Inland Seas Education Association Schoolship Teacher's Guide 2001

Protecting the Great Lakes Through Education

The Inland Seas Education Association was formed in 1989 by sailors, educators, and scientists to promote the study and conservation of the Great Lakes. Our primary goal is to directly involve students with the Great Lakes so that they will become good stewards of our natural resources in the future. The Inland Seas Education Association is a nonprofit, tax exempt Michigan corporation.

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Cost: $10.00

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The Schoolship Program

The mission of the Schoolship Program is two-fold: (1) to inspire young people to pursue academic interests related to the Great Lakes, particularly the sciences; and, (2) provide enhanced public understanding and stewardship of the Great Lakes.

Young people on the Schoolship become excited about science through their active participation in the program, such as: observing cloud types, measuring dissolved oxygen levels, comparing fish caught in the trawl, identifying zooplankton, classifying benthic organisms, and calculating latitude and longitude of the boat's position. Through this active participation they begin to *construct* their own understanding of the Great Lakes ecosystem.

From this understanding, and through the power of sail, we hope to inspire young people. If they are inspired and develop a sense of commitment towards the Great Lakes, then they will more likely become stewards of this international resource.

A one-day experience, however powerful and meaningful, could be made more effective if young people develop intellectual moorings upon which to secure the new experiences and understandings gained from the Schoolship program. Therefore, we have developed a series of hands-on activities that build important concepts like: food web, watershed, and exotic species.

Schoolship Schedule

The following is a typical half-day Schoolship program. If the length of this schedule appears to be inappropriate for the circumstances of any given school or group of schools, a request for an adjusted schedule should be made through the ISEA office one month in advance of the scheduled trip.

If your group is inadvertently delayed on the day of the trip, please notify the ISEA office (231-271-3077).

Arrival Times: Morning groups arrive at 8:30 A.M. Morning sessions leave the dock at 9:00 A.M. and return at 12:30 P.M. Afternoon groups should arrive at 1:15 P.M. for a 1:45 P.M. departure. Afternoon groups return to the dock at 5:15 P.M.

A. Assemble & Welcome (20 minutes)

1. Introduce instructors
2. Form small groups and choose group names
3. Discuss science log books
4. Sign the manifest (only if not filled out in advance)
5. Review of safety rules by the captain

B. Board vessel and cast off (10 minutes)

1. Additional vessel orientation
2. Explanation of activities of the day

C. Sampling and Measurements (45 minutes, for all activities)

Fish Collection (Large Group)

With the ship under power, the trawl is prepared for fish sampling. Students help launch the trawl over the side. During the trawl, the lead instructor may talk about history, life aboard ships, watersheds or glacial geology. Ten minutes later the ship stops while students haul in the net. The captured fish are placed in an aquarium for later identification at the Fish Station. The ship proceeds to the Sampling Station in Grand Traverse Bay or Suttons Bay. Weather observations and measurements begin underway.

Weather (Small Groups)

Students determine wind direction and velocity, identify cloud types and percent cloud cover, measure air temperature, read barometric pressure, note wave height, and estimate visibility. These data are sent to the National Weather Service by the Captain. Students measure water transparency with a Secchi disk. Factors affecting water transparency are discussed. Surface water temperature is also measured.

Limnology Sample Collection (Large Group)

Water Chemistry. An instructor and students collect water samples from the bottom using an Alpha bottle.

The temperature, pH, and dissolved oxygen are determined for the sample. The instructor explains how to run the tests, and the significance of the results. Dissolved oxygen, pH, and temperature results are discussed. **NOTE:** On some trips the pH and D.O. analysis will be done in a small group learning station.

Plankton. A student lowers the plankton net to the bottom and raises it vertically to collect zooplankton. Samples are set aside for later examination.

Sediment and Benthos. Samples of the lake bottom are taken with a Petite Ponar dredge. A core sample may also be gathered using a two-inch gravity core. Samples are set aside for later examination.

D. Hoisting Anchor, Sail Raising (30 minutes) (Large Group)

Students work together to raise the anchor. Students line up at the halyards to raise sails. Teamwork and cooperation are taught as sails go up. A hauling chantey adds fun to the job.

E. Quiet Time (3 minutes) (Large Group)

Students pause to listen to the sounds of lake and boat.

F. Learning Stations (Each learning station requires 12-15 minutes in rotation) (Small Groups)

Sediments and Benthos. The students examine sediments, and link historical changes in the watershed to materials in the sample (like sawdust from lumbering and sand from urbanization). The sample is washed through a screen and bottom fauna are recovered. Benthos are examined with a hand lens. The importance of benthos in the food web and life cycles of aquatic insects, worms, mussels, and crustacea are studied. A key is used to identify benthic animals. Aquatic rooted plants and the animals living on the plants are also identified and discussed. Students and instructor record types or number of organisms in the Ponar sample.

Fish and Fisheries. Fish from the trawl are observed in a tank. A key is used to identify fish species. Species and numbers are recorded on the data sheets. Students are led in a discussion of fish anatomy, sensory perception, respiration, habitat requirements, feeding adaptations, ecological relationships, and management problems. Invading exotic species (zebra mussels, sea lamprey, alewife) are discussed. Fish are returned live to the lake after the sessions.

Sailing and Seamanship. Students assist the captain and crew with steering the vessel and routine jobs around the ship. Students will learn to tie knots or coil lines, and will learn how the sails and lines control and power the ship. Students taken turn steering the ship. The concepts of buoyancy and Bernoulli's law are discussed.

Navigation. Students locate their position on a chart and identify key locations, shipping routes, and major routes out of the Lakes. They practice using a compass, GPS, plotting courses and bearings, and identifying aids to navigation.

Plankton. Contents of the plankton net are examined with a video microscope. A discussion follows on plant and animal plankton, ecological relationships, life histories, seasonal changes, and pollution effects. Students identify major types of zooplankton with a key. A videotape is made of the plankton for later use by the classroom teacher. Students record the types of zooplankton seen.

G. Schoolship Review: (Large Group) (10 minutes)

The Lead Instructor leaads students through a review of the days learning activities. Any gaps in the students’ science logs are filled in.

H. Great Lakes Songfest (optional)

A musician on board (if available) leads students in singing sea chanties and Great Lakes songs as the schooner heads back to the dock.

I. Docking and Disembarking

As the group disembarks, teachers are given an evaluation form and a package of post-trip activities for classroom use, including a student post-trip survey. The evaluation form and student surveys are used by ISEA to improve the program.

Cancellation Policy

If notice is given of a trip cancellation 45 days or more prior to your sailing date, we will refund your deposit. If cancellation falls within 45 days of your sailing date, refunds will be made **only** if we can arrange for another class to take your place.

Adverse Weather

We will contact you the day before your sail if adverse weather is threatening. The ship's captain has the ultimate authority in determining if we will sail. Sessions will be cancelled in the event of high winds, thick fog, or lightning; however, rain and cold will not deter us.

Occasionally, there are borderline situations where the following alternatives are offered just prior to program time. If the weather is uncertain we may:

? cancel the program and reschedule for an alternative date;
? cancel the program and refund your entire balance if rescheduling is not possible; or,
? conduct a dockside program onboard with all educational activities, except trawling and going under sail.
If the weather clears, we will cast off immediately and finish the program underway.

If bad weather threatens a program in progress, we will return to the dock and finish the program dockside. Please realize that the value of the program rests with the educational experience and not the boat ride. We will do everything possible to work around bad weather.

Getting to Your Ship's Dock (*Inland Seas*)

Your ship may be the *Inland Seas* or the *Manitou.* Some of you may even have classes on different ships. Please double check all your information--dates, arrival, and departure times, directions, and parking. Also, please go over this information with other relevant program participants, especially drivers!

The *Inland Seas* Departs From Suttons Bay

Classes sailing on *Inland Seas* will depart from the new *Inland Seas* dock located at the end of the "Old Coal Dock Area" on Suttons Bay (see map, page 5). The dock is located behind the Millside Building, just off of M22 in Suttons Bay.

Directions to the Inland Seas Dock

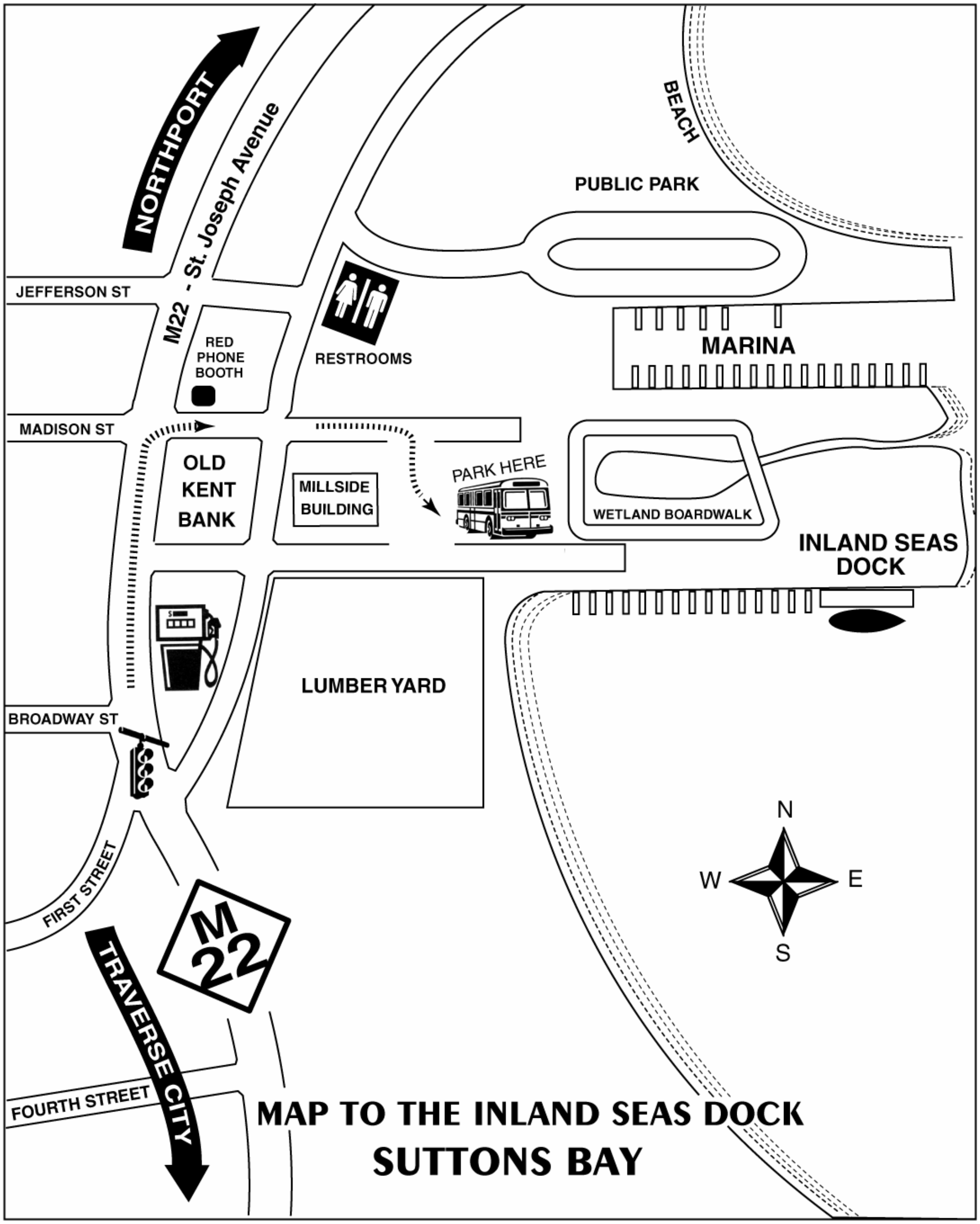
From Traverse City, take M22 north 15 miles to Suttons Bay. M22 is called St. Joseph Ave. in Suttons Bay. Just after the blinking light at Broadway, turn right onto Madison Street. Turn right again, into the parking lot behind the Millside Building. Park at the back of the lot, in the parking spaces adjacent to the wetland boardwalk (look for the "ISEA Parking" sign).

A Note About Bathroom Facilities

We recommend that you stop for a restroom break before departing on the Schoolship. Public restrooms in Suttons Bay are located at the entrance to the Marina, north of the Millside Building parking lot. Since it is quite a long way to walk, we recommend stopping with the bus or cars in front of the restroom, allowing students to disembark, use the bathroom, and then reload and proceed to the parking area. Please allow time in your schedule to accommodate a bathroom break.

Boarding Procedure

You will be met by an ISEA representative upon your arrival in the parking area adjacent to the wetlands board walk. The ISEA representative will escort your students to the dock.


NORTHPORT
M22 - St. Joseph Avenue
BEACH
PUBLIC PARK
JEFFERSON ST
RED
PHONE
BOOTH
RESTROOMS
MARINA
MADISON ST
OLD
KENT
BANK
MILLSIDE
BUILDING
PARK HERE
WETLAND BOARDWALK
INLAND SEAS
DOCK
LUMBER YARD
BROADWAY ST
N
W
E
S
FIRST STREET
M
22
TRAVERSE CITY
FOURTH STREET
MAP TO THE INLAND SEAS DOCK
SUTTONS BAY

Getting to Your Ship's Dock (*Manitou*)

The *Manitou* Departs from Traverse City

Classes sailing on the *Manitou* will depart from the dock across M22 from the Traverse Tall Ships Company office (see map, page 7). Upon your arrival at the Traverse Tall Ship Company you will receive directions on how and where to drop the students off at the dock.

Directions to the Traverse Tall Ship Company

The Tall Ship Company is located in Traverse City on M 22, approximately 1/2 mile north of the intersection of M 72 and M 22. It sits on the left side, set back from M 22. **Please note that you will be using your own transportation to move students from the Traverse Tall Ship Company office to the dock**. Do not drop the students off at the office or at the dock. Wait for an Inland Seas representative to give you directions on student drop-off procedures.

A Note About Bathroom Facilities

Bathroom facilities are available at the Traverse Tall Ship Company. Although bathroom facilities are available aboard ship, we encourage students to use bathroom facilities dockside and be accompanied by chaperons. Please supervise your students so the bathrooms are left in a clean and orderly condition.

Boarding Procedures

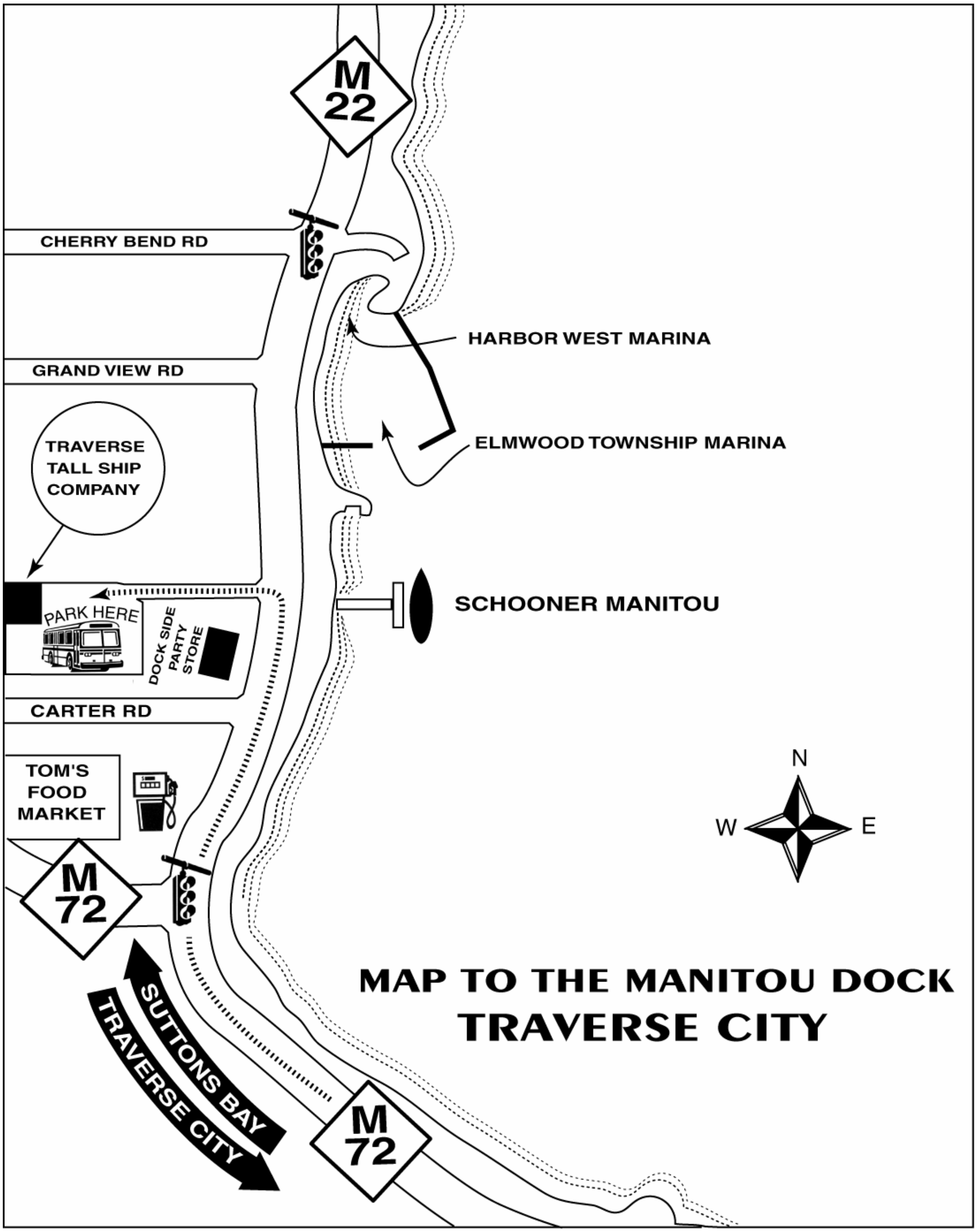
You will be met by an ISEA representative upon your arrival at the Tall Ships Company.
The ISEA representative will direct your driver(s) to the dock parking area.

Expected Behavior

There are local businesses and residents in the area where your students will arrive for their trip on the Schoolship. **Students are not permitted to shop in the stores adjacent to the Traverse Tall Ship Company**. Please ensure that your students behave accordingly (maintaining a reasonable noise level, polite conversation with residents and employees, and keeping bathrooms clean and litter free). We appreciate your help encouraging respectful behavior by students.

Special Notice

Schools that come with two groups on one bus: one group sailing on the *Manitou* in Traverse City, and the other group sailing on the *Inland Seas* in Suttons Bay. The driving time between the Traverse Tall Ship Company and the *Inland Seas* dock is about 25 minutes. <u>If you plan to drop one group in Traverse City and drive north to Suttons Bay with another group, plan to arrive at the Traverse Tall Ship Company by 8:00 A.M.</u>


M
22
CHERRY BEND RD
GRAND VIEW RD
HARBOR WEST MARINA
ELMWOOD TOWNSHIP MARINA
TRAVERSE
TALL SHIP
COMPANY
PARK HERE
DOCK SIDE
PARTY
STORE
SCHOONER MANITOU
CARTER RD
TOM'S
FOOD
MARKET
N
W
E
M
72
SUTTONS BAY
TRAVERSE CITY
M
72
MAP TO THE MANITOU DOCK
TRAVERSE CITY

Preparing Your Class

___ 1. Copy the student information sheet for each student.

___ 2. Review the student information sheet with your class, along with your expectations of students for the trip.

___ 3. Advise your students that the Schoolship sails despite rain and cold. If the temperature is 50 to 70 F on shore, then winter jackets and wool hats will almost certainly be needed on the ship.

___ 4. Ensure that a copy of the student information sheet goes home to every students' parents. You may have in place a process for parents to acknowledge that they have received and understood the information.

Note: It is extremely important that students understand the guidelines for this trip--especially in areas of behavior and proper clothing. Taking time to orient students and to set expectations can make the difference between an uncomfortable and difficult experience, and a positive and memorable one.

___ 5. Copy the student log books. You will find the directions on page ______. The students will be using these log books for learning on the ship. Please supply pencils for students.
___ 6. Review the daily schedule with students so they will know what to expect.
___ 7. Have students watch the Pre-Boarding Safety Instructional Video. **Return this video on the day of your sail.**
___ 8. Prepare and present pre-trip lessons.
___ 9. Make name tags for your students, teachers, and chaperons.
___ 10. Check arrival and departure times. Ensure that all drivers and trip organizers are aware of these times.
___ 11. Copy the enclosed map with directions to your designated parking area, and distribute them to drivers. Distribute any other maps and directions.
___ 12. Divide your class into five study groups. Each group will be assigned to a Schoolship instructor when you arrive.
___ 13. Complete the Schoolship Manifest form. Please bring it with you on the sailing day.
___ 14. Mail your Schoolship balance due to the ISEA office so it arrives 10 days prior to the date of your sail. A return envelope has been enclosed for your convenience. Please send your payment in the envelope. This helps us identify from where the money came. Do not bring payment with you to the ship.
___ 15. Suggestion: Have each student come with at least one question he/she would like answered about the Great Lakes—we will try to answer these questions.

Chaperons

Adult guests are expected to stay in their assigned groups and participate with students in shipboard activities. They are to assist the volunteer instructors in maintaining discipline and safety during shipboard activities. To maximize learning opportunities, however, chaperons should not answer questions posed to students. Please inform chaperons about the need to dress for the weather.

The Tradition of Keeping a Log Book

Inland Seas Education Association

Student Information Sheet

Safety is our primary concern. Vessels used are licensed and inspected by the U.S. Coast Guard and are sailed by licensed captains and professional crews. Our classes are led by experienced instructors. The following list of general guidelines will enable you to have an enjoyable and enriching Schoolship experience.

INCLEMENT WEATHER

Weather in northern Michigan can vary considerably. Our activities are conducted in a wide range of weather conditions. Dressing to meet those conditions will help you remain comfortable during your trip.

CLOTHING

It is almost always cooler on the water than on land. Layers of clothing will allow you to adjust to the daily temperature changes. "There is no such thing as bad weather, only bad clothing." Each student should bring rain gear, a heavy sweater, hat, and gloves. NO SHORTS. It is better to bring too many clothes than to be cold because you did not bring enough warm clothes. Pack your extra clothing in a soft duffle-type bag. There will be storage below deck for them.

SAFETY

Safety is our most important concern. Please listen to the captain and crew and obey their instructions (at times it will be necessary to be silent so that the captain and crew can communicate). Students will watch a safety orientation video prior to their trip.

MARINE TOILETS

The vessels are equipped with marine toilets (also called heads). Directions for their use are printed on a card on the bulkhead (wall). Waste is collected in a holding tank for later disposal ashore. If you have any questions concerning the operation of the head, please ask an instructor or crew member.

EMERGENCY MESSAGES

Inland Seas and *Manitou* are equipped with marine VHF radios and cellular telephone for communications. The ISEA office can be contacted at (231) 271-3077 and they will relay the message to *Inland Seas* or *Manitou.*

Sailors

Keeping a sailing log has been a tradition passed on from the early sailors who ventured to sea. Their records of weather, sea, position, and important events have left us a wealth of information about their adventures, as well as a means of reliving them.

Scientists

The scientist's journal is a tool that allows scientists to record observations and data that will not only serve as a record, but also provide a base of information to later analyze and investigate.

Students

Aboard the Schoolship, we ask each student to record his or her observations and data in a log book. These log books should go home with students. They become a souvenir of the trip as well as a chronicle of all that the student has learned. Information from the student log books is transferred to a school log sheet that returns to the school with the teacher. The observations and data will be placed on our interactive database that can be accessed by students via the Schoolship Web site (www.schoolship.org); this arrangement enables a continuing scientific record of Grand Traverse Bay.

Directions for Making Student Log Books

(refer to the completed log book, without cover, that was sent with this manual)

1. Copy back-to-back the log book pages that were sent with the pre-trip mailing. (Sample on pages 18-19.)

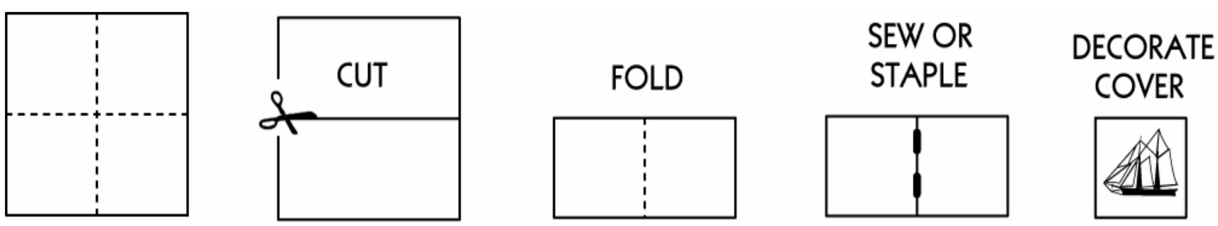
2. Cut the page in half. (You may also add a blank page for student observations.)

3. Take a page of construction paper or cardstock and cut this in half. This will make two covers.

4. Fold each half page and arrange so that it follows: cover, student log sheets, cover.

5. Fold in half and staple or sew down the middle.

6. Decorate cover. Students should put their names on their log.



Remember to have students bring a pencil or pen with them!

Geography/Navigation Station

Time of position fix ____________________

Latitude ____________ Longitude ____________

Depth ____________ Distance Log ____________

Compass Course ____________________

Variation ________ degrees W

True Course ____________________

Instruments Used:

____________________(Lat./Long.)
____________________(Depth)
____________________(Course)
____________________(Plotting Positions)

Notes:

THE GREAT LAKES SCHOOLSHIP
INLAND SEAS EDUCATION ASSOCIATION

Protecting The Great Lakes Through Education

Schoolship Student Log

Student name ____________________

School name ____________________

Date ____________________

Group Name ____________________

Schoolship Instructor's Name: ____________________

ISEA Web site address: www.schoolship.org

Sediment/Benthos Station

Ponar Sample:____________________

Sediment sample description:
Color ____________________
____
Texture ____________________
____

Animals Present	Number
____________	______
____________	______
____________	______
____________	______
____________	______

Trawl Sample:
Plants present ____________________
____
Animals present
____
____
____
____

Notes:

Weather Station

Air Temperature ________ °C ________ °F
Barometric pressure ________ trend ______(R/F/S)
Wind Direction ____________
Wind Speed ____________ (mph)
Wave Height ____________ (ft.)
Cloud Type(s) ____________________
____

Percent Cloud Cover ________ %
Visibility ____________ (st. miles)
Precipitation ____________
(rain, snow, mixed, hail, none)

Instruments used:

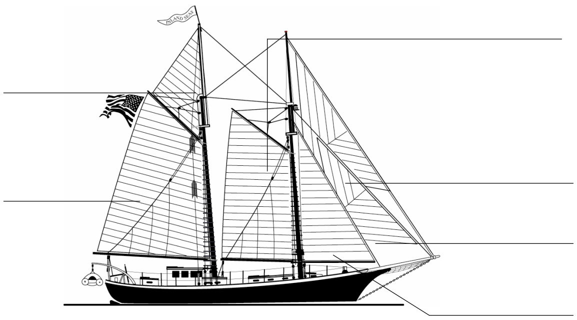
____________________(Temperature)
____________________(Barometric Pressure)
____________________(Wind Speed)
____________________ (Wind Direction)

Notes:

(Record surface water temperature and Secchi Disk on next page)

Seamanship Station

Name the sails and shade in the sails set today



Name of vessel ____________________________________

Home Port ______________________________________

Length __________ Beam ___________ Draft __________

Total sail area: __________________________________

No. of crew _____ Captain ________________________

When Built _______ Displacement __________________

Material ____

Main Sheet Mechanical Advantage:

Fish Station

Gear Used ___________________________________

Start Time __________ End Time ___________

Start Depth __________ End Depth ___________

Elapsed Time _______ Day Shape ___________

Fish Identification

Species	#	Characteristics

Notes/Sketches:

Water Sampling Station

Time _____________

Latitude ______________ Longitude ________________

Station Depth ______________________(ft.)

Surface Water Temperature __________°C ___________°F

Secchi disk transparency depth ____________(m)

Water Sample

Collection Device _________________________________

Sample Depth _______(ft. or m) Temp. _______°C _______°F

pH __________ Dissolved Oxygen ___________ mg/L

Vertical Plankton Tow

Mesh size __________ microns Net dia. ___________ (in.)

Volume of water filtered ____________________ (gallons)

(? r^2 x depth) (convert all units in feet; X 7.49 gallons/cubic ft.)

Sediment/Benthos Sample

Instrument used ________________________________

Notes:

Plankton Station

Magnification _________

Plankton Identification

Rankings (List in order of relative abundance)

A = abundant, C = common, R = rare

Species	Rank

Notes:

Schoolship Instructional Objectives and Related State Content Benchmarks

The Schoolship instructional program is based upon our mission to preserve and improve the quality of the Great Lakes ecosystem. In developing these objectives, we have attempted to reinforce some of the science objectives of the *Michigan Curriculum Framework (K-12).*

The Schoolship program offers an experiential education approach to learning that encourages the generation of authentic questions about the world and the experience promotes an awareness and sensitivity of the natural world, particularly the Great Lakes.

To further prepare you and your class for the Schoolship experience, we are listing our objectives for each of the learning stations included in our program along with related Michigan Content Benchmarks.

Weather Objectives
The students will make observations and record:

air temperature
barometric pressure
cloud cover and cloud type
precipitation
visibility
wave height
wind direction
wind speed

Related State Content Benchmarks
?? Use simple measurement devices to make metric measurements. (ES)
?? Use measurement devices to provide consistency in an investigation. (ES)
?? Describe the atmosphere. (ES)
?? Describe weather conditions and climates. (ES)
?? Describe patterns of changing weather and how they are measured. (MS)
?? Explain the water cycle and its relationship to weather patterns. (MS)
?? Explain and predict general weather patterns and storms. (HS)
?? Perform measurements and calculations to describe the speed and direction of an object. (HS)

Water Chemistry Objectives
The students will observe, assist in measurements, and record:

surface and bottom water temperature
water transparency
dissolved oxygen level
pH level

Students will also help sample:
?? plankton using the plankton net; and,
?? Sediment/benthos using the Ponar dredge.

Related State Content Benchmarks

?? Describe the basic requirements for all living things to maintain their existence. (ES)
?? Describe positive and negative effects of humans on the environment. (ES)
?? Measure weight, dimensions, and temperature of appropriate objects and materials. (ES)
?? Write and follow procedures in the form of step-by-step instructions, recipes, formulas, flow diagrams, and sketches. (MS)
?? Describe ways in which humans alter the environment. (MS)
?? Describe the origins of pollution in the hydrosphere. (MS)
?? Measure physical properties of objects or substances (mass, weight, temperature, dimensions, area, and volume) (MS)
?? Explain the effects of agriculture and other human activities on selected ecosystems. (HS)
?? Describe how human activities affect the quality of water in the hydrosphere. (HS)

Sediment/Benthos Objectives
The students will be able to:

?? classify sediments in terms of color, texture, and content;
?? describe key habitat conditions found at a depth of 80 feet in terms of light, temperature, food supply, predators, and dissolved oxygen;
?? identify and count benthos from the Ponar dredge samples and record in the log;
?? identify benthos found in the plant and bottom material from the fish trawl;
?? explain the origin of wood chips found in the sediment;
?? name one important difference between the deep water habitat (Ponar sample) and the shallow water habitat (fish trawl sample); and,
?? Recognize benthos as important food for fish and as “recyclers” of organic material.

Related State Content Benchmarks
?? Compare and classify familiar organisms on the basis of observable physical characteristics. (ES)
?? Describe life cycles of familiar organisms. (ES)
?? Compare and contrast food, energy, and environmental needs of selected organisms. (ES)
?? Explain how physical and behavioral characteristics of organisms help them to survive in their environments. (ES)
?? Identify familiar organisms as part of a food chain or food web and describe their feeding relationships within the web. (ES)
?? Explain common patterns of interdependence and interrelationships of living things. (ES)
?? Describe the basic requirements for all living things to maintain their existence. (ES)
?? Compare and classify organisms into major groups on the basis of their structure. (MS)
?? Describe common patterns of relationships among populations. (MS)
?? Predict the effects of changes in one population in a food web on other populations. (MS)
?? Describe how all organisms in an ecosystem acquire energy directly or indirectly from sunlight. (MS)
?? Identify some common materials that cycle through the environment. (MS)
?? Describe common ecological relationships among species. (HS)
?? Explain how energy flows through familiar ecosystems. (HS)
?? Describe general factors regulating population size in ecosystems. (HS)

Plankton Objectives
The students will be able to:

?? define phytoplankton as floating plants and zooplankton as suspended animals;
?? identify plankton as the basis of the aquatic food chain;
?? describe the trophic (feeding) relationships among phytoplankton, zooplankton, and fish; and ,
?? Identify zooplankton seen on the video monitor and record their findings in log books.

Related State Content Benchmarks
?? Same objectives as the sediment/benthos section above.

Fish Objectives
The students will be able to:

?? name the parts of a fish's anatomy with the aid of a diagram;
?? use the fish key to correctly identify fish caught in the trawl;
?? recognize the place of these fish in the food web;
?? identify existing threats to fish populations and their habitats in the Great Lakes (exotic species, persistent toxins, habitat destruction, and overfishing);
?? discuss the contribution of fish and fishing to the economy of the region; and,
?? give reasons for sampling and monitoring Great Lakes fish populations and for keeping scientific log books.

Related State Content Benchmarks
?? Compare and classify familiar organisms on the basis of observable physical characteristics. (ES)
?? Describe vertebrates in terms of observable body parts and characteristics. (ES)
?? Compare and contrast food, energy, and environmental needs of selected organisms. (ES)
?? Identify familiar organisms as part of a food chain or food web and describe their feeding relationships within the web. (ES)
?? Describe positive and negative effects of humans on the environment. (ES)
?? Compare and classify major groups on the basis of their structure. (MS)
?? Describe common patterns of relationships among populations. (MS)
?? Predict the effects of changes in one population in a food web on other populations. (MS)
?? Describe ways in which humans alter the environment. (MS)
?? Describe common ecological relationships among species. (HS)
?? Explain how energy flows through familiar ecosystems. (HS)
?? Describe general factors regulating population size in ecosystems. (HS)
?? Explain the effects of agriculture and other human activities on selected ecosystems. (HS)

Navigation Objectives
The students will be able to:

?? locate the Great Lakes and other major bodies of fresh water on a globe;
?? locate visible landmarks on shore and on a chart;
?? identify latitude and longitude;
?? understand the function of a compass and causes of variation and deviation; and,
?? "fix" a position on the chart using the GPS or visual bearings.

Related State Content Benchmarks
?Describe and identify surface features using maps. (MS)
?Describe how rainwater in Michigan reaches the oceans. (MS)

Seamanship Station Objectives

Students will be able to:

?? understand how the sails propel the ship (Bernoulli's Law);
?? understand how the wheel and rudder steer the ship, and the purpose of the keel (ballast counters heeling force of the sails; limits leeway);
?? steer the ship and respond correctly to steering commands from the Captain;
?? understand the basic operation of the ship's compass;
?? understand the concept of buoyancy; and,
?? Understand the concept of mechanical advantage as demonstrated by the main sheet.

Related State Content Benchmarks

?? Describe forces exerted by magnets, electrically charged objects, and gravity. (MS)
?? Use simple machines to make work easier. (ES)
?? Relate changes in speed or direction to unbalanced forces in two dimensions. (MS)
?? Relate changes in speed or direction to unbalanced forces in two dimensions. (MS)
?? Design strategies for moving objects by means of the application of forces, including the use of simple machines. (MS)
?? Perform measurements and calculations to describe the speed and direction of an object. (HS)
?? Analyze the operation of machines in terms of force and motion. (HS)

Social Studies

The following social studies benchmarks also relate closely with the Schoolship Instructional Objectives.

?? Describe how people use the environment to meet human needs and wants.
?? Suggest ways that people can help to improve their environment.
?? Describe the ways in which the environment has been changed by people, and the way in which their lives are affected by the environment.
?? Explain basic ecosystem concepts and processes.
?? Describe the major physical patterns, ecosystems, resources, and land uses of the state and region, and explain the processes that created them.
?? Explain how humans modify the environment and describe some of the possible consequences of those modifications.

Schoolship Student Evaluation Results
Inland Seas' Spring and Fall Programs, 2000

There were a total of 2,939 students from 101 classes who participated in the spring Schoolship season. The sample for this assessment included 215 students from eleven (11) school districts. Six (6) were middle school and five (5) were high school classes. The fall programs included 27 groups totaling 713 participants. The fall sample included 212 students from nine (9) classes. Five (5) were middle school and two (2) sixth grade classes. Four hundred and twenty seven (427) students completed the test. The items on this year's test were revised in an effort to include more of the learning objectives of the Schoolship Program. The following results are a compilation of both the spring and fall assessment activities, reported in percent of correct responses.

1. **Lake levels in Lake Michigan have gone down rapidly over the last two years because: (From this list) Lake Superior is letting less water flow out, There has been less rain and snow than normal, Evaporation has been greater than normal,**

   Students selecting both of the correct responses: "There has been less rain snow than normal", and "Evaporation has been greater than normal":

   Spring 67% Fall 50% Combined 58%

2. **At the plankton station, we looked at: (From this list): Animals that live in the bottom, Bugs and insects that fly above the ship, Microscopic plants and animals that float freely in the water, Plants that live on rocks.**

   Students selecting "Microscopic plants and animals that float freely in the water."

   Spring 83% Fall 80% Combined 82%

3. **Circle the invader species (exotics) in this list. Bythotrephes, Sea lamprey, Lake trout, Midge fly, Zebra mussels, Gulls.**

   Students correctly selecting one invader:

   Spring 28% Fall 21% Combined 25%

   Students correctly selecting two invaders:

   Spring 41% Fall 44% Combined 43%

   Students correctly selecting all (Bythotrephes, Sea lamprey, and Zebra mussels) invaders from the list:

   Spring 28% Fall 32% Combined 30%

4. **Fish are identified on the Schoolship by: (From this list) Studying the characteristics of the sample fish, Using a key to select matching characteristics, asking a fish expert.**

   Students correctly selecting both of the first two from the list:

   Spring 74% Fall 70% Combined 72%

5. **Benthic organisms: (From this list) Live in the sediment, Are recyclers of organic material, float in the**

water.

Students correctly selecting both of the first two from the list:

Spring 49% Fall 46% Combined 48%

6. The feeding relationship between aquatic organisms is best described as: (From this list) Survival of the biggest, Size and speed of the organism, A food web, The air and water temperature.

Students correctly selecting "A food web":

Spring 77% Fall 73% Combined 75%

7. The land that drains into a lake or river is called: (From this list) A tidal basin. A geological moraine, a watershed, A sewer system.

Students correctly selecting "A watershed":

Spring 87% Fall 83% Combined 85%

8. Bernoulli's law explains: (From this list) How sails propel the ship, Why a ship floats, The operation of a ship's compass, Why the crew stands watch.

Students correctly selecting "How sails propel the ship":

Spring 27% Fall 40% Combined 34%

9. Circle the following instruments used in navigating the ship: (In this list) Compass, Radar, The halyards, Radio, Galley, Global positioning system.

Students correctly selecting one:

Spring 10% Fall 5% Combined 7%

Students correctly selecting two:

Spring 19% Fall 19% Combined 19%

Students correctly selecting three:

Spring 67% Fall 74% Combined 70%

10. What geological condition in Lake Michigan keeps our water in the neutral range of pH? (From this list) Sandy beaches, High Moraines, Limestone bedrock, Old mountains.

Students correctly selecting "Limestone bedrock":

Spring 67% Fall 75% Combined 69%

11. Living organisms found in the bay prefer a pH level that is: (From these choices) 3-4, 7-8, 12-13, 25-26.

Students correctly selecting "7-8":

Spring 67% Fall 66% Combined 67%

12. Water transparency can be limited by: (From this list) Suspended plankton, Silt and clay in the water, Dredging and other human activities, All of the above.

Students correctly selecting "All of the above":

Spring 67% Fall 62% Combined 64%

13. Dissolved oxygen in water comes from: (From these choices) The atmosphere, Fish, Aquatic plants,

Students correctly selecting both "The atmosphere and Aquatic plants"

Spring 59% Fall 47% Combined 53%

14. What can you do to help protect the Great Lakes?

Most student comments dealt with avoiding pollution in general and specific ways. The comments from three students are quoted here as examples:

"Don't pollute, don't introduce species, don't over fish, do clean up pollution, do work on informing other people."

"Do beach sweeps, keep people from putting pollutants into the ground that would travel to the water, and inform others."

"You shouldn't bring boats in with zebra mussels in or on them. You shouldn't use pesticides on the ground because the ground water goes into the watershed which goes into the lakes."

Another student said "Don't screw up the food chain."

Schoolship Classroom Activities

The activities detailed here have been selected in part based upon teacher feedback. For example, in this edition we have added: another nautical chart activity, some background about sea shanties sung on the boats, a new activity regarding clouds and percent cloud cover, and an answer key for relevant activities. In recognition of the increasing importance of the Internet as an information source, we have included related Web sites with the activities. We have also spent a lot of time redesigning our Web site (www.schoolship.org) to make it more teacher and student friendly. Your students will find a section on Great Lakes on this Web site.

On the Schoolship, students are engaged in a multi-disciplinary program organized as learning stations. Mathematics and geography (navigation station); chemistry (limnology); biology, geology, and earth science (sediment-benthos station); biology (plankton and fish stations); and physics and history (seamanship station).The activities designed and adapted for this publication help support every facet of the Schoolship program. They are organized as follows:

Teaching Vocabulary (applies to all stations)

Geography/Navigation
A Watershed View of the Bay
Building Your Own Watershed
Journey to the Sea

Limnology
Lake Stratification (REVISED)
Acids and Bases

Weather
Calculating Cloud Cover (NEW)

Seamanship
Why Do Boats Float?
Sea Shanties and the Schoolship (NEW)

Sediment/Benthos, Plankton, and Fish
Great Lakes Food Web
What Do Scientists Know About Invader Species of the Great Lakes
Shoe Key

Likewise, effectiveness of the overall program is enhanced by an opportunity for students to "revisit" their experiences on the Schoolship and to see the value of their work. Last year we took digital photos on *Inland Seas* and the *Manitou.* and posted group photos on the Schoolship Web site (www.schoolship.org). This year we will continue that tradition and include programs on the schooner *Westwind*.

The Schoolship Database will be operational by the spring programs. Each program will have their own page on the database called the Ship's Log that includes their group photo along with the data that the group collected. Students and teachers who access the Web site can look-up their data and even link this page to their school's home page. (Please see Appendices for a detailed description of the Schoolship Web site and other resources available to teachers and students.)

We continue to develop a program that is greater than the sum of its parts. The Schoolship activities, Schoolship program, and Interactive Web site together form a coherent unit that should help build greater understanding and stewardship of this exceptional resource: the Great Lakes.

Teaching Vocabulary: A Collection of Activities

Grade Level: 5-12
Subject Areas: Language Arts, Visual Arts
Duration: 50 minutes
Setting: classroom
Skills: gathering information
Vocabulary: see "Vocabulary for the Scientist" and "Sailor-Scientist", pages

Objectives

Students will be able to:

? spell vocabulary words correctly, and when appropriate, use them in sentences in their log books; and,
? use the vocabulary words correctly in discussions about the Schoolship.

Materials

? books, construction paper, magazines, posterboard, plain paper

Activities

I. Create a word search using the Schoolship vocabulary (see " Vocabulary for the Scientist-Ecologist" and " "Sailor-Scientist", see pages 14-15). Or you may use the word search provided, see page 23.

II. Make flash cards with pictures of the vocabulary words. For example, for the phrase "food web", include a picture of a food web. For the word "buoy" include a picture of a buoy. Divide the class into partner groups and have them take turns quizzing each other.

III. Create bulletin boards using the different kinds of vocabulary words: an exotic species bulletin board might include pictures of sea lamprey, ruffe, zebra mussel.... Create a schooner diagram (see the drawing of the schooner *Inland Seas*, see page).

Aboard a ship:	**In a building:**
Overhead	ceiling
Deck	floor
Bow	front of the classroom
Stern	back of the classroom
Starboard	right side of classroom when facing the front (bow)
Port	left side of classroom when facing the front (bow)
Helm	paste poster of the wheel near the back of the classroom

V. Set up your classroom like a ship.
Arrange desks in the shape of a ship's deck.
Students or the teacher can label parts of the ship (see schooner diagram, see page 25).

V. Students make simple drawings of the ship.
Label sails, masts, booms, rudder....
Visit the Internet site: **www.baysail.com** . Very interesting section on sailing and seamanship.

VI. Have students look through old magazines and cut out pictures of boats, especially sailboats.
(Good magazines include: *Sail, Yachting,* and *Wooden Boat*). See if they can label the pictures correctly.

ISEA “Sailor - Scientist” Word Search

G	M	K	V	T	N	A	Z	B	L	S	H	B	D	J	O	E	T	M	L
A	T	A	N	E	F	H	O	B	C	U	D	K	Q	G	Z	D	S	O	F
F	L	P	D	B	J	E	N	I	L	D	A	E	L	S	F	R	A	N	F
F	B	O	E	S	T	A	L	F	N	G	K	R	B	A	L	A	L	P	A
P	T	G	O	F	D	D	S	B	J	L	E	N	S	R	Z	O	L	V	O
S	P	I	H	S	D	I	M	A	C	C	R	N	B	Q	L	B	A	F	V
U	N	F	T	D	N	E	R	E	T	T	I	B	G	L	U	R	B	S	P
G	R	D	L	Z	A	P	U	F	L	P	R	O	P	F	W	A	K	L	E
G	E	G	L	I	B	Q	R	S	G	O	C	E	T	J	N	T	R	E	A
T	B	V	H	T	J	R	L	N	B	S	A	G	Z	P	O	S	F	E	K
J	O	U	C	L	F	P	I	T	C	K	E	U	L	R	W	A	K	K	H
F	W	N	V	A	B	Y	R	C	H	C	D	S	F	Z	E	R	P	N	A
O	S	U	K	B	A	T	S	A	V	A	F	O	R	M	U	D	G	O	L
U	P	M	S	L	K	W	L	F	W	J	N	T	B	O	F	R	D	L	Y
R	R	G	E	U	N	Y	Z	H	X	Y	W	R	F	C	H	L	B	U	A
N	I	B	F	O	A	W	E	N	Y	Z	F	D	E	V	I	J	X	T	R
L	T	C	H	R	N	E	M	K	H	A	B	I	T	T	E	R	E	N	D
C	H	R	D	Q	L	B	M	T	X	L	G	K	R	E	S	V	P	L	T
E	O	S	W	Z	A	F	T	D	D	R	N	F	O	I	J	K	N	R	G
V	M	O	O	B	T	G	L	I	A	R	N	I	P	Z	L	Y	S	P	A

Word Search: circle the following words above that relate to sailing on a schooner.

AFT
AMIDSHIPS
AVAST
BALLAST
BELAYING PINS
BILGE
BITTER END
BOOM
BOWSPRIT
GAFF
HEAD
HORSE

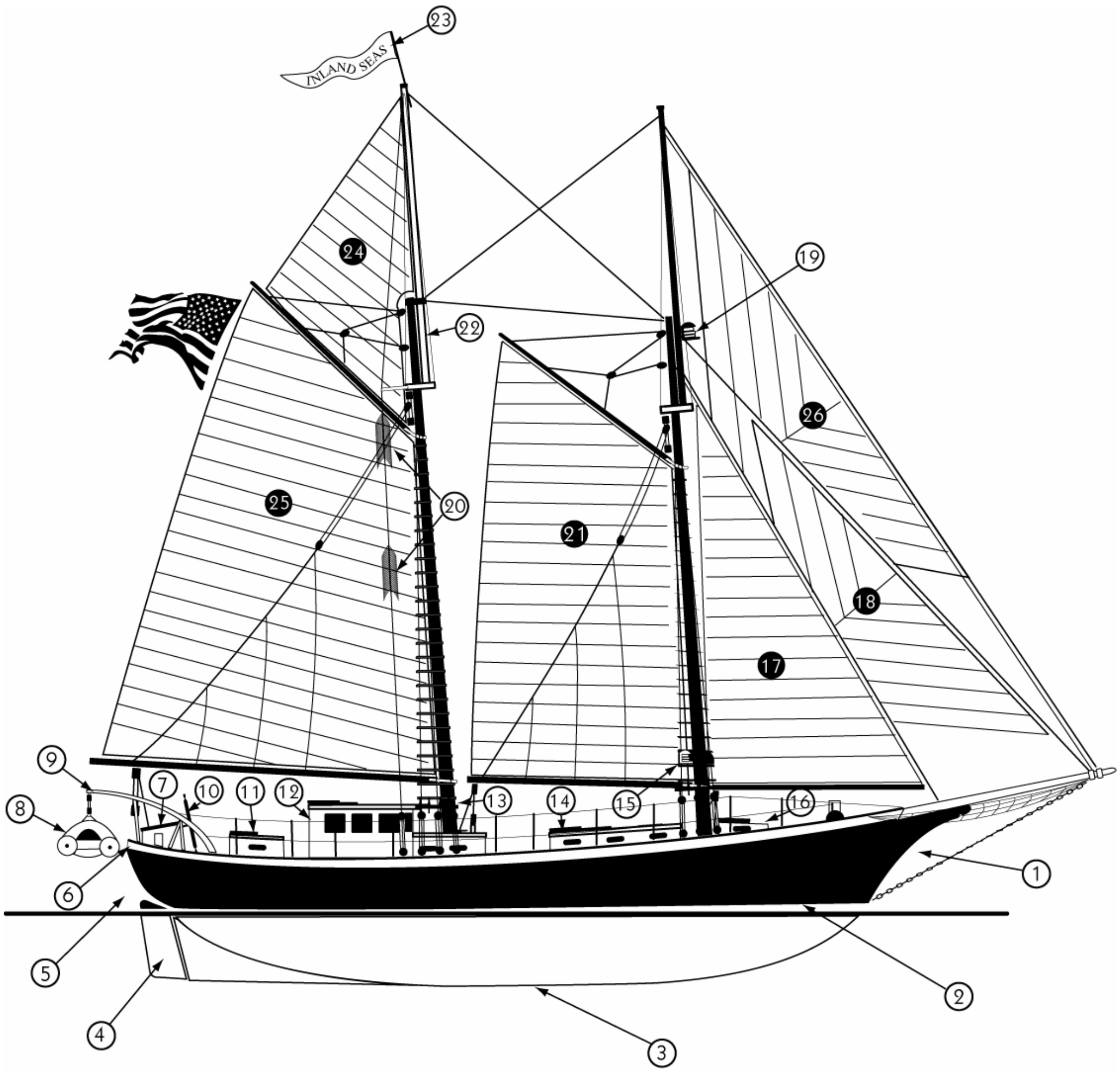
KEEL
KNOT
LAZY JACKS
LEAD LINE
LOG
PEAK HALYARD
PINRAIL
PORT
STARBOARD
STERN
WHEEL

Vocabulary for the Sailor - Scientist

Aft:	direction toward the stern.
Amidships:	middle of the ship.
Ballast:	lead weight in keel.
Belaying Pins:	wooden pins used to secure the halyards, sheets and other running rigging.
Bilge:	area at bottom of ship where water would collect.
Bitter End:	the end of a line not attached to an object.
Boom:	spar at the lower edge of the mainsail and foresail.
Bowsprit:	spar attached to the ship that extends forward from the bow.
Gaff:	upper spar on the mainsail and foresail. The halyards are attached to the gaffs. Gaffs should be raised in a horizontal attitude, and peaked up when lowered.
Halyards:	lines used to raise the sails, flags, topmast, etc.
Head:	ship's toilet.
Horse:	metal bar mounted athwartship, supporting the lower sheet blocks (also called the "traveler").
Keel:	finlike structure at the hull bottom. The keel contains ballast and prevents the ship from sliding sideways (to some extent).
Knot:	a nautical mile per hour. Equals 1.15 statute miles per hour. Never say "knots per hour".
Lazyjacks:	lines that hang from the quarterlifts, passing under the main and fore booms. Lazyjacks catch the sail as it is lowered.
Lead line:	manual depth sounder consisting of a calibrated line (ours is marked in fathoms - 6 ft.) with a lead weight at one end.
Line:	most ropes on a ship are called lines.
Log:	official record of the ships activities, kept by the captain. Also; device that records distance traveled.
Peak :	after end of the gaff.
Peak halyard:	line used to raise the peak end of the gaff.
Pinrail:	oak timber attached to the shrouds which holds the belaying pins. The halyards and other lines are belayed to these pins.
Port:	left side of the ship when looking forward
Rudder:	moveable fin that steers the ship. Located at the end of the keel.
Starboard:	right side of the ship when looking forward.
Stern:	the rear of the ship.
Wheel:	the steering wheel controls the position of the rudder. The propeller is sometimes referred to as the "wheel".

.

Inland Seas' Sail Plan



1-BOW 2-FLOATATION LINE 3-KEEL 4-RUDDER 5-STERN 6-BULWARK 7-WHEEL BOX
8-TENDER 9-BOAT DAVIT 10-WHEEL 11-CAPTAIN QUARTERS 12-PILOT HOUSE 13-PIN RAIL
14-MAIN CABIN 15-RUNNING LIGHT 16-FOCS'LE 17-FORESTAY SAIL 18-JIB
19-STEAMING LIGHT 20-BAGGYWRINKLES 21-FORE SAIL 22-MASTHEAD AND HOUSING OF TOPMAST
23-PIGSTICK 24-TOPSAIL 25-MAIN SAIL 26 -JIB TOPSAIL

Sea Shanties

Grade Level: 5-12
Subject Areas: Language Arts and Music
Duration: 50 minutes or less
Setting: classroom
Skills: interpreting information
Vocabulary: see list

Objectives

Students will be able to:

?? define sailing terms used on schooner; and,

?? learn a traditional sea shantey.

Material

"Me for the Inland Lakes" CD by Tom and Chris Kastle. [Contact Tom and Chris Kastle, P.O. Box 56474, Chicago, IL 60656, Web site: www.schoonerman.com/sextant.htm e-mail: kastle@enteract.com]

Background

During the Schoolship Program some of you may be lucky enough to be on board when maritime musicians, Tom and Chris Kastle are here. One of the sea shanties that they sing is the *Trip of the Bigler.* Included here is that shantey along with activities and some history about sea shanties (they were also sung on Great Lakes schooners) .

This maritime history information is taken from a maritime history unit: *The Age of Schooner, Life Along the Manitou Passage* that the Inland Seas Education Association is developing in cooperation with the Leelanau Historical Museum and Sleeping Bear Dunes National Lakeshore. This unit complements the ISEA maritime history Web site, and will be available to schools next winter as part of a sea chest loan program.

Sailors found that singing songs to fit the rhythm of their task helped them to work more easily together. In these songs, called shanties, a soloist (shanteyman) sang the verse and the crew joined in on a chorus, repeated after each verse. A shanteyman was chosen for his nimble wit and ability to make up or ad lib verses for the situation at hand as well as for a good voice. Most shanties had many verses to narrate special events or life at sea.

They had their own colorful vocabularies that were a blend of nautical terms and places they had been (or wish they had been). Sometimes they are hard to understand--they often used words not in use today, such as "Hilo" for Hawaii or "Barbaree" for the Barbary Coast of North Africa. Their rhythms were those of shipboard tasks: long, slow, and even for hauling lines, or quicker and more energetic for walking the capstan around. Familiar folk tunes adapted to nautical life and traditional old ballads were often sung at leisure or ashore.

Great Lakes sailors knew many of the old sea shanties, but also developed songs of their own which named Great Lakes ports, wrecks, reefs, storms, and lighthouses. As on the ocean, occasionally a crew member might have a concertina, pipe, or whistle aboard to play along.

Today, we know these shanties because of the work of folklorists and musicologists who have searched for them in museum archives and private documents, or recorded elderly seaman singing them and sharing their memories. They are again being sung on shipboard programs sailing the Lakes today.

The Activity

Work in groups of two, each group takes one passage of *The Trip of the Bigler* and explains to the rest of the group what is happening.

Chart Work

After listening to the song and reading the words: use the Great Lakes Chart #14500 to retrace the passage of the Bigler through the Great Lakes. Identify and mark each place name noted in the song: Milwaukee,….

The Trip of the *Bigler*

Please listen to the CD: "Me for the Inland Lakes" by Tom and Chris Kastle. One of the songs is of the schooner the *Bigler*. Note the special vocabulary used to describe sailing and parts of the boat, defined words and phrases are underlined.

Come all me boys and listen and a song I'll sing to you
It's all about the *Bigler* and of her jolly crew
In Milwaukee last October, I chanced to get a sight
On the schooner called the *Bigler* belonging to Detroit.

It was on a Sunday morning about the hour of ten
The *Robert Emmett* towed us out into Lake Michigan
We set sail where she left us in the middle of the fleet
And the wind being from the <u>*south'rd,*</u> oh, we had to <u>give her sheet</u>

But the wind chopped 'round the <u>*sou-souwest*</u> and blew both fresh and strong
And gently through Lake Michigan the *Bigler* she rolled on
And far beyond her foaming bow the flashing waves did fling
With every inch of canvas set her <u>courses wing and wing</u>.

But the wind it came ahead before we reached the Manitous
Three dollars and a half a day just suited the *Bigler's* crew
From there unto the Beavers we <u>steered her full and by</u>
And we kept her to the wind, me boys, as close as she would lie

CHORUS: And its watch her, catch her, jump up in her juber ju
Give her sheet and let her slide, the boys'll push her through
You ought to seen us <u>howlin'</u> as the winds were blowing free
On our passage down to Buffalo from Milwaukee

We made Skillagalee and Wobble Shanks, the entrance to the Straits
We might have passed the fleet had they <u>hove to</u> and wait
But we drove 'em all before us, the prettiest you ever saw
Clear out into Lake Huron through the Straits of Mackinac.

Well, the *Sweepstakes* she took eight in tow and all of us <u>fore and aft</u>
She towed us down through Lake St. Clair and set us on the flats
We parted the *Hunter's* towline in trying to give relief
But <u>stem and stern</u> went the *Bigler* into the boat they call the *Maple Leaf*

Well, the *Sweepstakes* she towed us outside the river light

Lake Erie for to roam and the blustering winds to fight
And the wind being from the south'rd, oh, we paddled our own canoe,
With our nose pointed for the dummy she's hell-bent for Buffalo.
And now we're safely landed in Buffalo Creek at last,
And under the Rigg's elevator the *Bigler's* she's made fast
And in some lager beer saloon we'll let the bottle pass
For we're all jolly shipmates and we'll take a social glass.

We soon received our stamps from our skipper Call McKee
And with our bags we went ashore but not to go on a spree.
To Abe and Mike's we started where we arrived in quiet repose,
And the boys fixed up with a splendid suit of clothes.

And now my song is ended and I hope that I've pleased you.
Let's drink unto the *Bigler* her officers and crew,
And may she sail next fall in command of Call Mckee
Between the ports of Buffalo and Milwaukee.

CHORUS
And its watch her, catch her, jump up in her juber ju
Give her sheet and let her slide, the boys'll push her through
You ought to seen us howlin' as the winds were blowing free
On our passage down to Buffalo from Milwaukee

Vocabulary

Bore away: to "fall off" or away from the wind so that the wind is off the beam of the boat more rather than off the bow.

Dummy: refers to a buoy (navigation marker).

Fore and aft: a line of boats towed fore and aft would be in a line, one behind the other; fore refers to the for ward part of a vessel (near the bow) and aft refers to the rear of the vessel (near the stern)

Give her sheet: the sheet is a line that controls the position of the sail. To give sheet means to let the sail out to catch the most wind.

Her course is wing and wing: the mainsail out to one side and the foresail sheeted out on the opposite side. Can only be done in a following wind off the stern--a wind coming directly from behind.

Hove to: to position the bow of the ship into the wind in a way that the ship makes little or no headway.

Howlin': the boat was sailing fast

Make fast: to secure lines to a dock or to a belaying pin.

Nose: bow of the boat

Repose: rest

South'ard: meaning southward or from the south

Sou-souwest: meaning the wind was from the south-southwest.

Stem and stern: stem is the main rib of a wooden vessel and stern is the rear of the vessel. Refers to the entire boat running into the other boat.

Starboard tack: sailing with the wind off the starboard or right side of the vessel when you are facing towards the bow.

Wind was fair: good wind for sailing, usually aft of the beam.

Calculating Cloud Cover

Grade Level: 5-12
Subject Areas: Earth Science
Duration: 1 class period
Setting: classroom, school grounds
Skills: estimating

Related State Content Benchmarks Objectives
?? **Describe weather conditions and climates**

Objectives
Students will be able to:
?? estimate percent cloud cover; and,
?? test their observations against objective measures of cloud cover.

Materials
?? Two sheets of paper (preferably one blue and one white) for each pair of students.

Background
During the Schoolship Program, students estimate percent cloud cover . As students look out from horizon-to-horizon, percent cloud cover can be a very subjective measure. Both students and adults tend to overestimate percent cloud cover. Described here is an activity that will give students a reference point for estimating percent cloud cover.

The Activity
1. Bring students outside, away from the building, and have them look up at the sky. Ask them to estimate percent cloud cover.

2. After they have made their estimates, ask them to return to the classroom and test their estimates with a simple activity.

3. Each pair of students should be given one blue sheet (sky), and one white sheet of paper (clouds).

4. Demonstrate the activity. Hold up the blue sheet representing the sky and the white sheet of paper representing the clouds. Fold the white sheet of paper in half and cut in half. Take one half of the sheet and rip these into various sized small pieces. Scatter these small white pieces of paper over the blue sheet. Ask the students to look at this and give their answer of percent cloud cover. It should, of course, be 50%.

5. In pairs, have students using their blue sheet and white sheet of paper, to replicate this activity but to try other percentages. You may help them to replicate the activity using their estimate of percent cloud cover when they went outside.

6. Ask students to share their cloud cover and request that others in the class try to estimate the percentage of cloud cover shown.

7. As a follow-up, ask students to estimate cloud cover outside again. Did the activity help?

A Watershed View of the Bay

Grade Level: 7-12
Subject Areas: physical sciences, life and space sciences
Duration: 1 to 2 class periods
Setting: classroom
Skills: map reading, analyzing and interpreting information
Vocabulary: topographic, confluence, delineate

Related State Content Benchmarks Objectives

?? **Describe how rainwater in Michigan reaches the oceans**

?? **Describe and identify surface features using maps**

Objectives

Students will be able to:

? delineate the boundary of the Grand Traverse Bay Watershed;

? locate all of the streams and rivers that flow into the bay;

? determine the stream order of each stream and river at its confluence with the bay; and,

? given another set of topo maps, construct or piece together another watershed.

Materials

? topographic maps that contain the watershed (Traverse City, Traverse City SW, Traverse City SE, Elk Rapids, Suttons Bay, Grawn, Mayfield, Jack's Landing, and South Boardman) *

? removable tape (photographic tape)

Background

Students should--at the middle school and high school level--understand how water flows through the Great Lakes Basin (watershed). They should also be able to roughly delineate the boundary of the watershed in which they live. Topographic maps are a great tool for helping to "get a picture" of the total area and configuration of the watershed. It may be helpful to introduce students to topographic maps by asking them to find their school and other points of interest. It is particularly important that students make the connection between high points (elevation) on a contour with a place they have visited. For students in the Traverse City area, such a high point could be Wayne Hill, or the top of the local ski area. This activity suggests topographic maps for the Grand Traverse Bay watershed (where the Schoolship Program sails); by working from the *Michigan Atlas* one can determine the topo maps suitable for other watersheds.

The Activity

1. Distribute one topographic map for every 3-4 students.

2. Ask the student groups to work together to identify features of their particular topo map: rivers, streams, roads, Lake Michigan, cities, etc.

3. Ask students to identify and link with removable tape each of the highest elevations in their topo map taking care to move around headwater tributaries of streams.

4. Ask students to generate a list of questions they need answers to in order to find the adjacent topographic map (students may use features such as rivers to help form questions).

5. Allow one student from each group to visit other groups and "find" the topo map that connects or continues their map. The idea is to "piece together" all of the topo maps in such a way that collectively t they form the watershed of Grand Traverse Bay.

* Topographic maps can be found at outdoor/camping stores, bookstores, planning departments, and

extension offices.

Additional Resources

A great resource for working with topographic maps is “How to Teach With Topographic Maps” by Dana Van Burgh, Elizabeth N. Lyons, and Marcy Boyington. Order from the National Science Teachers Association (NSTA) 1840 Wilson Boulevard, Arlington, Va 22201-3000, or visit their Web site @ http://www.nsta.org

Grade Level: 5 - 8
Subject Area: Physical Science and Life and Space Science
Duration: two-three class periods
Setting: classroom/lab
Skills: organizing, analyzing, and interpreting information
Vocabulary: watershed, nonpoint source pollution

Related State Content Benchmarks Objectives

? **Describe how rainwater in Michigan reaches the oceans.**
? **Describe and identify surface features using maps.**

Objectives

Students will be able to:

? construct a model watershed made out of modeling clay; and,
? predict how water will move off "the land" and where it will end up.

Materials

? 2 lbs. of modeling clay
? miscellaneous items like flexible plastic straws and tongue depressors
? food coloring or granulated jello mix
? sprayer

Background

A watershed is defined as the land area that drains water towards a common channel or body of water. For younger students, the concept of a watershed is fairly abstract and embodies such concepts as topography and energy potential. To help make the concept of watershed more concrete for younger students, it is helpful to link an outdoor activity, with a hands-on/constructive type activity. For the Grand Traverse Bay watershed, it is important that students make the connection between the relatively still waters of the bay and the moving waters of rivers that flow into the bay . It is also important that students understand that we are part of a much larger basin (the Great Lakes) that sends water through the St. Lawrence River to flow into the North Atlantic.

The Activity

1. To introduce this activity, and to assess prior knowledge, take students outside during, or immediately after a rain. Have students observe how water flows off parking areas or paved areas around the school. Where do these little rivers go? Do they ever flow uphill?

2. Give each student a piece of paper. Ask them to crumple up the paper into a ball, and then to gently undo the ball. Students will discover a piece of paper with little valleys and hills when they lay it on their desks. Student may place their pieces of paper on a waterproof tarp or plastic sheet, and spray theses piece of paper with water. Observe the routes that water takes as it flows "uphill". Talk about a watershed and introduce the clay watershed activity.

3. Inside the classroom, divide the class into small groups. Each group should have one lump of clay about the size of a softball. Explain that this will become their watershed. Students can form valleys and hills in the clay that look like the crumpled paper.

4. Once students have molded the clay into valleys, hills, mountains, rivers, and lakes remind them that they can use the tongue depressors to build bridges, or houses, or any structure they might see in their community. The food coloring or granulated jello mix can be applied to the surface of the model to highlight the flow of water from the sprayer.
5. As an extension activity, the flexible straws can represent sewers that students embed into their clay model. The food coloring or granulated jello mix represents pollutants on the land that are carried away by

the rainfall (nonpoint source pollution).

Additional Resources

Holling, Clancy. 1941. *Paddle to the Sea.* Boston, MA: Houghton Mifflin Company.

"Supplemental Curriculum Activities" for use with Clancy Holling's *Paddle to the Sea*.

Two very good related activities in this supplement: "Travel-to-the-Sea" and "In One Lake and Out Another" (Order from Ohio Sea Grant)

Locker, Thomas. 1984. *Where the River Begins.* New York, NY: Dial Books.

The Watercourse and Western Regional Environmental Education Council. 1995. *Project WET Curriculum and Activity Guide.*

Grade Level: 5-8
Subject Area: Earth and Space Science
Duration: 50 minutes or less
Setting: classroom
Skills: organizing information and applying learned information
Vocabulary: watershed

Related State Content Benchmarks Objectives
?? **Describe and identify surface features using maps.**
?? **Describe how rainwater in Michigan reaches the ocean.**

Objectives
Students will be able to:
- ? identify the Great Lakes and connecting channels;
- ? delineate the Great Lakes watershed; and,
- ? show how water flows out of the Great Lakes.

Materials
- ? drawing of the Great Lakes and St. Lawrence River
- ? colored markers or pencils

The Activity
1. Make copies of "The Great Lakes--St. Lawrence River" and distribute one/every two students.

2. Ask students to label the five Great Lakes on this drawing. You might give them the acronym (HOMES), or ask them to come up with an acronym that will help them remember the names of the five Great Lakes. Students should also label connecting channels: Niagara River (Falls); St. Lawrence River, St. Marys River, St. Clair River, and the Detroit River.

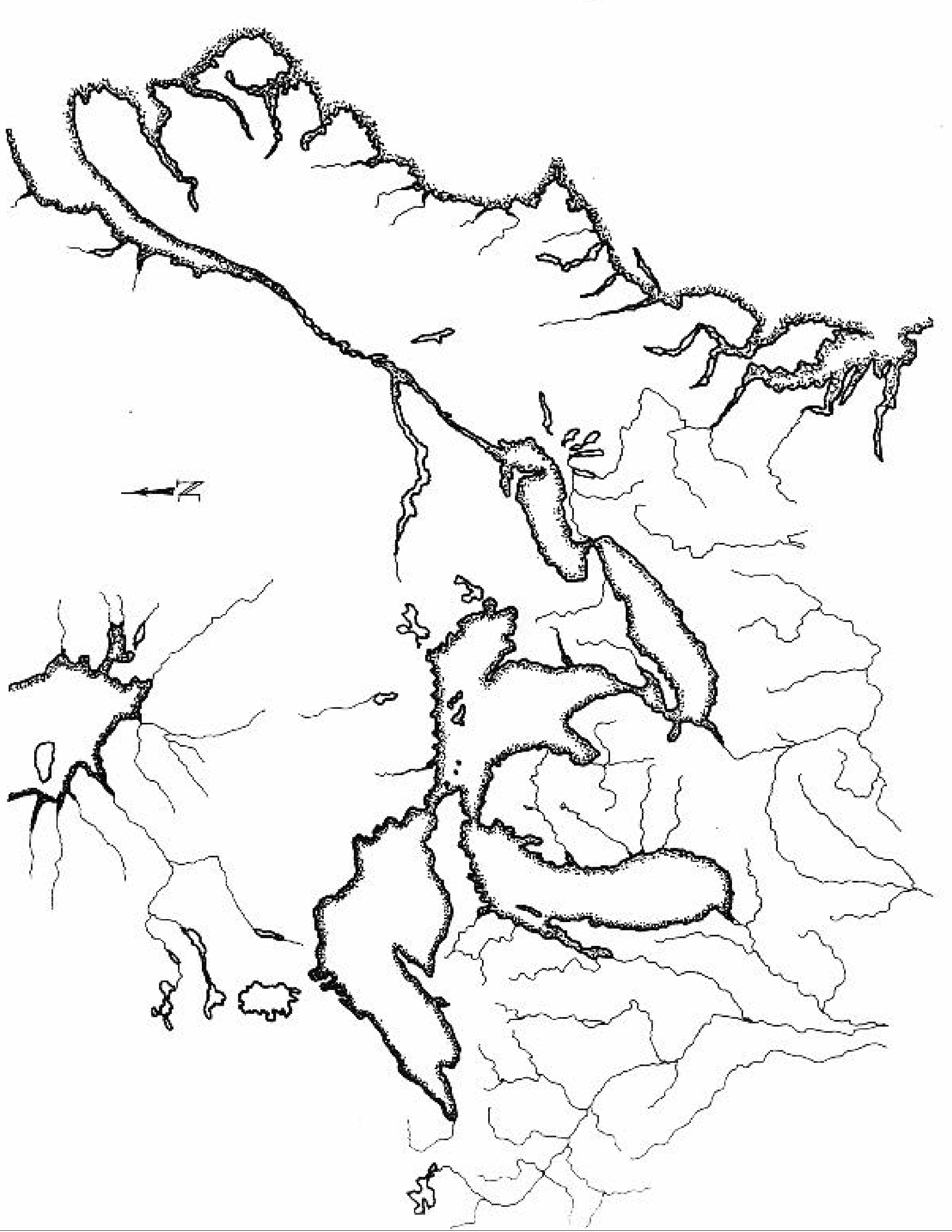
3. Given the information below, students should be able to show how water flows out of the Great Lakes. Lake levels are noted in feet and meters above sea level. A small amount of water flows from Lake Michigan via the Chicago Sanitary and Ship Canal to the Des Plaines River-Illinois River-Mississippi River. Lake levels taken from Table 1 of *The Great Lakes: An Environmental Atlas and Resource Book*, 1995, U.S. EPA and Environment Canada.

Lake Superior	183 meters	600 feet
Lake Michigan	176 meters	577 feet
Lake Huron	176 meters	577 feet
Lake Erie	173 meters	569 feet
Lake Ontario	74 meters	243 feet

4. Delineate the boundary of the Great Lakes watershed (basin) using a colored pencil or marker. See the two related activities: "Watershed View of the Bay" (see pages 32-33) and "Building Your Own Watershed" (see pages 34-35).

Lake Stratification

Grade Level: 8-12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Subject Area: Physical Sciences
Duration: 50 minutes or less
Setting: classroom/lab
Skills: gathering, organizing, analyzing, and interpreting information
Vocabulary: stratification, density, reservoir, thermocline

Related State Content Benchmarks Objectives

? **Explain basic ecosystem concepts and processes**
?? **Write and follow procedures in the form of step-by-step instructions, recipes, formuals, flow diagrams, and sketches**

Objectives

Students will be able to:

? explain why the red water layer lies below the blue water layer when mixed; and,
? explain the process of stratification in lakes

Materials

? blue food coloring
? red food coloring
? 2 pint Mason or similar jars (important that jar openings be the same size)
? reservoir of warm and reservoir of cold water
? edged baking pan
? 3 x 5 cards

Background

On the Schoolship, students record surface water temperature and bottom water temperature (often from 60-80 feet of water). In early May, these two values are often close (low 40F range). By the end of spring Schoolship, the sun has become more direct and air temperatures are on average much warmer. This lead to absorption of heat in the form of energy from the sun which warms the upper or surface water. This surface layer is called the **epilimnion** and because it is a warmer layer of water it is also less dense**.** Students who measure bottom water temperatures find relatively cold water; this is a more dense layer called the **hypolimnion.** The intermediate layer**--**between the warm epilimnion and the cold hypolimnion**--**is called the metalimnion or **thermocline**. By summer, Grand Traverse Bay is highly stratified. This has implications for organisms living in the bay. The differences in density mean that wind cannot physically mix atmospheric oxygen into the deeper parts of the bay. If enough oxygen-demanding material (organics) is present in bottom sediments these bottom areas can become oxygen deficient in summer.

There are also zones in the lake determined by the penetration of light. The "Common Lake Terms" diagram shows the **photic zone** and the **aphotic zone**. The photic zone is the depth to which light can penetrate in a lake (measured as 1 percent of the light on the surface). Students measure clarity or water transparency of the lake with a Secchi disk*. Of course, the photic zone supports photosynthesis (oxygen production) by algae and rooted aquatic plants. In clear, deep lakes, the photic zone may extend well into the hypolimnion. The aphotic zone extends below the photic zone to the lake bottom. Here, available light is too limited for photosynthesis.

The Activity

1. Fill first jar with cold water. Add **two** drops of red food coloring, making sure that jar is filled to the brim.
2. Fill second jar with warm water. Add **two** drops of blue food coloring, again making sure that the jar is filled to the brim.
3. Place 3x5 card firmly over the mouth of the warm water jar, and **carefully** set the warm water jar on top of the cold water jar**--**leave the 3x5 card between jars.
4. Students should predict what will happen when the card is removed.
5. CAREFULLY remove the 3x5 card from between the jars.

6. Observe the reaction.
7. Let stand for 15 minutes and observe any changes.
8. Repeat activity with the cold water on top.

Lake Stratification Activity

This activity is more advanced and is designed to demonstrate stratification in a lake.

Materials

?? distilled water
?? 25 x 200 mL tube with screw cap (ideal) or a large container (important to limit surface area)
?? large syringe or straw
?? blue, yellow, and red food color
?? poppy seeds

Preparation

?? To make the dense, "cold" hypolimnion, supersaturate 250 mL of water with salt. Keep adding salt (at least 20 g.) until the water will hold no more. Decant off the saltwater into a separate container.
?? To make the thermocline or metalimnion: mix this salt solution with pure, distilled water (tap water will also work) 1/2 and 1/2.
?? The surface layer or epilimnion consists of pure, distilled water.

The Activity

1 Begin with the dense salt water pouring this into the demonstration container (add several drops of blue food coloring).
2. On top of this, salt water, **carefully** add the 1/2 and 1/2 solution using a syringe (this is colored with the yellow food dye).
3. Finally, add the clear top layer (drop red dye into). You should end up with a blue bottom band of water, a yellow middle band, and a red surface band.

Demonstration

To demonstrate wind mixing, blow across the surface by using a straw. This shows that once a lake is stratified, wind and wave action don't usually cause mixing between the upper layer (epilimnion) and the cold, dense hypolimnion. Of course, this physical separation means that no or very little atmospheric oxygen is added through physical mixing of the surface water.

To demonstrate how phytoplankton congregate in the epilimnion and metalimnion, drop poppy seeds into the water. They should slowly sink through the epilimnion, but float just above the hypolimnion. Zooplankton are larger and motile and can move through the three layers.

Wrap-up

? Is warm water more dense (heavier/unit mass) or less dense (lighter/unit mass) than cold water?
? Where does most of the heating occur in a lake?
? How does this layering affect animals that live in the lake?

Additional Resources

Horne, Alexander J. and Charles R. Goldman. *Limnology*. (2nd ed.) McGraw-Hill, Inc.

The Watercourse and Western Regional Environmental Education Council, 1995. *Project WET Curriculum and Activity Guide.*

A good related activity in this guide is called "Adventures in Density". This activity combines literature with science to understand water density in relation to heat and salinity.

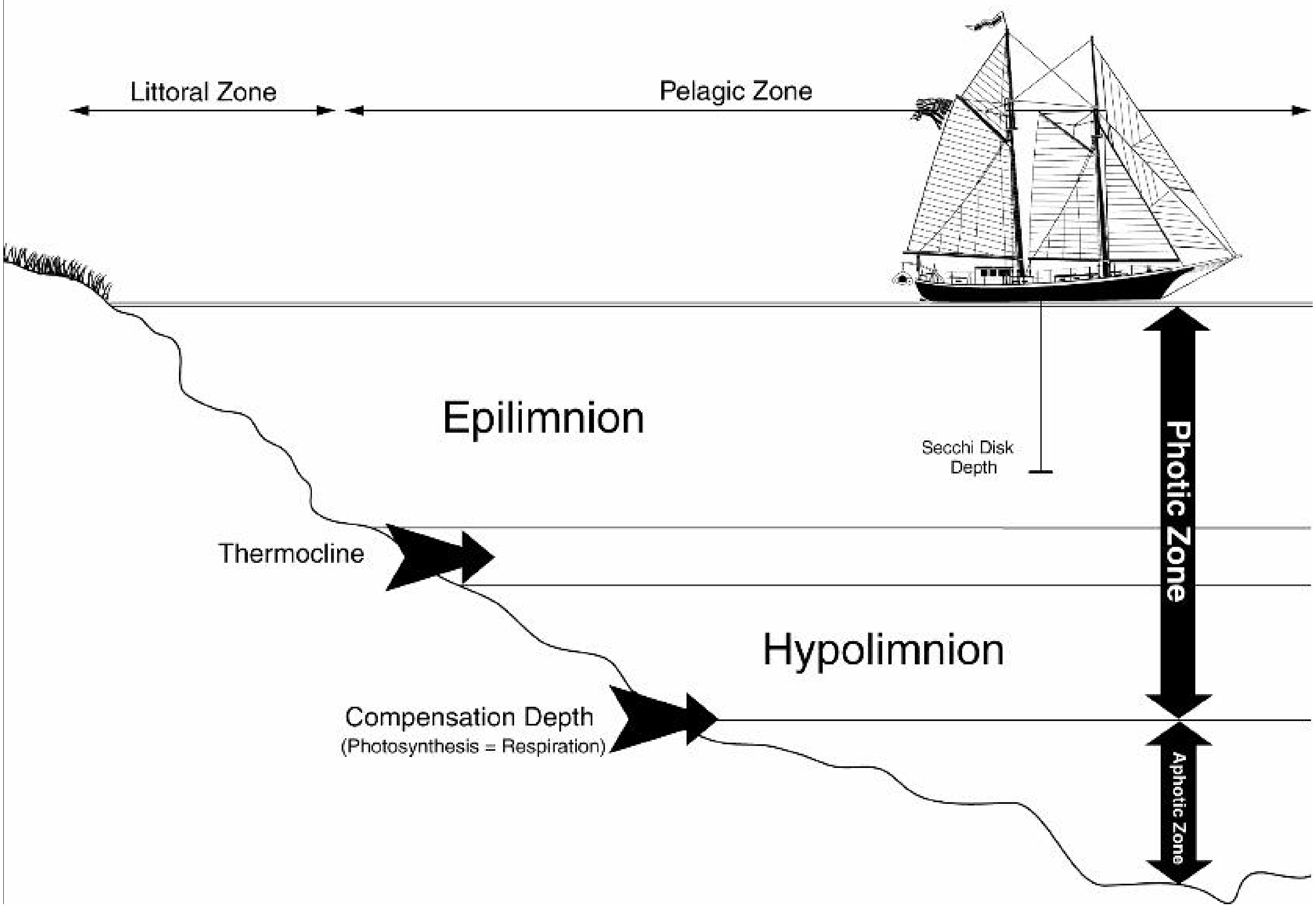
***The Secchi disk** has long been used as a tool of limnologists. It is a disk about 8 inches colored in alternating black and white quadrants. Students on the Schoolship lower this disk attached to a metered line. As the disk descends, students keep count of the meters. Students note the depth at which the disk just disappears. Then the disk is slowly raised and the depth of its reappearance is noted. The Secchi disk transparency depth is the average of the disappearance depth and the reappearance depth.

Visit the following web site for an interesting history of the Secchi disk: http://humboldt.kent.edu/~dipin/secchi.html

Acids and Bases

Grade Level: 6-12
Subject Areas: Earth and Space Science
Setting: classroom/lab
Skills: gathering, analyzing, and interpreting information; applying and evaluating learned information.
Vocabulary: pH, litmus paper, dilution, distilled.

Common Lake Terms



Related State Content Benchmarks Objectives

?? **Write and follow procedures in the form of step-by-step instructions, recipes, formulas, flow diagrams, and sketches.**

?? **Use measurement devices to provide consistency in an investigation.**

Objectives

Students will be able to:

? correctly test the pH of a solution by using litmus paper;

? record pH data, and summarize this data in the form of a chart or graph; and,

? make predictions about the pH of a substance based upon their findings.

Background

On the Schoolship, part of the limnology station is devoted to measuring pH of a bottom water sample. Students may predict that the pH of the bottom water will be acidic because of acid rain. Our normal pH range is about 7.0 - 8.0, or neutral to slightly basic. Most aquatic organisms live within a pH range of 6.0 - 9.0 (see pH chart, page 43). As the pH moves below a pH of 5.0, a lake begins to lose organisms. In certain areas of the Great Lakes (particularly western and northern Lake Superior) bedrock in the form of granite predominates. Limestone dominates the underlying geology of Lake Michigan. It is important for students to note that just as Pepto-Bismol neutralizes the effects of excess stomach acid, so limestone in the lake bed acts to buffer the impact of any acidic rain in Lake Michigan.

Materials

? litmus paper and color chart (order from scientific supplier, see Additional Resources)

? common household liquids, such as dishwashing liquid, laundry detergent, lemon juice, vinegar, soda, milk, tap water, baking soda, etc. (have students bring sample liquids they would like to test)

? clean, wide-mouthed containers (such as cups, margarine tubs or baby food jars) to hold small amounts of these liquids for each research team

? paper and pencils for the group

? distilled water

The Activity

1. Pour a small amount of each liquid you plan to test into a separate container. Make up a set of these containers for each research team. If some of the liquids are too thick or powdery, mix them with a small amount of tap water.
2. Introduce students to the concept of acids and bases. Divide the class into research teams of appropriate size, and distribute the liquids and other lab materials to each team.
3. Have students test the liquids by dipping a strip of litmus paper into each one. Students should use a new strip for each test.
4. Students determine which liquids are acids, and which are bases, by comparing the colors of dampened litmus paper strips to the colors shown on the color chart.
5. Students record their results by noting which liquids are acidic, which are basic, and to what degree.
6. Student teams should summarize this data as a chart or graph. They can share their results with each other to create a class data summary.
7. Discuss with the students some of the characteristics of acids and bases.
8. See if the students can use their knowledge of acids and bases to predict the pH of a new substance--cranberry juice or Pepto-Bismol for example.

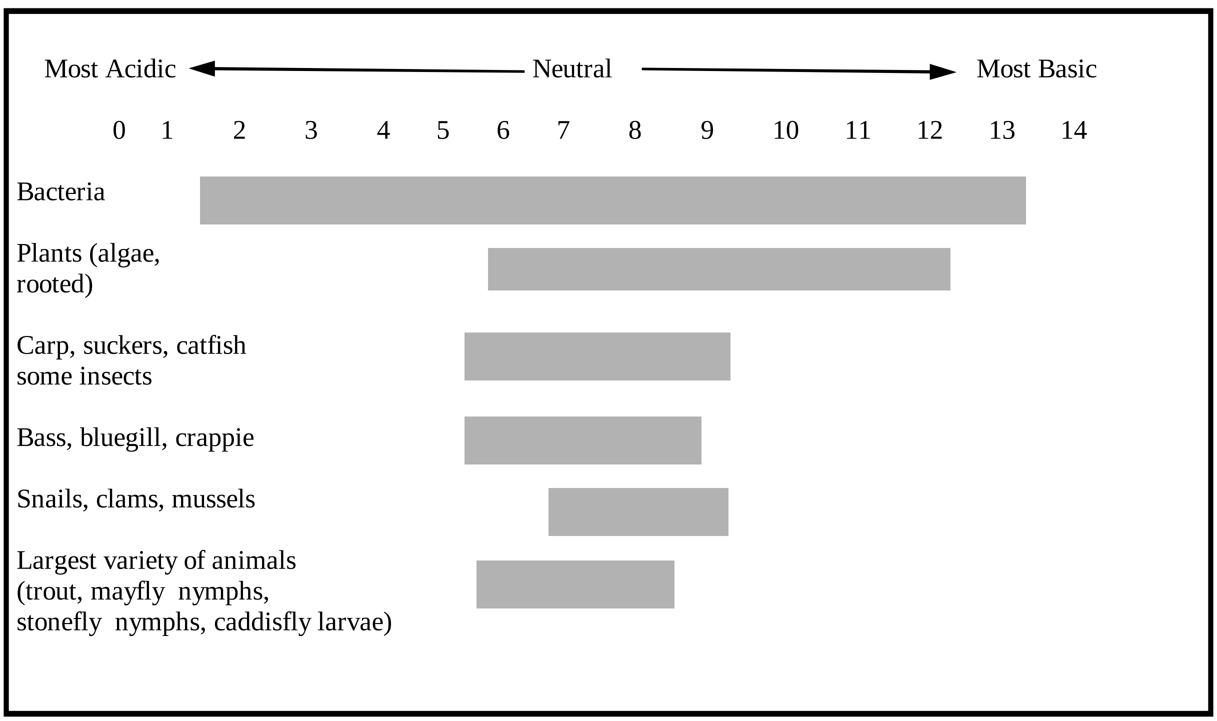
This activity was adapted from:

Schwartz, Linda. 1990. *Earth Book for Kids.*
The Learning Works, Inc., Santa Barbara, CA.

Additional Resources

To order litmus paper, the best quality is ColorpHast indicator strips. To measure most natural waters, the catalog # is S-65271-20D; and measures in the range of 6.5-10. For measuring a wide range of pH values, the pHydrion paper is best, catalog # S-65262-20; this includes two strips: one for a pH range of 1-11 and the second from 12-14. These can be ordered through Sargent-Welch , 1-800-SARGENT.

Mitchell, Mark K. and William B. Stapp. 2000. *Field Manual for Water Quality Monitoring*: *An Environmental Education Program for Schools*. Kendall-Hunt Publishing Co. Good section on the significance of pH and how to measure pH.



Why Do Boats Float?

Grade Level: 5-8
Subject Areas: Physical Science
Duration: 50 minutes or less
Setting: classroom/lab
Skills: gathering, organizing, and analyzing information application of learned information, evaluation of learned information
Vocabulary: buoyancy, displacement

Objectives
Students will be able to:
? design and build a clay boat;
? assess which shape best supports cargo without sinking; and,
? explain the relationship between surface area and buoyancy.

Materials
? 10-20 gallon aquarium filled with water
? pennies
? golf ball size clump of clay for each student or team

The Activity
1. Present a problem: each student or team will design and construct a vessel that will carry the greatest amount of cargo.
2. Give students time to engineer the vessel and to shape the clay.
3. Give each student, or team, a turn floating their vessel, and loading it with pennies until it sinks.
4. The vessel that supports the most pennies is deemed the most seaworthy.

Wrap Up
What shape best supported the weight of the cargo?
Did placement of the cargo affect buoyancy of the vessel?
What is the relationship between surface area and buoyancy?
Given this understanding, design a more seaworthy vessel.

Additional Resources
The Watercourse and Western Regional Environmental Education Council, 1995.
Project WET Curriculum and Activity Guide.

A good related activity in this guide is called "Water Crossings".
In this activity students build a boat that will float using natural materials.

Great Lakes Food Web

Grade Level: 5-8
Subject Area: Life Science
Duration: 50 minutes or less
Setting: classroom/lab
Skills: organizing and analyzing information, interpreting information, and applying learned information.

Related State Content Benchmarks Objectives

- **Identify familiar organisms as part of a food chain or food web and describe their feeding relationship within the web.**
- **Explain common patterns of interdependence and interrelationships of living things.**
- **Predict the effects of changes in one population in a food web on other populations.**
- **Describe how all organisms in an ecosystem acquire energy directly or indirectly from sunlight.**
- **Describe common ecological relationships among species.**
- **Explain how energy flows through familiar ecosystems.**

This activity is modified from "What is a food web?" included in the *Earth Systems* - *Education Activities for Great Lakes Schools* published by Ohio Sea Grant and copyrighted by The Ohio State University. Used with permission. See Additional Resources for ordering information.

Objectives

Students will be able to:

- describe how organisms are related to each other in a food web; and
- predict what might happen if an exotic species was placed in the food web.

Materials

? "Organisms in a Great Lakes Food Web" (modified from *Earth Systems - Education Activities for Great Lakes Schools*, ES-EAGLS)

Background

The concept, *food web*, is at the heart of the Schoolship biological stations: benthos, fish, and plankton. Within those three learning stations, students will see plankton (both phytoplankton and the zooplankton that eat phytoplankton); benthos or bottom-dwelling organisms that often eat dead plant and animal material (detritus)that has settled to the bottom; and small forage fish that consume zooplankton and benthic organisms.

The food web is important to understand in attempting to explain the impact of exotic species like the zebra mussel. Another concept that is covered in the Schoolship Program, particularly in the plankton station, is *biomagnification.* As one moves up the food chain, toxics stored in phytoplankton and zooplankton are carried up the food chain or throughout the food web and magnified.

The Activity

The "Organisms in a Great Lakes Food Web" page should be copied and distributed to students.

1. Students should draw arrows from the organisms that are being eaten to the ones that are eating them.

   In general, organisms on higher levels eat those on the lower levels. For example, lake trout are eaten by people, but lake trout also eat sculpin and alewife. Size of the organisms and their position in the food chain should provide clues to relationship.
2. Remind students that organisms that live in the bottom sediment may feed upon once-living plant and animal material (detritus). Green plants get their energy from the sun and convert this energy to food.
3. After they have completed their food web diagram, tell them about the zebra mussel (see activity: *What do scientists know about invader species of the Great Lakes?,*see page 43*).* Have students make some predictions (changes) to their food web based upon their knowledge of what zebra mussels eat.
4. Students should identify the two exotic species already included in the food web diagram.

Additional Resources

To order *Earth Systems - Education Activities for Great Lakes Schools* (ES-EAGLS) contact Ohio Sea Grant Publications, The Ohio State University, 1314 Kinnear Rd., Columbus, OH 43212-1194. For questions about ordering this material, phone: 614-292-8949. The ES-EAGLS is a set of booklets: *Land & Water Interactions in the Great Lakes*; *Great Lakes Climate & Water Movement*; *Great Lakes Shipping*; *Life in the Great Lakes*; and *Great Lakes Environmental Issues*. They are listed at $8.00/booklet.

The "Great Lakes Food Web" activity is modified from the *Life in the Great Lakes* booklet.

Organisms in a Great Lakes Food Web

Humans

Sea Lamprey

Lake Trout

Alewife

Sculpin

Crayfish

Zooplankton (daphnia, rotifers, copepods)

Midge Larva

Protozoa

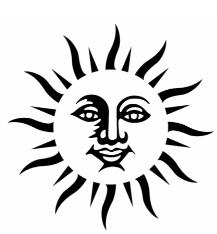
Algae (green algae and diatoms)

Bacteria and Fungi

Rooted Aquatic

Dead Plants and Animals (detritus)

Mineral Nutrients



What Do Scientists Know About Invader Species of the Great Lakes?

Grade Level: 5-12
Subject Area: Life Science
Duration: 50 minutes (2 or 3 class periods for full activity)
Setting: classroom
Skills: gathering information, organizing information, and analyzing information
Vocabulary: ecosystem, exotic species, ballast, brackish, imported.

Related State Content Benchmarks Objectives

?? **Describe common ecological relationships among species.**
?? **Describe general factors regulating population size in ecosystems.**
?? **Predict the effects of changes in one population in a food web on other populations.**

Objectives

Students will be able to:

?? name and visually recognize some invader (non-indigenous) species of the Great Lakes;
?? locate on a world map the origins of the Great Lakes invaders species;
?? explain the ways in which invader species are introduced into the Great Lakes; and,
?? analyze the impacts of invader species on the Great Lakes ecosystem.

Materials

For each group of 3-4 students:

?? copies of the included information cards; each of the three card categories (introduction, ecosystem impact, and invader pictures) should be copied onto a different color card stock paper-24 cards per group); and,
?? answer sheets.

Background

Since the early 1800s, over 140 species of aquatic plants, algae, fish, worms, mollusks, and other organisms have invaded the Great Lakes. Some North American species such as the green sunfish (*Lepomis cyanellus Rafinesque*) have migrated eastward and have become pests in Europe. Biologists worry about these intrusions, because each new species in the Great Lakes alters the region's ecosystems. Ecosystems have a fixed amount of energy that must be divided among all the species present. When a foreign (exotic) species invades an ecosystem, it often has no enemies. This allows an invader to rapidly multiply and to displace native organisms. The introduction of invader species has led to a loss of biological diversity in this region.

It is estimated that about 15 percent of the 175 species of fish in the Great Lakes are nonnative species that were introduced accidentally or intentionally. Eighty-six invader species are plants, although plants have received less attention as invaders. How these invaders get into the region is variable, but many have been shipped in unintentionally.

When ships are not loaded with cargo, they take on ballast to balance and stabilize them as they travel. The use of water as a ballast material has replaced the use of sand and stones. Ballast tanks are filled with water from the harbor where ships are loaded; this water is dumped along with any aquatic organisms present, when ships reach their destination. It is estimated that in the history of the Great Lakes, 34 percent of the invader species entered in solid ballast and 56 percent through ballast water. As shipping times between continents become shorter, the threat of introducing live exotics becomes greater.

The United States and Canada have requested that all ships entering the Great Lakes discharge their water ballast while still in the ocean, replacing it with salt water to reduce the introduction of new exotic species. About 90 percent of the ships currently comply with the request.

The Activity

1. Work in groups of three to four people each, with a complete set of 24 shuffled cards. (If there are eight groups, each group will be able to take a separate invader to report on at the conclusion of the activity).
2. Beginning with the picture of the invader, match the cards to determine which introduction and ecosystem impact card goes with each invader. For each picture, there should be one matching introduction card and ecosystem impact card.
3. When group members agree that they have matched the cards to the best of their ability, they may check their answers on the answer sheet.
4. Each group selects an invader to present to the class; construct a poster on the invader, develop a fact sheet, or create a skit to introduce your invader. The impact of the invader on human affairs should be discussed.
5. Consult the Internet for current information. Begin with sites for the Great Lakes Panel on Aquatic Nuisance Species, for example http://www.glc.org/projects/ans/anspanel.html, and the following:

   ? http://www.great-lakes.net/envt/exotic/exotic.html - Exotic Species in the Great Lakes region

   ? http://www.nfrcg.gov/nas/nas.htm - National Biological Service's, Nonindigenous Aquatic Species (NAS) Information Resource

   ? http://patton.nfrcg.gov:80/zebra.mussel - zebra mussel information resources

Additional Resources

To order *Earth Systems - Education Activities for Great Lakes Schools* (ES-EAGLS) contact Ohio Sea Grant Publications, The Ohio State University, 1314 Kinnear Rd., Columbus, OH 43212-1194. For questions about ordering this material, phone: 614-292-8949. The ES-EAGLS is a set of booklets:

Land & Water Interactions in the Great Lakes; *Great Lakes Climate & Water Movement*; *Great Lakes Shipping*; *Life in the Great Lakes*; and *Great Lakes Environmental Issues*. They are listed at $8.00/booklet. The activity: "What Do Scientists Know About Invader Species of the Great Lakes?" is modified from the *Life in the Great Lakes* booklet.

Michigan Sea Grant. Spiny Tailed *Bythotrephes*. "Its Life History and Effect on the Great Lakes" (booklet). *Upwellings* Vol. 11 (3), Summer 1990 Vol. 14(1), Winter 1992.

Michigan DNR. *Zebra Mussels in Lake Michigan: What recreational boaters and anglers should know* brochure). Office of Great Lakes, P.O. Box 30028, Lansing, MI 48909.

Ohio Sea Grant. *The Spiny Waterflea*, Bythotrephes. *A newcomer to the Great Lakes*. Dave Berg. 2pp. FS-049.

Wisconsin Sea Grant. *The Sea Lamprey: Invaders of the Great Lakes*. Warren Downs. 8 pp. WIS-SG-82-138. 1982.

Minnesota Sea Grant. *Seiche*, Spring 1992 - "Eurasian milfoil: Can it be controlled?"

Introduction

Originally, it came from the Atlantic Ocean, the St. Lawrence and Hudson Rivers (possibly Lake Ontario) and up their tributaries to spawn. It swam from Lake Ontario into Lake Erie through the Erie and Welland Canals, gaining entry into the upper Great Lakes by attaching to the hulls of boats.

Introduction

Originally it came from the Caspian Sea region of Poland, Bulgaria, and Russia. Canals built during the 1800s allowed it to spread throughout Europe. By 1830 it had invaded Britain. First introduction into the Great Lakes was about 1985, when one or more transoceanic ships discharged ballast water into Lake St. Clair. Freshwater ballast from a European port likely contained larvae and possible yearlings. This temperature, freshwater species foud a suitable habitat in plankton-rich Lake St. Clair.

Introduction

A native of Northern Europe, it made its way into Lake Huron in 1984 and was found in all of the Great Lakes by 1987. It is believed to have been brought over in fresh water or mud in the ballast water of European freighters from eastern Baltic ports. Studies show that the Great Lakes' species closely resemble those living in the ports of Finland and St. Petersburg (the former Leningrad).

Introduction

Arriving from the freshwater and brackish water in northern Europe, this invader was discovered in Lake Superior in 1986. It probably "hitchhiked" in ballast waters from Europe and Asia. In five years, its population reached 1.8 million adults, making it the most abundant fish in the Duluth harbor. This bottom feeder can reproduce in its first year and females may lay 13,000 to 200,000 eggs per season.

Introduction

This species was intentionally imported from northern Europe over 100 years ago, because its hardiness and beautiful flowers were popular with landscapers, florists, and gardeners.

Introduction

Coming from the salty Atlantic Coast, this invader migrated through water routes, including canals in New York State and up the St. Lawrence River. It swam into the upper Great Lakes through the Welland Canal, or the Erie barge canal, or both before 1931.

Introduction

It came from Europe, Asia, and North Africa and was introduced into North America as an aquarium plant. It has since spread to 37 states and 3 Canadian provinces

Introduction

From saltwater areas of the Atlantic Coast, this invader moved up the Hudson River and via various canal systems into Lake Ontario and Lake Erie.

Ecosystem Impact

This is a large plankton form that eats smaller zooplankton, thereby competing with small fish for food and affecting fish survival and growth rates. Its spiny tail prevents young fish from swallowing it, thus removing it from the food chain. It is an invader species so new that it may take years to determine its ecological impact.

Ecosystem Impact

Only about 8 inches long, this perch-like fish has no value as a sport or food fish. It is less temperature-dependent than perch and tolerates more polluted areas. It also can find hidden prey in soft sediments more efficiently than its competitors. The fish is not preferred by predators because of its spiny fins. It displaces sport and food fish, especially yellow perch and walleye, yet it is not readily consumed in the food web. This invader made up 90 percent of the fish population in the Scottish Lake, Loch Lommond, only 9 years after it was introduced.

Ecosystem Impact

It is called "the beautiful killer" because its' dense roots choke waterways as it competes with other vegetation. It spreads quickly, crowding out valuable plants that provide food for migrating waterfowl, and destroys habitat for almost all other forms of wetland life.

Ecosystem Impact

Forms thick mats that choke out native aquatic vegetation. It disrupts all forms of water recreation: boating, swimming, and fishing.

Ecosystem Impact

It destroys valuable fish, especially lake trout, by attaching with its sucker-like mouth to suck blood and other bodily fluids. It upsets the ecological balance by removing top predators, allowing for explosion of the populations of smaller fish such as alewives. It had great economic impact on the commercial fishing industry.

Ecosystem Impact

It filters plankton from water, binding what it doesn’ t use into pellets that cannot be used by other plankton-feeding organisms. It accumulates on objects such as boat hulls and underwater pipes and clogs valves of both industrial and municipal water intake pipes.

Ecosystem Impact

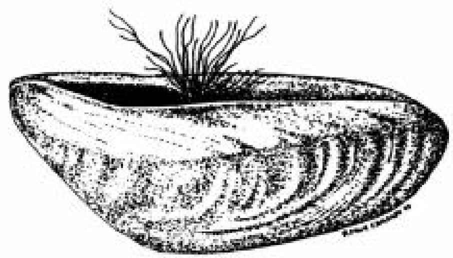
Suspected to be partially responsible for the decline of Lake Erie’ s yellow perch population because of competition.

Ecosystem Impact

Large numbers die off in spring and summer because of an electrolyte imbalance from living in fresh water. These die-offs clog municipal and industrial intake pipes and foul beaches. In 1967, bulldozers had to remove 50,000 tons of the rotting fish. The sea lamprey enabled this invader to thrive by killing lake trout and other fish at the top of the aquatic food chain. After the sea lamprey arrived, this invader proliferated. Between 1960 and 1966, for example, they went from representing 8 percent to 80 percent of Lake Michigan’ s fish by weight. Presently, this invader is food for larger game fish.

INVADER # 1

Zebra Mussel (dreissena polymorpha)
Adult size: 1-4 cm long

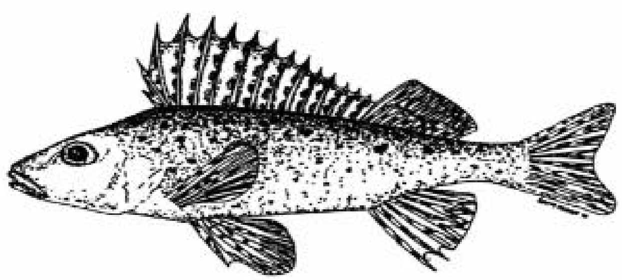


INVADER # 2

Sea Lamprey (Petromyzon marinus)
Adult size: 3 feet (91cm)

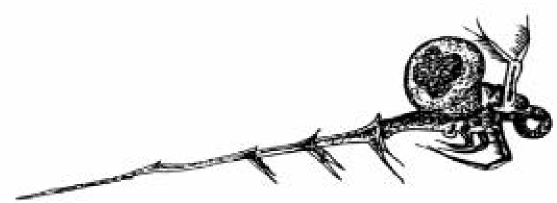
INVADER # 4

River Ruffe (Gymnocephalus cernus)
Adult size: usually less than 15 cm long



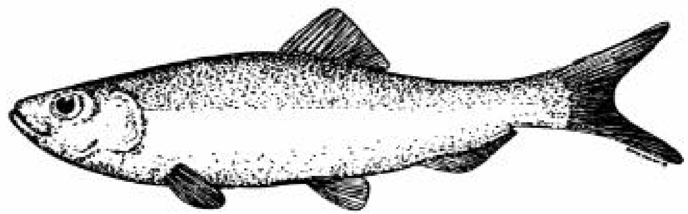
INVADER # 3

Spiny Water Flea (Bythotrephes cederstroemi)
Adult size: 1 cm



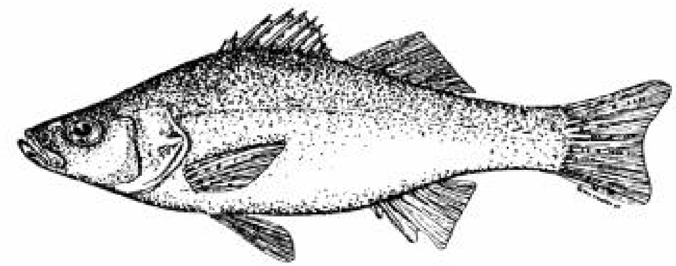
INVADER # 5

Alewife (Alosa pseudoharengus)
Adult size: 3 cm



INVADER # 6

White Perch (Morone americana)
Adult size: 30 cm K20 cm is more common)

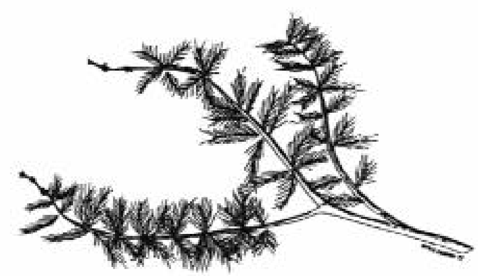


INVADER # 7

Purple Loosestrife (Lythrum salicaria)
Adult height: .5 to 2 meters tall

INVADER # 8

Eurasian Watermilfoil (Myriophyllum spicatum)
Leaflet is actual size.



Answers to Cards

Invader 1: Zebra mussel (*Driessena polymorpha*)

Introduction
Originally it came from the Caspian Sea region of Poland, Bulgaria, and Russia. Canals, built during the 1800s allowed it to spread throughout Europe. By 1830 it had invaded Britain. First introduction into the Great Lakes was about 1985, when one or more transoceanic ships discharged ballast water into Lake St. Clair. Freshwater ballast from a European port likely contained larvae and possible yearlings. This temperate, freshwater species found a suitable habitat in plankton-rich Lake St. Clair.

Ecosystem Impact
It filters plankton from the water, binding what it doesn't use into pellets that cannot be used by other plankton-feeding organisms. It accumulates on objects such as boat hulls and underwater pipes, and clogs valves of both industrial and municipal water intake pipes.

Invader 2: Sea Lamprey (*Petromyzon marinus*)

Introductions
Originally, it came from the Atlantic Ocean, the St. Lawrence and Hudson Rivers, (possibly Lake Ontario) and up their tributaries to spawn. It swam from Lake Ontario into Lake Erie through the Erie and Welland Canals, gaining entry into the upper Great Lakes by attaching to hulls of boats.

Ecosystem Impact
It destroys valuable fish, especially lake trout, by attaching with its sucker-like mouth to suck blood and other bodily fluids. It upsets the ecological balance by removing top predators, allowing for explosion of the populations of smaller fish such as alewives. It had great economic impact on the commercial fishing industry.

Invader 3: Spiny Water Flea (*Bythotrephes cederstroemi*)

Introduction
A native of northern Europe, it made its way into Lake Huron in 1984 and was found in all of the Great Lakes by 1987. It is believed to have been brought over in fresh water or mud in the ballast water of European freighters from eastern Baltic ports. Studies show that the Great Lakes species closely resembles those found in the ports of Finland and St. Petersburg (the former Leningrad).

Ecosystem Impact
This is a large plankton form that eats smaller plankton, thereby competing with small fish for food and affecting fish survival and growth rates. Its spiny tail prevents young fish from swallowing it, thus removing it from the food chain. It is an invader species so new that it may take years to determine its ecological impact.

Invader 4: River Ruffe (*Gymnocephalus cernus*)

Introduction
Arriving from the freshwater and brackish water in northern Europe, this invader was discovered in Lake Superior in 1986. It probably "hitchhiked" in ballast waters from Europe and Asia. In five years, its population reached 1.8 million adults, making it the most abundant fish in the Duluth harbor. This bottom feeder can reproduce in its first year and the females may lay 13,000 to 200,000 eggs per season.

Ecosystem Impact
Only about 8 inches long, this perch-like fish has no value as a sport or food fish. It is less temperature-dependent than perch and tolerates more polluted areas. It also can find hidden prey in soft sediments more efficiently that its competitors. This fish is not preferred by predators because of its spiny fins. It displaces sport and food fish, especially yellow perch and walleye, yet is not readily consumed in the food web. This invader made up 90 percent of the fish population in the Scottish lake, Loch Lommond, only 9 years after it was introduced.

Invader 5: Alewife (*Alosa pseudoharengus*)

Introduction
Coming from the salty Atlantic Coast, this invader migrated through water routes, including canals in New York State and up the St. Lawrence River. It swam into the upper Great Lakes through the Welland Canal, or the Erie barge canal, or both before 1931.

Ecosystem Impact
Large numbers die off in spring and summer because of an electrolyte imbalance from living in fresh water. These die-offs clog municipal and industrial intake pipes and foul beaches. In 1967, bulldozers had to remove 50,000 tons of the rotting fish. The sea lamprey enabled this invader to thrive by killing lake trout and other fish at the top of the aquatic food chain. After the sea lamprey arrived, this invader proliferated. Between 1960 and 1966, this invader went from representing 8 percent to 80 percent of Lake Michigan's fish by weight. This invader is now food for larger game fish.

Invader 6: White Perch (*Morone americana*)

Introduction
From saltwater areas of the Atlantic Coast, this invader moved up the Hudson River and via various canal systems into Lake Ontario and Lake Erie.

Ecosystem Impact
Suspected to be partially responsible for the decline of Lake Erie's yellow perch because of competition.

Invader 7: Purple Loosestrife (*Lythrum salicaria*)

Introduction

This species was intentionally imported from northern Europe over 100 years ago, because its hardiness and beautiful flowers were popular with landscapers, florists, and gardeners.

Ecosystem Impact
It is called "the beautiful killer" because the dense roots choke waterways as it competes with other vegetation. It spreads quickly, crowding out valuable plants that provide food for migrating waterfowl, and destroys habitat for almost all other forms of wetland life.

Invader 8: Eurasian Watermilfoil (*Myriophyllum spicatum*)

Introduction
It came from Europe, Asia, and North Africa and was introduced into North America as an aquarium plant. It has since spread to 37 states and 3 Canadian provinces.

Ecosystem Impact
Forms thick mats that choke out native aquatic vegetation. It disrupts all forms of water recreation--boating, swimming, and fishing.

Shoe Key

Grade Level: 6-12
Subject Areas: Life Sciences
Duration: 50 minutes or less
Setting: classroom
Skills: gathering, organizing, and analyzing information; applying learned information
Vocabulary: dichotomous, classification

Related State Content Benchmarks Objectives

? **Compare and classify familiar organisms on the basis of observable physical characteristics**
? **Compare and classify organisms into major groups on the basis of their structure**

Objectives

Students will be able to:

? construct a dichotomous key using shoes; and,
? apply their understanding of how a dichotomous key works.

Materials

? optional paper and pencils for students
? shoes

Background

A dichotomous key is a tool that scientists use to identify living things. At each level of the key are two category descriptions, **a** or **b**. Students observe the living things that they are attempting to identify, and match a description to that organism. The answer will either lead students to the name of the species, or to another level within the key. (Students should understand that scientists sometimes have trouble classifying certain organisms. For example, the blue-green algae defies easy placement in either the plant or animal kingdom.) The Schoolship Program has designed dichotomous keys for each biological station: benthos (bottom-dwelling organisms), plankton, and fish. At the fish station, students will be expected to identify fish by using a dichotomous key. Explain to the students that they will be constructing a key for shoes, and will apply that understanding of how a shoe key works to other dichotomous keys.

The Activity

1. Have each student take off one shoe.
2. Gather the shoes in a pile in front of the group, arranging them so that everyone can see the shoes.
3. Save one shoe for later identification.
4. Tell the students they will have to come up with two main categories of shoes (a way to divide the shoes into two groups of approximately even numbers). Examples are sport and non-sport shoes, leather and non-leather shoes, shoes with ties and shoes without ties. There will always be some shoes that are hard to classify, for example shoes with Velcro fasteners--is this a tied shoe or not? The students will have to adjust their classification system to handle the types of shoes represented.
5. Write your classification sytem on the board. You may have students copy the key on their own paper, or you can save this until the end of the lesson--it's optional.

EXAMPLE

1a. shoes with ties **2**
1b. shoes without ties ....… .4

6. Now divide one of the sub-categories again, roughly in half. Continue dividing the shoes until you

reach a description for an individual shoe; this represents the species level. If two students have the exact same shoe, then there will be more than one of that species. (Note that keys do not describe individual differences within a given species.)

EXAMPLE:

2a. High-top shoes ....… 3
2b. Low-top shoes ....…5

7. Now , bring out the shoe that was saved earlier for identification. Can students identify the mystery shoe using the key that they designed?

Suggested Readings

Children's Literature

Bach, Richard. 1995. *Jonathan Livingston Seagull,* Avon Books, New York.
Cooney, Barbara. 1991.*Island Boy*. Puffin Books
Gibbons, Gail. 1990. *Sunken Treasure.* Harper Trophy.
Holling Clancy Holling, 1984. *Paddle-to-the-Sea*. Houghton Mifflin, Boston, MA
Holling Clany Holling. 1975. *Seabird.* Houghton-Mifflin, Boston, MA.
Locker, Thomas. 1973. *Sailing With the Wind.* Dial Books, NY
Melville, Herman. 1981. *Moby Dick.* Bantam Classics
O'Dell, Scott. 1987.*Island of the Blue Dolphins*, Yearling Books.
Stone, Nancy. *Whistle Up the Bay*. EERD Man Publishing Co., Grand Rapids, MI
Taylor, Theodore. 1995. *The Cay*. Avon Books, NY
Van Allsburg, Chris. 1983. *The Wreck of the Zephyr*. Houghton Mifflin Co., Boston, MA

Educational

Adkins, Jan. 1994. *The Craft of Sail.* Walker and Company Publishing. Inc.
Coulombe, Deborah. 1992. *The Seaside Naturalist: A Guide to Study at the Seashore.* Prentice-Hall, NY
Earthworks Group. 1994. *50 Simple Things Kids Can Do to Save The Earth.* Scholastic, Inc.
Lehr Paul, Will Burnett, and Herbert Zim. 1987. *A Golden Guide: Weather*. Golden Books Pub. Co.
Simon, Seymour. 1988. *How to Be an Ocean Scientist in Your Own Home*. Lippincott Williams & Wilkins Publishers
Zim, Herbert, Hurst Shoemaker, and James Irving. 1987. *A Golden Guide: Fishes.* Golden Books Pub. Co.

Great Lakes

Bowen, Dana T. 1940. *Lore of the Lakes.* Freshwater Press, Inc.
Mitchell, John and Tom Woodruff. 1991. *Great Lakes and Great Ships: An Illustrated History for Children.* Suttons Bay Publications, Suttons Bay, MI
Mitchell, John and Tom Woodruff. 1995. Michigan: An Illustrated History for Children. Suttons Bay Publications
Ratigan, William. 1960. *Great Lakes Shipwrecks and Survival.* Wm B. Eerdmans Publishing Co.

Internet Resources

The following is a list of helpful Web sites organized according to the learning stations on the Schoolships.

Weather

http://www.nws.fsu.edu/B/buoy?station=45002
(access real time wind and wave data from the weather buoy in northern Lake Michigan, inactive during the winter, but should be up by April)

http://ww2010.atmos.uiuc.edu/
(an excellent site for all aspects of weather)

http://www.intellicast.com
(has forecast maps, radar summaries of cities and regions across the US)

Limnology

http://www.aslo.org/aslo/aquatic.html
(site of the American Society of Limnology and Oceanography)

http://www.nalms.org
(site of the North American Lake Management Society)

http://www.glerl.noaa.gov
(site of the NOAA Great Lakes Environmental Research Lab in Ann Arbor; includes information about research on the Great Lakes)

http://www.mdsg.umd.edu/NSGO/index.html
(this site links all of the Sea Grant programs around the Great Lakes

Sediment/Benthos

http://www.benthos.org
(site of the North American Benthological Society)

Plankton

www.cs.uwindsor.ca/users/h/hughm/private/cercopagis.html
(has photos and information about *Cercopagis pengoi* a large predatory invader zooplankton
This exotic plankton was first discovered in Lake Michigan by a school group on Inland Seas during a Schoolship program in the fall of 1999.)

www.ansc.purdue.edu/sgnis/publicat/fb31_97.htm
(site for *Bythotrephes cederstroemi*, a large predatory exotic zooplankton sampled in Grand Traverse Bay in later summer and fall)

Fish

http://www.seagrant.wisc.edu/Communications/Publications/Fish/index.html
(has photographs and descriptions of common Great Lakes fish)

http://www.great-lakes.org/
(informative site of the Great Lakes Sport Fishery Council)

http://www.fws.gov/r3pao/marquette

(site devoted to the sea lamprey and controls)

http://www.fisheries.org/
(site of the American Fisheries Society)

Navigation

http://www.baysail.com
(very interesting site about sailing, based in San Francisco)

http://www.great-lakes.net/
(general Web site about the Great Lakes from the Great Lakes Information Network)

www.ngac.noaa.gov/mgg/g/greatlakes/michigan.html

Seamanship

http://www.tallships.sailtraining.org/index.html
(site for the American Sail Training Association)

www.novagate.com/`schoonerman

www.oakland.edu/boatnerd

Other Interesting Web sites

Lake Levels

http://www.great-lakes.net/envt/water/hydro.html
(features overview of hydrology concepts, and includes links to current, forecasted, and historical data on lake levels)