materials
Watch or clock to record elapsed times
All Clogged Up! Data Sheet 7.1
All Clogged Up! Record Sheet 7.2
Piece of graph paper
(use Data Sheet 5.3)
Zebra mussel journal

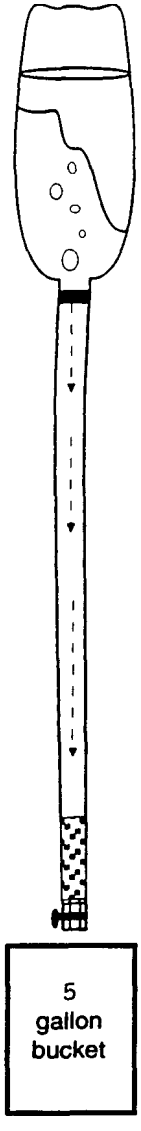
GETTING YOUR ACT TOGETHER

This will be a wet and messy activity. Have a mop on hand in case of spills. You will need to have an adequate supply of water nearby or will want to prepare for the lesson by having the water brought into the classroom. From the cafeteria, collect buckets, pickle jars, vegetable cans, even milk jugs to use for water, cleaning up, and collecting dirty water.

NOTE: You will want to consider teaching this lesson simultaneously with Activity Six, "Filtering Fools."

TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

STEPS **1-5**



1. Have each group fill a 2-liter bottle with water and place it on a desk or table. This bottle becomes your water intake source.
2. Securely attach the open end of the tube over the opening of a 2-liter bottle.
3. Watch the clock as you drain water through the tube. Start timing when the bottle is inverted. Note the number of seconds that have elapsed by subtracting the times on the Data Sheet 7.1. Repeat this process at least three times. The three times should all be similar. If not, why?
4. Add 5 cm of gravel to the open end of the tube and shake the gravel down to the screen. Repeat steps 1 through 3 three times. Have students record data for each repetition.
5. Add an additional 10 cm of gravel, repeat steps 1 through 3, and record the data.
6. Now have the students predict the rate of flow if you would add 5 cm more of gravel (20 cm total) to the hose. Make one prediction for 5 cm less of gravel (10 cm total gravel). Record these two predictions.
7. Check your predictions by completing steps 1 through 3 to find the actual time required. Have the students compare predictions. Which was the most accurate, the 10 cm or the 25 cm prediction?
8. Have the groups create a graph of their results without the predictions. Then have them draw a line though the observation points and develop extrapolations and interpolations for 10 cm and 25 cm of gravel. Were the graphs useful for this task?

9. Answer question on Record Sheet 7.2. Have each group share their data with the class and compare the water output values.

10. Have the students. draw the apparatus in their journals. When they have finished the drawing, have them draw a power plant with cooling tubes blocked with zebra mussels.

11. Have the Reporters for each group prepare a presentation for the group doing Activity Six. They should demonstrate the procedure and show the results.

WHAT DID YOU LEARN??

Compare the students' predictions to actual observations. Can you determine if their final prediction is fairly accurate? Are the children able to demonstrate how the zebra mussels block pipes in water or power plants.

WAIT, THERE'S MORE. . .

- Field trips to water utilities or power plants can provide an ideal opportunity for a first-hand look at the problems caused by zebra mussels.
- Invite a power plant operator or engineer to discuss zebra mussel impacts with the class.
- Make predictions about what would occur if the entire tube used in the lesson were clogged.

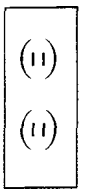
ACTIVITY EIGHT:	FAMILY REUNION
TIME:	(1) 45-minute lesson
SCIENCE PROCESS SKILL:	Predicting and inferring
SCIENCE CONCEPT:	Population density can be determined by sampling.
BENCHMARKS:	Students should: Know that, usually, there is no one right way to solve a mathematical problem; different methods have different advantages and disadvantages. Know that results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated, sometimes because of unrealized differences in the methods used or in the circumstances in which the investigation is carried out, and sometimes just because of uncertainties in observation. It is not always easy to determine the cause for different results. Keep records of their investigations and observations and not change the records later.
OBJECTIVE:	Students will calculate the number of zebra mussels in a given area.

1

WHAT YOU OUGHT TO KNOW

Zebra mussels attach to hard surfaces in lakes and rivers. They attach to rocks, docks, boats, and even to each other. This activity will engage the students in a sampling technique currently being used by scientists to estimate the number of zebra mussels in rivers and lakes. The students will engage in similar sampling techniques by taking samples of gravel (zebra mussels) from a cookie sheet (lake/river bottom), and then using this information to calculate the number of pebbles in the entire pan.

When sampling zebra mussel populations in rivers such as the Illinois River, Illinois Natural History Survey divers take large metal square frames to the bottom of the river. In the dark water, they push the heavy metal square very carefully into the river bottom. Then they carefully remove everything from inside the dimensions of the metal square and place the samples in collecting bags before bringing them to the surface. At the surface or in the laboratory, the scientists count the organisms. Several more samples are taken; the surface area of the entire location is measured; and the population for that large area is determined.



WHAT'S THE CONNECTION??

TO LANGUAGE:
The students can write directions for using sampling to determine the number of zebra mussels in a lake or river.

TO MATHEMATICS:
The students can determine the number of zebra mussels it would take to cover the gym floor, cafeteria wall, classroom floor, or playground area.

TO ART
Students can construct a zebra mussel colony using macaroni shells (2 sizes) to represent their sample.

TO SOCIAL STUDIES:
The students will brainstorm ways in which sampling can be used by business, industry, and the government to control the zebra mussel population.

WORDS OF WISDOM

Area, estimate, extrapolate, population, population density, predict, quantify-sampling (see also glossary on page 7)

RESOURCES AT THE READY

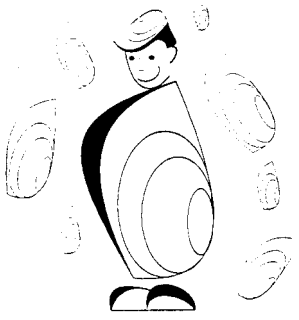
Set up four lab stations. Each group of students will rotate from station to station.

Each group will need:

- Cookie pans or other flat container (4 total in trunk)
- Lightweight gravel
- Spoons for moving and counting the gravel
- Teacher-collected cardboard drink (milk or juice) cartons (4)
- Family Reunion Data Sheet 8.1
- Zebra mussel journals

GETTING YOUR ACT TOGETHER

Collect, rinse, and clean drink cartons, one for each lab station. Cut out the carton's top and bottom so you have an open-ended square box. The carton box should be at least 5 cm deep. Fill four pans with 2 cm of gravel and move some of the gravel to make the surface uneven, thus more natural. Tell the class that the pans represent four sites on the river bottom. Assign groups to survey each site, just as they would if four boats were needed. The sites represent typical populations of zebra mussels for an area.



TiME To EXPERiENCE ZEBRA MUSSEL MANiA!!

1. Discuss the problem of counting an entire population of anything. This is what zebra mussel experts come across when they deal with an entire river or lake to determine a population. Pretend that the gravel covering the pans are zebra mussels. Ask the students if they could quickly count all the pebbles (zebra mussels) in the pan. The correct response is, “Not easily.” But students can learn to take samples and use those samples to extrapolate or predict a larger population.
2. Use the Data Sheet 8.1 to record the area of the pan and area of the carton.
3. Have the students estimate the number of cartons needed to cover the pan. They should record their predictions.
4. The students should then calculate the actual number of cartons needed to cover the pan and record this information. Determine the number of cartons needed by dividing the area of the pan by the area of the carton.
5. Take an actual sample from the pan by using the carton. Students should push the carton down, open ended, through the gravel until the carton rests on the bottom of the pan.
6. The students will remove their sample from the inside of the carton by using a spoon. Quantify the sample by counting. Record the sample counts in the journals and on Data Sheet 8.1.
7. After each group has completed the four samplings, have them share their results with the entire class. Place the numbers on the class chart. Show the class how to do an average. Have the students write the procedure for collecting samples in their zebra mussel journals.
8. Explain to the students that, by taking the average number of pebbles and multiplying that by the number of cartons needed to cover the pan, they will arrive at the population density of zebra mussels in the entire pan.

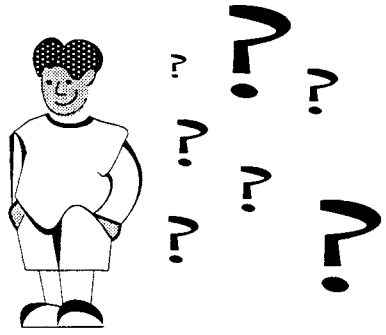
WHAT DID YOU LEARN??

Can the students tell you the procedure-for collecting a sample and determining the density of a population? You can determine the validity of the mathematical calculations by checking the students' data sheets. Do their sampling procedures reflect concern for developing accurate data?

WAIT, THERE'S MORE. . .

You also can quantify the sample by another sampling technique. To do this, use a balance to find the mass of a known sample, say 100 pebbles chosen randomly. If 100 has a mass of X grams, any future mass can be used to determine the number of pebbles.

ACTIVITY NINE:	**WEB OF LIFE GAME**
TIME:	(1) 45-minute lesson
SCIENCE PROCESS SKILL:	Inferring, predicting, and drawing conclusions
SCIENCE CONCEPT:	Nonindigenous species will severely impact a native food web.
BENCHMARKS:	Students should: Know that, for any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all. Know that organisms interact with one another in various ways in addition to providing food. Know that, in all environments - freshwater, marine, forest, desert, grassland, mountain, and others- organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter. In any particular environment, the growth and survival of organisms depend on the physical conditions. Know that models are often used to think about processes that happen too slowly, too quickly, or on too small a scale to observe directly; that are too vast to be changed deliberately; or that are potentially dangerous. Know that people can keep track of some things - see where they come from and where they go.
OBJECTIVE:	Students will demonstrate the critical changes in a native river ecosystem due to the introduction of zebra mussels.



WHAT YOU OUGHT TO KNOW

A native river habitat is a fluid yet fragile community. Introduced species have altered, permanently in some cases, the natural food chain. The “Web of Life Game” actively demonstrates to students the impact zebra mussels have in a native river environment. You should discuss at length the food pyramid overhead provided. Students will understand the impact of zebra mussels better by playing the “Web of Life Game.”

Dissolved oxygen, the available oxygen needed for species to live underwater, is a critical ingredient in a river habitat. All plants use carbon dioxide and water to produce oxygen during photosynthesis. In a river ecosystem, plants in the water produce oxygen; and underwater animals, including zebra mussels, use this dissolved oxygen. When zebra mussel numbers increase rapidly, they use tremendous amounts of dissolved oxygen, which cause native fish to die.

WHAT'S THE CONNECTION??

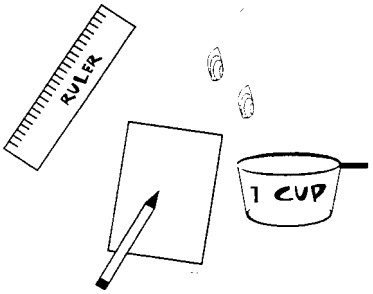
TO LANGUAGE:
Students will record in their journal each of the three phases of the game.

TO ART
Students will draw a river habitat before the game and before looking at the river poster included. After the game, when they are more familiar with the food chain, students will redraw or add to their pregame picture, using the rivers and wetland poster included.

TO SOCIAL STUDIES:
Interview Department of Natural Resources staff specialists about other ecosystems or habitats in trouble. Students will report their findings to the class.

WORDS OF WISDOM

Biological diversity, dissolved oxygen, ecosystem, food chain, food web, habitat, larval fish, native species, organic matter, zooplankton, veligers (see also glossary on page 7)



RESOURCES AT THE READY

Character name tags (double sided) with zebra mussels on the back of all 30 tags
Names: larval fish (10)
native mussels (10)
larger fish (10)
3 diving ducks (name tags without zebra mussels on the back)
150 blue game pieces - indicates dissolved oxygen
150 red game pieces - indicates zooplankton
Chalkboard, pad of paper, and pencil to record students' observations after the game has concluded
Food Pyramid overhead
Food Pyramid Teacher's Key 9.1
River and wetland posters

TIME TO EXPERIENCE ZEBRA MUSSEL MANIA!!

The following game is played in three rounds. As each round is completed, the teacher and students should discuss the changes that have occurred in this simulated ecosystem.

WEB OF LIFE GAME

SETTING UP THE GAME:
The following game instructions are based on using 30 students; the game may need to be adjusted for a different number of students. If possible, the game should be played in the gym or cafeteria, on the playground, or any other area with enough room to allow the students plenty of movement. Begin the game with 10 larval fish, 10 native mussels, and 10 larger fish.

OBJECT OF THE GAME:
To survive as long as possible.

DIRECTIONS FOR STUDENTS

ROUND ONE

1. Students put on the name tags, and the teacher scatters the game pieces in a large playing area so all students have easy access to the game pieces.
2. At a signal from the teacher, all students scramble to collect as many game pieces as possible.
3. Each species needs a certain amount of dissolved oxygen and zooplankton to survive. Students and teacher determine which species have survived based on the species needs in the following chart:

	DISSOLVED OXYGEN (blue game pieces)	**ZOOPLANKTON** (red game pieces)
larval fish	6	6
native mussels	6	6
larger fish	10	10
zebra mussels*	2	2
diving ducks*	14	14

*These two species will participate later in the game.

4. Species must have at least the required number of the specific game pieces to survive; survivors remain the same species for the next round. Species that do not have the required number of game pieces die and become zebra mussels in the next round (by turning their tag over).

ROUND TWO

5. Collect and rescatter the game pieces. Have the students again collect as many game pieces as possible.
6. Repeat step 3 to determine who survived. If many animals other than zebra mussels survive, repeat round two.
7. At the end of round two, each animal keeps the game pieces he/she collected in preparation for round three.

ROUND THREE

8. Select three students at random to become diving ducks. The diving ducks may "eat" any surviving animals by tagging them.
9. The diving ducks take all the game pieces from each animal as it is tagged. The tagged animal now has been "eaten" and is out of the game. The round concludes when all game pieces have been collected.
10. Students and teacher discuss who has survived and why (see chart in step 3).
11. Students and teacher discuss the game to illustrate the impact of zebra mussels on the native species, and the impact of diving ducks on zebra mussels and larval fish. Students should understand the effects of zebra mussels and how they can destroy an ecosystem and its biodiversity.
12. The results may be different each time the game is played. If you choose, play the game again.

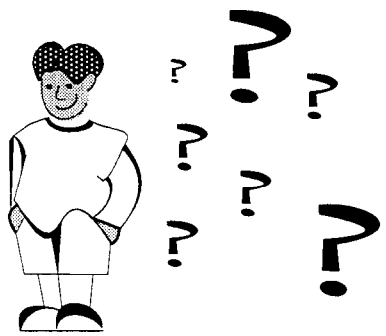
WHAT DID YOU LEARN??

Chart the results from the first and second games. Compare the results to see how in nature the food web interactions are constantly changing. More zebra mussels will reduce the numbers of large fish because the zebra mussels are depleting necessary nutrients and life support.

WAIT, THERE'S MORE. . .

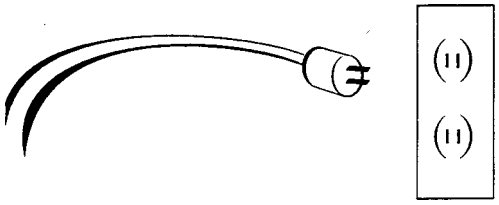
Play the game using different numbers of animals per species for different results.

ACTIVITY TEN:	**LIGHTS, CAMERA, ACTION**
TIME:	(2-3) 45-minute lessons
SCIENCE PROCESS SKILL:	Communicating
SCIENCE CONCEPT:	Scientific data can be applied to societal issues.
BENCHMARKS:	Students should: Know how to locate information in reference books, back articles, and databases; identify the sources used; and expect others to do the same. Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.
OBJECTIVE:	Students will apply prior knowledge to design an action project.



WHAT YOU OUGHT TO KNOW

The zebra mussel and exotic species issue can be addressed in an action project. After learning about the zebra mussel, students will want to provide information for the community about the zebra mussel infestation and the environmental and economic impact of this infestation. This is their opportunity to educate the public about zebra mussels. Each group should choose and develop an action plan. Then they should determine a mode of presentation. Some projects will take longer than others, and may exceed the suggested three class periods.

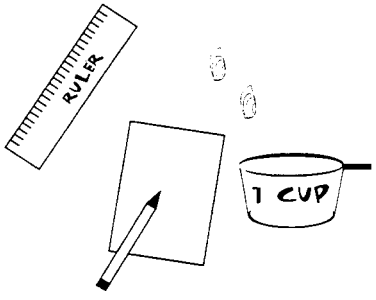


WHAT'S THE CONNECTION??

TO LANGUAGE, MATHEMATICS, ART, AND SOCIAL STUDIES:
For each chosen action project, work with your students to incorporate activities related to language, mathematics, art, and social studies.

WORDS OF WISDOM

Action project, brainstorm, community, documentary, questionnaire, public involvement, public information, sportsmen's organization (see also glossary on page 7)



RESOURCES AT THE READY

Each group will need different materials according to the chosen action project.

GETTING YOUR ACT TOGETHER

Review suggested action plans at end of this activity and decide which are appropriate for your school situation.

TiME To EXPERiENCE ZEBRA MUSSEL MANiA!!

1. Brainstorm with your students ways to inform the public about the zebra mussel problem. Decide who can benefit most by knowing more about zebra mussels and other alien invaders. If the students do not have an idea of how much local citizens know about zebra mussels, have them develop a questionnaire to determine level of interest and degree of knowledge by members of their community.
2. From the list of ideas you come up with in your brainstorming session, each group should choose the project it would like to develop and undertake. Your students may also wish to consider the ideas in the list found at the end of this activity.
3. Allow student groups an appropriate amount of time to gather information for their project. Students may need to have access to audiovisual equipment, computers, telephones, and fax machines.
4. You may also wish to have your students examine the impact of other nonindigenous species to a particular location.

WHAT DiD YOU LEARN??

Were all the students involved in the planning and execution of chosen action project? Are they able to tell you why the project was undertaken?

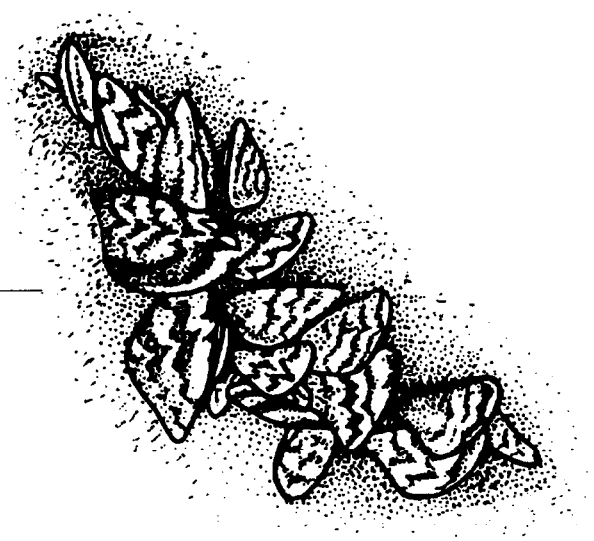
WAIT, THERE'S MORE. . .

LIST OF SUGGESTED IDEAS FOR THE ZEBRA MUSSEL ACTION PLAN -

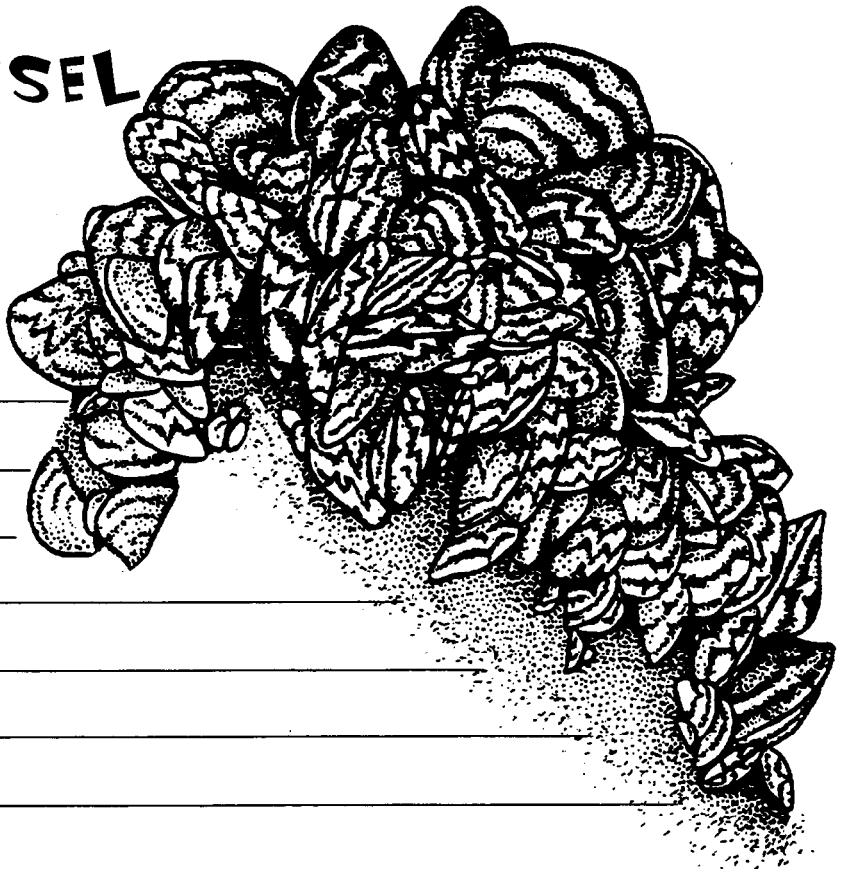
1. Write an illustrated story about zebra mussels and read your story to another grade or classroom of students.
2. Write a series of articles about zebra mussels for the local news.
3. Plan a “Zebra Mussel Day” in your school to inform other students and teachers of the problem.
4. Set up a zebra mussel information booth in a local bait or boat store.
5. Design posters, pamphlets, or brochures about zebra mussels and distribute or display them in your community.
6. Make a presentation on zebra mussels to a local sportsmen’s organization, fishing or hunting club, Ducks Unlimited, Pro Bass, Trout Unlimited, or similar organizations.
7. Write to the President, local congressperson, or senator urging them to propose laws aimed at preventing invasions of exotic species.
8. Set up a display or make a mini exhibit for a public or school library.
9. Make signs for local docks describing measures that boaters can take to prevent further spread of the zebra mussels. Be sure to cooperate with local officials in the appropriate natural resource agency.
10. Present a documentary for broadcast on a community cable access channel, the local television station, or community radio station.
11. Design T-shirts about zebra mussels. Produce the shirt and wear it to school.
12. Design a David Letterman-type “Top 10” list.
13. Write a play about zebra mussels that can be presented or filmed for local cable access channels.

Zebra Mussel Mania

Teacher's Guide for **Grades 5 and 6**
Activity Sheets



ZEBRA MUSSEL JOURNAL



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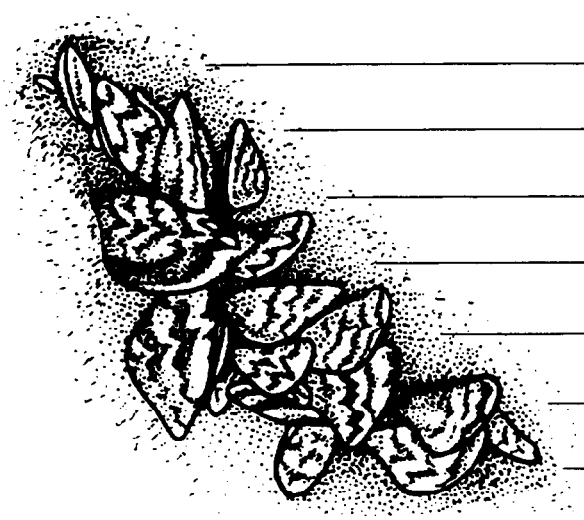


ALIEN INVADERS
RESEARCH ON EXOTIC SPECIES
RECORD SHEET 1.1

Zebra Mussel Watchers' Names:

_____

_____

1. Name of species: _____

2. Scientific name of species: _____

3. Description of species:

_____

_____

4. Method of introduction:

_____

_____

5. How the population spreads:

_____

_____

6. impact on native species:

_____

_____

7. Interesting facts:

_____

_____

8. Visual Aid:

-A detailed drawing of the species with the name clearly labeled for use in the oral presentation. One drawing per group.

ZEBRA MUSSEL MENACE OBSERVATION SHEET 2.1

Zebra Mussel Watchers' Names:

_____

_____

Predict the number of zebra mussels in 100 ml _____

Count the zebra mussels in 100 ml _____

Directions: Record your observations of zebra mussels. Remember that you have a ruler and scale!

Sight (visual) _____

Smell (olfactory) _____

Touch (tactile) _____

Sound (auditory) _____

Size (quantitative) _____

Draw a zebra mussel

ZEBRA MUSSEL MENACE RECORD SHEET 2.2

Zebra Mussel Watchers' Names:

_____

_____

Directions: Answer as many questions as you can while viewing the video.

1. Why are zebra mussels a concern? _____

_____

2. On what continent did zebra mussels originate? _____

_____

3. How did zebra mussels get to North America? _____

_____

4. Describe the zebra mussel. _____

_____

5. Who or what do zebra mussels affect? _____

_____

6. List some of the rivers and lakes that have been affected by zebra mussels.

_____

7. What are some of the factors that limit the spread of zebra mussels?

_____

_____

8. What can be done to decrease the spread of zebra mussels?

_____

_____

_____

_____

Fact Card 3.2

An adult zebra mussel filters approximately one liter of water per day

Don't Have a Clue

Fact Card 3.2

During dusk and dawn, the water is full of shadows. In this environment, walleye can hide and attack their prey Many people no longer fish for walleye during the day

Don't Have a Clue

Fact Card 3.2

Due to increased water clarity, sunlight penetrates the water causing increased growth in vegetation.

Don't Have a Clue

Fact Card 3.2

When zebra mussels die, they wash up on the shoreline and begin to decay

Don't Have a Clue

Fact Card 3.2

A zebra mussel was found in Lake St. Clair in 1988. They reproduce rapidly One female mussel can produce 30,000 to 100,000 eggs per year.

Don't Have a Clue

Fact Card 3.2

Because they find their prey by sight and chase them down, smallmouth bass like clear water.

Don't Have a Clue

Fact Card 3.2

Walleye generally are found in murky water where they can hide and attack their prey.

Don't Have a Clue

Fact Card 3.2

Walleye, who have eaten more small fish than were being produced, have diminished their current food source.

Don't Have a Clue

DON'T HAVE A CLUE OBSERVATION SHEET 3.3

Zebra Mussel Watchers' Names:

Questions on **"What Happened to Lake Michigan?"**

1. Why was the lake much clearer when Melanie returned in 1993?

2. What factors could have caused the increase in vegetation?

3. An odor was observed on the beach. What could have caused it?

4. Who or what could have been responsible for the decreased number of walleye?

5. What changes has the local fishing industry gone through?

MUSSEL TO MUSSEL
STORY 4.1

MR. BOEPPLE'S SHELLS

Hundreds of years ago, the American Indians and the Pilgrims lived off the land. They ate freshwater mussels. Sometimes they would find a treasure inside one of the mussels — a pearl that they could use to make jewelry. The mussels were easy to find, but they almost never had a pearl inside. Because the pearls were so rare, they became very valuable. The biggest pearls were worth the most money. People began to find pearls inside the mussels in the Mississippi River Valley during the 1850s. The pearl hunters became very rich. People began to race to find as many pearls as possible. This caused the disappearance of most of the freshwater mussels in the Mississippi River Valley.

In 1888, John Boepple came from Germany to hunt for the freshwater mussels. John was not looking for pearls. instead, he wanted to make buttons out of the shells. It would have been too expensive to bring the shells to Germany, so he decided to make the buttons in America. One day he was bathing in the Illinois River when he cut his foot on a sharp object. He had cut his foot on one of the freshwater mussel shells that he had been hunting. What a wonderful discovery to find the river bottom covered with the shells for which he had been searching.

During the next few years he struggled to learn English; and he collected as many shells as he could. Then in 1891, using the shells he had spent years collecting, Boepple set up his first button making business in Muscatine, Iowa. Two local businessmen helped him get started. They had the money to run the business, and Boepple had the skill to make the buttons. The men soon began to argue. The investors wanted to make as many buttons as quickly and cheaply as they could. John Boepple wanted to make a quality product, but he needed the businessmen's money. Eventually, the dispute caused Boepple to look for new business partners. (The first two partners tried to run their own button making business. They failed without Boepple because they knew nothing about making buttons.)

Boepple did not take long to find new partners that were very wealthy. They let him run his company as he wanted it run. The business flourished. The only problem was that Boepple had to collect the mussel shells by hand. This was a very slow process. Help was soon on the way be-

cause people began to discover pearls in the shells. Again, people began to hunt for the shells in the hope of finding a pearl inside. Just like 40 years earlier, word began to spread about how rich a person could become by finding pearls. Soon farmers, shopkeepers, and businessmen began wading into the shallow rivers and streams hoping to get rich. Boepple was now able to buy the shells he needed to make his buttons. As the supply of shells became larger, more people began to make buttons from the shells. This caused Boepple to become much more secretive about how he made his buttons.

In 1897, someone invented a new tool called a brail. The tool allowed mussel hunters to harvest mussels in deeper water from boats instead of wading into shallow waters. People crowded the rivers to find the mussels. Soon violence broke out. Pearl hunters robbed each other and fought over hunting space. Even though hunters rarely found pearls, they knew they could make a profit by selling the mussel shells to the button makers. As more people hunted for shells, more shells became available to make buttons.

The new button makers were not as concerned about quality as John Boepple. Everyone thought there would be an endless supply of shells. Button makers became more wasteful and used the shells more foolishly. Factories were springing up everywhere. New machines made buttons faster and cheaper. Boepple became very worried about the poor quality of the buttons being made. There were many arguments, and again, the person who knew more about making buttons than anyone else in the country was forced out of business. Boepple was left with nothing.

Seventeen years had passed since John Boepple first started making buttons. Again, shell collectors and button manufacturers became concerned about the natural supply of shells. History had repeated itself. In 1908, the mussels again became very difficult to find. The few that were found were too small to be useful for button-making. Finally, in 1911 the United States government asked John Boepple to help find ways to increase the mussel population.

Boepple traveled to Indiana in search of new ways to replenish the mussel supply. He waded in Indiana's rivers looking for mussels. Just as he had done so long ago on the Mississippi River, he cut his foot on a shell on the river bottom. This time the ending was not a happy one. After several months, John Boepple died from blood poisoning from the cut. This German-American immigrant had valued the freshwater mussel more than any person in the world. Ironically, he became a victim of the very thing that had given him his life's work.

Written by Cherie Van Camp • Adapted from: *The founding and Early History of the Pear/ Button industry* by Michael G. O'Hara, Muscatine Community College, Muscatine, Iowa

Mussel to Mussel
Shell Classification Game
Record Sheet 4 3

Teacher's Key

Name(s) _____

Place all shells (1-13) here. Move shells in and around the appropriate boxes as you answer questions.

Question: Is the shell a univalve snail?

yes

shells 7 and 11

Question: Is the shell slender and very pointed?

no

shells 1, 2. 3, 4. 5, 6. 8. 9.10.12.13

Question: Is the shell elongated, triangular, thin?

yes

shell 7

Question: _____

no

shell 11

Question: _____

yes

shells 1 and 5

Question: Does the shell have a bluish tinge?

no

shells 2, 3, 4, 6, 8, 9, 10, 12, 13

Question: Does the shell have a pink luster?

yes

Question: _____

no

Question: _____

yes

Question: _____

no

Question: _____

yes

shell 1

Question: _____

no

shell 5

Question: _____

yes

shell 8

Question: _____

no

shells 2, 3, 4, 6, 9, 10, 12, 13

Question: Is the shell longer than broad?

yes

yes

yes

yes

yes

yes

yes

yes

shell 9

no

no

no

no

no

no

no

no

shells 2, 3, 4, 6, 10, 12, 13

MUSSEL TO MUSSEL SHELL IDENTIFICATION SHEET TEACHER'S KEY 4.4

Zebra Mussel Watchers' Names:

_____

_____

Identification for Native Mussel Shell Collection:

1. Blue Mussel
2. Asiatic Clam
3. Washboard Clam
4. Maple Leaf Clam
5. Zebra Mussel
6. Pimpleback Clam
7. Silty Hornsnail
8. Pink Heelsplitter Clam
9. Yellow Sand Shell
10. Three-horned Wartyback
11. Ponderous Campeloma
12. Three-ridge Clam
13. Ebony Shell

Mussel to Mussel

Freshwater and Zebra Mussel Life Cycles

Observation Sheet 4.6

Zebra Mussel Watchers' Names:

_____

_____

Compare zebra and freshwater mussels	Contrast	
	Zebra mussels	**Freshwater mussels**

MUSSEL TO MUSSEL
FRESHWATER AND ZEBRA MUSSEL LIFE CYCLES
TEACHER'S KEY 4.6T

Zebra Mussel Watchers' Names:

_____

_____

Compare zebra and freshwater mussels	Contras	
	Zebra mussels	**Freshwater mussels**
Both have 2 shells	Longest is 4.5 cm	Longest may be up to 30 cm
Both live in rivers and streams	Has byssal threads	No byssal threads
Both have shells made of calcium carbonate	Distinct striped pattern and color of shell	Color of shell varies
	Thinner shell	Thicker shell
	Usually attach to hard substrate (on something solid); Shell attaches permanently after settlement	Can be found in most substrates from sand to mud to gravel and cobbles
	As adults, less than 2. inches	As adults, usually larger than 2 inches
	More offspring	Fewer offspring

Note: Snails are closely related to mussels, but are different in that they have only one shell. Another difference is that they can be terrestrial or aquatic.

How Big Are Your Mussels?
Zebra Mussel Length Frequency Chart
Data Sheet 5.1

Zebra Mussel Watchers' Names:

_____

_____

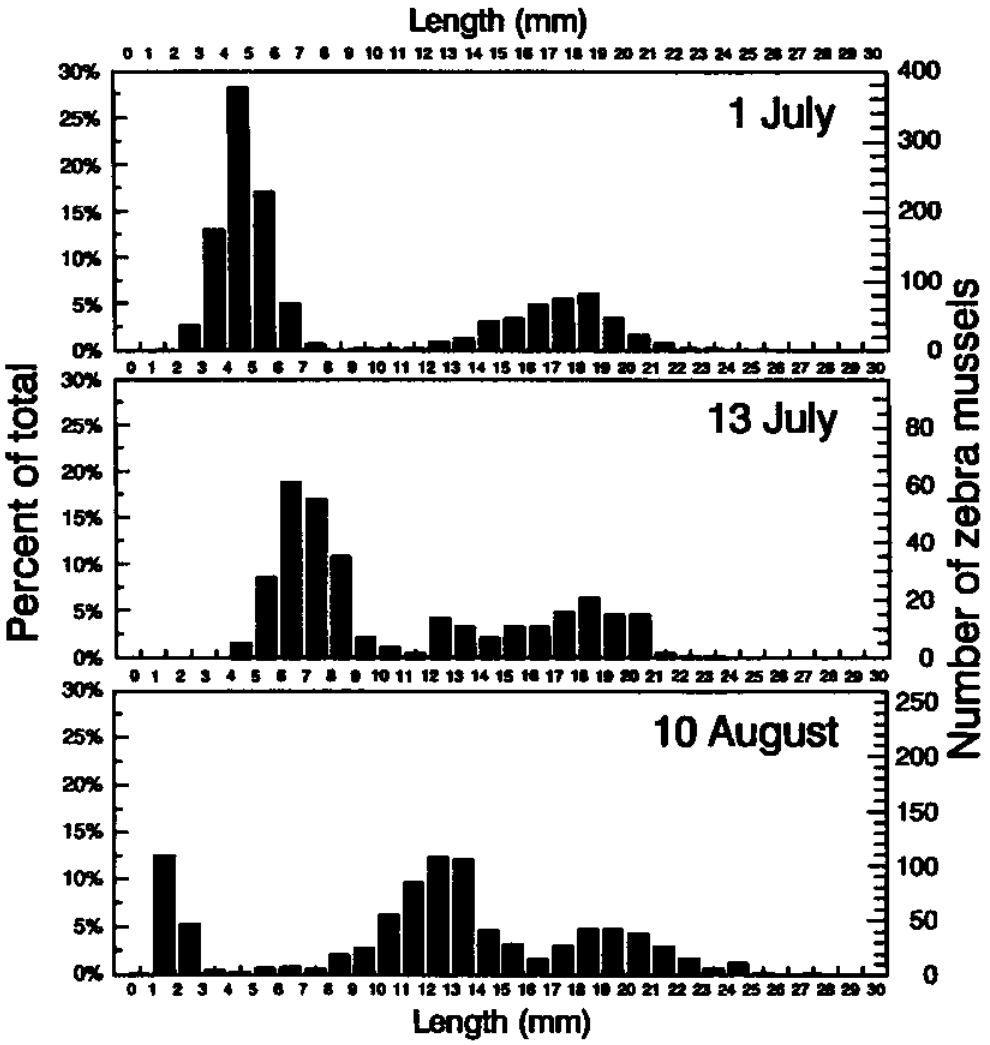
Length	Number	Total	Percentage
1 mm			
2 mm			
3 mm			
4 mm			
5 mm			
6 mm			
7 mm			
8 mm			
9 mm			
10 mm			
11 mm			
12 mm			
13 mm			
14 mm			
15 mm			
16 mm			
17 mm			
18 mm			
19 mm			
20 mm			
21 mm			
22 mm			
23 mm			
24 mm			
25 mm			
26 mm			
27 mm			
28 mm			
29 mm			
30 mm			

maximum length_____ minimum length_____ _____ Total shells

How Big Are Your Mussels? Zebra Mussel Length Frequency Bar Graph 2.2

Researchers from the Illinois Natural History Survey made random collections of zebra mussels from the Illinois River near Peoria, IL on three dates in 1993. The samples were returned to the laboratory where the length of each shell was determined. These length data were sorted into 1-mm length intervals. Numbers of zebra mussels from each collection in each interval were tabulated, and the percentages of shells in each interval were calculated (see the table below). Percentages were then used to construct the three length frequency distribution graphs below.

Length Interval (mm)	1 July 1993		13 July 1993		10 August 1993	
	Number	Percent	Number	Percent	Number	Percent
0 – 1	0	0.0%	0	0.0%	1	0.1%
1 – 2	1	0.1%	0	0.0%	109	12.6%
2 – 3	37	2.8%	0	0.0%	47	5.4%
3 – 4	175	13.1%	0	0.0%	4	0.5%
4 – 5	377	28.3%	5	1.6%	3	0.3%
5 – 6	229	17.2%	28	8.7%	6	0.7%
6 – 7	68	5.1%	61	18.9%	7	0.8%
7 – 8	9	0.7%	55	17.1%	5	0.6%
8 – 9	0	0.0%	35	10.9%	18	2.1%
9 – 10	2	0.2%	7	2.2%	24	2.8%
10 – 11	3	0.2%	4	1.2%	55	6.3%
11 – 12	3	0.2%	2	0.6%	84	9.7%
12 – 13	12	0.9%	14	4.3%	108	12.4%
13 – 14	17	1.3%	11	3.4%	106	12.2%
14 – 15	42	3.2%	7	2.2%	41	4.7%
15 – 16	46	3.5%	11	3.4%	28	3.2%
16 – 17	67	5.0%	11	3.4%	15	1.7%
17 – 18	75	5.6%	16	5.0%	26	3.0%
18 – 19	82	6.2%	21	6.5%	42	4.8%
19 – 20	48	3.6%	15	4.7%	42	4.8%
20 – 21	22	1.7%	15	4.7%	37	4.3%
21 – 22	11	0.8%	2	0.6%	26	3.0%
22 – 23	2	0.2%	1	0.3%	15	1.7%
23 – 24	2	0.2%	1	0.3%	6	0.7%
24 – 25	1	0.1%	0	0.0%	10	1.2%
25 – 26	1	0.1%	0	0.0%	2	0.2%
26 – 27	0	0.0%	0	0.0%	0	0.0%
27 – 28	0	0.0%	0	0.0%	1	0.1%
28 – 29	0	0.0%	0	0.0%	0	0.0%
29 – 30	0	0.0%	0	0.0%	0	0.0%
Total	1332	100%	322	100%	868	100%

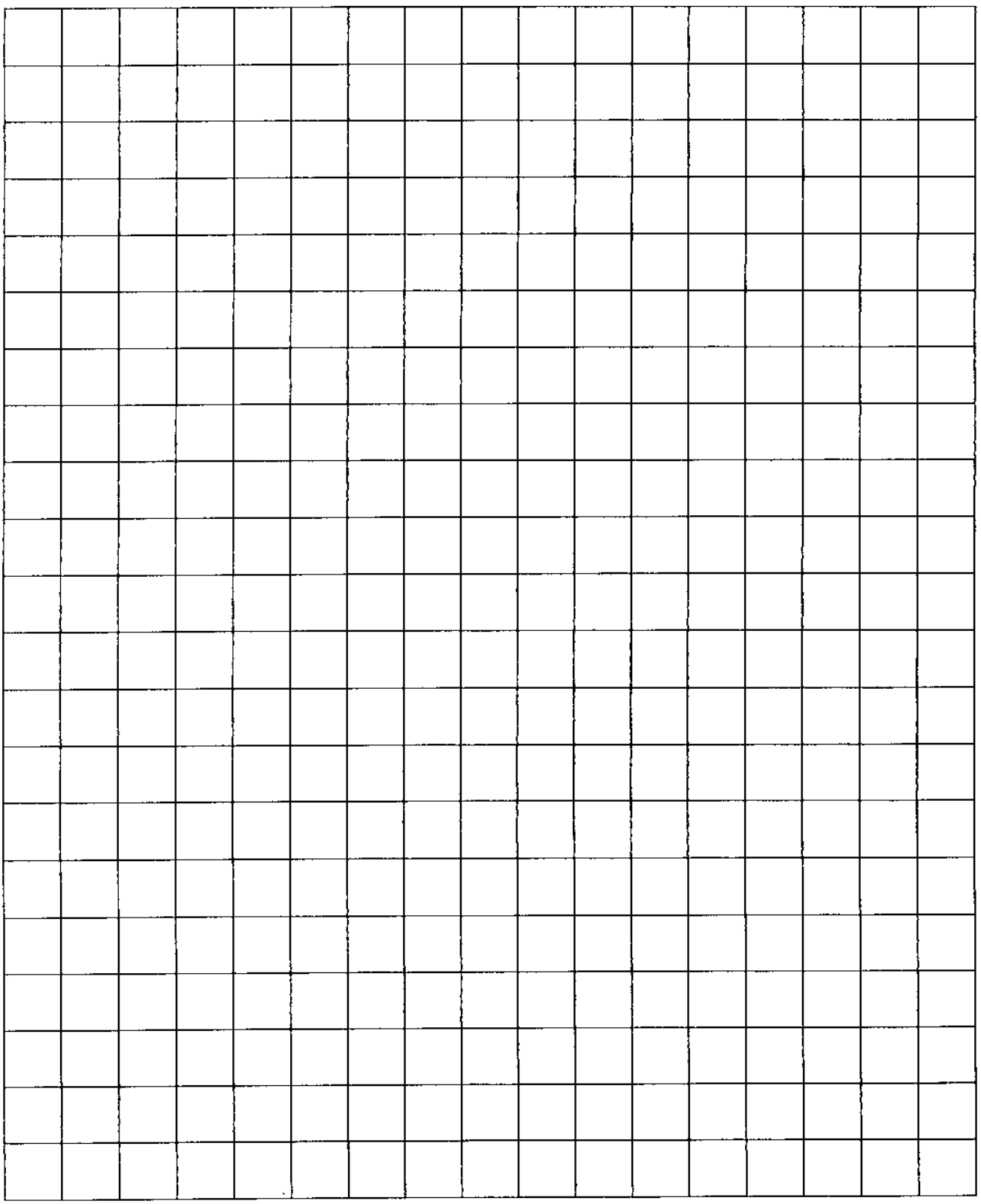


How Big Are Your Mussels?
1 Centimeter Grid
Data Sheet 5.3

Zebra Mussel Watchers' Names:

_____

_____

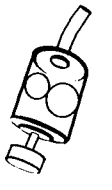


FILTERING FOOLS DATA SHEET 6.1

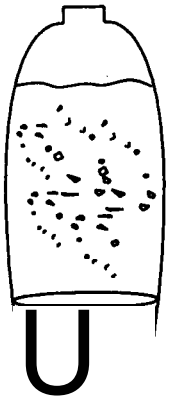
Zebra Mussel Watchers' Names:

	Unfiltered water 1 cottonball	100 ml filtered with 2 cottonballs	100 ml filtered with 4 cottonballs	100 ml filtered with 6 cottonballs
Describe the water.				
	0 zebra mussels	2 zebra mussels	4 zebra mussels	6 zebra mussels
Describe how zebra mussels affect water, based on cotton-balls above.				

STEPS 4-5



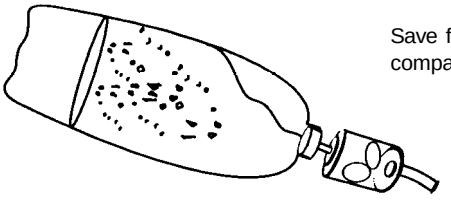
2 cottonballs



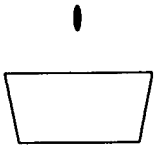
Screw the zebra mussel filter model on bottle.

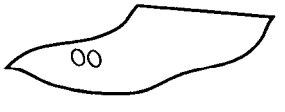
Add the dirty water to a clean P-liter bottle.

STEPS 6-7



Save filtered water for comparison.





Repeat steps 1-7 using 4 then 6 cottonballs.

FILTERING FOOLS OBSERVATION SHEET 6.2

Zebra Mussel Watchers' Names:

_____

_____

1. Compare the cottonball filters. Did the 2, 4, or 6 filters remove more material from the water?

_____

2. How does this filtering demonstration relate to the zebra mussel?

_____

_____

_____

3. Write a paragraph telling why filtering of zebra mussels has such a great impact on a body of water.

_____

_____

_____

_____

_____

4. List at least 5 ways that filters are used by people.

_____

_____

_____

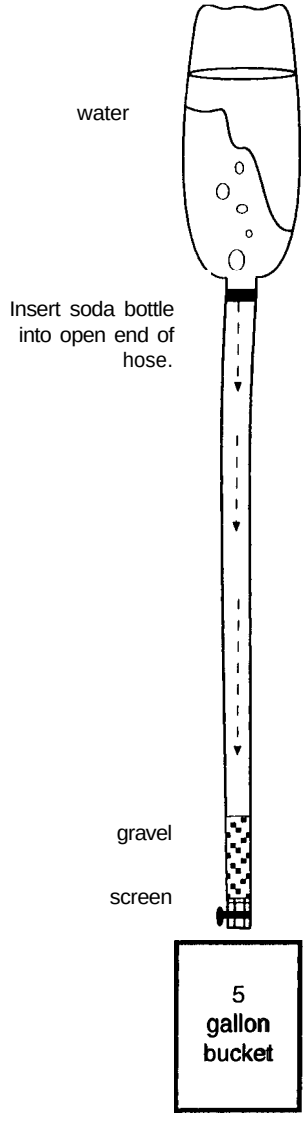
ALL CLOGGED UP! DATA SHEET 7.1

Zebra Mussel Watchers' Names:

_____

_____

STEPS 1-5



Rate of Flow Data Table

Amount of gravel	Rate of flow in seconds			
	Trial 1	Trial 2	Trial 3	Average
no gravel				
5 cm				
15 cm				
20 cm				

Make a prediction after plotting the data on the graph paper.

Predicted rate of flow using 10 cm of gravel _____seconds

Predicted rate of flow using 25 cm of gravel _____seconds

ALL CLOGGED UP!
RECORD SHEET 7.2

Zebra Mussel Watchers' Names:

_____

_____

Questions

1. How good was your group's prediction at the 10 cm of gravel level? Why?

_____

_____

_____

2. How good was your group's prediction at the 25 cm of gravel level? Why?

_____

_____

_____

3. Which prediction (10 or 25 cm of gravel) should have been more accurate? Why was one prediction more accurate than the other?

_____

_____

_____

4. How does this demonstration relate to zebra mussels?

_____

_____

_____

5. Describe how the zebra mussel might affect pipes in water or power plant systems.

_____

_____

_____

_____

FAMILY REUNION! DATA SHEET 8.1

Zebra Mussel Watchers' Names:

_____

_____

1. Area of pan_____cm^2 Area of carton_____cm^2 (length x width = _____)

2. Estimate cartons per pan_____

3. Actual cartons per pan_____ (determined by area of pan x area of carton)

Average number of pieces of gravel per carton_____

Number of cartons sampled_____

Number of Pebbles Collected

River site	Student sampling group				Average
	A	B	C	D	
1					
2					
3					
4					

Total population density of: site 1_____ site 2_____ site 3_____ site 4_____
(determined by taking the sample average x actual number of cartons that fit into pan)

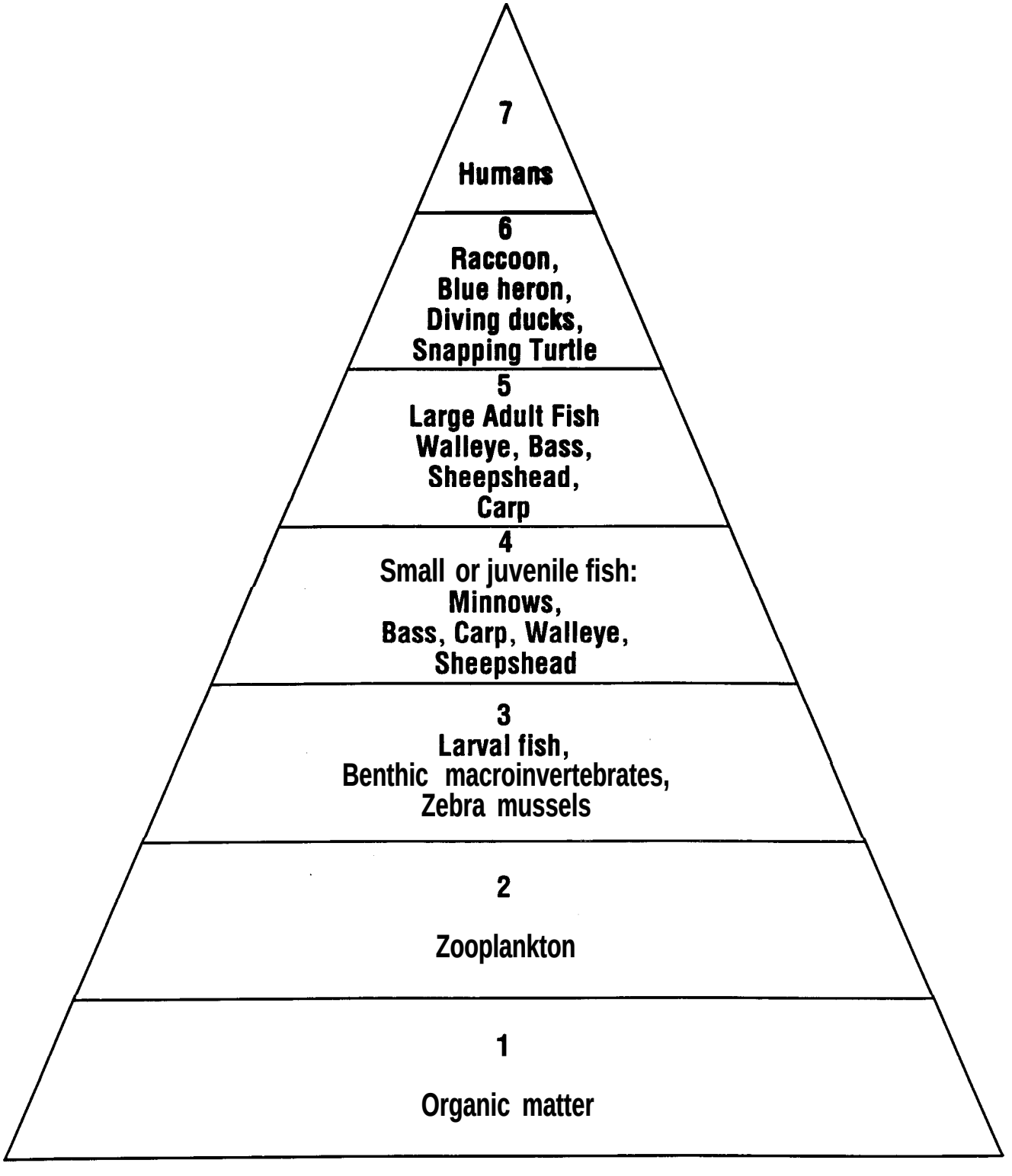
Total population density of all sites_____
(add population densities of all sites and divide by 4)

WEB OF LIFE GAME
FOOD PYRAMID OVERHEAD
TEACHER'S KEY 9.1

Food Pyramid

The food pyramid describes the energy flow between producers and consumers. Producers are plant forms on the lower levels of the food pyramid. They consist of plants and orgnic matter. These plants and organic matter produce the energy that begins its journey through the food pyramid. The plants grow, store energy, and are consumed by organisms called consumers. The consumers that eat only plants are called herbivores. Carnivores are meat eaters, and omnivores are consumers that eat both plants and animals. As you progress up the food pyramid, the foods that are eaten by consumers become more varied. The variety helps many organisms to survive when one type of food becomes extinct.

The Food Pyramid



Zebra Mussel Mania

Teacher's Guide for **Grades 5 and** 6

Reference Materials

A Great Lakes Sea Grant resource list on zebra mussels and other nonindigenous species

This list includes material that is distributed by the six Sea Grant programs in the Great Lakes Sea Grant Network as of December 1993. Many of the other Sea Grant programs are producing material about the zebra mussel, too. For example, Rhode Island (401/792-6842) Virginia (804/924-5965) and North Carolina (919/515-2452) Sea Grant programs all currently have material available. Other U.S., state and Canadian agencies also have material available.

To order any item in this resource list, complete and mail the order form for the program distributing the material. Free items are for *sing/e copies only* unless specified otherwise. For prices on bulk orders, contact the program that is distributing the material. Please prepay all orders.

Resources on zebra mussels

The first three publications provide information on how this species was introduced into the Great Lakes, areas colonized in the lakes, what methods of eradication exist, provides tips on what you can do to slow the mussel's spread, and the impact zebra mussels will have on industry, recreation and the Great Lakes ecosystems.

Zebra mussels **in the Great Lakes: The invasion and its implications.** December 1993. *Fred L. Snyder, David W. Garton*, and *Maran Brainard*. 4 pp. OHSU-FS-045. Free for any size order. OH

Zebra mussels: A 1992 Great Lakes overview. 1992. *Avery Klauber. 8* pp. Free; multiple copies are $.10 each. NY

Zebra mussels in the Great Lakes. 1992. 2 pp. MICHU-SG-92-700. Free. **MI**

Mid-Atlantic zebra mussel fact sheet. Reprinted January 1994. ***Barbara Doll. 6*** pp. Explores the possible routes of entry the zebra mussel might take and examines the environmental characteristics that would make this area a hospitable host, including the expansive estuaries and freshwater rivers and lakes. Free. To order, write N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Zebra mussel: An unwelcome visitor. 1993 *Kurin A. Tammi. 2* pp. Describes the biology, impact and history of zebra mussels in the United States along with identification information and help to Rhode Islanders to prevent their introduction into the state. ***$.50*** To order, write R.I. Sea Grant Information Office, URI Bay Campus, Narragansett, RI 02882, 401/792-6842.

Zebra mussels in Virginia's future. March 1993. 2 pp. Includes the zebra mussel's physical requirements and a list of its potential range in Virginia's waters. Free. To order, write Virginia Institute Marine Science, Gloucester Point, VA 23062.

New concerns emerge as zebra mussel spreads. 1992. 2 pp. MICHU-SG-92-702. Free. MI

The zebra mussel *(Dreissena polymorpha)*: An unwelcome North American invader. 1991. *Charles R. O'Neill, Jr. and David B. MacNeill. 12 pp.* NYSGI-G-91-013. $1.00 NY

Boaters - Slow the spread of zebra mussels and protect your boat, too. 1993. *David 0. Kelch. 2* pp. OHSU-FS-054. Free for any size order. OH

Identification of juvenile *Dreissena polymorpha* and *Mytilopsis leucophaeata. 1992. David B. MacNeill.* 3-fold brochure includes diagrams, glossary and references for the zebra mussel and dark false mussel. NYSGI-G-92-001. Free NY

Zebra mussel information needs survey for municipal and industrial water users-Summary report. 1992. *Robin Goettel and Gail Snowdon. 8* pp. A survey of 29 southern Lake Michigan municipal and industrial water users provided findings on what types of zebra mussel information were most needed and in what form the information could best be delivered. Free **IL-IN**

Control of zebra mussels in residential water systems. 1993. *Charles R. O'Neill, Jr. 8* pp. $1.00 NY

Zebra **mussels may clog irrigation systems.** 1993.2 pp. MICHU-SG-93-701. Free. MI

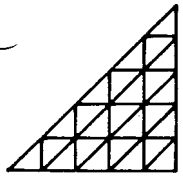
Engineering Notes. 1992. ***Philip Keillor.*** Free. **WI**

#l: Case studies of constructed filter bed intakes. A description of 10 such systems in the western Great Lakes that range from one to 100 years old. Included is information on operational experience and whom to contact (plant operators and design engineers) for further information, plus commentary from marine contractors and design engineers. 16 pp.

#2: Infiltration intakes **for very large water supplies: Feasible? A** review of four 20-year-old papers that considered design feasibility as a means of protecting larval organisms from entrainment in power plant and water diversion project intakes. 11 pp.

#3: Zebra mussel ***(Dreissena polymorphu)*** **distribution: Reported size, depth and temperature variables. A summary** of relevant data about zebra mussels intended for project design engineers. 7 pp.

#4: **Using filtration and induced infiltration intakes to exclude organisms from water supply systems. A** literature review plus an overview of slow sand filtration and infiltration systems. 13 pp.



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. This list was compiled by Ohio Sea Grant Communications (Projects M/P-2 and A/ZM-1 grant NA90AA-D-SG496.) as OHSU-FS-052. December 1993.

Printed compliments of Mercury Marine, A Brunswick Company

Sand filter intakes could safeguard vital water-supply systems from zebramussels. ***1991. PhilipKeillor. 4pp.WIS-SG-91-428-13.*** Free. WI

Don't let these invaders hijack your boat! is a 17"x22" humorous cartoon poster telling boaters what to do to slow the spread of zebra mussels. Perfect for fishing/bait shops. Pub X6. Free. MN

Don't pick up hitchhikers! Stop the zebra mussel is a 3 pp. flier and 11"x17" poster. One or two copies of the flier and poster are free. NY

Zebra mussel watch identification card. *Christine Kohler and Stephen Wittman.* Wallet-sized cards have a color picture of the zebra mussel with text describing their appearance and what to do if you find a mussel. Free; 20 cards for $1 .00. Available from each program., Order customized cards from Wisconsin. WI

Zebra mussel distribution map from the latest issue of ***Dreissena polymorpha information review.*** Free. NY

Zebra mussel distribution in Michigan. Free. MI

Zebra mussels: From spawning to settlement. January 1994. 20-minute video shot through a microscope shows mussels spawning naturally and induced. Voice-over provides details. $15.00.**OH**

Zebra mussels. 1993. Produced by New York Sea Grant and PBS-affiliate WLIW, Long Island as 30-minute show. $12.00. NY

Protecting your boat from zebra mussels. Revised 1993. This 15 minute video gives pointers on how to prevent damage to your recreational boat and tips on preventing the spread of the mussel to inland waters. $10.00. NY

Too much mussel. January 1991. This 5.5 minute video (VHS format) provides an overview of the impact of zebra mussels to Lake Erie. $15.00. **OH**

Zebra mussel features. Collection of 90 second feature stories produced by Outreach Communications TV at Michigan State University. Contact Carol Swinehart at MSU 517/353-9723. $10.00.

Nonindigenous Species Graphics Library contains slides, photographs and illustrations of zebra mussels and other aquatic nuisance species. Also includes a videotape resource list. Contact Michigan Sea Grant at 313/764-1138 for more information.

Resources on other species

A field guide to aquatic exotic plants and animals. 1992. Developed by MN Sea Grant, MN DNR and Bell Museum of Natural History. 10-page, four-fold, color brochure describes eleven common exotics in the Great Lakes region. Pub X9. Free. MN

Biology and potential impacts of the rudd in the Great Lakes. October 1993. ***David MacNeill. 4*** pp. Free. NY

The Ruffe invasion, *Gymnocephalus cernuus.* 1993. ***Mike McLean.*** Describes the aggressive, perch-like fish found in Lake Superior. This invader was first identified in the St. Louis River in 1987. It is now the most numerous forage fish in the estuary and its range is expanding. PUB X7. Free. **MN**

Effects of spiny tailed *Bythotrephes* on Great Lakes fish. 1993. ***D. Rae Barnhisel.*** Explains affect of ***Bythotrephes*** on fish predation. 2 pp. MICHU-SG-93-704. Free. MI

Don't let exotics ride with you. 1992. A simple card explaining four major exotics that threaten our lakes and rivers and what boaters and anglers can do to prevent their spread. 2 pp. Free for any quantity. **Available from each program. OH**

The spiny water flea, *Bythotrephes:* A newcomer to the Great Lakes. 1991. ***David J. Berg. 2*** pp. OHSU-FS-049. Free. OH

Spiny tailed *Bythotrephes:* Its life history and effects on the Great Lakes. 1990. ***Carla E. Caceres and John T. Lehman.*** Explains the anatomy, reproductive cycle and behavior of ***Bythotrephes*** and how this exotic may affect the Great Lakes ecosystems. 7 pp. MICHU-SG-90-700. Free. MI

Pacific Salmon in the Great Lakes: The history and future. 1986. ***Warren Downs. 5*** pp. WIS-SG-86-149. Free. WI

Sea Lamprey: Invader of the Great Lakes. 1982. ***Warren Downs.*** 8 pp. WIS-SG-82-138. $.50. WI

Is it a white bass or a white perch? Reprinted 1991. ***Fred L. Snyder.*** 1 p. OHSU-FS-005. Free. **OH**

Getting to know your catch: Lake Erie Salmonid identification. Reprinted 1991. ***David 0. Kelch. 2*** pp. OHSU-FS-031. Free. **OH**

Scientific publications on zebra mussels

"Biology of recent invertebrate invading species in the Great Lakes: The spiny water flea, *Bythotrephes cederstroemi* and the zebra mussel, *Dreissena polymorpha"* by ***David W. Garton, David J. Berg, Ann M. Stoeckmann and Wendell R. Haag*** reprinted from ***Biological Pollution: The Control and Impact of Invasive Exotic Species, Bill McKnight*** (ed.), pp. 63-84,1993.OHSU-RS-165. Free. **OH**

"Reduced survival and fitness in native bivalves in response to fouling by the introduced zebra mussel *(Dreissena polymorpha)* in western Lake Erie" by ***Wendell R. Haag, David J. Berg, David W. Garton and J.L. Farris*** reprinted from ***Can J Fish and Aquat Sci*** 50(1):13-19,1993. OHSU-RS-157. Free. **OH**

"Changes in planktonic diatoms and water transparency in Hatchery Bay, Bass Island Area, Western Lake Erie since the Establishment of the zebra mussel" by *Ruth E. Holland* reprinted from ***J Great Lakes Res*** 19(3):617-624,1993. MICHU-SG-93-306. Free. MI

"Effects of deionized water on viability of the zebra mussel, *Dreissena polymorpha"* by ***J.L. Ram and J. U. Walker*** reprinted from ***Comp Biochem Physiol 105C(3):409-414. 1993. MICHU-SG-93-304.*** Free. MI

"The zebra mussel *(Dreissena polymorpha),* a new pest in North America: Reproductive mechanisms as possible targets of control strategies" by *J.L. Ram, P. Fong, R.P. Croll, S.J. Nichols and D. Wall* reprinted from ***Invertebrate Reproduction and Development 22:1-3*** (1992) ***77-86. MICHU-SG-93-303.*** Free. **MI**

"Spawning in the zebra mussel *(Dreissena polymorpha):* Activation by internal or external application of serotonin" by ***J.L. Ram, G. W. Crawford, J.U. Walker, J.J. Mojares, N. Patel, P. Fong and K.*** Kyozuka reprinted from ***J Experimental Zoology 265:587-598, 1993. MICHU-SG-93-300.*** Free. MI

"Attitudes of 1990, 1991, and 1992 Mid-America Boat Show and 1991 Fairport Symposium patrons concerning the zebra mussel *(Dreissena polymorpha),* Lake Erie, and Great Lakes pollution" by ***Frank R. Lichtkoppler, David 0. Kelch and M. Annie Berry*** reprinted from ***J Great Lakes Res*** 19(l): 129-135, 1993. OHSU-RS-158. Free. **OH**

"Seasonal reproductive cycle and settlement patterns of *Dreissena polymorpha* in western Lake Erie" by ***David W. Garton and Wendell R. Haag*** reprinted from ***Zebra Mussels: Biology, Impacts and Control***, Thomas F.Nalepa and Donald W. Schloesser (eds.),pp. 111-128, 1992. OHSU-RS-159. Free. **OH**

"Investigations of the toxicokinetics of hydrophobic contaminants in the zebra mussel" by ***Susan W. Fisher, Duane C. Gossiaux, Kathleen A. Bruner and Peter F. Landrum*** reprinted from ***Zebra Mussels: Biology, Impacts and Control,*** Thomas F. Nalepa and Donald W. Schloesser (eds.), pp. 465-490, 1992. OHSU-RS-160. Free. **OH**

"The use of endod to control the zebra mussel" by ***Harold H. Lee, Akilulu Lemma and Harriett J. Bennett*** reprinted from ***Zebra Mussels: Biology, Impacts and Control,*** Thomas F. Nalepa and Donald W. Schloesser (eds.), pp. 643-656,1992. OHSU-RS-161. Free. **OH**

"Early detection of the zebra mussel *(Dreissena polymorpha*)" by ***Clifford Kraft*** reprinted from ***Zebra Mussels: Biology, Impacts and Control,*** Thomas F. Nalepa and Donald W. Schloesser (eds.), pp. 705-714, 1993. WISCU-R-93-001. Free. WI

"Multivariate model for predicting population fluctuations of *Dreissena polymorpha* in North American Lakes" by *Charles W. Ramcharan, Dianna K. Padilla and Stanley I. Dodson* reprinted from ***Can J Fish Aquat Sci*** 49(1):150-158, 1992. WIS-SG-92-944. Free. WI

"Models to predict potential occurrence and density of the zebra mussel *(Dreissena polymorpha)"* by ***Charles W.Ramcharan, Dianna K. Padilla and Stanley I. Dodson*** reprinted from ***Can J Fish Aquat Sci*** 49(12):2611-2620, 1992. WISCU-R-92-032. Free. WI

"Bioenergetics model of zebra mussel, *Dreissena polymorpha,* growth in the Great Lakes" by *Daniel W. Schneider* reprinted from ***Can J Fish Aquat Sci*** 49(7):1406-1416, 1992. WISCU-R-92-017. Free. WI

"Synchronous spawning in a recently established population of the zebra mussel, *Dreissena polymorpha,* in western Lake Erie, USA" by *Wendell R. Haag and David W. Garton* reprinted from ***Hydrobiologica 234:103-119,*** 1992.OHSU-RS-151. Free. **OH**

International zebra mussel research conference (1991) proceedings sponsored by the Great Lakes Sea Grant Network and hosted by New York Sea Grant. 52 pp. $8.00. NY

"Heterozygosity, shell length and metabolism in the European mussel, *Dreissena polymorpha,* from a recently established population in Lake Erie" by *David W. Garton and Wendall R. Haag* reprinted from ***Comp Biochem Physiol* 99A(1/2):45-48, 1991.OHSU**-RS-140. Free. **OH**

"Molluscicidal activity of potassium to the zebra mussel, *Dreissena polymorpha:* Toxicity and mode of action" by *Susan Warwick Fisher, Paul Stromberg, Kathleen A. Bruner and J. Denise Boulet* reprinted from *Aquatic Toxicology 20:219-234, 1991. OHSU-RS-146.* Free. **OH**

"Zooplankton grazing and phytoplankton abundance: An assessment before and after invasion of *Dreissena polymorpha"* by ***Lin Wu and David A. Culver*** reprinted from ***J Great Lakes Res* 17(4):425-436,199l.OHSU-RS-149.** Free. **OH**

"Methods for evaluating zebra mussel control products in laboratory and field studies" by **Susan Warwick Fisher and Dennis Bernard rcprintcd from *J Shellfish Res* 10(2):367-371,199l.OHSU RS-150. Free. OH**

International zebra mussel research conference (1990) proceedings sponsored by the Great Lakes Sea Grant Network and hosted by Ohio Sea Grant. 32 pp. OHSU-TS-019 also available as **"Abstracts of technical papers presented at the International Zebra Mussel Research Conference Columbus, Ohio 1990"** reprinted from ***J Shellfish Res 10(1):243-260,*** 1991. OHSU-RS-144. Both are free. **OH**

Scientific publications on other species

'Embryonic and postembryonic development in *Bythotrephes cederstroemi"* by ***P.M. Yurista*** reprinted from ***Can J Fish Aquat Sci*** 49(6):1118-l125, 1992. MICHU-SG-92-307. Free. **MI**

"Zooplankton *Bythotrephes cederstroemi)* spine induces aversion in small fish predators" by D. Rae Barnhisel reprinted from *Oecologia* 88:444-450, 1991. MICHU-SG-92-303. Free. **MI**

"Causes and consequences of cladoceran dynamics in Lake Michigan: Implications of species invasion by *Bythotrephes"* by ***John T. Lehman*** reprinted from ***J Great Lakes Res 17(4):437-445.*** 1991. MICHU-SG-92-302. Free. MI

Genetics and ecology of an invading species:* Bythotrephes cederstroemi *in western Lake Erie.1991. David J.Berg. 164pp.TD-030. On loan from the Sea Grant Depository, Pell Library Building/Bay Campus University of Rhode Island, Narragansett, Rhode Island 02882. (All items listed in this publication can be borrowed from the Depository.)

"Occurrence of *Bythotrephes cederstroemi* (Schoedler 1877) in Lake Superior, with evidence of demographic variation within the Great Lakes" by *David W. Garton and David J. Berg* reprinted ***from J Great Lakes Res*** 16(1):148-152,1990 OHSU-RS-138.Free. **OH**

"Thermal tolerances of the predatory cladocerans *Bythotrephes cederstroemi* and *Leptodora kindti:* Relationship to seasonal abundance in western Lake Erie" by *David W. Garton, David J. Berg and Robert J. Fletcher* reprinted from ***Can J Fish Aquat Sci 47(4):731-738,*** 199O. OHSU-RS-125. Free. **OH**

The white perch and its interaction with yellow perch in Lake Erie. 1989. ***Donna L. Parrish. 137*** pp. TD-021. $15.50. **OH**

Newsletters

***Dreissena polymorpha* information review.** Summaries of research, meetings, legislation and sitings of the zebra mussel for the interested professional. Bimonthly. $60.00 annual subscription rate includes other benefits. Contact Zebra Mussel Clearinghouse at 800/285-2285.

Zebra mussel update reports on the status of the zebra mussel invasion in the region, zebra mussel-related research, upcoming conferences, new publication, etc. Written by *Clifford Kraft.* Published irregularly; Free. WI

The following Sea Grant program newsletters cover Great Lakes issues, education, environment. economic development, fisheries and aquaculture activities in each state. Conferences, publications and journal articles may also be listed. Contact your closest Sea Grant program for a subscription. Some programs also produce additional topic-specific newsletters.

- **The HELM, issued quarterly by Illinois-Indiana. Free.**
- ***Upwellings,* issued quarterly by Michigan. Free.**
- ***The Seiche,* issued quarterly by Minnesota. Free.**
- ***Coastlines,* issued quarterly by New York. Free.**
- ***Twine Line,* issued bimonthly by Ohio. $4.50 a year. Each issue includes a zebra mussel update.**
- ***Littoral Drift, issued* monthly by Wisconsin. Free.**

For more information..

Illinois-Indiana Sea Grant Program
University of Illinois
65 Mumford Hall
1301 W. Gregory Dr.
Urbana, IL 61801-3068
211/333-9448

New York Sea Grant Institute
SUNY College at Oswego
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New York Sea Grant
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Swetman Hall
Oswego. NY 13126-3599

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Publication #	Title	Quantity	Price

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OH PUBLICATIONS

Ohio **Sea Grant College Program**
The Ohio State University
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Columbus, OH 43212-1194

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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 48624

The Groat 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

Produced by Michigan and Ohio Sea Grant programs as a joint project for the Great Lakes Sea Grant Network. It is available from Michigan Sea Grant as MICHU-SG-93-703 and Ohio Sea Grant as OHSU-FS-059. (Michigan Sea Grant projects FIRM-7, AC-I, AFT-4, grant NA89AA-D-SG083. Ohio Sea Grant project M/P-2, grant NA90AA-D-SG496.)

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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.

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

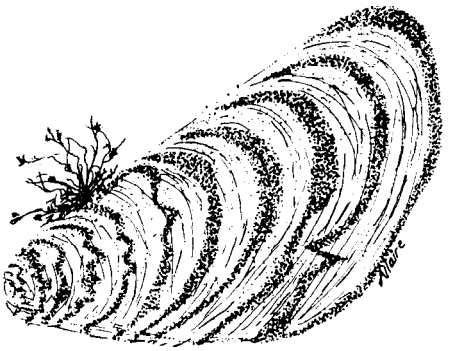
Safety Rules

These safety rules may be discussed and posted during science activities, or the teacher may have the class generate a list of safety procedures to follow.

1. Listen to your teacher's instructions.
2. Don't touch or pick up any materials unless your teacher tells you to.
3. Follow directions.
4. Ask your teacher for help if you need it.
5. Cooperate with a partner or with your group.
6. Never put anything in or near your eyes or mouth, and wash your hands when you have finished.
7. Clean up work area and return all materials to their proper places.
8. Always walk in the science area.
9. Talk quietly in groups.
10. Tell your teacher immediately in case of accidents.
11. Be Careful! ! !

Zebra Mussels

Zebra mussels have a life span of three years. Both males and females become mature and are able to reproduce at about one year old. The breeding season occurs between May and October when water temperatures are warmer. Spawning is triggered by such factors as temperature and the abundance of zooplankton, the food they “love to eat.”



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Life Cycle of the Zebra Mussel

1. Zebra mussel reproduction occurs when the female releases eggs into warm water and males release sperm. Scientists are finding that both males and females can start the spawning process by chemical signals they send to each other. This process is called external fertilization.

   During the spawning season, females can release an average of 30,000-40,000 eggs into warm water. Some large females can produce up to 1 million eggs. Peak spawning months are July and August.

2. Hours after fertilization, the larvae develop from fertilized eggs. At this stage the larve are known as veligers, which have a clump of hair-like filaments, called cilia. Cilia help the veligers stay suspended and swim in the water. The microscopic larvae of zebra mussels are free-swimming, unlike other freshwater mussels.

3. The veligers float in water for 10-l5 days and are transported by water currents. During the free-floating time, they feed heavily on plankton and grow in size. When they become the size of a dime they are too heavy to stay afloat, so they settle on the river or lake bottom. Here, they try to find a hard surface to which they can attach. The veligers that settle out are called post-veligers. Settling is a vulnerable period in the zebra mussel life history. This is because they can be eaten by other species at this time or can die due to water quality and temperature factors.

   Most veligers do not succeed in finding the right environmental conditions needed for survival, so they die. They are also preyed upon by zooplankton and are greatly affected by environmental factors such as temperature. Their death rate is about 99% — this means that only 1% of the veligers are able to complete the life cycle. Keep in mind, however, the millions of adults, each producing on average up to 30,000 offspring each year.

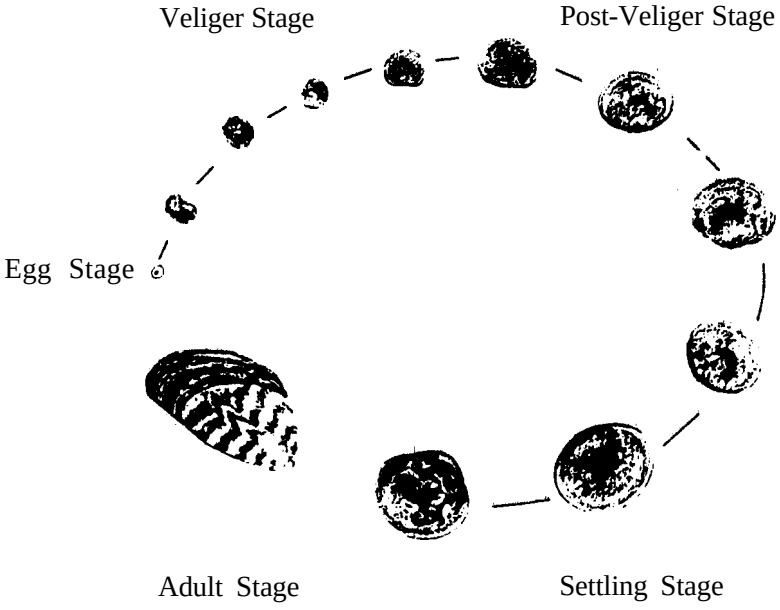
4. The shell of a post-veliger begins to lengthen and grow, eventually becoming triangular. They also grow a long, powerful foot, which secretes byssal threads. These strong byssal threads are what zebra mussels use to attach themselves to the surfaces.

   Many zebra mussel clusters can be found on the ends of native mussels, close to their inhalant siphons where food is taken into the shells. These post-veligers usually live well because they are guaranteed a constant food source since they steal the incoming food of the "host" mussel.

5. Within the next three weeks, post-veligers transform into juvenile forms. These resemble adult mussels and become fully mature within a year. Juveniles detach their byssal threads and move in search of areas rich in zooplankton. Needing to move again, the mussels can grow new buoyant threads which allow them to drift with the current.

   Zebra mussels grow very rapidly and will measure about two centimeters during the first year. In their second year they may add an additional one to two centimeters of growth. The maximum length of the zebra mussels collected in the United States has been 4 cm.

Life cycle of the Zebra Mussel



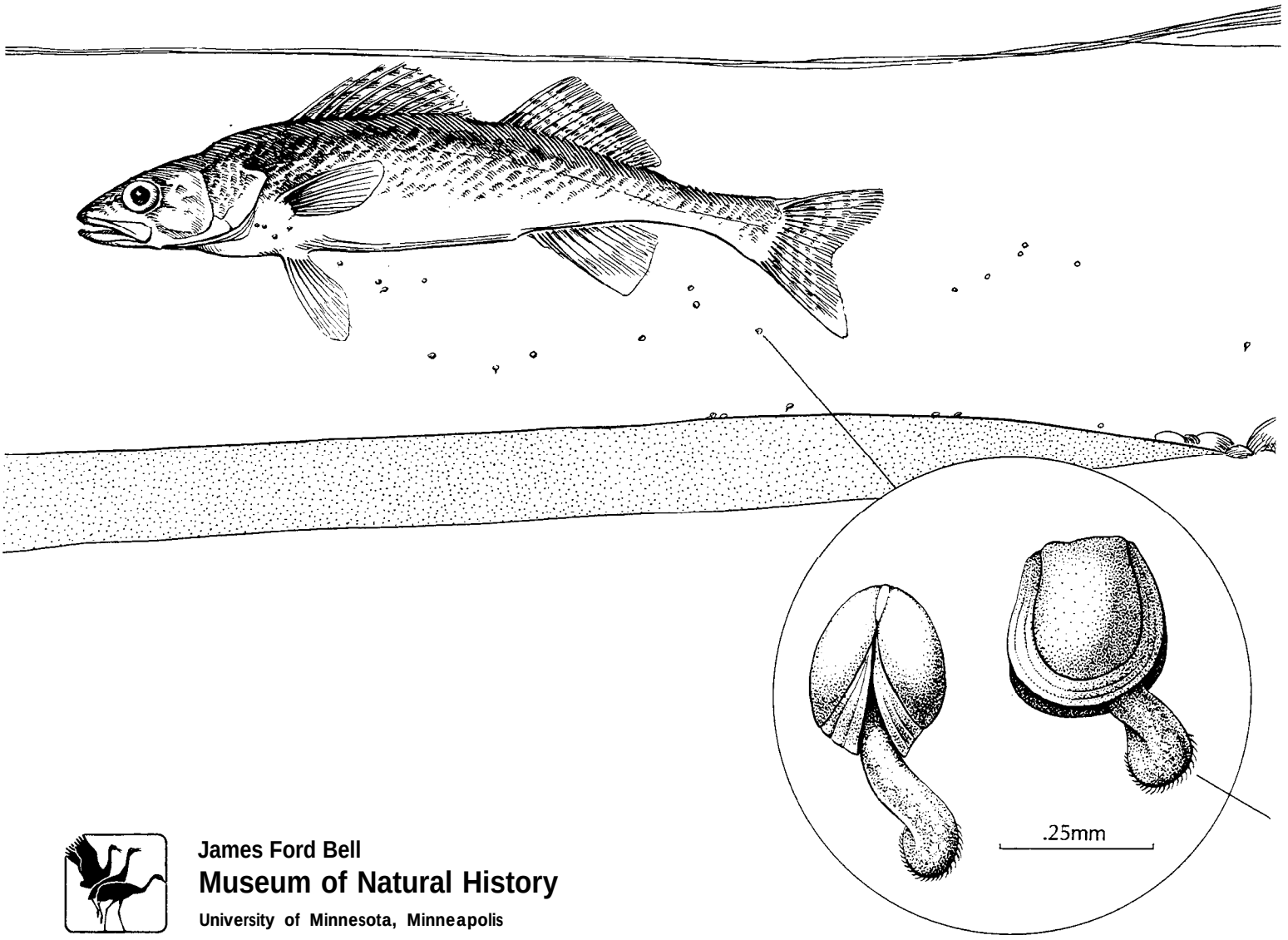
Freshwater Mussels

Lying partly buried in the bottom sediments of lakes and streams, mussels are easily overlooked and disregarded. We sometimes hear of how the Indians feasted on them and left great mounds of discarded shells. Or about how they were collected by the ton for the pearl button industry But little is usually said about how these animals quietly make their living or about their rather elaborate life cycle.

Like most other bivalve mollusks, freshwater mussels are sedentary filter feeders. Water is drawn in through an opening called a siphon, and passes over the gills. Food-tiny plankton and organic detritus--sticks to the mucus lining of the gills and is slowly swept to the mouth by cilia. Filtered water and wastes pass out the excurrent siphon.

The shell is secreted by the mantle, a sheet of tissue that surrounds the mussel's body and lines the shell. During the winter, growth slows or stops, and rings form on the outside of the shell that can be counted like tree rings to estimate the age of the shell. Mussels can be extremely long lived. Thick shelled species typically live 20 to 40 years and some may reach 100.

A great diversity of mussels lives in the rivers of the Mississippi drainage. Forty-eight species are found in the Upper Mississippi alone, but only a dozen are known from all the rivers of Europe. This species richness indicates that mussels probably evolved from their salt-water ancestors in North America. The challenge facing these sedentary animals was how to colonize new habitats upstream. Marine mussels and clams have free-swimming larvae which are spread by ocean tides and currents to new locations. But in a river; such larvae would always be swept back out to sea. The solution found by freshwater mussels was larvae that attach themselves to fish, thus hitching a free ride upstream.



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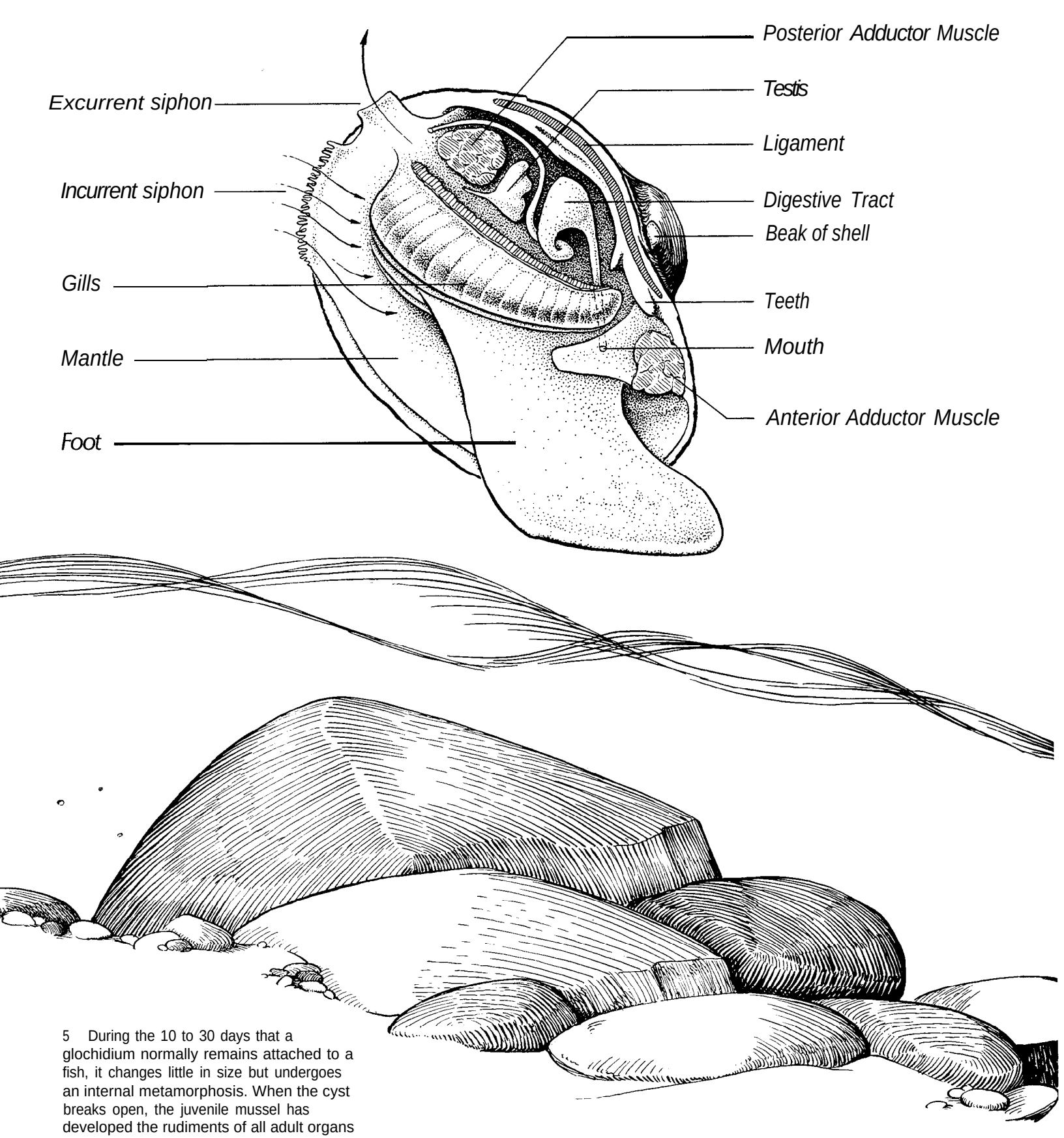


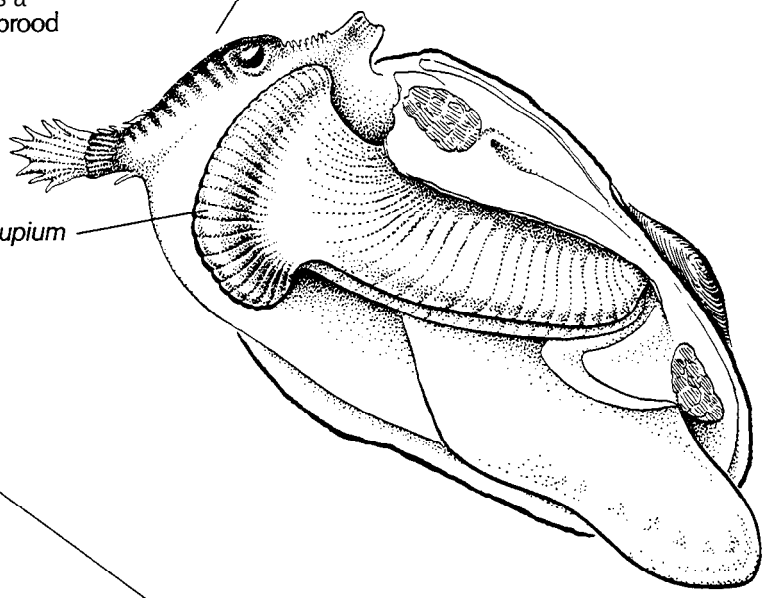
5 During the 10 to 30 days that a glochidium normally remains attached to a fish, it changes little in size but undergoes an internal metamorphosis. When the cyst breaks open, the juvenile mussel has developed the rudiments of all adult organs and can also move about actively by extending its foot. Juveniles may become the prey of other animals or may perish if they don't settle in an appropriate habitat.

Cilia on the juvenile foot aid locomotion. *The foot is also sticky, helping the young mussel* cling to aquatic plants or the stream bottom.

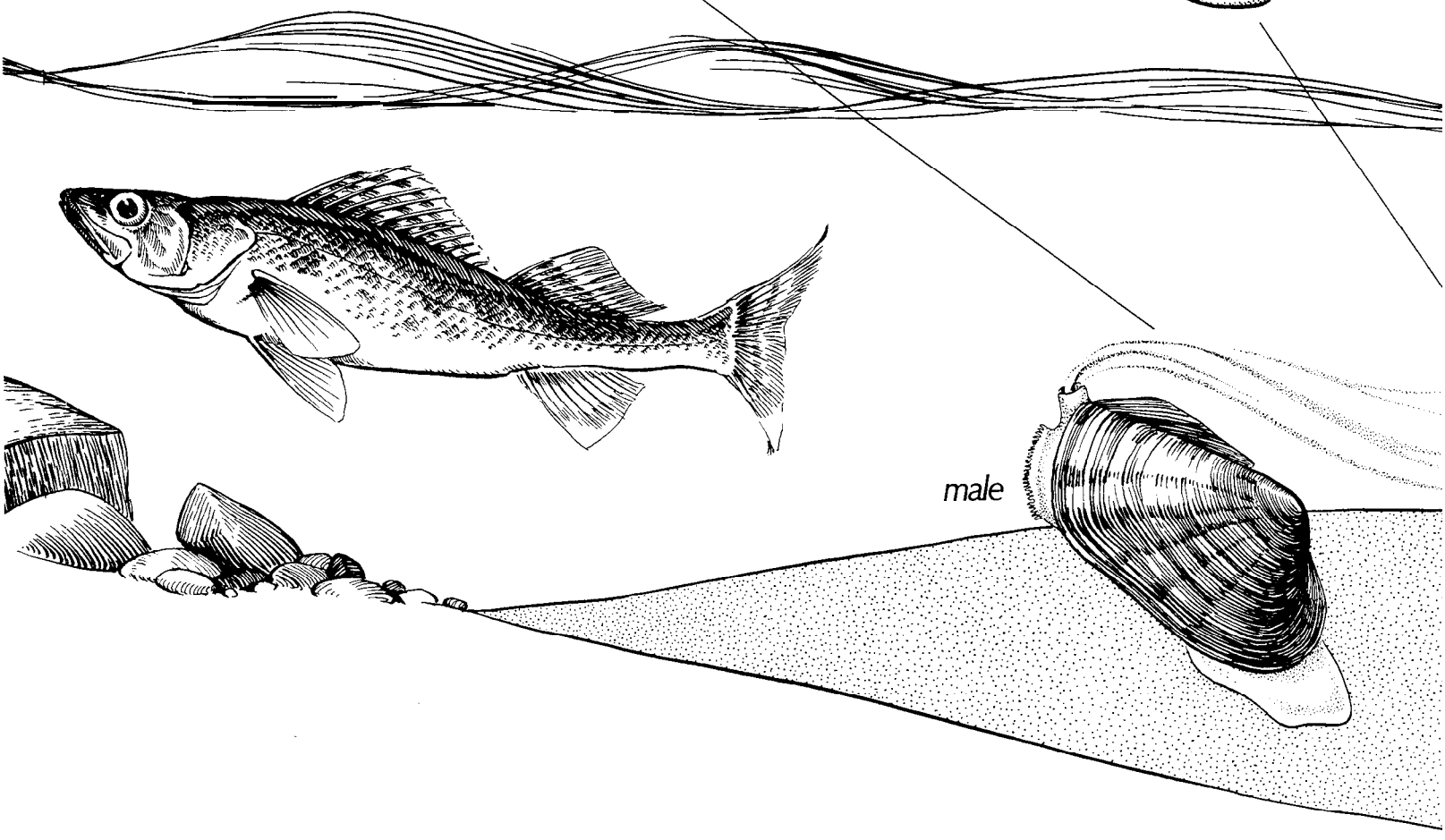
Mussel Life Cycle

Some mussels *have a feature that improves the odds of infecting fish with their glochidia. Flaps of mantle extrude beyond the edge of their shells and look, flapping in the current, like tiny tasty fishes. When larger fish strike at this lure, the mussel closes its shell and squirts a stream of glochidia into the fish's mouth.*

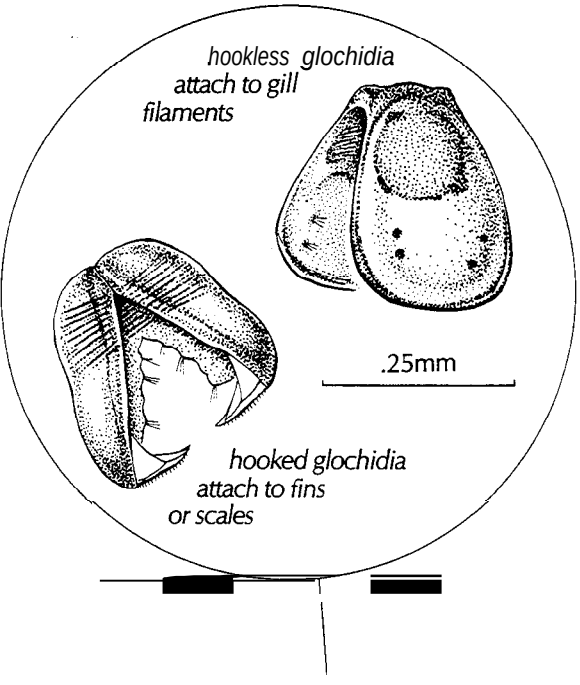
2 The fertilized eggs are retained within the gills of the female while they develop into specialized larvae known as glochidia. A small mussel may harbor several thousand embryos, whereas larger mussels can contain millions. In many species a section of gill is expanded to form a brood pouch called a marsupium.

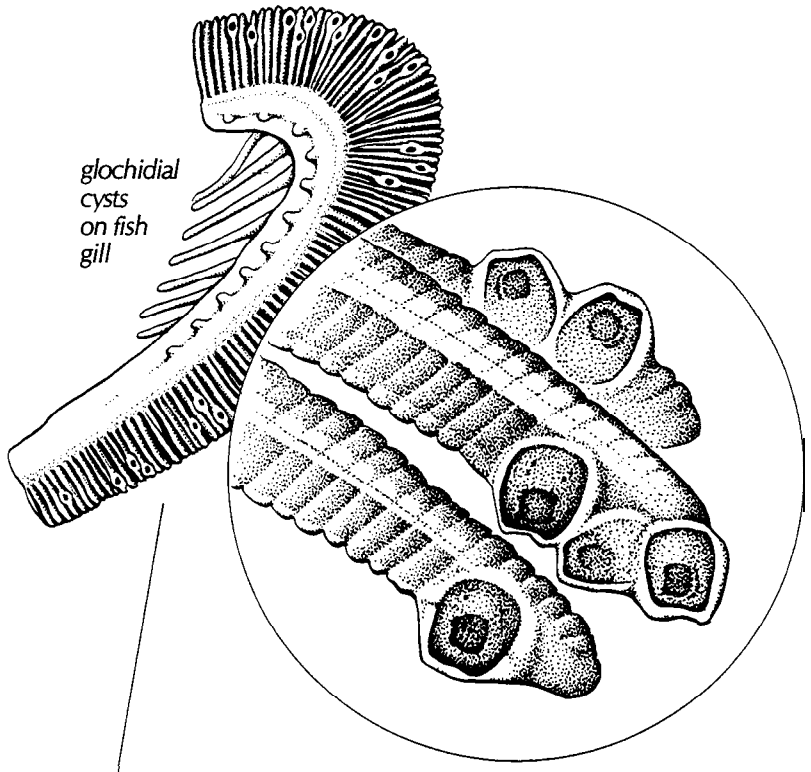


1 Sex for the mussel is an anonymous affair, as males shed clouds of sperm into the water which enter the female through her incurrent siphon with water that the mussel filters for its food. Fertilization of the eggs takes place in the female's gills.



3 The microscopic glochidia are the parasitic stage of the mussel life cycle. Though shaped like adults, with two valves, their internal structure is very different. When they contact the tissue of a fish, the two valves clamp shut and hang on.

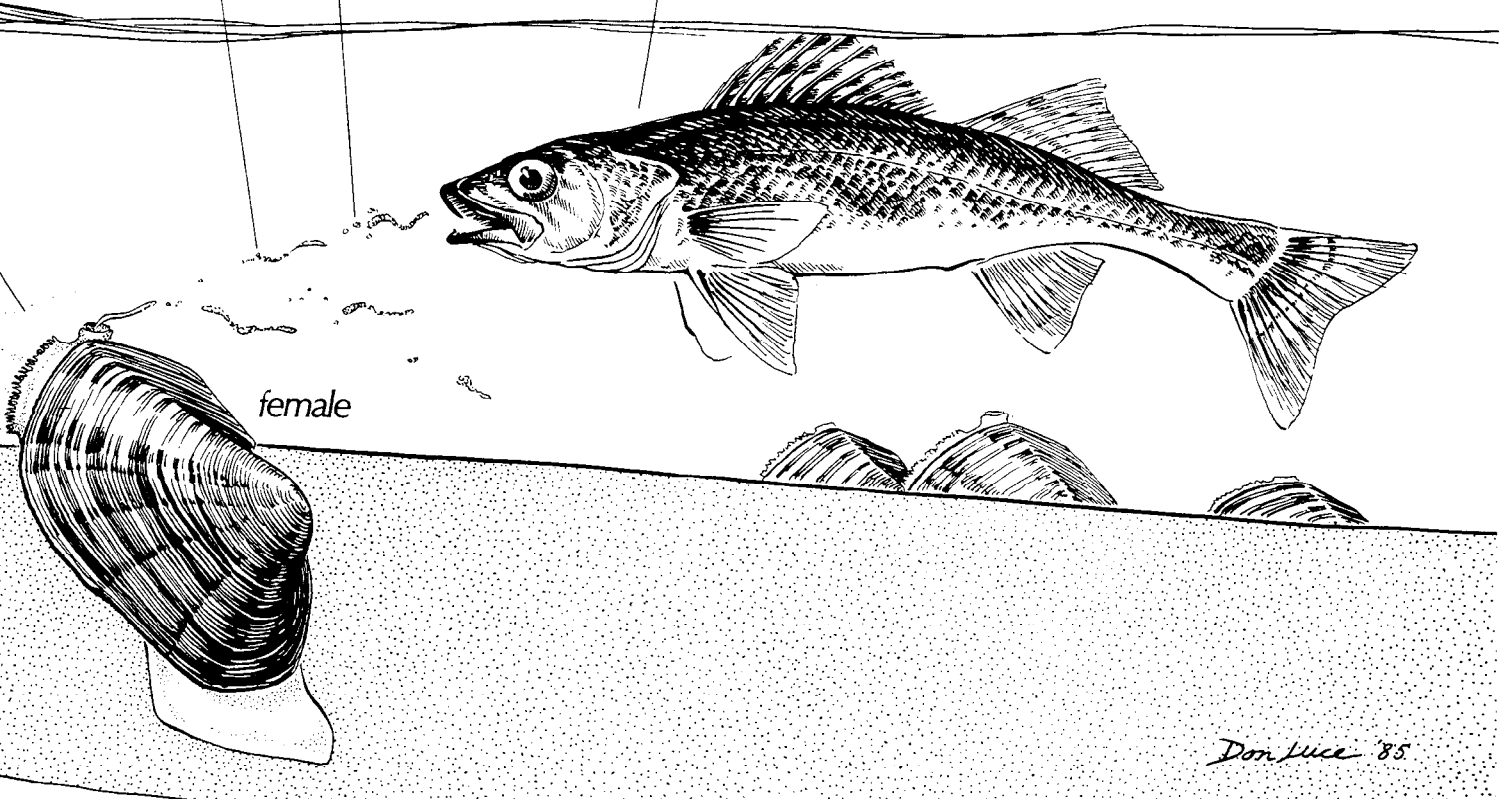




4 Once attached to a gill filament, the glochidium becomes surrounded by host tissue, forming a small cyst. Glochidia do little or no harm to their hosts, since an infected fish usually only harbors a few of them.

Some mussels can successfully parasitize only one or a few species of fish. If a glochidium attaches to the wrong host or to a fish that has developed immunity it soon drops off.

Many *species release their glochidia in clumps shaped like small worms or newly hatched fish fry Fish feed on these and in the process become infected.*



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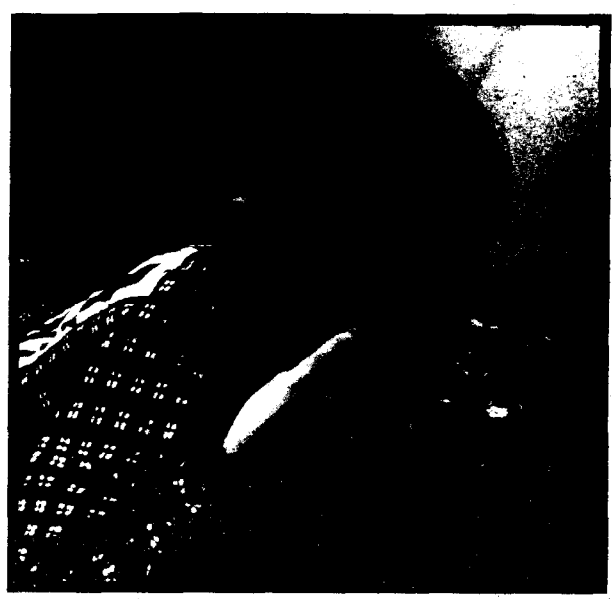

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Sea Grant

Brochure Project Coordinator: Linda Aylsworth
Writers: Robin Goettel and Marie Sales
Photographers: Ken Moran and Robin Goettel

MN-SG-X38

Illinois-Indiana Sea Grant and Minnesota Sea Grant are part of the National Sea Grant Program. which is funded by the National Oceanic and Atmospheric Administration.

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Each trunk includes museum-quality preserved specimens of: zebra mussels, Eurasian ruffe, purple loosestrife, Eurasian watermilfoil, and spiny waterfleas.

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- $60 for a seven-day period if shipped to you.
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If you live in the Duluth, MN, area the trunk will be FREE for loan during the 1996-97 school year. A **completed evaluation form must be returned with the trunk.**

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Fill out the tear-off request form inside this brochure. Send no money now.

WHO DEVELOPED THIS TRUNK?

The **Exotic Aquatics** Traveling Trunk project was sponsored and coordinated by Minnesota Sea Grant with funds appropriated by the 1994 Congress based on the Nonindigenous Species Act. Project partners include the University of Minnesota Bell Museum of Natural History, National Park Service, U.S Fish and Wildlife Service, National Park Foundation, and Minnesota Department of Natural Resources, which produced the trunk's video through a matching contribution.

QUESTIONS?

Call Minnesota Sea Grant at (218) 726-8712.
If you have Internet access, our homepage is at:
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ZEBRA MUSSELS, WHICH INVADED NORTH AMERICA IN 1988, HAVE CAUSED SERIOUS ECONOMIC AND ENVIRONMENTAL PROBLEMS. THEY ARE RAPIDLY SPREADING BEYOND THE GREAT LAKES REGION INTO MANY INLAND WATERWAYS.

ZEBRA MUSSEL MANIA TRAVELING TRUNK

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Each trunk includes a teacher-friendly curriculum guide with ten activities that integrate science with other subjects. Other resources used in experiments and games include: zebra mussel shells, four video programs, student worksheets, posters, shell classification, web of life ecology game, pre- and post-tests, and a teacher resource portfolio. filled with background reading.

WHERE DO I ORDER THE TRUNK?

(Choose 1 of 3 options:)

- Borrow the Zebra Mussel Mania Traveling Trunk from one of the lending centers listed in this brochure. Call a lending center near you. A user fee/deposit may be charged.
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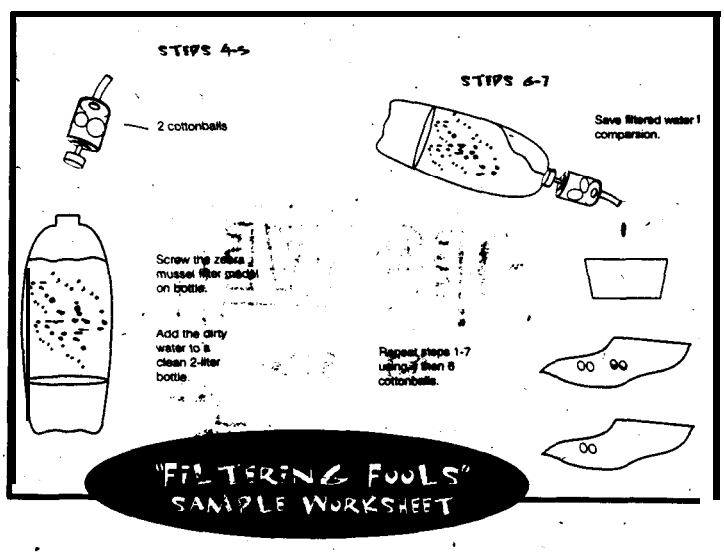
- Purchase a complete trunk, curriculum guide and resource portfolio for $360, plus $20 shipping from the address listed on the request form. Use the tear-off request form inside this brochure.

WHO DEVELOPED THIS TRUNK?

The Zebra Mussel Mania Traveling Trunk Project was sponsored and coordinated by Illinois-Indiana Sea Grant in partnership with Illinois Rivers Project with funds appropriated by the 1994 Congress based on the Nonindigenous Species Act. Fifth and sixth grade teachers created the curriculum. Technical expertise was provided by the Illinois Natural History Survey, Illinois American Water Company, Illinois Power Company, and a curriculum specialist from the Bell Museum, of Natural History..



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E-mail: _____

*If you would like to **borrow** a Zebra Mussel Mania Traveling Trunk, please contact a lending center near you; please see the list in this brochure.*

☐ Please send me information on **duplicating** the trunk.

☐ I want to **purchase** a curriculum guide ($35).

☐ I want to **purchase** a resource portfolio ($35).

Make a check payable to: *University of Illinois*
Mail to: Robin Goettel
Illinois-Indiana Sea Grant Program
University of Illinois, 65 Mumford Hall
1301 West Gregory Drive
Urbana, IL 61801
(217) 333-9448, r-goettel@uiuc.edu

☐ I would like to **purchase** ,a complete trunk.

Make a check for $380 payable to: *Illinois Rivers Project*
Mail to: Robert Williams
Illinois Rivers Project
Box 2222, SIUE
Edwardsville, IL 62026
(618) 692-3788, rivers@siue.edu

How did you hear about the traveling trunk?

_____

_____

How do you plan to use the trunk? In what kind of activities?

_____

_____

Packing List of Materials for Zebra Mussel Traveling Trunk

ITEM	#/KIT	SUPPLIER	COST/KIT
16 to 18 gallon Rubbemaid "Tote" container with lid	1	Discount Store	**$7.00**
Aluminum cookie pan	**4**	Discount Store	$4.00
Cottonballs	1 bag	Discount Store	$1.00
Cups, plastic	8	Discount Store	$0.50
Fact card master sheet for Clue Game*	1	Illinois-Indiana Sea Grant	$0.50
Fact cards for Clue Game	**4 sets**	Illinois-Indiana Sea Grant	$4.00
Food pyramid tmnsparency	1	Illinois-Indiana Sea Grant	$0.50
Funnel (use top of 2-liter bottle)		Self-supplied	—
Game places, Web of Life Game	150 blue 150 red	Illinios-Indiana Sea Grant	$3.00
Gravel, Arkrolyte	2 bags (5 lb. each)	Garden/Landscape Suppliers	$4.00
Information brochures on six exotic species	8 sets	Illinois-Indiana Sea Grant	$4.00
Life cycle chart, freshwater mussel	4	Illinois-Indiana Sea Grant	$4.00
Life cycle chart, zebra mussel	4	Illinois-Indiana Sea Grant	$4.00
Metric ruler	8	Discount Store	$4.00
Mussel **shells, assortment**	4 bags (13 ea.)	Illinois River	$16.00
Name tags for Web of Life game	33 name tags	Illinois-Indiana Sea Grant	$12.00
Nonindigenous species information cards'	4 sets of 6	Illinois-Indiana Sea Grant	**$10.00**

*** The starred materials are found** *in a pocket folder marked for each group.*

ITEM	#/KIT	SUPPLIER	COST/KIT
Posters:			
Wetlands: Water, Wildlife, Plants and People	1	Illinois-Indiana Sea Grant	$3.50
Exotic Species Poster	1	Illinois-Indiana Sea Grant	$8.00
Water: The Resource That Gets Used for Everything	1	Illinois-Indiana Sea Grant	$3.50
Groundwater: The Hidden Resource	1	Illinois-Indiana Sea Grant	$3.50
Groundwater and Land Use in the Water Cycle	1	Illinois-Indiana Sea Grant	$3.50
National Wildlife and Scenic River System	1	Illinois-Indiana Sea Grant	$3.50
The Water Cycle: Nature's Reoycling System	1	Illinois-Indiana Sea Grant	$3.50
America's Pearly Mussels	1	Illinois-Indiana Sea Grant	$3.50
Shell button set*	4	Illinois Rivers Project	$5.00
Shell Classification Game	4	Illinois-Indiana Sea Grant	$20.00
Spoons, plastic	8	Discount Store	$1.00
Video (all 3 on one tape) Mussel Menace...Zebra Mussels and You; Zebra Mussels; Help Save America's Pearly Mussels	1	Illinois-Indiana Sea Grant	$20.00
Vinyl tubing 1.4 m long, 3.5 cm diameter, with screen	4	Plumbing Supply and Hardware Store	$30.00
Zebra mussel filter model	4	Illinois Rivers Project	$5.00
Zebra mussel shells	1 bag	Illinois Rivers Project	$5.00
		Total	$194.00

The starred materials are found in a pocket folder marked for each group.

Zebra Mussel Mania Post-Test

NAME:

MATCHING

1. ____ ballast water
2. ____ byssal threads
3. ____ exotic species
4. _____ Food chain
5. ____ indigenous species
6. ____ phytoplankton
7. ____ veliger
8. ____ zooplankton

a. the organisms that are foreign, not native to a particular location

b. a zebra mussel larvae

c. the water carried in a boat or ship to give stability

d. microscopic aquatic animals eaten by larger aquatic animals

e. a tuft of filaments used to attach the mollusk to the substratum

f. the organisms that are native to a particular area

g. the microscopic plants eaten by larger aquatic animals

h. a sequence of organisms, each of which uses the next lower member of the sequence as a food source

TRUE OR FALSE

9. _____ Zebra mussels have only positive effects on freshwater mussels.

10. _____ Classification of shells is done using color, size, texture, and other methods involving the senses.

11. _____ There is no way to tell the difference between a shell button and a plastic button.

12. ____ The Great Lakes have been affected by zebra mussels.

13. ____ Zebra mussels traveled to North America in the ballast water of ships.

Zebra Mussel Mania Post-Test (cont'd)

14.____ Zebra mussels live well in water that is very salty and very cold.

15____ People are the main transporters of zebra mussels.

16.____ Zebra mussels filter up to 1 liter of water a day.

17.____ Zebra mussels help the food web of a lake.

FILL IN THE BLANK

1. It is extremely hard for small fish to eat the exotic species_____because of its sharp spines.

2. The exotic species, _____, attaches to its prey and sucks the blood and other fluids, killing the host.

3. Mussels and clams which have two shells are_____ mollusks.

4. Taking a small part or quantity of something to determine population density is called _____

5. Through _____, zebra mussels improve water clarity.

6. The variety of life in an ecosystem is called _____

SHORT ESSAY

How do zebra mussels affect the food chain?

Zebra Mussel Mania Post-Test (cont'd)

Name two negative effects of zebra mussels.

Name two exotic species and describe the problems they have created for other species.

Draw a zebra mussel.

Describe the life cycle of a zebra mussel.

Name two ways that zebra mussels spread.

What are barriers to the spread of zebra mussels?

Zebra Mussel Mania Post-Test Teacher's Key

NAME:

MATCHING

1. C ballast water
2. E byssal threads
3. A exotic species
4. H food chain
5. F indigenous species
6. G phytoplankton
7. B veliger
8. D zooplankton

a. the organisms that are foreign, not native to a particular location

b. a zebra mussel larvae

c. the water carried in a boat or ship to give stability

d. microscopic aquatic animals eaten by larger aquatic animals

e. a tuft of filaments used to attach the mollusk to the substratum

f. the organisms that are native to a particular area

g. the microscopic plants eaten by larger aquatic animals

h. a sequence of organisms, each of which uses the next lower member of the sequence as a food source

TRUE OR FALSE

9. F Zebra mussels have only positive effects on freshwater mussels.
10. T Classification of shells is done using color, size, texture, and other methods involving the senses.
11. F There is no way to tell the difference between a shell button and a plastic button.
12. T The Great Lakes have been affected by zebra mussels.
13. T Zebra mussels traveled to North America in the ballast water of ships.

Zebra Mussel Mania Post-Test Teacher's Key

14. F Zebra mussels live well in water that is very salty and very cold.

15. T People are the main transporters of zebra mussels.

16. T Zebra mussels filter up to 1 liter of water a day

17. F Zebra mussels help the food web of a lake.

FILL IN THE BLANK

1. **It is** extremely hard for small fish to eat the exotic species SPINY WATER FLEA because of its sharp spines.

2. The exotic species, SEA LAMPREY, attaches to its prey and sucks the blood and other fluids, killing the host.

3. Mussels and clams which have two shells are BIVALVE mollusks.

4. Taking a small part or quantity of something to determine population density is called SAMPLING.

5. Through FILTERING, zebra mussels improve water clarity.

6. **The variety of life in an ecosystem is called BIODIVERSITY.**

SHORT ESSAY

How do zebra mussels affect the food chain?

Zebra mussels compete with other aquatic organisms for food in rivers, lakes, and streams. Because there are so many zebra mussels competing for food with other animals at their level in the food web, less food is available for other animals. These other animals can die for lack of food.

Zebra Mussel Mania Post-Test Teacher's Key

Name two negative effects of zebra mussels.

Zebra mussels clog intake pipes at water treatment and plants, causing great expense for removal and cleanup. They can also clog and damage the engines on boats. Zebra mussels may reduce populations or even eliminate native mussels from rivers and lakes by competing with native mussels for food, space, and oxygen.

Name two exotic species and describe the problems they have created for other species.

The ruffe is a fish that can lay as many as 90,000 eggs a year. It has sharp spines so that larger fish cannot eat it. Ruffe has destroyed some species of fish in an area because their large numbers eat the food other species need.
The sea lamprey is a parasite that causes the death of many fish. It attaches to a fish and sucks blood and other body fluids until the fish dies.

Draw a zebra mussel.

Describe the life cycle of a zebra mussel.

Zebra mussels start life as an egg. They develop into a larval, or veliger stage. They have hair-like clumps called cilia that help them stay suspended in water and "swim." They attach to a hard surface where they grow to the post-veliger stage. During this stage, they develop a long foot that secretes byssal threads, which is how they attach to surfaces At this stage, they transform into a juvenile form. They look like an adult but are smaller. They grow to an adult stage within one year.

Name two ways that zebra mussels spread.

They attach to boats. The juvenile form is free floating and can be carried in water currents. Zebra mussels can attach to animals or birds such as diving ducks which move from one location to another.

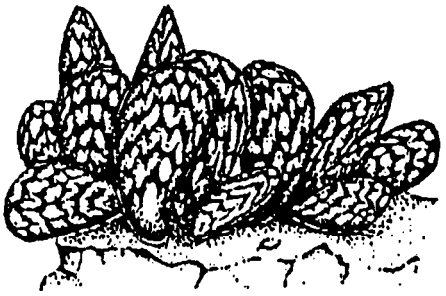
What are barriers to the spread of zebra mussels?

Chlorine has been used to control zebra mussels. Boaters should clean their boats with hot water before leaving an area. This will help prevent further spread of zebra mussels.

Zebra Mussel Mania Post-Test

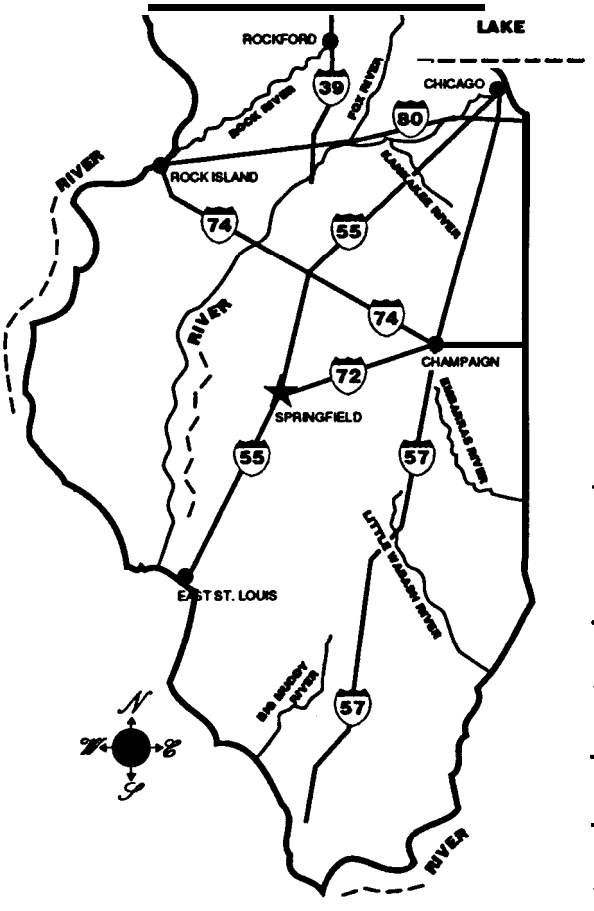
All About Zebra Mussels

What is a zebra mussel?



The zebra mussel is a bottom-dwelling invertebrate* native★ to Europe. Its name comes from the stripe pattern on its shell. These mussels are invading Illinois waters. Even though they are less than two inches in size, they can live up to five years and will attach to almost any hard surface. Can you name the four areas below where they are found?

Why are *biologists* concerned *about* the invasion of zebra mussels?



Where large populations of zebra mussels become established they can impact fish spawning habitat and possibly decrease the numbers of some fish. They may also threaten a variety of water users. Fill in the numbered spaces with the correct letter to discover the Illinois water users that could be affected by these exotic* invertebrates.

Look up the meaning of the words with a ★ after them in a dictionary.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	2	3	4	5	8	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	23	23	24	25	28

2	15	1	20	5	18	19
-	-	-	-	-	-	-
19	23	9	13	13	5	18	19

1	14	7	12	5	18	19
-	-	-	-	-	-	-	-	-	-
9	14	4	21	19	20	18	9	5	19

12	15	3	1	12		23	1	20	5	18		19	21	16	16	12	9	5	18	19					

3	21	12	20	21	la	5	4		18	5		1	18	12		9	14	4	21	19	20	18	25		
-	-	-	-	-	-	-	-	-	-	-	-	-	m	m											
14	1	20	9	22	5		13	21	19	19	5	1	2		19										

Answers: LAKE MICHIGAN, MISSISSIPPI RIVER, ILLINOIS RIVER, OHIO RIVER – BOATERS, SWIMMERS, ANGLERS, INDUSTRIES, LOCAL WATER SUPPLIERS, CULTURED PEARL INDUSTRY, NATIVE MUSSELS.

This brochure has been furnished by the Illinois Department of Natural Resources.

More Zebra Mussel Fun

Mussel Multiplication

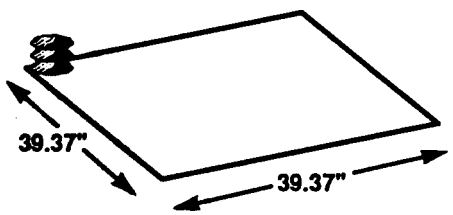
A female zebra mussel produces 40,000 eggs a year. If 1% of the young survive, the mussels live only one year and 50% are females, how many zebra mussels would there be in 3 years?

	# FEMALES	YOUNG PRODUCED	SURVIVED
YEAR ONE	1	**40,000**	**400**
YEAR TWO	**200**	_____	_____
YEAR THREE	_____	_____	_____

Challenge yourself! Can you calculate the population growth to year five?

More Mussel Math

If a zebra mussel is 1 inch long and I/2 inch wide, how many could lay side-by-side on a square meter (39.37" x 39.37")? Round your answer to the nearest hundred. _____



Colonies of zebra mussels have been found denser than 100,000/ square meter. Given the number you found could fit in a square meter, how many layers of mussels would it take to have a density of 100,000/square meter?

100,000/ _____ = _____

Mussel Meals

Zebra mussels are filter feeders. They feed on the microscopic plants and animals called plankton*. Large populations of zebra mussels can act as mini-sewage treatment plants and clean the water, sometimes too much.

0 Predatory fish like walleye and sauger ambush their prey. Will these fish feed more or less often in clear water?

❷ What affect would a decrease in the number of phytoplankton have on the food chain?

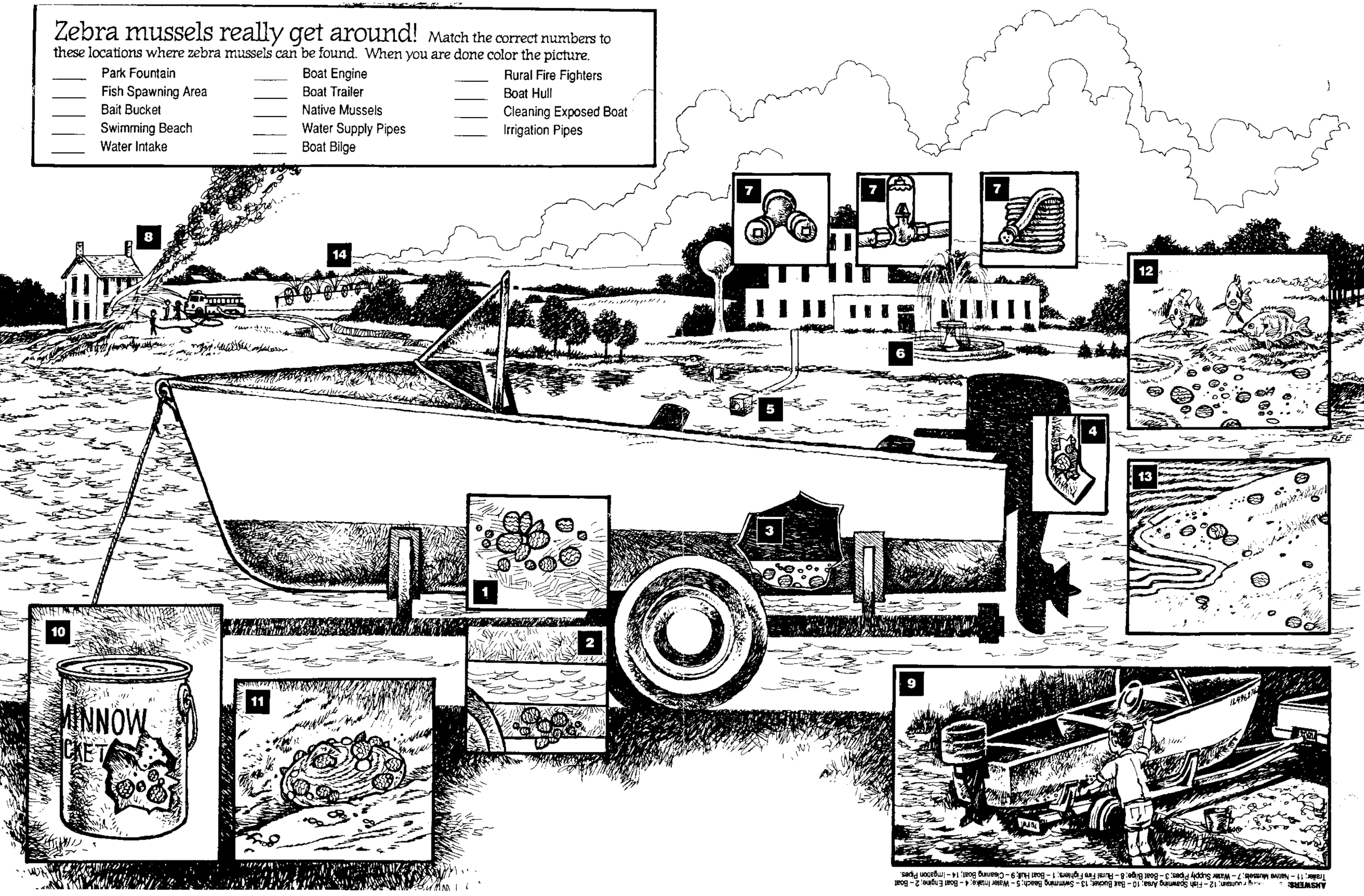
❸ Rooted aquatic plants benefit from the removal of phytoplankton by the associated increase in light penetration*. These plants also benefit from the increased waste products produced by zebra mussels. What are some positive benefits of increased rooted aquatic plants? Are there any drawbacks?

ANSWERS: *Mussel Multiplication* – Year Two: 8,000,000 Produced; 80,000 Survived. Year Three: 40,000 # Females; 1,600,000,000 Produced; 16,000,000 Survived. *More Mussel Math*: 3,100 side by side in a square meter; 32 layers.

Zebra mussels really get around!

Match the correct numbers to these locations where zebra mussels can be found. When you are done color the picture.

____ Park Fountain
____ Fish Spawning Area
____ Bait Bucket
____ Swimming Beach
____ Water Intake
____ Boat Engine
____ Boat Trailer
____ Native Mussels
____ Water Supply Pipes
____ Boat Bilge
____ Rural Fire Fighters
____ Boat Hull
____ Cleaning Exposed Boat
____ Irrigation Pipes



ANSWERS: Park Fountain: 12 – Fish Spawning Area; 10 – Bait Bucket; 13 – Swimming Beach; 5 – Water Intake; 4 – Boat Engine; 2 – Boat Trailer; 11 – Native Mussels; 7 – Water Supply Pipes; 3 – Boat Bilge; 8 – Rural Fire Fighters; 1 – Boat Hull; 9 – Cleaning Boat; 14 – Irrigation Pipes.