THE DEVELOPMENT AND IMPLEMENTATION OF A GREAT LAKES THEMATIC UNIT AT SHEBOYGAN FALLS MIDDLE SCHOOL

By

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APPROVED BY THE GRADUATE ADVISOR

[Signature]

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ABSTRACT
Abstract

The purpose of this project was to create an integrated unit which would expose all seventh grade students at Sheboygan Falls Middle School in Sheboygan Falls, Wisconsin to the Great Lakes. The school is located in Sheboygan County and is about fifteen minutes from Lake Michigan.

During the 2001-2002 school year, information was given to the seventh grade teachers and the director of instruction regarding the activities that would be included in the project with requests for feedback. In the spring of 2003 each teacher was given a binder that included all materials needed for them to teach their academic portion of the unit. In each binder was a divider that contained standards covers in each academic area, a divider for each activity to be taught and a divided section for papers that would need to be copied for the students. In addition there were evaluation forms to be filled out at the completion of the unit. Each activity had an introductory page with the school and EE standards listed, brief directions if needed and any rubrics or overheads which would be needed to teach the activity.

All seventh grade students spent from one to two weeks learning about the Great Lakes. Activities included local history and the connection to the Great Lakes, water usage, groundwater, invasive species and water quality.

After completing the unit some teachers commented that they liked the format with all materials included and ready to use. The students demonstrated their knowledge in discussions, a written reflection and participation on the S/V Denis Sullivan. Students demonstrated an increase in their knowledge and a greater awareness and concern for the Great Lakes region.
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CHAPTER ONE
THE PROBLEM AND ITS SETTING

Introduction

This project took place in the city of Sheboygan Falls, Wisconsin with an approximate population of 6,741. The school district includes one high school, one middle school and a new elementary school. This project took place as part of the seventh grade curriculum.

Sheboygan Falls Middle School houses grades five through eight. The seventh grade class has about 150 students. The students have 49 minute class periods which include a related studies block. In addition to regular education students we have EBD, LBD and CBD students.

Prior to the implementation of this project, the seventh grade teachers did not all incorporate EE into their respective curriculums. The following is a statement of the problem and subproblems focused on throughout the duration of the project.

The Statement of the Problem

The purpose of this project is to develop, implement and evaluate a seventh grade environmental education integrated unit on the Great Lakes at Sheboygan Falls Middle School.
The Subproblems

Subproblem 1: To determine which Wisconsin standards will be covered in each discipline (science, math, social studies and language arts) in relation to the Great Lakes.

Subproblem 2: To locate resource materials containing information and activities on environmental education and the Great Lakes.

Subproblem 3: To develop an environmental education integrated unit on the Great Lakes.

Subproblem 4: To work with the director of instruction on an in-service for the seventh grade team members to implement the curriculum.

Subproblem 5: To create an instrument for seventh grade teachers to evaluate the curriculum after its implementation.

The Significance of Problem

The significance of the problem is that the administration of the Sheboygan Falls School District requires the implementation of at least two integrated units in the middle school. The current seventh grade curriculum includes only one integrated unit. There is also a lack of environmental education in the current seventh grade curriculum. One of the guiding principles of environmental education from the Tbilisi Declaration states:
Environmental education should be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective.

The stated principle confirms the need for integration of environmental education and therefore presents two good opportunities to infuse EE and to add a second integrated unit to the seventh grade curriculum

The Limitations

This study is limited by:

1. The cooperation of each teacher on the team to complete the integrated unit.
2. Maximum of one week for the unit.

The Definitions of Terms

**Environmental education** (EE)- producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution.

**Integrated**- bringing together of different parts into a functional or unified whole.

**Unit** – a collection of materials to be taught in the classroom on a specific subject.

**Implement** - in servicing the teachers to teach a unit on the Great Lakes to put the unit into action.
Evaluation - a questionnaire for the teachers to fill out at the end of the unit on their in-service and quality of the program.

Seventh grade team – all core academic teachers (science, math, social studies, and language arts) in seventh grade and the seventh grade learning disabilities teacher

The Assumptions

The assumptions in this project include:

1. The Sheboygan Falls seventh grade teachers will participate in implementation and evaluation of an integrated environmental education unit.

2. Sheboygan Falls Middle School administration will support this project.

3. There is a need for integration of environmental education into the Sheboygan Falls seventh grade curriculum.

4. There is an interest in the Great Lakes at Sheboygan Falls Middle School.
CHAPTER TWO
LITERATURE REVIEW

Importance of Standards in Curriculum

According to the Department of Public Instruction (1998), standards are necessary to serve as rigorous goals for teaching and learning. These standards were devised to allow the public to know what material students should have learned at a given time. These standards should be the platform on which statewide assessment is established.

When considering the standards, I reflected on what Simmons (1998) stated; that the goals required for education should set a national mandate to establish high standards for the disciplines. These standards are designed to define what students will learn and to what level they should be able to perform to be considered literate in all subject areas.

I obtained copies of the standards provided by the district of Sheboygan Falls and a copy of the environmental education standards. These documents were used as a guide when selecting activities for this project. (Appendix A)

Simmons (1999) article on curriculum focuses on the importance of environmental education in a standards-based curriculum. Since there is great focus on standards based instruction in the district, I did try to tie the districts standards, which are written to meet the needs of a specific discipline, with the standards of environmental
education. I found after reading the EE and the Sheboygan Falls science standards that there was not always a close correlation between the two documents, so I used both documents to ensure all that all standards would be covered. (Appendix A) It was the correlation between the two standards documents which allowed me to integrate environmental education into the classroom. Simmons (1999) gives the hypothization that infusing EE into the curriculum would ideally lead to environmental literacy.

Great Lakes

Support for this project idea came from Fortner and Mayer’s (1991) research on the Great Lakes. They felt that environmental awareness did show some correlation to an increased knowledge after instruction. The two areas they did notice that environmental education were being overlooked in were in the areas of art and music. I found that this was relevant in my school but I also found that both departments were very excited about participating and incorporating materials about the Great Lakes into their programs.

With a discussion of the Great Lakes, I felt that exotic species awareness was a critical issue and found supporting research from Mills (1994). I found it interesting that there is debate as to which species were introduced and which were natural. With exotic species being of great concern to the ecosystem to the lakes, I looked into curriculum materials from Wisconsin Lake Schooner Education Association and
Wisconsin Sea Grant. I was able to find several videos and activities that would provide extensions for environmental action. With some of the activities, the students are to brainstorm what they believe will be the future impact of the various invasives. I was surprised that it is believed that there are at least 139 exotic species that have been introduced into the Great Lakes.

To create a well rounded curriculum I also found materials from Ohio Sea Grant, Lake Michigan Federation, The Groundwater Foundation, USEPA and the DNR which had materials on lake quality, overturn, shipwrecks, water usage, groundwater contamination and how runoff can enter Lake Michigan. In music class the students learned a variety of songs sung by early sailors on the Great Lakes and in art class they did fish printing.

Curriculum Development and Integration

May (2000) found that it is important that the curriculum is multidimensional and incorporates elements both within and beyond the classroom walls. It was this realization that multi-dimensional EE needs to take place both in the classroom and outside which caused me to look into a fieldtrip that would expand on the classroom experiences. I found that Wisconsin Lake Schooner had an excellent program which studied the lake while experiencing sailing on the S/V Denis Sullivan. To me improving education and doing what is best for kids is top priority, but I have realized that is not the case for all teachers. I found this statement by May very fitting. May
cautions that there needs to be dedicated teachers and administrations to support any EE program, in addition to well-written assessments to measure student growth.

I was concerned about creating a unit that would be valid for the seventh grade curriculum, and that would be accepted by the seventh grade team members. Prior to assembling the curriculum I looked at the content and the disciplines that will be integrated and checked validity for the activities and lessons... Burton (2001) focuses on three types of curriculum integration. Thematic integration is the first example, where themes become the curriculum organizer. The second is knowledge integration. This is a higher level of learning that is connected between two or more disciplines. The third is learner-initiated integration. This type of integration is believed to be the most important, since it relates to higher level thinking skills throughout life. The Great Lakes integrated unit that will be implemented in the seventh grade will focus on the second type of integration, with a concentration on higher level thinking. One goal I have is to include a yearly field trip aboard the S/V Denis Sullivan where the students will be required to expand on in-class learning by participating in sailing on Lake Michigan and water quality testing.

I found the rationale Simmons (1989) gives for infusing EE is something that all districts should keep in mind. “If EE is incorporated throughout the total curriculum at every grade level, a more comprehensive treatment of environmental concerns can be accomplished.” Even though it is mandated that EE be taught in the schools, I personally don’t believe it is incorporated throughout the total curriculum. It appears
that EE is an enrichment course or a part of the science curriculum. This perception is reinforced by a study that found that many teachers believe that EE should be part of the science curriculum and not infused with all subject areas. Simmons (1989) found in her study that most of the available curriculum materials are for science. In conclusion, for infusion to take place, more curriculum materials need to be available and should also be easy to access and use.

EE is to prepare individuals to be responsive to our changing world, but the question is how this should be done. Wisconsin is a frontrunner since it models having EE incorporated into the existing curriculum plans. Ramsey, Hungerford, and Volk (1992) have stated that environmental content and skills can often be integrated into existing courses without interfering with desired curriculum plans. I have personally found that not all teachers are enthusiastic of new ideas or being asked to teach different materials even if they meet the standards that the district requires them to teach.

Implementation of the Curriculum

Konen and Horton (2000) looked at the change in anxiety, confidence and interest in teachers using a workshop to inform them about materials to be taught. They discussed that teachers found hands-on training helpful. With the training, the teacher’s anxiety about teaching the material decreased and their confidence increased. Teachers experience curriculum the same way students would, which increased the teacher interest and curiosity. My plan was to follow this advice and
use a hands-on training for the introduction of the Great Lakes unit. I thought that by involving the teachers in the materials, they in turn would become more interested and excited about participating in the unit.

Stone (1989) stated that if teachers do not have positive attitudes toward EE, very little instruction in this area would occur in the classroom. The teachers were a little hesitant about being required to teach this unit. To help them feel more at ease with the material, I made a binder for each teacher that would contain all necessary materials they would need for the unit and a brief timeline as to when all materials should be completed but with plenty of flexibility in the schedule.

Evaluation of Unit Materials

The Office of the Queensland School Curriculum Council (2001) has stated that evaluation is a basis for decision making about the need for, and direction of, change within curriculum. It is also believed that the outcomes of evaluation may improve student learning. With this in mind, I felt it was important to have the seventh grade teachers evaluate the material so we could assess ways to improve the curriculum. I looked at various types of evaluation forms and decided the format that left open ended questions would provide better feedback for improving the curriculum.

(Appendix F)
CHAPTER THREE
PROJECT METHODOLOGY

SUBPROBLEM ONE
To determine which Wisconsin standards will be covered in each discipline in relation to the Great Lakes.

To determine the standards that would be utilized in this unit, copies of the standards for Sheboygan Falls Middle School were obtained for the subjects of science, math, Language Arts and social studies. These were obtained from the Director of Instruction, Jean Born. In addition to the standards for Sheboygan Falls, Wisconsin’s model academic standards for environmental education also needed to be obtained. After acquiring the standards and reflecting on the science documents, I realized I would be required to use both documents independently due to the fact there were numerous gaps in what EE standards were covered. (Appendix A)

SUBPROBLEM TWO
To locate resource materials containing information and activities on environmental education and Great Lakes.

To locate resources containing materials relating to environmental education and the Great Lakes, an internet search was done in addition to utilizing the library at the University of Wisconsin Stevens Point and discussion with Bill Nimke, education
director, from Wisconsin Lake Schooner. Materials were ordered from Ohio Sea Grant, Lake Michigan Federation, Wisconsin Lake Schooner Education Association, The Groundwater Foundation, USEPA, Wisconsin DNR and Wisconsin Sea Grant. Once the resources were obtained, they were evaluated and selected for lessons which would accommodate the relevant standards.

SUBPROBLEM THREE

To develop an environmental education integrated unit on the Great Lakes.

To develop an integrated unit, I took the curriculum guides and marked each possible activity with a post-it note which included subject area and standards. With all activities marked, each was read to look for correlation with the standards. The lessons were grouped by subject and then selected for the unit. The selected activities needed to relate to each other and occupy less than two total weeks. For each academic curricular area a typed outline for each lesson was prepared that included the standards (Appendix B,C,D,E). The outlines and copies of lessons were given to Jean Born, Director of Instruction, and by subject area to the seventh grade team members. Feedback was requested from each teacher and from Jean Born, Director of Instruction. In addition to the academic materials being evaluated by the teachers, the planning and scheduling of a sailing expedition aboard the S/V Denis Sullivan was also done by myself and the principle, Robert Flaherty. (Appendix G)
SUBPROBLEM FOUR

To work with seventh grade team members and the director of instruction to implement the curriculum.

After sending a copy of the material to the Director of Instruction, Jean Born, a verbal approval of the material was communicated. Further communication was done via E-mail to report progress of implementation. A binder was made for each seventh grade team member containing the necessary materials to teach their content area. Meetings were set up with each discipline to discuss the materials and expectations for each lesson. Each teacher was given their own binder including overheads, role cards and laminated posters. The unit was taught between May 19, 2003 and June 6, 2003. This gave some flexibility in scheduling for each teacher.

SUBPROBLEM FIVE

The creation of an evaluation form for the seventh grade teachers to use upon the conclusion of the unit.

A list of possible questions was created and ranked as possible evaluation questions. A narrative list of four questions was prepared for each teacher to complete upon completion of the unit. A copy of the evaluation questions was forwarded to the Director of Instruction along with a copy of the unit. An evaluation form was inserted in each teacher’s binder on the first page with a reminder note to fill in and return the form at the end of the unit. Upon collection of the evaluations, suggestions were used for the improvement of the unit (Appendix F).
CHAPTER FOUR

PROJECT RESULTS

SUBPROBLEM ONE - RESULTS

To determine which Wisconsin standards will be covered in each discipline in relation to the Great Lakes.

I was able to obtain a copy of the middle school standards from the Director of Instruction, Jean Born. I also obtained a copy of the Wisconsin EE standards from the EE Resources Coordinator, Phyllis Peri. Once I obtained the standards I studied both documents for areas where they overlapped. There were many environmental standards that were not covered by our middle school standards. I did share with the Director of Instruction the EE standards I felt were not clearly being met in our district standards.

SUBPROBLEM TWO- RESULTS

To locate resource materials containing information and activities on environmental education and the Great Lakes.

I contacted Bill Nimke about the use of the S/V Denis Sullivan for a personal water and sailing experience for my students. After discussing this unit with the Director of Instruction we thought this would be an excellent field trip for our students to do as a culmination of the unit. It was planned that the seventh grade class would travel to Milwaukee on two separate days where the students would be
able to participate in the expedition program in groups of 45. In addition to contacting Wisconsin Lake Schooner for the use of the S/V Denis Sullivan and their education resource manual, I obtained materials from Sea Grant, EPA, Lake Michigan Federation, DNR, and the Inland Seas Education Program. In Sea Grant, I found activities on invader species; with EPA, I used their resource book for background information in several activities and the resource book *Great Minds? Great Lakes!* was used for several social studies activities. The Lake Michigan Federation provided excellent resources that could easily be applied to math, the DNR provided several posters and additional information on local exotics, and from the Inland Seas Education Program I found a great Language Arts activity that used music to help teach about life on the lakes.

**SUBPROBLEM THREE- RESULTS**

To develop an environmental education integrated unit on the Great Lakes.

Each possible activity was marked with a post-it note and the subject area it fit under. Once the activities were marked, the EE standards and the Sheboygan Falls School District Standards were marked on the post-it notes. Upon the identification of the standards, a unit outline was created for each subject area. The outline included the name of the activity and the source where the activity came from, the standards and a brief set of directions for the completion of the lesson. With a basic idea of the activities and standards that were to be incorporated, a copy was given to each teacher according to his or her subject area and I asked for feedback from him or her. After feedback was asked for, a copy of the tentative unit was taken to the
Director of Instruction for insight and additions. A copy of the project at its current state was sent to Dr. Randy Chamepau. A general revision process continued though the summer of 2002. A meeting on July 15, 2002 with Dr. Chamepau was used to go over the revised unit. Revisions continued prior to the implementation of the unit. The history lesson for social studies was altered from a book to a web page assignment with the help of Karen Wodach, Josh Schuren and Sloan Allen. (Appendix C, H)

**SUBPROBLEM FOUR – RESULTS**

To work with the seventh grade team and the director of instruction to implement the curriculum.

All members were kept up-to-date on the progress of the unit through verbal communications and e-mail. As the unit neared completion, a copy was given to the director of instruction for approval. Since not all seventh grade teachers teach the same subject we held subject area meetings for in-service where we discussed each activity and went over the binder each teacher was given that contained all materials they would need to teach their subject material. (Appendix B, C, D, E) Meetings were set up first with the social studies teachers followed by the Language Arts and math with science being last. The unit was devised to allow teachers freedom in the scheduling of the activities which would fall into the timeline dates of May 19- June 6 for completion of the unit.

**SUBPROBLEM FIVE – RESULTS**
The creation of an evaluation form for the seventh grade teachers to use upon the conclusion of the unit.

A form was completed and was included with each teacher's binder. Not all teachers filled out the form. The answers to the questions focused solely on the sections of the unit each teacher worked with. Some of the answers focused on the field trip and not truly on the unit. The following are the responses provided by the seventh grade teachers that reflected the unit.

The first question: "In what ways do you feel this program on the Great Lakes was beneficial to middle school students?"

Responses: "Middle school students need hands-on experiences to cement their learning. This program provides such experiences."

"Gives them an awareness of what the Great Lakes actually are and their significance to our area and the world"

"It made them realize how much water they use and why that's not good"

The second question: "How has this program influenced your belief as to whether or not you can make a difference environmentally speaking in your teaching?"

Responses: "The program helped to reinforce what I try to teach the students about the environment."

"I think studying the impact humans have on the environment by actually seeing polluted water and soil"
The third question: “Is it worthwhile to continue this type of program? Why or why not.”

Responses: “It is worthwhile because the message of the program is relevant to students who live here in the Great Lakes region and for future use of water resources.”

“It is worth continuing because the children take the Great Lakes for granted. This program shows them how wonderful and diverse the Great Lakes system really is.”

“Yes, since we need to take care of our water sources and this is a good way of teaching that.”

The fourth question: “Based on the material you taught what recommendations do you have in regards to rubrics, lesson material, or time requirements?”

Response: “It took longer than I thought”

“Everything well designed, thought-through, and user friendly. I just presented the activities and away we went!”

“I think the time requirement fit well in the end-of-the-year schedule.”
CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

Subproblem one concluded with the realization that the Sheboygan Falls School Districts standards and the EE standards did not truly overlap. I found that the EE standards are not all encompassed into our districts standards. What I did find is that in Wisconsin’s Model Academic Standards for Science under the heading of Life and Environmental Science is the location where a majority of the standards came from for EE. Since the two documents didn’t completely relate, I made a list for each EE standard covered and a list for the ones not covered. A recommendation I have is to work with the Director of Instruction and to have Wisconsin’s Model Academic Standards for EE more completely incorporated into our current standards. I believe that more of the standards could easily be met if teachers knew more about them.

Subproblem two concluded after spending many hours on the internet looking for activities. I did find the Internet to be a good tool, but many of the resources had a fee so it did cost me some money to get the different materials that were needed. Some books I did have the school district purchase, but the ones I wanted to keep for myself I chose to purchase. When researching activities for specific subject areas, a recommendation is to look at the suggested subject area. Finding middle level activities for all subject areas was a little difficult. I found that finding math activities which were grade appropriate was especially challenging. Using post-it notes was an easy was to bookmark and jot down notes and standards. One thing I would change is that I would use different color notes for
each subject area. This would make it easier to reference in the activity books. When recording the standards I referenced only the identification numbers. This saved time and I was able to put all the information on the post-it note. The next step was to create an outline for each discipline. I focused on subject area to prepare a list of the activities and the standards that would be taught. This did take a while to type all the standards out for each area. I did copy and paste the repeated standards.

Subproblem three concluded with great efforts for coordinating an experience on the S/V Denis Sullivan for the spring of 2003. The first challenge was in finding if they could bring the schooner to Sheboygan. This was important to cut down on bussing costs since it will cost about $5,500 to have all students participate on the schooner. Once finding that Wisconsin Lake Schooner was not able to bring the Denis Sullivan to Sheboygan I had to get an ok by the budget committee for a portion of the money to pay for the experience. Having gotten clearance by the budget committee I was able to confirm with Bill Nimke and start planning for the sailing experience and the pre-sailing activates that are recommended. This took a lot of time and discussions between Bill Nimke and myself to set up. We set this up over a year in advance and have still had some problems in finding times where the schooner would be available. There continued to be some problems with Wisconsin Lake Schooner. The contract was sent about a month late and was received on the last day of school 2002. The
contract was given to the principal to look over and sign, as well as to check for any concerns that the district would have.

Subproblem four concluded with the introduction of the project idea to my academic teaching team. Unfortunately they were not very interested until I clearly let them know I was going to do all the leg work and prepare the materials. Then they were more interested in teaching the unit. The math teacher liked the activities and the fact there were not a lot of them (Appendix D). I know there is a time factor in math to complete a specific amount of material. The social studies teacher was very interested and thought about looking at them and maybe even trying part a year early (Appendix B). I do not know if he did this or not. I worked closely with the language arts teachers to fine-tune the activities and rubrics so they fit the 6-trait writing we are using in the district (Appendix E).

Once I had given the seventh grade teachers a chance to comment on the activities, I took the unit to the Director of Instruction. She was very excited about the unit and the materials that were incorporated into the unit. I found her to be a great person to bounce ideas off of as I was preparing and finalizing the unit. It really made a difference to have support from Jean Born, Director of Instruction. Requiring more than a two-hour drive to UWSP, it was not convenient to personally deliver the unit so a copy was sent to Dr. Chamepau. I continued to prepare the final unit and worked with one of the social studies teachers, Karen Wodach, to modify the local history activity (Appendix B). With collaboration, we took a local history research project and turned it into a webpage project with the help of the computer teacher and the second social
I was very excited about the change in this activity and the support to incorporate it into a webpage. Unfortunately this project did not receive such support from all my team members. On numerous occasions when I brought up the unit for feedback or discussion for the culminating field trip on the S/V Denis Sullivan that I would get comments that it is a science project or it is not until June and to not worry about it. The team I worked with changed from the initial group that previewed the activities to the group that implemented the unit. The unit was not accepted as well by the implementing team as it was by the previous group. I did find this very difficult to accept and work with. I even talked with the principal and director of instruction about the lack of support for the unit and for their help to persuade implementation in all subject areas. There was more acceptance for the unit after the intervention from administration. With continued resistance from the team I did not do the in-services as I would have liked having the teachers participating in the activity from each academic area. Instead I met with each teacher by discipline and we just discussed the activities after they had an chance to look over the materials. This did go better than I thought it would because my team members were more accepting of the unit than in prior discussions. After the discussion sessions there was not much discussion of the unit in our team meeting except for dates of teaching the unit. I don't feel I met one of my goals of providing an experience where the non-science teachers are excited about the infusion of EE into their subject areas with the exception of social studies. The social studies teachers’ response to this unit and its incorporation is what EE needs to have integration in curriculum. Karen Wodach
has taken my materials and went even farther to find other activities and lessons which could be used to enhance our study of the Great Lakes.

Subproblem five concluded with the creation of the evaluation forms (Appendix F). I tried to make them as simple as possible while still providing useful information for myself. The teachers that were accepting of the unit did complete the forms with useful information, in comparison to the teachers that were not as open-minded to participation in the unit. This is what I expected to happen and the only way to get completed forms from every teacher would have required administrative intervention and I did not feel that this would truly provide responses of better quality. Looking back on this project, one final recommendation I have is to only undertake this type of project if you are working with a team that is willing to participate. I believe that the final outcome of the project would have been better if all members would have been supportive of the idea of the Great Lakes unit.
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Bibliography of literature


*Wisconsin’s Model Academic Standards for Environmental Education.* (1998). Milwaukee, WI; Wisconsin Department of Public Instruction

Bibliography of activities


Lake Michigan Federation. The Great Lakes in my World. U.S.A.


APENDIX A

STANDARDS
### Wisconsin’s Model Academic Standards for Environmental Education
#### 8th Grade

<table>
<thead>
<tr>
<th><strong>EE8thgradestandnum</strong></th>
<th><strong>Standard Text</strong></th>
<th><strong>fully</strong></th>
<th><strong>partially</strong></th>
<th><strong>not at all</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>EE-A</td>
<td>Questioning and Analysis Content Standards: Students in Wisconsin will use credible research methods to investigate environmental questions, will revise their personal understanding to accommodate new knowledge and perspectives, and will be able to communicate these understandings to others.</td>
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<tr>
<td>EE-A.8.1</td>
<td>Identify environmental education issue questions that can be investigated using resources and equipment available</td>
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<tr>
<td>EE-A.8.2</td>
<td>Develop possible solutions to their investigations, conduct experiments, and collect information from a variety of resources.</td>
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<tr>
<td>EE-A.8.3</td>
<td>Use observations and techniques such as models and simulations to organize information gathered in their investigations</td>
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<tr>
<td>EE-A.8.4</td>
<td>Interpret and analyze gathered information using critical thinking strategies.</td>
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<tr>
<td>EE-A.8.5</td>
<td>Draw conclusions, develop answers, and revise their personal understandings as needed based on their investigations.</td>
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<tr>
<td>EE-A.8.6</td>
<td>Communicate their understanding using a variety of media, logically defending their answers based on findings gained from their investigations</td>
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<td>EE-B</td>
<td>Knowledge of Environmental Processes and Systems Content Standard: Students in Wisconsin will demonstrate an understanding of the natural environment and of the interrelationships among natural systems</td>
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<tr>
<td>EE-B1</td>
<td>Energy and Ecosystems Theme</td>
<td></td>
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</tr>
<tr>
<td>EE-B1.8.1</td>
<td>Describe the flow of energy in an natural and artificial ecosystem using the laws of thermodynamics.</td>
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<tr>
<td>EE-B1.8.10</td>
<td>Explain and cite examples of how humans shape and control the environment by creating knowledge and developing new technologies.</td>
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<tr>
<td>EE-B1.8.11</td>
<td>Describe our society as an ecosystem.</td>
<td></td>
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</tr>
<tr>
<td>EE-B1.8.2</td>
<td>Explain how change is a natural process, citing examples of succession, evolution, and extinction.</td>
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<tr>
<td>EE-B1.8.3</td>
<td>Explain the importance of biodiversity.</td>
<td></td>
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<tr>
<td>EE-B1.8.4</td>
<td>Map the levels of organization of matter.</td>
<td></td>
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<tr>
<td>EE-B1.8.5</td>
<td>Give examples of human impact on various ecosystems.</td>
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<tr>
<td>EE-B1.8.6</td>
<td>Describe major ecosystems of Wisconsin.</td>
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<tr>
<td>EE8thgrade/standard</td>
<td>Standard Text</td>
<td>fully</td>
<td>partially</td>
<td>not at all</td>
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<tr>
<td>EE-B1.8.7</td>
<td>Illustrate the conservation of matter using biogeochemical cycles.</td>
<td></td>
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<tr>
<td>EE-B1.8.8</td>
<td>Explain interactions among organisms or populations of organisms.</td>
<td></td>
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<tr>
<td>EE-B1.8.9</td>
<td>Explain how the environment is perceived differently by various cultures and how different cultural perspectives may lead people to interpret information and experiences relating to the environment.</td>
<td></td>
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<tr>
<td>EE-B2</td>
<td>Natural Resources and Environmental Quality Theme</td>
<td></td>
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</tr>
<tr>
<td>EE-B2.8.1</td>
<td>Provide examples of the economic, aesthetic, and cultural values of natural resources and how different cultures use these resources.</td>
<td></td>
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<tr>
<td>EE-B2.8.10</td>
<td>Identify the effects of pollution and other environmental changes on plant, animal, and human health.</td>
<td></td>
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<tr>
<td>EE-B2.8.11</td>
<td>Identify careers related to natural resources and environmental concerns.</td>
<td></td>
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<tr>
<td>EE-B2.8.12</td>
<td>Identify governmental and private agencies responsible for environmental protection and natural resource management.</td>
<td></td>
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<tr>
<td>EE-B2.8.13</td>
<td>Create a timeline of Wisconsin history in resource management.</td>
<td></td>
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<tr>
<td>EE-B2.8.2</td>
<td>Diagram how resources are distributed around the world.</td>
<td></td>
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<tr>
<td>EE-B2.8.3</td>
<td>Identify which natural resources are found in Wisconsin and which are imported.</td>
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<tr>
<td>EE-B2.8.4</td>
<td>Analyze how humans impact their environment through resource use.</td>
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<tr>
<td>EE-B2.8.5</td>
<td>Recognize that resource availability depends on technology and human priorities.</td>
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<tr>
<td>EE-B2.8.6</td>
<td>Explain how human resource use can impact the environment.</td>
<td></td>
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<tr>
<td>EE-B2.8.7</td>
<td>Identify major air/water/land pollutants and their sources and distinguish between point and nonpoint source pollution.</td>
<td></td>
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<tr>
<td>EE-B2.8.8</td>
<td>Identify types of solid waste and methods for waste reduction.</td>
<td></td>
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<tr>
<td>EE-B2.8.9</td>
<td>Identify and analyze individual, local, regional, national, and global effects of pollution.</td>
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<tr>
<td>EE-C</td>
<td>Environmental Issue Investigation Skills Content Standard: Students in Wisconsin will be able to identify, investigate, and evaluate environmental problems and issues</td>
<td></td>
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<tr>
<td>EE8thstandnum</td>
<td>Standard Text</td>
<td>fully</td>
<td>partially</td>
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</tr>
<tr>
<td>EE-C.8.1</td>
<td>Define and provide examples of environmental issues, explaining the role of beliefs, attitudes and values.</td>
<td></td>
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<tr>
<td>EE-C.8.2</td>
<td>Use environmental monitoring techniques such as observations, chemical analysis, and computer mapping software to collect data about environmental problems.</td>
<td></td>
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</tr>
<tr>
<td>EE-C.8.3</td>
<td>Investigate an environmental issue using questioning and analysis skills, including interviews and surveys, to identify participants in the issue and to classify their positions (beliefs, attitudes, values).</td>
<td></td>
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<tr>
<td>EE-C.8.4</td>
<td>Evaluate the credibility of information, recognizing social, economic, environmental, technological, and educational influences.</td>
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<tr>
<td>EE-D</td>
<td>Decision and Action Skills Content Standard: Students in Wisconsin will use findings from environmental issue investigations to develop decision-making skills, and to gain experience in citizen action skills.</td>
<td></td>
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<tr>
<td>EE-D.8.1</td>
<td>Identify alternatives for addressing an environmental issue and evaluate the consequences of each alternative.</td>
<td></td>
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<tr>
<td>EE-D.8.2</td>
<td>List the advantages and disadvantages of short-term and long-term solutions to an environmental issue or problem.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE-D.8.3</td>
<td>List reasons why an individual or group chooses to participate or not participate in an environmental activity in the home, school, or community.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>EE-D.8.4</td>
<td>Explain political and legal options for resolving local, state, and national environmental issues, and that those options have both costs and benefits of those options.</td>
<td></td>
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</tr>
<tr>
<td>EE-D.8.5</td>
<td>Explain how their personal actions can impact an environmental issue such as volunteer work in conservation.</td>
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<tr>
<td>EE-D.8.6</td>
<td>Develop a plan and identify their role to improve or maintain some part of the local environment.</td>
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<tr>
<td>EE-D.8.7</td>
<td>Identify examples of how personal beliefs can influence environmental decisions.</td>
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<tr>
<td>EE-D.8.8</td>
<td>Give examples of political, educational, economic, and governmental institutions influence on an environmental issue, and the role of citizens in policy formation.</td>
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<tr>
<td>EE-E</td>
<td>Personal and Civic Responsibility Content Standard: Students in Wisconsin will develop an understanding and commitment to environmental stewardship.</td>
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<tr>
<td>EE-E.8.1</td>
<td>Formulate a personal plan for environmental stewardship.</td>
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<tr>
<td>EE-E.8.2</td>
<td>Explain the importance of characteristics (such as trust, patience, self-discipline, respect, and open-mindedness) that enable people to function together to resolve environmental issues.</td>
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</tbody>
</table>
The Sheboygan Falls Middle School Science Curriculum (Grades 5-8) has many scientific themes embedded throughout the science standards. These include:

- Change
- Constancy
- Measurement
- Evidence
- Explanation
- Systems
- Models
- Order
- Organization
- Form & Function
- Equilibrium
- Evolution
<table>
<thead>
<tr>
<th>Grade Taught</th>
<th>Grade Assessed</th>
<th>Covered</th>
<th>Bench Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,8</td>
<td>8</td>
<td>Knows that the earth is the only body in our solar system that appears to support life</td>
<td></td>
</tr>
<tr>
<td>6,8</td>
<td>8</td>
<td>Knows that the solid Earth is layered with a thin brittle crust, hot convecting mantle, and dense metallic core; three-fourths of the Earth’s surface is covered by a thin layer of water; and the entire planet is surrounded by a blanket of air</td>
<td></td>
</tr>
<tr>
<td>6,8</td>
<td>8</td>
<td>Knows the composition and structure of the Earth’s atmosphere</td>
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<tr>
<td>6,8</td>
<td>8</td>
<td>Knows that clouds, which are formed by the condensation of water vapor, affect weather and climate; some do so by reflecting much of the sunlight that reaches Earth from the Sun; others hold heat energy emitted from the Earth’s surface</td>
<td></td>
</tr>
<tr>
<td>6,8</td>
<td>8</td>
<td>Knows that because of the tilt of the Earth’s axis, sunlight and, hence, heat fall more intensely on one part or another of the Earth during its one-year revolution around the Sun; the difference in heating of the Earth’s surface produces the planet’s seasons and weather patterns</td>
<td></td>
</tr>
<tr>
<td>6,8</td>
<td>8</td>
<td>Knows that the Earth’s climate sometimes changes radically in response to the effects of geological shifts (e.g., the advance or retreat of glaciers over centuries, a series of huge volcanic eruptions in a short time)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Knows that even relatively small changes of atmospheric content or ocean temperature can have widespread effects on climate if the change lasts a long time</td>
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<tr>
<td>6,8</td>
<td>8</td>
<td>Knows that the cycling of water in and out of the atmosphere plays an important role in determining climatic patterns; water evaporates from the surface of the Earth, rises and cools, condenses into rain or snow and falls to the surface, where it forms rivers and lakes and collects in porous layers of rock</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>Knows that water is a solvent; as it passes through the water cycle it dissolves minerals and gases and carries them to the oceans</td>
<td></td>
</tr>
<tr>
<td>6,8</td>
<td>8</td>
<td>Knows that the Sun is a major source of energy for phenomena on the Earth’s surface, such as winds, ocean currents, the water cycle, and the growth of plants</td>
<td></td>
</tr>
</tbody>
</table>
### Science Standards
#### 5-8

<table>
<thead>
<tr>
<th>Grade Taught</th>
<th>Grade Assessed</th>
<th>Covered</th>
<th>Bench Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,6,8</td>
<td>8</td>
<td></td>
<td>Knows that the composition and texture of the soil and its fertility and resistance to erosion are greatly influenced by plant roots and debris, bacteria, fungi, worms, rodents, and other animals as they break up the soil and add organic material to it</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td>Knows that rock contains evidence of the minerals, temperatures, and forces that created it</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td>Knows that sediments of sand and smaller particles (sometimes containing the remains of organisms) are gradually buried, cemented together by dissolved minerals, and eventually turned into rock again</td>
</tr>
<tr>
<td>6,8</td>
<td>6,8</td>
<td></td>
<td>Knows how land forms are created through a combination of constructive and destructive forces; constructive forces include crustal deformation, volcanoes and deposition of sediment; destructive forces include weathering and erosion</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td>Knows that thousands of layers of sedimentary rock confirm the long history of the Earth and the long history of changing life forms whose remains are found in successive layers of sedimentary rock; the newest layers may not always be found on top because of the folding, breaking and uplifting of layers</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td>Knows that fossils provide important evidence of how life and environmental conditions have changed on the Earth over time (e.g., changes in atmospheric composition, movement of crustal plates, impact of an asteroid or comet)</td>
</tr>
<tr>
<td>6,8</td>
<td>8</td>
<td></td>
<td>Knows that the use of the earth’s resources by humans in both past and current cultures are the basis for efforts to conserve and recycle renewable and non-renewable resources</td>
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<tr>
<td>Grade Taught</td>
<td>Grade Assessed</td>
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<td>Bench Mark</td>
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<tr>
<td>5,8</td>
<td>8</td>
<td>Knows that the Earth is a medium-sized star, located at the edge of a disk-shaped galaxy, part of which can be seen on a clear night as a glowing band of light</td>
<td></td>
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<tr>
<td>5,8</td>
<td>5,8</td>
<td>Knows that nine planets of differing sizes and surface features and with differing compositions move around the Sun in nearly circular orbits; some planets have a variety of moons and rings of particles orbiting around them (e.g., the Earth is orbited by one moon, many artificial satellites, and debris)</td>
<td></td>
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<tr>
<td>5,8</td>
<td>8</td>
<td>Knows we live on a fairly small planet, the third from the Sun in the only system of planets definitely known to exist, although other similar systems might yet be discovered in the universe</td>
<td></td>
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<tr>
<td>5,8</td>
<td>5,8</td>
<td>Knows that the Sun’s gravitational pull keeps the Earth and other planets in their orbits, just as the gravitational pull of planets keeps their moons in orbit around them</td>
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<tr>
<td>5,8</td>
<td>5,8</td>
<td>Knows that many pieces of rock and ice orbit our Sun: some meet the Earth in its orbit, glow and disintegrate from friction as they plunge through our atmosphere; other objects have long, off-center orbits that bring them close to the Sun, whose radiation boils off material and pushes it into a long, illuminated tail</td>
<td></td>
</tr>
<tr>
<td>5,8</td>
<td>5,8</td>
<td>Knows that the Moon’s orbit around the Earth once in some 28 days changes how much of the Moon is lighted by the Sun and how much of that part can be seen from the Earth, resulting in the phases of the moon</td>
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<tr>
<td>5,8</td>
<td>5,8</td>
<td>Knows that the universe contains many billions of galaxies, each containing many billions of stars</td>
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<tr>
<td>5,8</td>
<td>5,8</td>
<td>Knows that light travels from the Sun to the Earth in a few minutes, from the next nearest star in four years, and from very distant stars in several billion years; the distance light travels in a few years would take the fastest rockets thousands of years to travel</td>
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</table>
### Science Standards
5-8

#### Life Science

4. Knows about the diversity and unity that characterize life

<table>
<thead>
<tr>
<th>Grade Taught</th>
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<th>Covered</th>
<th>Bench Mark</th>
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<tbody>
<tr>
<td>5,6</td>
<td>6</td>
<td></td>
<td>Knows that major categories of living organisms are plants, which get their energy directly from sunlight, and animals, which consume energy-rich foods; some kinds of organisms cannot be neatly classified as either plants or animals</td>
</tr>
<tr>
<td>5,6</td>
<td>6</td>
<td></td>
<td>Knows that all organisms, including the human species, are part of and depend on two main global food webs; one global food web starts with microscopic ocean plants and seaweed and includes the animals that feed on them and subsequent animals that feed on the plant-eating animals; the other global food web begins with land plants and includes animals that feed on them and so forth</td>
</tr>
<tr>
<td>6,7</td>
<td>6,7</td>
<td></td>
<td>Knows that organisms can be classified according to the function they serve in a food chain (producer, consumer and/or decomposer of organic matter) and by the details of their internal and external features</td>
</tr>
<tr>
<td>5,6,7</td>
<td>6,7</td>
<td></td>
<td>Knows that animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce</td>
</tr>
<tr>
<td>6,7</td>
<td>6,7</td>
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<td>Knows that for sexually reproducing organism, a species compromises all organisms that can mate with one another to produce fertile offspring</td>
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</tbody>
</table>
Science Standards
5-8

5. Understands the genetic basis for the transfer of biological characteristics from one generation to another

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<tr>
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<th>Benchmark</th>
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<tbody>
<tr>
<td>5,6,7</td>
<td>6,7</td>
<td>Knows that reproduction is a characteristic of all living systems: since no individual organism lives forever, reproduction is essential to the continuation of species</td>
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<tr>
<td>7</td>
<td>7</td>
<td>Knows that in some kinds of organisms, all the genes come from a single parent, whereas in organisms that have sexes, typically half of the genes come from each parent</td>
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<tr>
<td>6,7</td>
<td>7</td>
<td>Knows that sexual reproduction, an egg from a female unites with a sperm from a male to begin the development of a new individual that has an equal contribution of information from its mother and its father; sexually produced offspring are never identical to either of their parents</td>
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<tr>
<td>7</td>
<td>7</td>
<td>Knows that the characteristics of an organism can be described in terms of a combination of traits; some traits are inherited and others result from interactions with the environment</td>
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<tr>
<td>7</td>
<td>7</td>
<td>Knows that hereditary information is contained in genes, located in the chromosomes of each cell; each gene carries a single unit of information, and an inherited trait of an individual can be determined by either one or many genes</td>
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## 6. Knows the general structure and functions of cells in organisms

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<tr>
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<th>Bench Mark</th>
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<tbody>
<tr>
<td>7</td>
<td>7</td>
<td>Knows that living systems at all levels of organization demonstrate complementary of structure and function; the major levels of organization for structure and function include cells, tissues, organs, organ systems, whole organisms and eco-systems</td>
<td>Knows that living systems at all levels of organization demonstrate complementary of structure and function; the major levels of organization for structure and function include cells, tissues, organs, organ systems, whole organisms and eco-systems</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Knows that all organisms are composed of cells, which are the fundamental units of life; most organisms are single cells, but other organisms (including humans) are multicellular</td>
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</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Knows that cells carry on the many functions needed to sustain life and that cells are able to grow and divide; this requires that cells take in nutrients, which they use to power their work and to make the materials that a cell or organism needs</td>
<td>Knows that cells carry on the many functions needed to sustain life and that cells are able to grow and divide; this requires that cells take in nutrients, which they use to power their work and to make the materials that a cell or organism needs</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Knows that disease represents a breakdown in structures or functions of an organism; some diseases are the result of intrinsic failures of the system, whereas others are the result of infection by other organisms</td>
<td>Knows that disease represents a breakdown in structures or functions of an organism; some diseases are the result of intrinsic failures of the system, whereas others are the result of infection by other organisms</td>
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<tr>
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<tr>
<td>5,6</td>
<td>6</td>
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<td>Knows that all organisms must be able to obtain and use resources, grow, reproduce and maintain a relatively stable internal environment while living in a constantly changing external environment; regulation an organism's internal environment involves sensing external changes and changing physiological activities to keep within the range required to survive.</td>
</tr>
<tr>
<td>7,8</td>
<td>7,8</td>
<td></td>
<td>Investigate a specific problem to which science and technology has provided a solution, including courses of actions, choices, reasons for choices, new problems created and community satisfaction.</td>
</tr>
<tr>
<td>5,6,7</td>
<td>7</td>
<td></td>
<td>Knows that all species ultimately depend on another; interactions between two types of organisms include producer/consumer, predator/prey, parasite/host, and relationships that can be mutually beneficial or harmful.</td>
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<tr>
<td>5,6</td>
<td>6</td>
<td></td>
<td>Knows that populations consist of all individuals of a species that occur together at a given place; all of the populations living together (community) and the physical factors' with which they interact compose an ecosystem.</td>
</tr>
<tr>
<td>5,6</td>
<td>6</td>
<td></td>
<td>Knows that the number and types of organism an ecosystem can support depend on the resources available and abiotic factors such as quantity of light and water, range of temperatures, and the soil composition; limitations of resources and other factors such as predation and climate limit the growth of populations in specific niches in the ecosystem.</td>
</tr>
</tbody>
</table>
Science Standards
5-8

9. Understands the basic concepts of the evolution of species

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<tr>
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</tr>
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<tbody>
<tr>
<td>6,8</td>
<td>8</td>
<td></td>
<td>Knows how the fossil record, through geologic evidence, documents the appearance, diversification, and extinction of many life forms; millions of species of animals, plants and micro-organisms living today differ from those who lived in the remote past, and each species lives in a specific and fairly uniform environment</td>
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<td>Knows that extinction of a species occurs when the environment changes and the adaptive characteristics of a species do not enable it to survive in competition with neighbors; extinction of species is common – most of the species that have lived on the Earth no longer exist</td>
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<tr>
<td>8</td>
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<td></td>
<td>Project how current trends in human resource use and population growth will influence the natural environment and show how current policies affect those trends</td>
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<tr>
<td>5,6,8</td>
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<td></td>
<td>Knows that biological evolution accounts for a diversity of species developed through gradual processes over many generations; species acquire many of their unique characteristics through biological adaptation (e.g., changes in structure, behavior, or physiology that enhance reproductive success), which involves the selection of naturally occurring variations in populations</td>
</tr>
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### 10. Understands basic concepts about the structure and properties of matter

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<td>5,7,8</td>
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<td></td>
<td>Knows that there are more than 100 known elements that combine in numerous ways to produce compounds, which account for the living and nonliving substances that we encounter; chemical elements do not breakdown by normal laboratory reactions such as heating, electric current, or reaction with acids.</td>
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<tr>
<td>5,6,8</td>
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<td>Knows that many elements can be grouped according to similar properties, such as reactivity, density, melting points, boiling points, conductivity, magnetic attraction, solubility, and reactions to common physical and chemical tests.</td>
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<tr>
<td>5,8</td>
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<td></td>
<td>Knows that different arrangements of atoms into groups compose all substances: atoms are far too small to see directly through a microscope.</td>
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<td>5,8</td>
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<td>Knows that atoms in solids are close together and don’t move about easily; in liquids, atoms are close together and stick to each other, but move about easily; atoms in gas are quite far apart and move about freely.</td>
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<tr>
<td>5,8</td>
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<td>Knows that atoms often combine to form a molecule (or crystal), the smallest particle of a substance that retains its properties.</td>
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<td>Knows that the temperature and acidity of a solution influence reaction rates; many substances dissolve in water, which may greatly facilitate reactions between them.</td>
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<td>Knows that oxidation involves the combining of oxygen with something else – as in burning or rusting.</td>
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<td>Knows that substances react chemically in characteristic ways with other substances to form new substances (compounds) with different properties; however in chemical reactions the total mass is conserved.</td>
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<td>Knows that atomic model and theories have changed over time, and will continue to change due to technological advances.</td>
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11. Understands energy types, sources, and conversions, and their relationship to heat and temperature

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<tr>
<td>6</td>
<td>6</td>
<td>Knows that energy comes in different forms, such as light, heat, chemical, nuclear, mechanical and electrical</td>
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<td>Understands that energy cannot be created or destroyed but only changed from one form to another</td>
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<td>5,6,8</td>
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<td>Knows that the Sun is a major source of energy for changes on the Earth’s surface; the Sun’s energy arrives as light with a range of wavelengths consisting mainly of visible light with significant amounts of infrared and ultraviolet radiation</td>
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<td>5,6</td>
<td>6</td>
<td>Knows that heat energy moves in predictable ways, flowing from warmer objects to cooler ones until both objects are the same temperature</td>
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<td>5,6</td>
<td>6</td>
<td>Knows that heat can be transferred through materials by the collisions of atoms or across space by radiation; if the material is fluid, currents will be set up in it that aid the transfer of heat</td>
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<tr>
<td>6</td>
<td>6</td>
<td>Knows that electrical circuits provide a means of converting electrical energy into heat, light, sound, chemical, radio waves, magnetic fields, gravity, and electrical fields</td>
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<td>8</td>
<td>Knows that in most chemical reactions energy is released or added to the system in the form of heat, light, electrical, or mechanical energy in the laboratory and in real life situations</td>
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### 12. Understands motion and the principles that explain it

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<td>6</td>
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<td>Knows that vibrations (e.g., sounds, earthquakes) move at different speeds in materials, have different wavelengths, and set-up wave-like disturbances that spread away from the source</td>
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<td>5,6</td>
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<td>Knows that light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection); to see an object, light from that object (emitted by or scattered from it) must enter the eye</td>
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<td>6,8</td>
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<td>Knows that only a narrow range of wavelengths of electromagnetic radiation can be seen by the human eye; differences of wavelength within that range of visible light are perceived as differences in color</td>
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<td>Knows that an object’s motion can be described and represented graphically according to its position, direction of motion and speed</td>
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<td>5,7</td>
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<td>Knows that the motion of an object is always judged with respect to some other object or point and so the idea of absolute motion is misleading</td>
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<td>5,7</td>
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<td>Knows that whenever an object is seen to speed up, slow down, or change direction, we know that an unbalanced force (e.g., friction, speed, velocity, acceleration, momentum, and changes over time) acts on it</td>
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<tr>
<td>5,7</td>
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<td></td>
<td>Knows that if more than one force acts on an object, the forces can reinforce or cancel one another depending on their direction and magnitude; unbalanced forces will cause changes in speed and/or direction of an object’s motion</td>
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<td>5,7</td>
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<td>Knows that an object that is not being subjected to a force will continue to move at a constant speed and in a straight line</td>
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<td>Knows that just as electric currents can produce magnetic forces, magnets can cause electric currents</td>
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<td>5,6,7,8</td>
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<td></td>
<td>Knows that scientists often repeat an experiment many times before accepting a consistent result as true</td>
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<td>5,6,7,8</td>
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<td></td>
<td>Knows that scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models; although all scientific ideas are tentative and subject to change or improvement in principle, for most core ideas in the sciences there is much experimental and observed confirmation</td>
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<td>5,6,7,8</td>
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<td>Knows that in areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the evidence or theory being considered; until evidence is available that supports one position over another, scientists acknowledge that a conflict exists</td>
</tr>
<tr>
<td>5,6,7,8</td>
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<td>Knows that although scientists may disagree about certain aspects of an investigation or explanation, they do agree that skepticism, questioning, and open communication are essential to progress in science</td>
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<td>5,6,7,8</td>
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<td>Knows that there is no fixed procedure called “the scientific method” but that investigations involve carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations</td>
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<td>Designs, conducts, and explains scientific investigations (e.g., formulates questions, designs and executes investigations, interprets data, uses inferences, synthesizes evidence into explanations, proposes alternative explanations, critiques explanation and procedures)</td>
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<td>5,6,7,8</td>
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<td>Uses appropriate tools (including computers) and techniques to gather, analyze, and interpret scientific data</td>
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<td>Establishes relationships based on evidence and logical argument (e.g., provides cause for effects)</td>
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<td>5,6,7,8</td>
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<td></td>
<td>Knows that scientific explanations use evidence and logically consistent arguments to propose, modify, or elaborate principles, models, and theories in science; the scientific community accepts and uses such explanations until displaced by better scientific explanations; when the latter occurs, science advances</td>
</tr>
<tr>
<td>5,6,7,8</td>
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<td></td>
<td>Knows that scientific investigations sometimes result in new ideas, objects, and phenomena for study, new methods or procedures for an investigation, or new technologies to improve the collection of data; all of these results lead to new investigations</td>
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<tr>
<td>5,6,7,8</td>
<td>5,6,7,8</td>
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<td>Use computer software and other technologies to organize, process and present their data</td>
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<tr>
<td>5,6,7,8</td>
<td>5,6,7,8</td>
<td></td>
<td>Use relevant sources i.e. textbooks, encyclopedias, library books, computers, etc….to research scientific concepts</td>
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<td>5,6,7,8</td>
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<td></td>
<td>Knows that women and men of all ages, backgrounds, and groups participate in the various areas of science and technology as they have for many centuries</td>
</tr>
<tr>
<td>5,6,7,8</td>
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<td></td>
<td>Knows that tracing the history of science can show how difficult it was for scientific innovators to break through preconceptions of their times to reach conclusions which today seem obvious</td>
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<td></td>
<td>Identify and investigate the skills and academic courses a person needs that are necessary for a career in science and technology</td>
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17. **Understands the nature of technological design**

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<th>Bench Mark</th>
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<tbody>
<tr>
<td>6,8 IT, 7,8 FCE</td>
<td>8 IT, 7,8 FCE</td>
<td>Designs a solution or product, taking into account needs and constraints (e.g., cost, time, trade-offs, materials needed)</td>
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<tr>
<td>6 IT, 7,8 FCE</td>
<td>6 IT, 7,8 FCE</td>
<td>Implements a proposed design (e.g., organizes materials and other resources, plans one's work, makes use of group collaboration, chooses suitable tools and techniques, works with appropriate measurement methods)</td>
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### Science Standards

5-8

18. Understands the interactions of science, technology, and society

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<tr>
<td>5,6,7,8</td>
<td>8</td>
<td></td>
<td>Knows that science and technology have advanced through the contributions of many different people, in different cultures, and at different times in history; science and technology have contributed to the economic growth and productivity of societies and groups within societies</td>
</tr>
<tr>
<td>5,6,7,8</td>
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<td></td>
<td>Knows that technology is essential to science because it enables observations of phenomena that are far beyond the capabilities of scientists due to factors such as distance, location, size and speed</td>
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<tr>
<td>6,8</td>
<td>6,8</td>
<td></td>
<td>Knows that technological solutions have trade-offs, such as safety, cost, efficiency, and appearance; engineers often build in back-up systems to provide safety, risk is a part of living in a highly technological world</td>
</tr>
</tbody>
</table>
SS Standards

Falls

A.8.4 conduct a historical study to analyze the use of local environment in a Wisconsin Community to explain the effect of this use on the environment.

A.8.7 describe movement of people through the world.

B.8.7 identify significant events and people in the eras of U.S.

D.8.11 describe how personal discussions can have a global impact on issues such as conserving the environment.

EE

A.8.5 use the results of their investigations to develop answers, draw conclusions, and revise their personal understanding.

E.8.1 Formulate a personal plan for environmental stewardship.

E.8.2 explain the importance of characteristics that enable people to function together to resolve environmental issues.

D.8.1 identify options for addressing an environmental issue and evaluate the Consequences of each option.

D.8.6 develop a plan for improving or maintaining some part of the local environment and identify their role in accomplishing this plan.
S.S.

Settlers – Great Lakes People (*Great Minds? Great Lakes!*)

Falls

A.8.4 Conduct a historical study to analyze the use of local environment in a Wisconsin Community to explain the effect of this use on the environment.

A.8.7 Describe movement of people through the world.

Discuss why people originally moved to Great Lakes

- Use the section titled “Great Lakes People” for background
- Use material From Historical Society to research history of Sheboygan Falls.
- Create at Web page that reflects the history of Sheboygan Falls.
History of Sheboygan Falls/Sheboygan County: Research and Web Page

Goal: Research the history of Sheboygan County and Sheboygan Falls in terms of the geographic themes:

Human/Environment Interaction: Evidence of the use of Wisconsin waterways, the Great Lakes and the Sheboygan River for settlement and industrial development

Movement: Evidence of modes of travel by Native Americans, fur traders, European immigrants for exploration, transportation and trade

Place: Details that make Sheboygan Falls unique from other towns or Sheboygan County unique from other regions of Wisconsin. Consider special buildings, businesses, prominent citizens or events from history.

(30 points for research; 10 points of information per theme; covers scope of history from fur trade to Wisconsin statehood to Falls establishment to early 1900’s industrial development)

Objective: Use the research to construct a web page in computer literacy.

Contents/Outline of Web Page:

Part One: Summary report of the history of Sheboygan County and Sheboygan Falls with a timeline stated in your own words

Part Two: Special history report on one of the following options:

• place/building in Sheboygan Falls (past and present use/renovations)
• business in town (still in existence or from the past)
• person significant to the settlement of the town
• special group/organization (eg., club, service organization, lodge)
• special event (eg., fire, flood, shipwreck, circus) in Sheboygan Falls or Sheboygan County
• mode of transportation (eg., railroad, automobile, horse and buggy, ships, street cars)
• entertainment, recreation or daily life (eg., Falls movie theater, dance halls, snow sports, shopping, family gatherings, food preparation, household chores)

Part Three: A visual or graphic that relates to Part Two information.

• map showing location of a place or event in Sheboygan Falls or Sheboygan County
• modern photograph showing results of changes or renovations to a site or building
• artistic rendering of historic building or scene
• photograph of antique equipment/vehicle/people in period clothing
• historic photograph of person or building (related to topic of Part Two)
History of Sheboygan Falls/Sheboygan County:
Research and Web Page

Research Questions: These questions can help you focus your Sheboygan Falls history research. They can guide your reading of the history packets in social studies class for Part One of your web page. Answer them as a way to focus your writing for your Part One paragraph. They can help you and your partner decide which topic to choose for Part Two of your web page. They can give you ideas for your interview for Part Four of the web page.

1. Why did people choose to settle along the Sheboygan River?

2. How did the Great Lakes influence the settlement of Sheboygan County?

3. Who first settled in Sheboygan Falls and why?

4. What businesses developed along the Sheboygan River? How was the river used or needed? How did the business affect the river?

5. What buildings have been added to Falls? When were they constructed? What style of architecture was used for each? How have the buildings been renovated or changed? Which ones have been torn down? Why?

6. Which buildings are landmarked for special historical significance? What style of architecture is it? How is the building used now?

7. What was life like in Sheboygan County or Wisconsin in the 1930's? 40's? 50's? 60's? 70's? Who can I ask for information about the history of Sheboygan Falls or about life in a different era from the present? What can I ask them?

8. What interests me most about Falls history:
   - schools
   - jobs/businesses
   - homes
   - festivals/carnivals/special events
   - floods/fires
   - names of places/streets
   - "famous" people
   - dates and details of major events
   - old styles of doing/making daily things
and as far west as the northern West Coast. In some places, the glaciers were over 6,500 feet thick, almost a mile-and-a-quarter high. Through the sheer weight of the ice, coupled with the varying hardness of the rocks beneath it, the glaciers tore up the river terrain, creating natural dams and dikes that obstructed the drainage of the ancient river system. As the glacier receded from North America, the Great Lakes began to form from the melting receding glacial water which had enlarged the original river basin. During the Ice Age, modern humans, saber tooth tigers, mammoths, and numerous other animals began to roam the Earth. In addition, the first grasslands, herbaceous plants, and forests developed.

Great Lakes People

For a variety of reasons, the Great Lakes have attracted many different kinds of people from all over the world. From Native Americans to European immigrants, these people contribute to its diversity and cultural richness. This lesson introduces students to the people of the Great Lakes Basin.

About 10,000 years ago, around the time that the glacier receded, the first inhabitants of the Great Lakes area appeared. It is believed that these Native Americans came from South America or across the land bridge once connecting the continents of North America and Asia in Alaska. Tribes of Native Americans peopled the shores, among them the Iroquois, Alumettes, Chipewas, Hurons, Ottawas, Senecas, Mohawks, Eries, and Ojibways. Many cities take their names from the tribes or great chiefs of these tribes, including Ottawa, Canada; Pontiac, Michigan; and Erie, Pennsylvania. Lake Huron was named directly for the Huron Indians. Other present-day cities were once Indian villages, including Quebec, Canada, which was once Stadacona; and Montreal, Canada, which was Hochelaga.

In Europe, two events increased curiosity about the so-called New World: voyages by Norsemen in the twelfth to fourteenth centuries and the voyage to America by Christopher Columbus in the fifteenth century. Artifacts such as a Viking sword, axe and shield found in Ontario and southwestern Minnesota suggest that the Vikings and Norsemen may have reached the North American continent as far inland as Minnesota via the Hudson Bay.

In the 1500s and 1600s, the French were the primary explorers and settlers in and around the Great Lakes. Less than 200 years after Norsemen reached the Great Lakes, French explorers and missionaries began to arrive. Over a period of time, they constructed forts along the Great Lakes all the way to Kingston, Ontario, where Fort Frontenac was located.

The British were active, too, constructing Fort Oswego on Lake Ontario's south shore in the early 1700s. The British had already colonized the New England states and parts of Pennsylvania. Steady migration by the British into French-dominated territory around the Great Lakes led to war between the two nations over the fur trade. The first African Americans arrived in the Great Lakes area in the late 1700s, when Jean Baptiste Pointe DuSable, a trapper, built a cabin in the Chicago area. African Americans came in greater numbers in the late 1800s.

During the 1800s, there was a mass influx of other ethnic groups from Europe. They came to the New World in search of freedom and prosperity. In all, more than 21 different nationalities settled in the Great Lakes area. Scandinavians again were among the first to arrive. Norwegians founded the first permanent colony on the Fox River in Illinois, and Swedes settled at Pine Lake, Wisconsin, west of Milwaukee. Belgians also came, and the largest population of Belgians in the United States are now in Door County, Wisconsin. The Irish represented the largest immigrant group in Canada. The first group of Finns settled on the upper peninsula of Michigan and worked in the copper mines there. They also peopled the areas around Duluth, Minnesota, working in the open-pit mines of the Vermilion and Mesabi ranges. Germans flocked to the Great Lakes Basin.
Lakes area, particularly in Sandusky, Ohio, on Lake Erie and in Milwaukee, Wisconsin.

Also among the immigrants to the Great Lakes Basin were the Canadians, French-Canadians, Russians, Czechs, Greeks, Turks, Persians and Spaniards, Welshmen, Scotsmen, and Dutch. Immigrants from Mexico, Puerto Rico, and other Central American countries came at the turn of the century, with significant migration occurring during World War I.

Activities

1) Have the students research the Native American and European people who first settled in the Great Lake Region. Locate early settlements on the map.

2) As a class, research and dress up as early explorers of the Great Lakes region and describe their experiences. Have the students write a make-believe journal entry of an explorer’s adventures.

3) Have the class research the history of your town. Write to a local historical group or invite a long-time resident to share his or her memories of the town’s history with the class.

Shipwrecks

A sailor’s life journeying the five Great Lakes sounds romantic, but not all the journeys have been smooth sailing. The Great Lakes have seen their share of shipwrecks over the years.

Explorer Robert de LaSalle’s ship, The Griffin, one of the first large ships ever to sail the Great Lakes, was launched in 1679 and carried a load of furs out of Green Bay on its maiden voyage. She was never seen again and no splinter ever washed ashore. The Griffin leads the long parade of ghost ships that provide us with the great mysteries of the Great Lakes.

In 1871 alone, 1,167 disasters were recorded. In the two decades between 1878 and 1898, the United States Commissioner of Navigation reported 5,999 vessels wrecked on the Great Lakes and 1,093 of these were total losses. 1905 was a particularly bad year on the Lakes with 271 vessels damaged, 54 of which were lost through the stress of weather.

Whereas luck and intuition were the tools available to early skippers, today’s captains have the finest and most sophisticated navigational aids available. Ships are equipped with weather warning systems, radios, direction finders, and depthometers. Careful study of previous shipwrecks has taught us how to improve ship construction and methods of navigation.

Despite all that modern technology can offer, surviving a Great Lakes storm is still a challenge. The storms of the Great Lakes have been compared with a “witches brew,” and a “devil’s harvest.”

Storms can explode across hundreds of miles of open water with little or no warning. Storms on the Great Lakes often can be more difficult to navigate than ocean storms. Waves on the Great Lakes jump and strike quickly compared to the lethargic rolling and swelling of ocean waves.

Just as there are comparisons to be made between ocean storms and lake storms, there are differences in the way each of the Great Lakes reacts in a storm. Most veteran captains and crews find Lake Erie the least agreeable in either fair or foul weather because of its shallow depth and muddy bottom.

Lake Superior is a favorite among mariners because its large size affords the greatest amount of room for maneuvering during a storm. However, it too poses a challenge to navigate with its rocky coastline, cold temperatures (40 degrees in summer or winter), and huge waves that develop because of the Lakes’ depth. An ancient Chippewa legend warns that Superior “never gives up its dead.”

Lake Michigan commands the greatest respect among seafarers for several reasons. Prevailing winds sweep its length...
Who Governs the Great Lakes *(Great Minds? Great Lakes!)*

Falls

D.8.11 describe how personal discussions can have a global impact on issues such as conserving the environment

EE

E.8.1 Formulate a personal plan for environmental stewardship

E.8.2 explain the importance of characteristics that enable people to function together to resolve environmental issues

D.8.1 identify options for addressing an environmental issue and evaluate the Consequences of each option

D.8.6 develop a plan for improving or maintaining some part of the local environment and identify their role in accomplishing this plan

- Read the information “Who Governs the Great Lakes?” and Where Would We be Without the Great Lakes?” for background information
- On the overhead map name each state or providence
- Divide the class into groups for each state and providence
- Each group is to make a plan for protecting the Great Lakes.
- All state groups will meet to share their ideas and develop one overall plan for the U.S. The Canadian provinces will need to do the same.
• One representative from each country is asked to speak at the "summit" and they must work out an international agreement for protecting the Great Lakes. Both countries must agree on the plan.
Where Would We Be Without the Great Lakes?

The Great Lakes are part of our daily lives. They provide us with fresh drinking water; industries and jobs including agriculture, fisheries, manufacturing, shipping, and tourism; and beautiful shorelines and parks. This section explores how we depend on the lakes and the many ways we use them.

The Great Lakes provide us with fresh water for just about any kind of activity you can imagine. Today, there are approximately 37 million people living in the Great Lakes Basin and more than 26 million of these people rely on the Great Lakes for their drinking water. Most of the original settlements which grew into cities were established near tributaries that provided a supply of fresh water for domestic and industrial use.

How much water do these 26 million people use in a day, a week, or their lifetime? The Great Lakes contain about 5,500 cubic miles of water. If a person took 3 baths a day, it would take over 110 billion years to use all the water in the Great Lakes! If all 26 million people took 3 baths a day, it still would take 4,254 years to use all the water in the Lakes.

Many people don’t realize it, but resources in the Great Lakes Basin are responsible for the quality of our lives. So much of our lives depend on the Great Lakes’ rich farmland, abundant fish, water power, transportation, and natural beauty.

Within the 201,000 square miles of the Great Lakes Basin, 67,000 square miles are devoted to agriculture—an area larger than each of the bordering states except Minnesota. The main agricultural products produced in the region today are wheat, corn, soybeans, barley, and oats. Grapes are grown in the Lake Ontario region for wine-making in New York. The Lake Michigan area contains the most farmland of all the Great Lakes and is a leading grower of fruits and vegetables. The State of Wisconsin is known for its cheeses and other milk-products. The Lake Erie region leads the Great Lakes in the raising of pigs, sheep, soybeans, wheat, and chicken corn. The Lake Huron Basin is the world’s biggest producer of navy beans, and the Lake Supe-

### How Much Water Is Used...?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Daily Use</th>
<th>Annual Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the average residence per year:</td>
<td>107,000 gallons</td>
<td></td>
</tr>
<tr>
<td>By an average person daily:</td>
<td>168 gallons</td>
<td></td>
</tr>
<tr>
<td>To flush a toilet:</td>
<td>5-7 gallons</td>
<td></td>
</tr>
<tr>
<td>To take a shower:</td>
<td>25-50 gallons</td>
<td></td>
</tr>
<tr>
<td>To take a bath:</td>
<td>50 gallons</td>
<td></td>
</tr>
<tr>
<td>To brush your teeth (with water running):</td>
<td>2 gallons</td>
<td></td>
</tr>
<tr>
<td>To wash dishes by hand:</td>
<td>20 gallons</td>
<td></td>
</tr>
<tr>
<td>To run a dishwasher:</td>
<td>15-25 gallons per cycle</td>
<td></td>
</tr>
<tr>
<td>To wash clothes in a washing machine:</td>
<td>35 gallons per cycle</td>
<td></td>
</tr>
<tr>
<td>To water your lawn:</td>
<td>35 gallons per half acre</td>
<td></td>
</tr>
</tbody>
</table>

### Discussion:

1) Discuss how students and their families use water in their daily lives and explore how important water is as a natural resource.

2) Discuss what would happen if fresh water was not readily available. Talk about ways drinking water is wasted and how it can be conserved.

3) Using the information on water use, calculate how much water the students and their families use each day. Have students measure the amount of water they use to brush their teeth once, then calculate how much water they use a week or a month.
rior region is an active forest products producer.

Great Lakes fish are an important source of food for people and hundreds of species of animals and birds. The average annual commercial fishing catch is approximately 110 million pounds. Major species caught in the Great Lakes include whitefish, yellow perch, lake trout, salmon, walleye, lake herring, rainbow smelt, chubs, white bass, brown bullhead, and carp. One of the most prosperous fishing areas is Lake Erie, where the walleye pike fishery is widely considered the best in the world. In Canada, the Lake Erie fishery represents nearly two-thirds of the country's total Great Lakes harvest.

Shipping has been responsible for the development of the entire Great Lakes Region. The Great Lakes and their interconnecting channels have provided a natural transportation system for exploration and settlers, and trade and transport of goods—particularly mineral resources and agricultural products. Boom towns have come and gone as shipping enabled natural resources to be reached and transported, and today shipping continues to be a major industry on the Lakes. Iron ore from the Lake Superior area is shipped to mills in Chicago, Cleveland, and Gary to be made into steel. This steel is then shipped to Detroit, Cleveland, and Lorain, Ohio. Among the other products transported on the Lakes are coal, limestone, grain, newsprint, and cement. In 1959, completion of the St. Lawrence Seaway drastically changed the Great Lakes shipping industry by expanding it to include international transport.

Many manufacturing industries are attracted to the Great Lakes area because of the advantages of being near a water source which provides cheap electricity and convenient transportation routes. Major manufacturing industries in the Great Lakes region include steel, paper, chemicals, and automobiles. Thirty-six percent of United States automobiles and 38% of Canadian automobiles are produced in the Basin. The steel industry is concentrated at the southern end of Lake Michigan, and in Detroit, Cleveland, and Lorain, Ohio. Paper mills are located primarily in the upper Lakes, with a large concentration of mills along the Fox River that feeds into Green Bay on Lake Michigan. Chemical manufacturers are on the Niagara River, the Saginaw Bay in Lake Huron, and in Sarnia, Ontario.

Tourism and recreation also are major industries in the Great Lakes Basin. For example, in Ottawa County, Ohio, the regular population of 40,000 increases to about 250,000 on weekends as tourists come to enjoy the sights. In many areas of the Basin, small unprofitable marinas have been turned into multimillion dollar complexes with stores, restaurants, and swimming pools. Sport fishing also is a major component of the recreation industry. The sale of licenses, equipment, and boat rentals generates hundreds of millions of dollars every year. Charter fleets and a large fish stocking program have been developed to fuel the industry. Over 60 million people each year visit the 98 state parks, 39 provincial parks, and 12 national parks on the United States and Canadian Great Lakes shores.

When we consider the benefits we gain from all of these industries in the Great Lakes Basin, it is important to remember that each of these industries have environmental consequences.

**Activities:**

1) On a map, fill in the major cities mentioned and trace the channels between Lakes which allow ships to travel between Lakes. Draw in symbols or figures representing different types of industries located around the Lakes.

2) Have each student draw a picture of his or her favorite Great Lakes recreational activity. Make a collage of all the pictures.
Who Governs the Great Lakes?

The Great Lakes are so big that their shores span the boundaries of eight states and two Canadian provinces. With so many government bodies involved, preservation of the Great Lakes requires cooperation and teamwork. This section will explore the necessity for governments and people to work together to solve the environmental problems facing the Great Lakes region.

Because the United States and Canada share the Great Lakes as a border, many governments are involved with environmental problems in the Great Lakes Basin: on a federal level, the U.S. Environmental Protection Agency and Environment Canada; eight state governments (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin); and two Canadian provinces (Ontario and Quebec). Having both Canada and the United States involved presents the unique situation of two nations responsible for managing and protecting a natural resource.

To officially agree on how to protect the Great Lakes, the United States and Canada signed a treaty in 1909 called the Boundary Water Treaty. The treaty declared that neither Canada nor the United States has the right to pollute the resources of its neighbor. It also said that both countries have equal rights to the use of waterways that cross the international border of the Lakes. Despite the agreements made in the treaty, pollution problems began to mount, and by the early 1970s, the two countries had to reconsider the Boundary Water Treaty.

The two countries decided to make a more specific commitment to restoring and maintaining the environmental health of the Great Lakes Basin. The agreement, called the Great Lakes Water Quality Agreement, was signed in 1972 and created a bi-national commission that would be responsible for reducing pollution in the Great Lakes and developing specific plans for cleaning up many of the pollution problems in the Basin. The commission is referred to as the International Joint Commission.

Making progress on the problems that affect the Great Lakes is not easy. This is because the problems are not simple ones and because every proposal has ramifications that are both good and bad. For example, an environmental protection proposal that limits industrial growth may help prevent further pollution of the Great Lakes, but it may have negative effects on the economy and the availability of jobs.

Discussion:

1) Imagine what it would have been like living in the Great Lakes area before trains, cars, and airplanes were invented. Why were the Great Lakes important to the settlers?

2) Discuss the types and functions of ships used on the Great Lakes such as freighters, commercial fishing ships, and pleasure crafts. Ask students what types of ships they have seen on the Lakes.

3) Discuss why the Great Lakes are important to farming. How does the water get from the Lakes to the farms? What would happen if the water in the Lakes were so polluted it could not be used for farming?

4) Talk about what would happen if there were no fish in the Great Lakes. With no fish to eat, insects, what would happen to the number of insects?

5) Ask the students what kind of fun activities they can do around the Great Lakes. Have they visited any state or national parks in the Great Lakes Basin? Why is it important to have parks along the border of the Great Lakes? (minimizes shoreline development)
Discussion:
1) Talk about other natural resources we share with Canada and other countries such as air, oceans, and wildlife.
2) Ask students if they know who is in charge of making decisions about how to clean up pollution on the Great Lakes. Discuss how we can influence our governments to work hard on ways to protect the Lakes.
3) Talk about jobs students could have in the future that will contribute to protecting the Lakes (engineer, teacher, scientist, zoologist, biologist, politician).
4) Brainstorm ways that working cooperatively with a partner or group can be beneficial in solving problems.

Acid Rain: A Shared Problem

When talking about acid rain, the old adage applies—what goes up must come down. This section explores acid rain, an example of a difficult environmental issue facing the United States and Canada. By focusing on this complex environmental concern, the lesson reveals why it is so important for governments to work together and be aware of how their actions affect the quality of life of others.

Acid rain is rain, snow, hail, fog, dust, or soot containing high levels of acid. Pollutants that are transferred from the air into the Lakes are responsible for harming the quality of the water in the Lakes, as well as the health of the plants and animals that call the Great Lakes home. But acid rain isn’t just a regional problem; it is a global problem and there is little worldwide agreement on how to tackle it. Neither the United States nor Canada can combat acid rain alone. It is carried across national frontiers and often affects distant places more strongly than where it is produced. Solving the acid rain problem requires an understanding of the consequences of our actions in the United States and Canada, and the necessity of cooperating in the search for a solution.

With the issue of acid rain, attention is drawn to the Great Lakes Basin. This is because many “smokestack” industries are located in and near the Basin, and many people believe that the pollution from these industries contributes to the acid rain problem in Ontario, eastern Canada and northeastern United States. Many Canadians get upset with the United States because so much of the pollution coming from industry in the United States blows with the wind, sometimes ending up in Canada.

There are no simple solutions to this problem. Cost, economics, and available technologies are all issues at stake. Most leaders anticipate that stopping acid rain will be costly. Many dollars will have to be spent to change the way fuels are burned and how other industrial processes are used to make the goods and services on which our society depends. Because so much of the industry is located on the United States side of the Lakes, some Great Lakes states are nervous that they will be responsible for much of the cost.

Long term solutions to the acid rain problem include instituting strict air quality legislation, developing technologies to

Activities:
1) On the Great Lakes map provided, have students identify and color in the United States, Canada, the Great Lakes, and states and provinces that border the Great Lakes. Using a different color, trace the United States and Canadian border. Have the students ever crossed any borders? Could they tell they were entering another country?
2) Conflict Resolution
Divide the class into groups representing each state and province. Have each group make a plan for protecting the Great Lakes. All state groups should meet to share their ideas and develop one overall plan for the United States. Do the same with the Canadian provinces. Finally, one representative is chosen from each country to work out an international agreement for protecting the Great Lakes. The agreement has to be acceptable to both countries. If there are disagreements, ask the students to explore creative ways of solving conflicts. This activity is easily adapted to different grade levels. For lower grades, students could explore plans for keeping the school yard clean. Higher grade levels could expand the students roles to represent various interests and industries affected by such agreements.
Shipwrecks (Great Minds? Great Lakes!)

Falls

B.8.7 identify significant events and people in the eras of U.S.

EE

A.8.5 use the results of their investigations to develop answers, draw conclusions, and revise their personal understanding

Play Edmond Fitzgerald

Read material on shipwrecks for background

Internet research on Lake Michigan and Lake Superior shipwrecks with news article on the history, final voyage, and today of each ship.

Have students research and then create a Great Lakes Shipwreck News Article

Grade with rubric

[http://www.seagrant.wisc.edu/shipwrecks](http://www.seagrant.wisc.edu/shipwrecks)

Shipwreck Oral Report Rubric

Knowledge of Topic (50% of grade)

10 -- Excellent knowledge of shipwrecks history, final voyage, and information about today
8 -- Lacking knowledge in one major concept
6 -- Lacking knowledge in two major concepts
4 -- Lacking knowledge in all three major concepts
2 -- Demonstrates a serious or complete lack of knowledge in the topic

Comments

Seriousness of Presentation (25% of grade)

5 -- Seriously attempts to present knowledge to the class and demonstrates scholarship in the presentation
4 -- Serious presentation which somewhat lacks scholarship
3 -- Exhibits nervousness but attempts to communicate knowledge
2 -- Communication is attempted, but often in a less than serious manner
1 -- Little or no effort to communicate actual knowledge to the class

Comments

Presentation Mechanics (25% of grade)

5 -- Excellent diction and volume, did not read from paper or cards
4 -- Excellent volume and diction but either read from cards or paper
3 -- Adequate to excellent volume and diction, but read from paper or cards
2 -- Inadequate diction and/or volume but did not read from paper or cards
1 -- Completely inadequate in all the above mentioned categories

Comments
The Story of the S.S. Edmund Fitzgerald
(Thanks to John Lienhard, at the University of Houston)

The Great Lakes are just that to most of us. They're just lakes. They reveal none of the majesty or the menace of the open seas. The only difference was that you can't see the other side. Yet the voyage from Duluth to the eastern end of Lake Ontario is almost a thousand miles.

The Sault Ste Marie locks opened in 1855; and they connected Lake Superior to Lake Huron. Iron ore began moving from Minnesota's Mesabi Range eastward to the steel mills. As shipping began in earnest, we saw why the Indians named Lake Superior Gitche Gurnee -- why they held it in awe. Ships found themselves sailing a treacherous ocean. Today, we count some six thousand Great Lakes shipwrecks, and November seems to be the worst month. On November 13, 1913, a single storm sank 12 ships and killed 250 people. The great blizzard of November 11, 1940, sank two ships and killed 46 people.

The largest ship went down on November 10th, 1975. It was the S.S. Edmund Fitzgerald. The day before, the 17-year-old Fitzgerald had left Superior, Wisconsin, loaded with almost 30,000 tons of iron ore pellets called taconite. In her star-crossed life the Fitzgerald had run aground once, she'd collided with the walls of the locks twice, she'd lost an anchor on one trip and suffered structural cracking on another. This time she left Superior with two damaged hatches. And twenty minutes after she sailed, gale warnings were posted. Just past midnight, winds were reaching sixty miles per hour and driving ten-foot waves.

By the afternoon of November 10th, the Fitzgerald had suffered more damage and was running both her 7000-gallon-per-minute pumps. Then she lost the single antenna that served both her radar units. So she radioed the Whitefish Point radio station and asked for help with navigation. Now her troubles really began compounding.

The Whitefish radio beacon was out. The Fitzgerald might've been helped by radio equipment aboard an ocean ship that was in port at Whitewater. But that ship's captain scoffed at the storm. He said, "This is just a lake," and he sailed off.

So the Fitzgerald blindly rode 16-foot waves. She began to list. With water washing over her wheelhouse the captain sent a last tight-lipped message: "We're holding our own." Then the Fitzgerald and her 29-person crew vanished. The following spring, search boats found what was left of her on the bottom. Like the Titanic, she'd split in two as she sank. The stern section lay upside down, the bow, right side up.

Gitche Gurnee had claimed her 6000th ship, and we're left with those words, "It's just a lake." After 118 years this ocean, posing as a lake, was still deceiving us with her placid everyday face.

Wreck of the Edmund Fitzgerald - Lyrics by Gordon Lightfoot

The legend lives on from the chippewa on down of the Big lake they call "Gitche Gurnee" The lake, it is said, never gives up her dead When the skies of November turn gloomy,

With a load of iron ore twenty-six thousand tons more

The Great Lakes are just that to most of us

Than the Edmund Fitzgerald weighed empty.
That good ship and true was a bone to be chewed
When the "Gales of November" came early.

The ship was the pride of the American side
Coming back from some mill in Wisconsin
As the big freighters go, it was bigger than most
With a crew and good captain well seasoned

Concluding some terms with a couple of steel firms
When they left fully loaded for Cleveland
And later that night when the ship's bell rang
Could it be the north wind they'd been feelin'?

The wind in the wire made a tattle-tale sound
And a wave broke over the railing
And every man knew, as the captain did too,
'Twas the witch of November come stealin'.

The dawn came late and the breakfast had to wait
When the Gales of November came slashin'.
When afternoon came it was freezin' rain
In the face of a hurricane west wind.

When suppertime came, the old cook came on deck
sayin' "Fellas, it's too rough to feed ya."
At Seven P.M. a main hatchway caved in', he said
"Fellas, it's been good t'know ya"

The captain wired in he had water comin' in
And the good ship and crew was in peril.
And later that night when his lights went outta sight
Came the wreck of the Edmund Fitzgerald.

Does any one know where the love of God goes
When the waves turn the minutes to hours?
The searches all say they'd have made Whitefish Bay
If they'd put fifteen more miles behind her.

They might have split up or they might have capsized;
May have broke deep and took water.
And all that remains is the faces and the names
Of the wives and the sons and the daughters.

Lake Huron rolls, Superior sings
In the rooms of her ice-water mansion.
Old Michigan steams like a young man's dreams;
The islands and bays are for sportsmen.

And farther below Lake Ontario
Takes in what Lake Erie can send her,
And the iron boats go as the mariners all know
With the Gales of November remembered.

In a musty old hall in Detroit they prayed,
In the "Maritime Sailors' Cathedral."
The church bell chimed till it rang twenty-nine times

http://www.pennsmart.com/stories/Edmund.htm
For each man on the Edmund Fitzgerald.

The legend lives on from the Chippewa on down
Of the big lake they call "Gitche Gumee".
"Superior", they said, "never gives up her dead
When the ‘Gales of November’ come early!"

http://www.pennsmart.com/stories/Edmund.htm
Lakes area, particularly in Sandusky, Ohio, on Lake Erie and in Milwaukee, Wisconsin.

Also among the immigrants to the Great Lakes Basin were the Canadians, French-Canadians, Russians, Czechs, Greeks, Turks, Persians and Spaniards, Welshmen, Scotsmen, and Dutch. Immigrants from Mexico, Puerto Rico, and other Central American countries came at the turn of the century, with significant migration occurring during World War I.

Activities
1) Have the students research the Native American and European people who first settled in the Great Lake Region. Locate early settlements on the map.
2) As a class, research and dress up as early explorers of the Great Lakes region and describe their experiences. Have the students write a make-believe journal entry of an explorer's adventures.
3) Have the class research the history of your town. Write to a local historical group or invite a long-time resident to share his or her memories of the town's history with the class.

Shipwrecks
A sailor's life journeying the five Great Lakes sounds romantic, but not all the journeys have been smooth sailing. The Great Lakes have seen their share of shipwrecks over the years.

Explorer Robert de LaSalle's ship, The Griffin, one of the first large ships ever to sail the Great Lakes, was launched in 1679 and carried a load of furs out of Green Bay on its maiden voyage. She was never seen again and no splinter ever washed ashore. The Griffin leads the long parade of ghost ships that provide us with the great mysteries of the Great Lakes.

In 1871 alone, 1,167 disasters were recorded. In the two decades between 1878 and 1898, the United States Commissioner of Navigation reported 5,999 vessels wrecked on the Great Lakes and 1,093 of these were total losses. 1905 was a particularly bad year on the Lakes with 271 vessels damaged, 54 of which were lost through the stress of weather.

Whereas luck and intuition were the tools available to early skippers, today's captains have the finest and most sophisticated navigational aids available. Ships are equipped with weather warning systems, radios, direction finders, and depthometers. Careful study of previous shipwrecks has taught us how to improve ship construction and methods of navigation.

Despite all that modern technology can offer, surviving a Great Lakes storm is still a challenge. The storms of the Great Lakes have been compared with a "witches brew," and a "devil's harvest." Storms can explode across hundreds of miles of open water with little or no warning. Storms on the Great Lakes often can be more difficult to navigate than ocean storms. Waves on the Great Lakes jump and strike quickly compared to the lethargic rolling and swelling of ocean waves.

Just as there are comparisons to be made between ocean storms and lake storms, there are differences in the way each of the Great Lakes reacts in a storm. Most veteran captains and crews find Lake Erie the least agreeable in either fair or foul weather because of its shallow depth and muddy bottom.

Lake Superior is a favorite among mariners because its large size affords the greatest amount of room for maneuvering during a storm. However, it too poses a challenge to navigate with its rocky coastline, cold temperatures (40 degrees in summer or winter), and huge waves that develop because of the Lakes' depth. An ancient Chippewa legend warns that Superior "never gives up its dead."

Lake Michigan commands the greatest respect among seafarers for several reasons. Prevailing winds sweep its length
and the currents caused by wind shifts around the Straits of Mackinac cause it to be the trickiest of the Lakes to keep on course. It also has a scarcity of natural harbors and human-made places of refuge.

Activities:
1) Have students research a Great Lakes shipwreck and tell the story to the class (see back cover for resources).
2) Contact a maritime museum in your state and ask what underwater archeology is currently being done in the Great Lake nearest you.

Discussion:
1) Talk about the different navigational challenges posed by each Great Lake. The information mentions that previous shipwrecks lead to the development of further safety precautions. Discuss with the students what might be learned from shipwrecks. How can shipwrecks tell us about the way people lived long ago and about the history of shipping?
2) Discuss what inventions and advancements in weather prediction have made navigation on the Great Lakes safer.

The Fate of the Christmas Tree Ship

It was late November and the sights and sounds of the holiday season were creeping into the bustling city of Chicago. Each year, the arrival of the creaking old three-masted schooner Rouse Simmons served as a signal for the beginning of the Christmas season. The schooner always ended her shipping season by bringing to Chicago a large and profitable cargo of Christmas trees.

Along with the annual tree buyers, peg-legged and bearded Claud Winters eagerly awaited the arrival of the Rouse Simmons. Claud and Captain Schunemann, owner and master of the ship, had an unusual bond. Although their lives were quite different, they seemed to understand and sympathize with each other.

Claud was soft-hearted under his rough outer appearance. As a child he had lost a leg under a boxcar, so he couldn’t handle the demands of being a seafarer. Claud admired the Captain as a fearless sailor and a smart ship operator. In the great storm of 1889 the Rouse Simmons was the only sailing ship that was not severely damaged or lost.

The Captain was legendary for his stinginess and stubbornness in working with anyone who might cut into his profit. Claud would have enjoyed the thrill and adventure of a sailor’s life. The Captain must have understood this about Claud because he was unusually generous to his stocky peg-legged friend. Once the Captain gave Claud a silver dollar saying, “Always keep this and you’ll never be broke.” Whenever they met, Claud would show him the coin and say, “Here it is... still as good as new and still a yarnin’ to be spent.”

On the morning of November 27, 1912, Claud stomped onto the Clark Street wharf to await the early morning arrival of the Rouse Simmons. Claud had hired a group of men to unload the fragrant pine and balsam trees. When the ship was nowhere to be seen, Claud was sure the Captain was floating offshore waiting for the fog to lift so he wouldn’t have to pay charges for a tug to bring him in. But by 4:00 PM many of Claud’s hired companions had tired of waiting and left. Claud himself was feeling tired, discouraged and hungry. Many busy tugs had come upriver, but nowhere on the horizon could he see the sails or masthead lamps of the Rouse Simmons.

The year 1912 had been a devastating one for Great Lakes shippers. The worst snow storm in a century had blasted the lakes for four days in early November, destroying 10 large freighters and littering the shoreline with debris. Four hundred seamen were lost in those four disastrous days.

Meanwhile Captain Schunemann was realizing he could turn a disaster into a fortune. Snow had buried tree farms in Michigan and Wisconsin. Chicago tree dealers were desperate for trees. Captain Schunemann was happy to deliver! At Thompson Harbor just southwest of Manistique, Michigan trees were being crammed into every available space on the Rouse Simmons. Well into the evening, the Captain had more bundles of trees tied on board the deck, row upon row. The schooner sagged under the weight of her fragrant cargo. He expected this could be the most profitable run he had ever made.

Despite stormy weather, the Rouse Simmons set sail at noon on November 25, 1912. The schooner Dutch Boy was seeking shelter when its captain spied the Rouse Simmons off his bow. He exclaimed above the howling wind, “Mother of God, look! That...”
crazy Dutchman's going out in this, and him with every inch of canvas up!"

As the Rouse Simmons swung west southwest on course toward Chicago, she was caught in deadly winds of 60 miles per hour. Every part of the ship creaked, moaned, and shrieked in the howling gale. Some time during the night two sailors were sent to check the lashings. A tremendous wave swept them, along with many of the bundled trees and a small boat, into the raging seas. With less weight on board, Captain Schunemann and his first mate were able to maneuver the vessel toward shelter at Bailey's Harbor.

As fate would have it, the violent wind changed suddenly, producing a furious snowstorm and an incredible drop in temperature. A thick blanket of ice quickly thickened as the unrelenting waves pounded the ship. The situation of the Rouse Simmons was becoming more desperate each moment. Battered hatch covers could no longer prevent water from entering the hold where it quickly turned into ice on the trees.

From the station tower at Sturgeon Bay, Wisconsin, men of the old United States Lifesaving Service sighted the Rouse Simmons flying distress signals as she continued to move low in the water, driven along by the force of the gale. A rescue team 25 miles to the south launched a surfboat in an attempt to intercept the suffering schooner. Visibility was difficult and a two-hour search was unsuccessful. But suddenly there was a break in the snowstorm and the pitiful ship was sighted. She was barely afloat and resembled a mass of ice. Rescuers desperately moved full steam ahead as blinding snow again made it impossible to see the schooner. The Rouse Simmons vanished from sight and was never seen again.

Meanwhile, Claud Winters continued to believe that the Rouse Simmons would arrive even after a note was found in a bottle on the beach in Sheboygan, Wisconsin. It said, "Friday... everybody goodbye. I guess we are all through. During the night the small boat was washed overboard. Leaking bad. Ingvald and Steve lost too. God help us. Herman Schunemann."

Chicago suffered from a shortage of Christmas trees that year.

That Christmas Eve, Claud made his daily trip to the dock. He stood in the falling snow waiting for the Rouse Simmons to arrive. The next morning a policeman found him blanketed with snow. Believing to the end that the Captain would come through, Claud's sad life was ended. As the policeman picked up his lifeless body, a silver dollar fell from his frozen fingers and rolled into a crack in the dock, landing in the icy black water below.

It was another 10 years before evidence of the Rouse Simmons was discovered. Captain Herman Schunemann's wallet was found among the fish caught in the nets of a Wisconsin fisherman.

Discussion:
1) Discuss Claud Winters and Captain Herman Schunemann's personalities, interests, and appearance.
2) Talk about what kind of person would choose the life of a seaman in the early part of the century.

Activities:
1) Have the students trace the route of the Rouse Simmons on the Great Lakes map.
2) Have the students write a diary entry that Claud Winters might have written after one of the evenings he spent at the dock waiting for the Rouse Simmons to arrive, or have them write a message one of the crew of the Rouse Simmons might have written and put into a bottle in hopes that it would eventually reach his family.
3) Assuming that the Rouse Simmons had made it safely to Chicago, use the information below to make up math problems appropriate to the level of your class:

Number of trees loaded onto the ship: 1,000
Number of trees washed overboard in the storm: 300
Price Captain Schunemann paid for the trees: $0.25/each
Price of trees when sold in Chicago: $0.75/each

For older students, discuss gross and net profits, taking into consideration the cost of shipping the trees and the cost of the lost trees.
APENDIX C

SCIENCE ACTIVITIES
Groundwater Demonstration and Edible Aquifer (*Cool Groundwater Activity*)

EE

B.8.5 Examples of human impact on various ecosystems

- Use the groundwater demonstration to help students understand how wells can become polluted and how what we do in Falls can impact the Great Lakes
- Follow directions in Groundwater demonstration activity
- When finished make the Edible Aquifer
GROUNDWATER DEMONSTRATION

Vocabulary (Adapted from the USGS Poster Series panel)

**groundwater** - water beneath the land surface in the saturated zone

**saturated zone** - zone beneath the land surface where all the pores or fractures are filled with water

**unsaturated zone** - the zone immediately below the land surface where the pores or fractures contain both water and air

**water table** - the top of the water surface in the saturated zone of an unconfined aquifer; "the top of the water is the table"

**aquifer** - an underground body of porous sand, gravel or fractured rock filled with water and capable of supplying useful quantities of water to a well or spring

**recharge** - replenish; the addition of water to an aquifer

**permeable** - the capacity of porous rock for transmitting water; large connected spaces that allow water to flow through

<table>
<thead>
<tr>
<th>Materials</th>
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<tbody>
<tr>
<td>clear pan, 3&quot; deep</td>
<td>2 clear 10 oz. cups for waste water</td>
</tr>
<tr>
<td>gravel (5 lb. bag of aquarium gravel)</td>
<td>½ C gravel, sand &amp; clay (each in a clear cup or jar)</td>
</tr>
<tr>
<td>spray bottle with 2 cups of water</td>
<td>tablespoon</td>
</tr>
<tr>
<td>pipette or medicine dropper</td>
<td>extra water</td>
</tr>
<tr>
<td>food dye or drink mix powder</td>
<td>nylon net (for clean up)</td>
</tr>
</tbody>
</table>

DIRECTIONS

1. Pour gravel into clear pan. Arrange gravel so that it is deep in front. Make a depression for a lake; leave about ½" of gravel under the lake. Place an object under the back of pan so that the water will run toward the front. Tell the students that this is a model of a cross section of the earth so we can see what is happening underground. Point to the depression and note the earth’s surface is not even.

2. Mix blue food dye in the water, dark enough so that the water will be seen. From one side of the pan, slowly pour water. Leave at least ¼" of unsaturated rocks. Do not pour directly into the lake. Have students note that the spaces between the gravel are filling with water. This is called groundwater. Tell the students that where the area where all the spaces are filled with water is called the saturated zone. Point out the water table - the line between the saturated and the unsaturated zone. Show with the pipette that if you try to pump water out of the unsaturated zone you will not be very successful. Show the difference when you pump water from the saturated zone. Explain that wells are dug below the water table into the saturated zone.

3. Pour enough water so that some is visible in the lake. Once again, show the water table. Note that one way lakes and rivers are formed is where the water table is above the earth’s surface. Students should understand that groundwater is connected to surface water and that if groundwater is harmed, it may affect surface water, too.
4. Pump the well many times. Is the water table affected by over pumping? *(The water table visibly decreases in the lake. Students can infer that it is decreasing by the well.)* Add 2 drops of red food color (representing a pollutant) between the lake and the well and another drop on the far side of the lake. Watch how it moves. Spray the model with a heavy rainstorm *(recharge)*. Watch again. Now pump the well multiple times and place the discharge in a second cup. Compare the color. What has happened to the quality of the drinking water? What would happen to the lakes and rivers that are fed by water from this aquifer?

Ask the class what you could do now that the well is contaminated *(information regarding common responses is in the last paragraph of the background section)*. Demonstrate moving your well to another spot. Pump there multiple times. *(As you pump, the direction of flow will change and go toward the well.)* Note how a small amount of pollutant can affect the whole aquifer. Note how the pollutant from the far side of the lake is moving toward the lake. Groundwater moves towards areas of less pressure. *(If the lake had an outlet, it would be affected even more. It is affected in this demonstration because water is being pulled toward the well as it is being pumped.)* Pour the remaining water on the model and note the color of the lake.

If you throw toxic items in the trash at home, how could that affect the water? *(The trash goes to the landfill; the landfill might leak into the soil. Once in the soil the contaminants can affect large areas of groundwater which could end up in wells or lakes.)*

5. For water to move in an aquifer, the pores between rock materials and fractures in rock must be connected. If there is a good connection, water can move freely and we say the material is permeable. Water moves through different materials at different rates. Faster through gravel, slower through sand and much slower through clay. Therefore, gravel is more permeable than sand, which is more permeable than clay. Demonstrate by placing $\frac{1}{2}$ cup of clay, gravel and sand each in their own clear cup. Add 1 Tbsp. of water at a time over each sample. Can you tell which kind of material holds the most water? the least? *(There are more pores in gravel so you can add more water before it will be saturated. Clay holds the least amount of water.)*

The aquifer in our first model is gravel. Sand and gravel aquifers are common in Wisconsin. If the type of soil and rock were different, the amount of groundwater that could come from the ground would be different and the speed it moves would be different. In clay the pores are so close together, there is hardly anywhere for water to fill. Water moves around clay. If there were a layer of clay in the middle of the model, a well would need to be shallow (above it) or drilled through it to reach a saturated zone. An aquifer that is covered with an impervious material is called a confined aquifer.

*(If you do the Cool Groundwater Activity, make the analogy that the gravel is equivalent to the ice, the imagined clay layer to the ice cream layer with the ice below representing a confined aquifer and the ice above an unconfined aquifer. The variety of other types of rocks and soils are represented by the sprinkles. The pipette is like the straw, both represent wells and pumps.)*

To clean up, cover the pan with the nylon stocking and pour out the water. Allow the gravel to dry before putting the lid on the pan. *(If mold should develop, rinse the gravel with some diluted bleach.)*
Cool Groundwater Activity

Edible Earth Parfaits

Background:
This activity is a fun and easy way to understand the geology of an aquifer. You will build your own edible aquifer, learn about confining layers, contamination, recharge and water tables.

Key Topics: Geology, Groundwater, Wells

Subject Area: Science

Grade Levels: all ages

Duration: 25 – 30 minutes

Materials Needed:
- Blue or red food coloring
- Vanilla ice cream
- Clear soda pop
- Crushed ice
- Variety of colored cake decoration sprinkles and sugars
- Drinking straws
- Clear plastic cups

Objective:
To teach about the geologic formations in an aquifer, how pollution can get into groundwater and how pumping can cause a decline in the water table.

Activity Steps:
1. Review What is groundwater? and Groundwater ABCs.
2. Begin to construct your edible aquifer by filling a clear plastic cup 1/3 full with crushed ice (represents gravels and soils).
3. Add enough soda to just cover the ice.
4. Add a layer of ice cream to serve as a "confining layer" over the water-filled aquifer.
5. Then add more crushed ice is added on top of the "confining layer."
6. Colored sugars and sprinkles represent soils and should be sprinkled
over the top to create the porous top layer.

7. Now add the food coloring to the soda. The food coloring represents contamination. Watch what happens when it is poured on the top of the "aquifer." Keep in mind that the same thing happens when contaminants are spilled on the earth's surface.

8. Using your straw, drill a well into the center of your aquifer.

9. Slowly begin to pump the well by sucking on the straw. Watch the decline in the water table.

10. Notice how the contaminants can get sucked into the well area and end up in the groundwater by leaking through the confining layer.

11. Now recharge your aquifer by adding more soda which represents a rain shower.

12. Review what you have learned as you enjoy eating your edible aquifer.

Edible Earth Parfaits was adapted from Making A Bigger Splash, co-published by The Groundwater Foundation and the US EPA, Region VII. If you are interested in more activities based on environmental issues, see the online catalog or contact The Groundwater Foundation at 1-800-858-4844.
Falls

12.7 knows that if more than one force acts on an object, the forces can reinforce or cancel one another depending on their direction and magnitude

- pre-activity discussion using questions 7, 10, 11, 12, 13
- complete the activity
- discuss results of activity using questions 6, 9, 7
Why Do Boats Float?

Objectives (Learners will be able to):
- Design and build a clay boat that floats and holds "cargo"
- Explain buoyant forces
- Explain the relationship between surface area and buoyancy

Focus
- What materials are used to make boats?
- If you have a piece of steel and throw it into the water, would it float?
- Why then do steel boats float?
- Does an empty steel barrel float? Why?
- Do you think the ability to float has something to do with the shape of the boat?

Procedure
1. Working in pairs, students will begin to mold their clay into various floating hull shapes. Ask them if the previous activity has might have something to do with the shapes they are now forming. Of course, it does!
2. Ask each pair to design a vessel hull that will carry more cargo (i.e., pennies or washers) than any other student team's hull.
3. Before they proceed, have them create a T-diagram (see below) to record each action and each result, from design considerations to loading their vessel with its cargo.

<table>
<thead>
<tr>
<th>WHAT I DID (ACTIONS)</th>
<th>WHAT HAPPENED (RESULTS)</th>
</tr>
</thead>
</table>

Grade Level
4-8

Estimated Time
50 minutes

Materials
- 10-20 gallon aquarium filled with water
- pennies or washers
- 3-inch diameter clump of clay for each student or team

Vocabulary
- Buoyant force
- Displacement
- Gravity
- Equilibrium
- Hypothesis

Discussion
What boat shape best supported the weight of the cargo?
Did displacement of the cargo affect buoyancy of the vessel?
What is the relationship between surface area and buoyancy?

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4. Remind them to be observant of every action and result from placing each penny into their boat.

5. Keep count of the number of cargo pieces that are placed into the boat.

6. Determine whose boat was the most "seaworthy" by virtue of holding the most cargo.

7. Based on this activity, now ask, "Why do steel boats float?"

8. Discuss possible explanations, asking students to relate to the results of this activity and to the earlier hypothesis: "An object that weighs more than an equal volume of water will sink in water."

9. Ask students, "What force is responsible for the weights that were measured earlier?" The answer of course is gravity.

10. Explain to students that there are primarily two forces acting on a boat as it floats in the water. The downward force of gravity is equal to the weight of the boat and everything in it. At the same time, there is an equal and opposite upward force on the boat. What might that be? Newton's 3rd Law of Motion states that for every action there is an equal and opposite reaction.

11. Working in pairs, ask the students to face his/her partner and touch palms. Ask one student to represent the downward force of gravity of the boat. If the other person does not push back, what happens? What happens if the other person exerts only a little force? A lot of force? Can there be a balance (equilibrium)?

12. The second student represents the upward force of the water pushing back on the submerged vessel. It is called the buoyant force. The boat in the water takes up space and pushes water out of the way. The water is displaced. The water that is pushed out of the way pushes back on the boat (buoyant force). The buoyant force is equal to the weight of the displaced water. Ask students to explain why steel boats floats, using vocabulary such as "forces of gravity" and "buoyancy." "An object floats when the total downward force of gravity is equal to the total upward buoyant force of the displaced water."

13. Archimedes Principle states that the buoyant force on an completely or partially submerged object is equal to the weight of the fluid the object displaces.

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Timely Temperatures (A Teacher’s Guidebook Aboard the Denis Sullivan)

Falls
1.10 knows that the Sun is a major source of energy for phenomena on the Earth’s surface

- complete activity one in groups and answer questions
- complete activity two in groups and answer questions
- with a partner read the material Is the Lake “Clean”?
- discuss all material
**Timely Temperatures**

**Objective (Learners will be able to):**
Create a model of a stratified lake
Gain a better understanding of how lake water becomes stratified, when it occurs, and why it is important that stratification occurs

**Focus**
Ahead of time, put cold water in a large container and make it colder by adding ice. Before using the water, scoop out the unmelted ice. Stir the water. Put 100 mL of the cold water into a 100 mL graduated cylinder. In an identical 100 mL cylinder, put an equal amount of warm water. On a balance, measure the masses of each separately. If you have a double pan balance, you can put one on each pan. The cold water should have the greater mass because it is more dense. Discuss the fact that cold water is more dense than warm water because the molecules are closer together when the water is colder (*relate to Hangin’ Together activity*).

**Procedure**

**Activity One:** Have a large container or pitcher of warm water available for the students. Make sure the container is one that the students can use to pour the warm water into a different container for transporting the water. Have students pour the warm water into a large container (about 1/3 full) that will be their “lake” (a 500 mL beaker or small aquarium tank will work). Have a similar large pitcher filled with cold water. You can make the water extra cold by adding ice ahead of time. Add blue food coloring to this cold water before it is used. Have students predict what will happen when the cold water is added to the warm water. Using a funnel with a long stem or hose that will touch the bottom of the container, slowly pour the cold blue water to the bottom of the “lake.” Be sure that the stem of the funnel or hose touches the bottom the entire time. Carefully remove the funnel so as not to disturb the layers in the beaker. Ask students to record their observations and discuss the following

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**Grade Level**
4-8

**Estimated Time**
1 class period

**Materials**
- 2 identical 100 mL beakers or graduated cylinders
- Clear tub, beaker, or aquarium tank to be the “lake”
- 2 containers or pitchers
- ice
- balance
- funnel with long stem or hose
- thermometers
- red ice cubes
- red and blue food coloring
- pencils

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Discussion / Questions
What is the temperature of the clear layer? What is the temperature of the blue layer?
Which layer is more dense? (Cold water is heavier than the clear water and remains separated until the temperatures equilibrate)

Activity Two: Ahead of time, freeze some red colored water in ice cube trays. You will need one red ice cube for each group of students. Have each group slowly place one ice cube on top of the water in their "lake" container. Remind them to not disturb the blue and clear water layers. Observe and record what happens over the next few minutes.

Questions
As the ice melts, how does the red water move?
Is the red layer more or less dense than the clear layer? Than the blue layer?

Explanation
As the ice melts and begins to sink, it warms up a bit. This new layer represents the boundary between the upper warmer layer and the bottom colder layer. The thickness of this boundary is not sharp and distinct but rather a narrow gradual zone. During the summer months, Lake Michigan heats up from the top down. The warm water is less dense than the cold water and forms a layer above the colder water. This upper layer is called the epilimnion. The colder bottom layer is called the hypolimnion. The intermediate layer or zone is known as the metalimnion or thermocline. On the Denis Sullivan, students will record surface and bottom water temperatures. Depending on the cruise, this measurement may be taken in 25-30 feet of water or 60-80 feet. In spring, the two readings will not vary much. By summer, however, as the lake becomes increasingly stratified, the temperature range from surface to bottom will be greater.

Activity Three: Next, add crushed ice to the top of the water. This will cause the water on the surface to cool down. Observe and record what happens. This movement of water is called thermal overturn. During what time of the year does this happen in Lake Michigan?

Vocabulary
- Stratification
- Epilimnion
- Metalimnion
- Hypolimnion
- Overturn

Source
Adapted from the Ohio Sea Grant, Daniel W. Jax, 1989.
Is the Lake “Clean”?

A frequently asked question on our expeditions and daysails is "what is the water quality?" Many of the procedures performed on the vessel help to answer that question. Water quality is defined in terms of physical, chemical, and biological parameters with respect to a certain use. For instance, acceptable water quality for warm water fishes would not be optimum for cold water fishes, and standards for drinking water differ from those for boating and recreation. No single factor alone indicates good water quality, and the quality varies with factors such as season and location. Long-term water quality measurements from well-defined locations are needed to tell if conditions are changing or remaining the same.

No Two Lakes Are Alike

Lakes are particularly useful for ecological study. Relatively easy to understand annual physical events take place in many temperate lakes, including our vast Great Lakes. During the warm part of the year, the surface water of a temperate lake is warmed above by the sun. The upper warm layer, or epilimnion, essentially floats over a bottom layer of colder, more dense water, the hypolimnion. Separating the two is a fairly thin layer, the thermocline, in which there is a sharp temperature decline. The stratification of warm water over cold is fairly stable throughout the summer months. In the fall, when surface water is already cooling off, stronger winds help to overturn the lake, mixing the epilimnion and hypolimnion. In spring, the layering will emerge again, thus completing an annual cycle in temperate lakes.

More plants and animals will live in the water layer where there is more available light (photic zone) and often warmer temperatures. The more organisms that are photosynthesizing, breathing, eating, and growing, the higher the growth rate or productivity. The bottom portion of a deep lake receives little or no light. The water is colder. It is not as well mixed by wind. The decay of dead organic matter, called decomposition, is the main physical, chemical, and biological activity there. Lakes of low productivity or fertility are called oligotrophic. Lakes that are very fertile are considered eutrophic.
Large, deep lakes such as Lake Michigan are considered oligotrophic. Still, thermal stratification has interesting consequences for the bottom waters and bottom habitats (benthic). As mentioned before, photosynthesis thrives in the top water where there is greater sunlight. Oxygen-producing phytoplankton help to keep the epilimnion well supplied with essential dissolved oxygen. In the darker areas of the hypolimnion, there may be almost no photosynthesis, and thus, no oxygen is produced. Bottom dwelling animals must still respire, and thus the reserve of dissolved oxygen in the hypolimnion will be used up. This oxygen depletion is made worse by oxygen-consuming bacteria and other decomposers feeding on the bottom. Thus, the fall and winter turnover serves a vital function in such lakes, helping to mix and replenish oxygen-poor environments in the deep hypolimnion.

**Physical Properties Of Water**

Water is a unique chemical compound that exists naturally on Earth in the gaseous (water vapor), liquid, and solid (ice) states. It has a maximum density at 4° C, and water boils at 100° C and freezes at 0° C. A relatively large amount of heat is needed to raise water temperature. Physical properties of water that are measured on the vessel may include water transparency or clarity, color, turbidity, and temperature. Suspended particles in water influence water color and clarity. These particles settle to the bottom and contribute to a build up of sediment. Instruments and equipment used to quantify these properties include the Secchi disk, turbidity meters, thermometers, and the YSI DataSonde.

**Chemical Properties Of Water**

Water chemistry is influenced by many factors such as the geology of a region, photosynthesis and respiration, pollutant load, pressure, temperature, and time of day. Water behaves as a solvent in which a substance (solute) dissolves. The resulting solution may contain individual ions (particles with charges) or molecules. Gases, solids, and other liquids are capable of dissolving in water but some of these substances do not dissolve, e.g., they are insoluble. The solubility of a solid in water generally increases with temperature while the solubility of a gas decreases with temperature. Concentrations of a chemical in water are generally expressed in terms of milligrams per liter (mg/L), parts per million (ppm), and percent saturation for gases. Chemical properties of water explored on the Expedition include pH, dissolved oxygen, and conductivity. Nutrients (phosphorus and nitrogen), heavy metals, and organic compounds require specialized laboratory equipment for their measurement and are not usually analyzed on a standard cruise.

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Biological Properties Of Water

Like other ecosystems, lakes and rivers host a complex combination of plants (producers), animals (consumers), and decomposers, which are interrelated through food chains and food webs. Introduction of exotic species can upset the balance of existing food chains. The productivity of a body of water is dependent upon variables such as the available nutrients, light, and temperature.

Aquatic plants and animals are generally divided into three groups:

1. **Plankton - organisms that drift with the currents**
   - A. phytoplankton - plants
   - B. zooplankton - animals

2. **Nekton - larger size organisms that can swim freely**

3. **Benthos - organisms which live in or on the bottom of a body of water**

These organisms have a spatial distribution that is defined by regions adjacent to the shore (littoral), open waters (limnetic or pelagic), and the bottom (benthic). Sampling with plankton nets and PONAR grab samplers will allow analysis of plankton and benthos.

Lake Michigan Food Web

The general flow of biomass in Lake Michigan is through trophic levels that include the producers, phytoplankton and aquatic plants, and consumers, zooplankton, forage fishes, predator fishes, and fish eating humans and other animals. The Lake Michigan food web is composed of two distinct but overlapping parts: the pelagic food web associated with offshore open water (pelagic) and the bottom (benthic) food web. Both webs are dependent upon the phytoplankton in the surface waters.

Members of the pelagic food web include small invertebrates such as cladocerans and copepods. The benthic food web is fueled by the direct conversion of detritus (dead and decomposing organic matter) that falls from the upper part of the water column (photic zone). Two large macrobenthic animals, the opossum shrimp (*Mysis relicta*) and amphipod or "sideswimmer" (*Diporeia sp.*) are important species.
The biological integrity of the fish community that is dependent on pelagic and benthic species is no longer present. Increased pleasure and commercial fishing and human-induced environmental degradation have greatly altered the composition of fish species. Additional stresses of the sea lamprey and alewife contribute to a less complex, less stable food web. Control of the sea lamprey and introduction of salmon and trout have helped to increase stability and shift the balance from dominance of single fish species to a diversity of about 78 fish species in Lake Michigan and 130 in the tributaries to the lake. Alewife, rainbow smelt, and bloater represent prey species for the salmon in offshore regions. The inshore fish community includes yellow perch, walleye, smallmouth bass, pike, catfish, and panfish. Important fish of the benthic food web are lake whitefish, round whitefish, sturgeon, suckers, and burbot.

Besides man, consumers of Great Lakes fish include birds such as herons, osprey, bald eagles, loons, cormorants, and mergansers. Minks and river otters also consume fish. The web comes full circle with the detritus and decomposers completing the cycle.

**Exotic Or Nonindigenous Species**

Exotic or nonindigenous species are plants and animals that are found beyond their original range. They may be beneficial to an ecosystem, but they can also disrupt the ecological balance of an area. Harmful aquatic nuisance species include the zebra mussel, quagga mussel, ruffe, round goby, spiny water flea, sea lamprey, Eurasian watermilfoil, and purple loosestrife. When released into habitats where there are no natural controls such as pathogens, parasites, and predators, these species can grow at an exponential rate quickly establishing themselves.

Over one third of the 140 exotic species in the basin have been introduced since the opening of the St. Lawrence Seaway for shipping 30 years ago. Ballast water from ships is an important transporter of these species. The National Invasive Species Act of 1996 reauthorized a mandatory Great Lakes ballast program restricting the dumping of ballast. Other means of transport for exotic species are the water used for the bait industry, food processing, exotic pet trade, and the aquarium trade. Boat transfers from one body of water to another and landscape practices are other ways of transporting aquatic nuisance species. Inland lakes as well as the Great Lakes have seen invasions of exotic species.
Data collected by citizens on aquatic nuisance species can contribute to the research base for early detection of the spread of aquatic nuisance species. Participants in the cruises on the S/V Denis Sullivan have an opportunity to contribute to monitoring of aquatic nuisance species. Sightings of exotic species are recorded in the vessel database and may be shared with scientists and state agency personnel working on management of nonindigenous species.

Zebras mussels (*Dreissena polymorpha*) were first discovered in the Great Lakes basin in Lake Saint Clair in 1988 and Lake Michigan in 1989. They have now spread to all five Great Lakes and many inland lakes. Zebras mussels attach to intake pipes, rocks, buoys, docks, piers, and many other submerged substrates including clams. The mussels are filter feeders, which cause a decline in phytoplankton that would otherwise feed planktivorous fish species. Colonies of zebra mussels clog water intakes and use rocky substrate that is important to fish spawning. There have been reports of mussel feeding activity increasing water clarity and leading to the growth of plants attached to lake bottoms as more sunlight penetrates deeper. A deep-water relative of the zebra mussel, the quagga mussel (*Dreissena bugensis*), has also been discovered in the Great Lakes. Look for zebra mussels attached to plants and in bottom samples. The free-floating larval forms of zebra mussels called veligers may be found in plankton samples.

Another aquatic nuisance species found in plankton samples is the spiny water flea (*Bythotrephes cederstroemi*) or B.C. *Bythotrephes* is a predaceous, shrimp-like zooplankter that grows to about one centimeter (0.4 inch) in length. It feeds on small aquatic animals that would otherwise be food for fish. It reproduces rapidly and can monopolize the food supply. The spiny water flea is protected from fish predators by its unusually long tail spine with protruding barbs. Many fish such as young alewives, lake trout, and perch can easily capture *Bythotrephes*, but they have a hard time swallowing it. The spiny water flea is native to Europe and China and is thought to have been transported in ballast water to the Great Lakes in the 1980s with the first appearance in Lake Michigan in 1986.

Eurasian watermilfoil (*Myriophyllum spicatum*) was accidentally introduced to North America from Europe and reached the midwestern states between 1950 and 1980. Watermilfoil can form vast mats of vegetation at the water's surface which crowds out native plants and interferes with recreation. The plant reproduces quickly. Plant fragments cling to boats and are carried from lake to lake.

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Although quite scenic, purple loosestrife (*Lythrum salicaria*) is changing the character of Michigan wetlands. A native of Europe and Asia, the plant was introduced to North America in the 1800s. The main difficulty with purple loosestrife is that it thrives and reproduces in wetlands forming dense, impenetrable stands unsuitable for wildlife food, cover, or nesting sites. Native vegetation is displaced, and the wetlands lose their species diversity as well as food sources for wildlife. Look for purple loosestrife along the edges of rivers and inland lakes.

**Evaluation Of Water Quality**

One of the best ways to understand water quality is to compare two areas that differ in their water quality. A valuable extension activity of your LakeWatch Eco-Expedition would be to compare and contrast Lake Michigan with another water body. Lake Michigan has a surface area of about 22,300 square miles making it the third largest Great Lake. The flushing time of the Lake is 99 years. The average depth of Lake Michigan is 279 feet with a maximum depth of 923 feet, making it the second deepest Great Lake. In contrast, Wisconsin's approximately 15,000 inland lakes vary widely in size from one-acre spring ponds to the 137,708-acre Lake Winnebago.

Overall water quality can be evaluated by considering the trophic status or biological productivity. Eutrophication, or aging of lakes, progresses through various trophic states (oligotrophic $\rightarrow$ mesotrophic $\rightarrow$ eutrophic). Nutrient levels, organic matter content, dissolved oxygen levels, and water transparency indicate the trophic state or biological productivity of a water body.

The open waters of Lake Michigan are oligotrophic, and some near-shore areas are mesotrophic. Low nutrient levels, low biomass, high oxygen concentrations, and high transparency characterize oligotrophic lakes. These lakes are usually deep. Eutrophic lakes are highly productive with high nutrient levels, high biomass, low oxygen concentration in the bottom waters, and low transparency. The large volume of organic matter accumulated in bottom sediments depletes oxygen as it decomposes. Mesotrophic lakes are between the other two trophic states in their characteristics.
AQUATIC FOOD WEBS

One of the greatest thrills for students on each vessel trip is discovering the organisms that live in the water. Comprehension of food webs and the interaction between organisms that form a food web is an important concept for students to understand before boarding the vessel. Perhaps most important when beginning to look at the Lake Michigan food web is to identify common organisms and then explain the interactions. The Lake Michigan food web is composed of two distinct but overlapping parts: the open water and offshore (pelagic) food web and the bottom (benthic) food web. Both webs are dependent upon the plankton in the surface waters.

Members of the pelagic food web include small invertebrates (cladocerans and copepods), phytoplankton (free floating algae), salmon, trout, alewife, rainbow smelt, and bloater in offshore regions. The inshore fish community includes yellow perch, walleye, smallmouth bass, pike, catfish, and panfish. Detritus (dead and decomposing organic matter) that falls from the upper part of the water column (euphotic zone) fuels the benthic food web. Two benthic animals, the opossum shrimp (Mysis relicta) and an amphipod or "sideswimmer" (Diporeia sp.), are prominent species. Important fish of the benthic food web are lake whitefish, round whitefish, sturgeon, sucker, and burbot.

The general flow of energy and biomass in Lake Michigan is through trophic levels that include the producers (phytoplankton and aquatic plants) and consumers (zooplankton, forage fishes, predator fishes, and other animals that eat fish). Increasing levels of fishing pressure and human-induced environmental degradation have greatly altered the composition of fish species. Additional stress of the sea lamprey and alewife contributed to a less complex, less stable food web; however, the web still comes full circle as detritus and decomposer complete the cycle. Students will explore two basic parts of the food web during their vessel experience - plankton and benthic organisms.
Is the Lake "Clean"

No two lakes are alike why?

Physical properties of water include how to measure.

Chemical properties include solvent and solubility.

Biological properties of water include the 3 groups.

Lake Michigan Food Web include members and consumers of the fish.
Exotic or nonindigenous Species: How have they gotten here? Write brief explanations for each.

Explain how the exotics have been introduced.

Zebra mussels

Spiny water flea

Eurasian watermilfoil

Purple loosestrife
Lake Michigan
Size:
Depth:

Oligotrophic lakes:

Eutrophic lakes:

Mesotrophic lakes:
What do scientists know about invader species of the Great Lakes? *(Ohio Sea Grant Education Program)*

**Falls**

15.5 establishes relationships based on evidence and logical argument

15.7 use computer software and other technologies to organize, process, and present their data

15.8 use relevant sources to research scientific concepts

**EE**

A.8.1 identify environmental issue questions that can be investigated using resources and equipment available

A.8.5 use the results of their investigations to develop answers, draw conclusions, and revise their personal understanding

- Follow directions in activity
- Have each team research their invader using the internet and make a poster that includes a fact sheet to present to the class must include the impact of the invader on the lakes and humans.
- Include a copy of information and grading rubric for portfolio
## Invader Species Rubric

<table>
<thead>
<tr>
<th></th>
<th>Outstanding</th>
<th>Satisfactory</th>
<th>Needs Improvement</th>
<th>Teacher Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Idea</strong></td>
<td>Poster has a clear title, which gives specific information about the main idea of the poster. (3 points)</td>
<td>Poster has a title that gives some information about the main idea of the poster. (2 points)</td>
<td>Poster is missing a title or statement of main idea. (1 point)</td>
<td></td>
</tr>
<tr>
<td><strong>Details from Research</strong></td>
<td>Poster includes all details from research and has clear labels, phrases, or sentence descriptions. (5 points)</td>
<td>Poster includes most details from research and has clear labels or phrases. (3 points)</td>
<td>Poster includes a few details from research using labels or phrases. (1 point)</td>
<td></td>
</tr>
<tr>
<td><strong>Effectiveness of Poster</strong></td>
<td>Poster gives others a thorough understanding of topic researched with specific examples or illustrations. (5 points)</td>
<td>Poster gives others a solid understanding of topic researched. (3 points)</td>
<td>Poster gives others a general understanding of topic researched. (1 point)</td>
<td></td>
</tr>
<tr>
<td><strong>Quality of Poster</strong></td>
<td>Poster includes illustrations and labels. Content of poster is edited for spelling and punctuation and has no errors. (3 points)</td>
<td>Poster includes illustrations and labels. Content of poster is edited for spelling and punctuation and has less than 3 errors. (2 points)</td>
<td>Poster includes illustrations and labels. Content of poster is not edited for spelling and punctuation and more than 3 errors. (1 point)</td>
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</tbody>
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**Total Score:**
What do scientists know about invader species of the Great Lakes?

Since the early 1800s, over 140 species of aquatic plants, algae, fish, worms, mollusks, and other organisms have invaded the Great Lakes. Likewise, 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 ecosystem. Any environment has 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 increase rapidly, displacing native organisms by filling their niches. This change allows the once biodiversified region to lose some of its genetic diversity.

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, and then 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 becomes 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.
Source

Modified from "What do scientists know about Great Lakes invader species and the effects of global change on them?" in Great Lakes Instructional Material for the Changing Earth System (GLIMCES) by Rosanne W. Fortner, Heidi Miller, and Amy Sheaffer. Ohio Sea Grant Education Program, The Ohio State University.

Earth System Understandings

- This activity focuses on ESU 3, 4, and 5. In addition, extensions address ESU 1, 2, 6, and 7. Refer to the Framework for ESE for a full description of each understanding.

Materials

For each group of 3-4 students:

- Copies of the included information cards. Each of the three card categories (invader picture, introduction, ecosystem impact) should be copied onto a different color card stock paper. [24 cards per group]
- Answer sheet.

Invader Species in this Activity

Zebra Mussel  
(Dreissena polymorpha)

Sea Lamprey  
(Petriomyzon marinus)

Spiny Water Flea  
(Bystotrephes cederstroemi)

River Ruffe  
(Gymnocephalus cernuus)

Alewife  
(Alasa pseudoharengus)

White Perch  
(Morone americana)

Purple Loosestrife  
(Lythrum salicaria)

Eurasian Watermilfoil  
(Myriophyllum spicatum)

OBJECTIVES

At the completion of this activity you should be able to:

- Name and visually recognize some invader (nonindigenous) species of the Great Lakes.
- Locate on a world map the origins of the Great Lakes invader species.
- Explain the ways in which invader species are introduced into the Great Lakes.
- Analyze the impacts of invader species on the Great Lakes ecosystem.

PROCEDURE

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 card of each other color.

3. When group members agree that they have matched the cards to the best of their ability, you may check your answers on the answer sheets.

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 included.

5. Consult the Internet for up-to-date information. Begin with sites for the Great Lakes Panel on Aquatic Nuisance Species, for example http://www.glc.org/projects/ans/anspanel.html, and find others you find interesting. Other examples include:


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

   http://putton.nfrcg.gov:80/zebra.mussel - zebra mussel information resources, including U.S. distribution maps by year.
REVIEW QUESTIONS

1. Why should people be concerned about nonindigenous species? How do they affect ecosystems?

2. How can the transfer of invader species be controlled or stopped in the Great Lakes or elsewhere in the world? Draft a piece of legislation that your group thinks could be enacted to stop exotic species from invading the Great Lakes.

3. Identify as many Great Lakes jobs as possible that are impacted by invader species. (Some impacts may be positive; that is, new jobs may have been created by the newcomers.)

EXTENSIONS

1. Do research on controls that have been tried on various invader species and report on their successes or failures. Brainstorm a creative way to control one of the invaders.

2. Draw a humorous cartoon depicting the problem of invader species. (Example: A zebra mussel looking for a place to attach on an already-overcrowded lake bottom, a white perch nudging out a yellow perch, purple loosestrife choking other plants, etc.)

REFERENCES


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

Answers to Review Questions

1. Invading species threaten to change present ecosystems, often in unpredictable ways. Because invaders frequently do not have predators, they often have the ability to disrupt the existing ecological balance and dominate an area. Consider the effects of European humans after their introduction to North America. How many other species have humans displaced?

2. Bilge water is critical to the spread of invaders. Have students brainstorm different ways that invaders can be introduced and possible methods for preventing their spread.

3. Increased numbers of researchers are needed to study the potential impact and spread of the invaders. There could be new public water systems and industry jobs to keep pipes clean. Fishers will be affected because the type and quality of catch (fish size and health) will be different. Beach cleaners would be needed to get rid of dead fish, and boat cleaners will be in great demand to protect boats from invaders (potentially by developing and applying special toxic paints that will prevent zebra mussels in particular from adhering to boat hulls). Recreation facilities will most likely also experience some increased business because of the added water clarity that zebra mussels cause by filtering water, but may also lose some business because of decreased fishing opportunities. Park systems and gardeners must be concerned, because invader species will compete with the native vegetation and wildlife.
**Invader #1**
Zebra Mussel (*Dreissena polymorpha*)
Adult size: 1-4 cm long

**Invader #2**
Sea Lamprey (*Petromyzon marinus*)
Adult size: 3 feet (91 cm)

**Invader #3**
Spiny Water Flea (*Bythotrephes cederstroemi*)
Adult size: 1 cm

**Invader #4**
River Ruffe (*Gymnocephalus cernuus*)
Adult Size: usually less than 15 cm long
**Invader #5**

Alewife (*Alosa pseudoharengus*)
Adult size: 3 cm

**Invader #6**

White Perch (*Morone americana*)
Adult size: 30 cm (20 cm is more common)

**Invader #7**

Purple Loosestrife (*Lythrum salicaria*)
Adult height: 0.5 to 2 meters tall

**Invader #8**

Eurasian Watermilfoil (*Myriophyllum spicatum*)
Leaflet is actual size
INTRODUCTION

Originally it came from the Caspian Sea region of Poland, Bulgaria, and Russia. Canals built during the early 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. Being a temperate, freshwater species, it found the plankton-rich Lake St. Clair suitable as a habitat.

INTRODUCTION

Arriving from the freshwater and brackish water in northern Europe, this invader was discovered in Lake Superior in 1986. It is assumed that it "hitchhiked" in ballast waters from Europe and Asia. In 5 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.

INTRODUCTION:

Originally, it came from the Atlantic Ocean, the St. Lawrence, and Hudson Rivers, and their tributaries for spawning, and possibly Lake Ontario. 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.

INTRODUCTION

A native of northern Europe, it made its way into Lake Huron in 1984 and was present in all Great Lakes by 1987. It is believed to have been brought over in fresh water or mud in ballast water of European freighters from Eastern Baltic Ports, as studies show that the Great Lakes species closely resembles the species in the ports of Finland and St. Petersburg (the former Leningrad).
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 the St. Lawrence River. It swam into the upper Great Lakes through the Welland and/or Erie barge canal 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 the smaller plankton, thereby competing with small fish for their food source and affecting their 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 total 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. 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 Lomond, 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 out the blood and body tissues. 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 of the Great Lakes during the 1950s.

ECOSYSTEM IMPACT

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

ECOSYSTEM IMPACT

It filters the 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, clogging valves of both industrial and municipal water intake sources.

ECOSYSTEM IMPACT

Large numbers die off in spring and summer because of 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 in Lake Erie 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.
ANSWERS TO CARDS

Invader 1: Zebra mussel (Dreissena polymorpha)

Introduction: Originally, it came from the Caspian Sea region of Poland, Bulgaria, and Russia. Canals built during the early 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. Being a temperate, freshwater species, it found the plankton-rich Lake St. Clair and Lake Erie to be suitable habitats.

Ecosystem Impact: It filters the 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, clogging valves of both industrial and municipal water intake sources.

Invader 2: Sea Lamprey (Petromyzon marinus)

Introduction: Originally it came from the Atlantic Ocean, the St. Lawrence and Hudson Rivers, and their tributaries for spawning, and possibly Lake Ontario. 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 out blood and body tissues. It upsets the ecological balance by removing top predators, allowing for explosion of populations of smaller fish such as alewives. It had great economic impact on the commercial fishing industry of the Great Lakes during the 1950s.

Invader 3: Spiny Water Flea (Bythotrephes cederstroemi)

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

Ecosystem Impact: This is a large plankton form that eats the smaller plankton, thereby competing with small fish for their food source and affecting their 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 total impact.
Invader 4: River Ruffe (*Gymnocephalus cernuus*)

**Introduction:** Arriving from the freshwater and brackish water in northern Europe, this invader was discovered in Lake Superior in 1986. It is assumed that it "hitchhiked" in ballast waters from Europe and Asia. In 5 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 between 13,000 to 200,000 eggs per season.

**Ecosystem Impact:** Only about 8 inches long, this perch-like fish has little 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. This fish is not preferred by predators because of its spiny fins. It displaces sport and food fish, especially 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 Lomond, 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 the St. Lawrence River. It swam into the upper Great Lakes through the Welland and/or Erie barge canal before 1931.

**Ecosystem Impact:** Large numbers die off in spring and summer because of 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 in Lake Erie 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 forage 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 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.

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.

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Ohio Sea Grant Education Program

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Use or Abuse (Water Activities to Encourage Responsibility)

B.8.5 examples of human impact on various ecosystems

B.8.8 explain interactions among organisms of or populations of organisms

D.8.5 explain how personal activities can impact an environmental issue

- Follow the directions in the activity
- Have copies of maps
- Discuss the actions of each persons roll to the lake
If you only marked one "x" for each kind of use, the total would be 80 gallons (using only the bath and not the shower). That's more than 100 times as much water as you need to keep your body alive. Where does all that water come from?

Ask your parents to help you find out where your household water supply comes from. Write it here ___________. Does someone pay for the water? ___________. How much? _______. Many other uses of water indirectly benefit you too. For example:

It takes 75 gallons of irrigation water to grow just one ear of corn!
... 130 gallons to produce one egg!
... 200 gallons to make the rubber for one car tire!
... 1,000 gallons to produce one quart of milk (figure for a gallon)!
... 650 gallons to produce the steel for one bicycle!
... 3,500 gallons to produce one pound of beef!

It's a good thing there's a lot of water on this earth, and that it doesn't get used up!

Water is never used up. When you drink water, it is later perspired or excreted away. When a plant draws water from the ground into its roots, water moves up into the leaves, stem and a fruit. Most of it is released into the air as water vapor through pores (transpiration). One important use of water for both you and the green plant is to carry away wastes. These stay is the water.

If all the water we now use has been used many times before in the history of the world, how is it possible that we have any clean water at all?

(To be used with Activity IV. Water Supply)

V. USE OR ABUSE?

CONCEPTS:
To explore decisions, values, and economics related to water pollution.

OBJECTIVES:
Participants will develop a better awareness of how people (and animals) depend on lakes.
Participants will develop a better understanding of the complexity of economic decisions faced by polluters of lakes.
Participants will develop a better understanding of how they, as individuals, can avoid polluting lakes.

MATERIALS NEEDED:
Large map of Lake Superior (15' x 20') including cities with dots and state/province borders with lines (do not identify them by name), 10 liter (or larger) bucket filled with clean...
water to represent Lake Superior, red food coloring (one full eyedropper to 100 ml of water), eyedropper (one full eyedropper equals one unit of color), four small vials or envelopes filled with dust or mud, clean container (500 ml for withdrawing municipal water supplies), similar clear container filled with slightly colored water (about two drops of food color in 100 ml of water) to use as a standard for comparing the extent of pollution, play money for roles involving paying instead of polluting, a piece of plastic with the word "shipwreck" on it, a Secchi disk for estimating water clarity (see instructions).

PROCEDURE:

(Prepatory Activity)

• Hand out a map of Lake Superior and its drainage basin, accompanied by the Lake Superior worksheet.

• Orient the participants to the map. Explain that all water within the watershed boundary (theoretically) drains into Lake Superior.

• Mention other sources or reservoirs of water within the watershed, such as lakes, streams, wetlands and groundwater. Stress that the reservoirs of water are interconnected: pollution of upstream inland lakes and rivers eventually affects Lake Superior.

• Have participants fill out the worksheet. Indicate that some of the questions do not have right or wrong answers. Look at economic constraints: what we would like to see happen is often tempered by money constraints.

(Playing the Game)

• Place the bucket representing Lake Superior in the center of the map. Place the "shipwreck" sign at the bottom of Lake Superior. Hand out money to participants.

• Near Lake Superior, set up the pollution solution and eyedropper, the container for withdrawn water, mud, etc.

• Distribute the role cards and assign a playing order. If you have a small group of participants, eliminate some roles or assign more than one role per person. If you have more than 26 participants create additional roles that require action.

• Encourage players to role play. They should step into the shoes of the person they are representing and act as that person would.

• Have players find their "home" around the lake, read their cards (cards may need to be adapted using vocabulary appropriate for a particular age level), and consider their decision.

• Have players read their roles and announce their choices out loud.
Have players perform appropriate actions according to their cards and decisions.

Discuss the students' decisions as you play. Balance economic considerations against idealism. If no students opt to pollute, ask how realistic that is. Compare the high-priced, million-dollar decisions with what they can do as individuals to reduce or prevent pollution. You can also take money from each player for taxes used to fund agencies that research and assist in pollution prevention.

Remind participants that the bucket is a simple model of Lake Superior. In reality, water is constantly being added through precipitation and runoff; pollution is diluted or flushed. Stress that water in Lake Superior is a limited resource, not infinite.

Follow the game with a discussion of values and economics and review what participants can do to prevent/reduce pollution of Lake Superior. Although they may not be able to easily affect corporate decisions, they can choose to recycle, avoid littering and support family actions that reduce pollution.

NOTE:

The order of play often affects the decisions made. You may want to "stack the deck" somewhat. Ensure that some of the polluters with no choice precede the people that remove drinking water. This makes it more difficult to see the shipwreck and the "drinking water" is not very appealing.

ROLE CARDS:

These are examples of roles, decisions and actions that can be used in the game. The roles are based on real-life situations, but do not necessarily reflect the circumstances of any particular individual or community. (See page 20).

(Adapted with permission from Minnesota Sea Grant Extension's "Lacustrine Lessons")
LAKE SUPERIOR WORKSHEET

1. Who uses the water in Lake Superior? List at least 10 uses.

2. What do you feel are the three most important uses of water from Lake Superior (in order)?

3. What is unique or special about Lake Superior?

4. What is the most damaging source of pollution to Lake Superior today?

5. Who should decide if water can be diverted from the basin? Should the same person or group decide how much water is taken and where it goes?

6. How does Lake Superior affect the economy of our region? List at least five businesses or industries that depend on Lake Superior.

7. Who is responsible for keeping Lake Superior clean?

8. On your map, locate and label:

WORKSHEET ANSWERS:

Most of the questions have no correct or incorrect answers. The questions are meant to provoke thought. Participants will have very different answers for some of the questions.

1. Users include residents, tourists and visitors, animals and industry. Uses include domestic activities, transportation, industry, recreation and tourism, fishing research and wastewater treatment.

2. Any three.

3. Any, including its size, beauty, depth, storms, clarity, clean water, history, etc.

4. Answers may reflect value judgments, but current thought has it that the most pressing concern is atmospheric deposition to the lake for things such as acid rain, mercury, organic contaminants like PCBs, etc.

5. A decision-making body could include representatives from three states and Ontario, both federal governments, people from outside the basin, etc. The question gets at the problem of identifying who "owns" the resource.

6. Any five, including shipping, industrial processing, recreation and tourism, water supply, wastewater treatment, commercial fishing and real estate.

7. Everyone!

LAKE SUPERIOR:

USE IT, DON'T ABUSE IT

IT IS A SUPERIOR LAKE!

Lake Superior and the other four Great Lakes represent America's fourth coast. The size of the lakes and the resources associated with them make the Great Lakes an ecosystem that is vital to the economy and quality of life in the United States. Among the Great Lakes, Lake Superior stands out as unique. The problems and opportunities associated with Lake Superior reflect the magnitude of its size.

Lake Superior is about 350 miles long and 160 miles wide. It is bordered by the states of Minnesota, Michigan and Wisconsin, and the Canadian province of Ontario. Because it lies at the headwaters of the Great Lakes and is at the head of the St. Lawrence Seaway, Lake Superior is of critical concern to Americans and Canadians alike.

The Great Lakes are huge. Together they represent about 20 percent of the fresh water available on the surface of the earth. Lake Superior is the largest surface area of freshwater lake in the world. It covers 31,700 square miles, roughly the area of Massachusetts, Connecticut, Rhode Island, Vermont and New Hampshire.
In addition to being the largest of the Great Lakes in surface area, Superior is also the deepest, with a maximum depth of 1,330 feet. Lake Superior has an average depth of 483 feet and contains nearly three quadrillion gallons of water.

Lake Superior is valued for transportation. Ships are the most cost-effective way of moving bulky and/or heavy cargoes over long distances. Major commodities moving across Lake Superior include grain and other agricultural products, western coal, iron ore, steel, limestone and cement. Maintaining adequate water levels is important to shipping. Unfortunately, optimal water levels for shipping can cause coastal erosion.

The water of Lake Superior is important for power generation, manufacturing and mineral processing. Although much water is withdrawn each year for these uses, only a small amount (about 21,134 million gallons) is consumed (not returned to the lake). Compared to the amounts consumed from other Great Lakes, this is nearly insignificant.

Domestic water use is also important. The shores of Lake Superior are sparsely populated. The coastal area has about 14 people per square mile. This ratio is less than 10 percent of the Great Lakes average of 183 people per square mile and far below Lake Erie's ratio of 567 people per square mile. Lake Superior's sparse population has helped it remain the cleanest and clearest of the Great Lakes. Municipal and domestic use of Lake Superior's water is minor when compared to figures from the other Great Lakes. Municipal and individual effluent released to lake Superior contribute a minimal amount of pollution.

The quality of Lake Superior's water is vital to the aesthetic and recreational uses of the lake and to the sport and commercial fisheries. The quality of the water is therefore important to our economy. If the concentration of PCBs in the lake increased, fish would be considered inedible. Polluted water would also attract fewer visitors, who are major contributors to the region's economy.

Residents and visitors are not the only people concerned about the quality of Lake Superior's water. Those further down the Great Lakes are eventually the recipients of Lake Superior's water. An estimated 23 million people get their drinking water from the Great Lakes. Many more live and recreate along the Great Lakes coast. These people are also concerned about Lake Superior.

Water quality in Lake Superior needs to be preserved, because once such a large lake becomes contaminated it is difficult to clean up: it takes about 182 years for water in Lake Superior to be flushed out. Pollutants come from five major sources: 1) the atmosphere, 2) municipal and industrial discharges, 3) farmland and municipal runoff, 4) contaminated groundwater and 5) contaminated sediments. Over half of the toxics entering Lake Superior are believed to come from the atmosphere.

The concern for Lake Superior's water quality extends beyond its shores. The care for Lake Superior's water quality also needs to extend beyond its shores. As a society we need to use Lake Superior without abusing it.
I am a research scientist from the Univ. of Minnesota in Duluth. I paid $20,000 to use the research submersible to study fish that live near the bottom of L. Superior. If the water is too cloudy I won’t be able to see the fish and I will have wasted my research money. (Lower the Secchi disk to the bottom of the bucket. If it can be seen, the lake is clear enough for your study.)

I own a company in Marquette, Michigan. We want to send water to California and have $4 million to spend in the community if you let us take the water. You will hardly miss it and you could clean up a lot of pollution with $4 million. All the people who live around the lake must vote on whether to let us divert the water. (If the group votes to let you divert the water, remove four cups of water.)

I own a commercial fishing company in Bayfield, Wisconsin. If I catch fish that contain toxic materials that exceed the U.S. Environmental Protection Agency guidelines for fish consumption, I cannot sell them to the public and my company will go to broke. (Compare the color of 500 ml of water from L. Superior to the standard color. If the color in the lake is darker than the standard, the fish are too contaminated to sell.)

I own a mining company near Wawa, Ontario. We have been told to clean up our process. We will have to pay $1 million to clean up or continue to pollute L. Superior. (Pay or add two units of color.)

I am in charge of a fish hatchery in Nipigon, Ontario. My job is to stock fish in L. Superior. If the lake is too polluted, the fish won’t survive, so there is no point in stocking. (Compare the color of water from L. Superior to the standard color. If the water from the lake is darker than the standard, it is too polluted to stock fish.)

I represent the city of Duluth, Minnesota. We need 400,000 gallons of clean water from L. Superior each day for our city to use. (Remove eight cups of water from L. Superior.)

I am a careless tourist from the U.S. driving along the north shore of L. Superior near Marathon, Ontario. I throw a burning cigarette out my window and start a major forest fire. Because many trees are destroyed, much soil and ashes are washed into L. Superior and pollute it. (Add mud and stir.)

I run an industry at Houghton, Michigan that dumps particles into the lake and causes the water to become cloudy. We can pay $1 million to clean up our process or we can continue to pollute the lake. (Pay or add mud and stir.)

I own a resort on the shore of L. Superior near Grand Marais, Michigan. My septic system is old and doesn’t work well. I know it is polluting the lake, but it will cost me $5,000 to repair it. If I pay that much to repair the system, I will have to charge tourists $75 per night for a room. I don’t think they will pay that much. (Pay or add one unit of color. You may ask for the people around the lake to vote on whether they would pay higher rates.)

I head the Board of Directors of an electric power company in Duluth. We would like to clean up our emissions by building scrubbers on our towers, but it will cost $1 million. I don’t think the public will agree to pay higher rates for electricity. If I won’t pay for the clean up, our power company will cause acid rain and pollute L. Superior. (Pay or add one unit of color. You may ask for the people around the lake to vote on whether they would pay higher rates.)

I own an industry in Thunder Bay, Ontario that used 500,000 gallons of water each day in its processing plant. We return 100,000 gallons of polluted water to the lake each day. We can pay $1 million to clean up the process or continue to pollute L. Superior. (Remove five cups of water and get rid of four. If you choose to pollute, add one unit of color to the fifth cup and return it to the lake; if you choose to pay to clean up the process, put the water back into the lake without adding color.)

I have a cabin near Ontonagon, Michigan. I only live there for three months each year and don’t think it is worth paying $500 to get my septic system fixed. I cause some pollution of L. Superior. (Add one unit of color.)
I own a well near Silver Bay, Minnesota. I don't use water from the lake for my water supply so I don't care if the lake gets polluted. My system is old and needs repairs that will cost $300. I'd rather use the money for a trip to Florida. I have to choose whether to fix it up, or let my leaky system pollute L. Superior. (Pay or add one unit of color.)

I represent the Canadian Department of Transportation in Marathon, Ontario. We salt our highways during winter. This makes the road safer for travel, but the salt runs off in the spring and pollutes L. Superior (Add two units of color.)

I run a sewage treatment plant at Sault Ste. Marie, Michigan. We don't think our customers will pay the extra $15 a month needed to clean up our process. We continue to pollute the lake. (Add two units of color.)

I am a logger living near Grand Marais, Minnesota. I cut trees from an area too close to a stream, which caused erosion and the sides of the streambank to collapse into the stream. This makes the stream cloudy polluting the lake. (Add mud to lake and stir.)

I own a mining company at Nipigon, Ontario. It will cost us $1 million to clean up our process. If we pay we will go out of business, and 300 people will lose their jobs. I have to choose whether to clean up and go bankrupt or continue to pollute L. Superior. (Pay or add four units of color.)

I am a resident of Ashland, Wisconsin. I have to choose whether to spend an extra $120 a year for my electric bill to clean up smokestack pollution that causes acid rain. If I choose not to spend the extra money, I will cause pollution of L. Superior. (Pay or add one unit of color.)

I live near Knife River, Minnesota and I know I should take my garbage to the landfill, but it's cheaper and easier to dump it in my backyard. I continue to dump it in my backyard. This pollutes both the creek and the lake. (Add one unit of color.)

I own a campground near Wawa, Ontario. Families will stay here as long as L. Superior is clean and they can catch fish, but if the lake is too polluted they won't stay and I will go broke. (Compare the color of water from L. Superior to the standard, if it is too polluted people won't stay at the campground.)

I own an industry in Ashland, Wisconsin, but none of the company officials live in the region. We aren't very responsible and we don't care if we pollute L. Superior. (Add three units of color.)

I am a shipowner from Thunder Bay, Ontario. My ship has made the trip from the lower Great Lakes and the tanks are full of polluted water. I can pay $1,000 to clean the water before emptying the tanks or I can save money and pollute L. Superior. (Pay or add three units of color to lake.)

I am a resident of Marquette, Michigan who likes to scuba dive. I paid $1,500 for scuba equipment. If the lake is too cloudy, I can't enjoy my dive and have wasted money. (Try to read the word on the bottom of L. Superior.)

I am in charge of a paper mill in Michigan. We use 500,000 gallons of water each day. Most of the water is supposed to be cleaned before being returned to the lake, but I know there is something wrong with the system and we are putting contaminated water into the lake. If I report the flaw, I will lose my job. If I don't report it, pollution of the lake will continue. (Give up job or add two units of color.)
HOW TO MAKE A SECCHI DISK

A Secchi disk is a simple tool used to determine water clarity (transparency). The depth to which a Secchi disk is visible is directly related to the transparency of the water in a lake. For this activity a Secchi disk can be cut from a white plastic coffee can lid. It should be a circle about 5 cm in diameter with a cord threaded through the center. (When used for scientific studies, Secchi disks normally measure 20 cm in diameter). The disk should be divided into four equal pie-shaped sections. Two opposite sections should be colored black with an indelible marker and two should be left white. The disk will have to be weighted so that it sinks when lowered into the bucket.
MAP TO HAND OUT TO STUDENTS (Enlarge to place on the floor for game. See "Procedures").
APENDIX D

MATH ACTIVITIES
MATH

The Great Lakes: A National Economic Resource (*The Great Lakes in my World*)

Falls

6.4 Analyses and makes predictions from data presented in various forms

6.5 Constructs, reads, and interprets data charts

7.3 Extracts, interprets, and analyses information from organized and displayed date and is able to write about it.

EE

B.8.10 Explain and cite examples of how humans shape the environment

B.8.5 Give examples of human impact on various ecosystems

Starting with Procedure Part A (17)

- Go over each question to give background information to students.
- Continue with Part B and C.

Assessment

Going Deeper (18) Complete number 1, 2, 3,
THE GREAT LAKES: A NATIONAL ECONOMIC RESOURCE

Grade: Upper, Intermediate/Upper 6-8
Subjects: Social Studies, Math, Science
Concepts: The Great Lakes are an important water source; the economy of the area is dependent on this water source.
Skills: Using numbers, using data from tables and graphs; interpretation; prediction
Materials: Pen or pencil, graphs and tables, graph paper, colored pencils

Objectives:
After completing this activity each student will be able to:
1. identify five major uses of lake water (for consumption, not navigation) and some industries that rely on lake water,
2. list four major materials transported on the lakes,
3. discuss the economic benefits of Great Lakes shipping,
4. identify four uses of the Great Lakes shoreline, and
5. explain the relationship between population growth and activities on the lakes.

BACKGROUND

The abundant freshwater in the Great Lakes plays an important part in the economic development of the region. Large volumes of lake water are used by electric utilities and for the manufacture of products such as steel, chemicals, processed food, pulp and paper.

Shipping on the Great Lakes provides an economical means of transporting raw materials and other products. The water resources provide substantial opportunities for regional development of commercial and sport fishing as well as recreation facilities for pleasure boating, parks and vacation resorts.

Great Lakes water is also used to irrigate farm fields, and the lakes modify climate so that commercial fruit, vegetables, tobacco and other crops can thrive along their shores far north of their normal range.

GREAT LAKES DATA

Drinking Water Supplies

Thirty-five million people live within the watershed of the Great Lakes. Twenty-six million of these people rely on the lakes for drinking water. Thirty-six percent of municipal water throughout all of the watersheds contained in the eight U.S. Great Lakes states is supplied from the Great Lakes. More than half of Ontario's residents depend on the lakes for drinking water.

Shipping

Eighty percent of U.S. iron ore comes from the Lake Superior area. It is sent by ship to Chicago, Illinois, Gary, Indiana and Cleveland. Ohio mills which produce more than one-third of all U.S. steel. Much of this steel is then shipped via the Great Lakes to Detroit, Michigan automakers who make two-thirds of all U.S. cars.

Over 200 million tons of freight is carried on the Great Lakes St. Lawrence River system each year. Eighty-five percent of this cargo consists of iron ore, coal, limestone and grain. The remaining 15 percent...
includes petroleum products, newsprint, rock salt, iron and steel products, cement, chemicals, and overseas general cargo trades.

International shipping on the Great Lakes is estimated to generate $3 billion annually for the region's economy.

Industry

Hundreds of industries and power plants take billions of gallons of water daily from the Great Lakes for manufacturing operations and for cooling their equipment and products. Industries in the Great Lakes region withdraw 13.6 billion gallons of water each day to produce:

1. more than 70% of U.S. and Canadian steel;
2. more than half of the automobile and machine parts; and
3. more than one quarter of U.S. chemicals.

One-fifth of U.S. manufacturing is located along the shores of the Great Lakes.

In 1983, 23.7 billion kilowatt hours of hydroelectric power were generated in the U.S. and another 20 billion in Ontario by waters flowing through the lakes. Seventy power plants located in the eight states bordering the Great Lakes use the lake water in steam condensers and for boiler feed water. Electric utilities that withdraw 23.2 billion gallons per day are among the region’s biggest water users.

Twenty-five percent of the chemical companies in the U.S. are now located in the Great Lakes region, and one-fourth of the Nation’s paper products come from manufacturers near western Lake Michigan alone.

Agriculture

Of the 201,000 square miles of land in the Great Lakes Basin, 67,000 square miles is farm land. Agriculture uses 151 million gallons of lake water to irrigate crops producing millions of tons of wheat, corn, soybeans, barley and oats that are shipped to ports overseas.

The lakes also moderate the region’s climate and increase the growing season so fruits, vegetables, tobacco, and other crops thrive on lakeshore lands, far north of their normal ranges.

Recreation

Ninety-eight state parks, 39 provincial parks and 12 national parks border the U.S. and Canadian Great Lakes’ shores. An estimated eight million people visited the national parks in 1983, and another 55 million people visited at least one of the state or provincial parks. In Chicago, 20 million people visit the city’s Lake Michigan beaches each summer. Collectively, the Great Lakes’ shorelines have 370 miles of public beaches and 1,220 miles of private recreational areas. More than one million privately owned small boats cruise the lakes during warmer months.

Sport fishing is very popular. The sale of licenses, equipment and related recreational expenses generate hundreds of millions of dollars a year. In 1988, Ohio anglers harvested 5 million walleye from Lake Erie compared with 160,000 in 1976. The 1988 catch exceeded 10 million pounds.

Increased tourism and recreation has helped small industries and businesses grow larger and more successful. By 1988, charter fishing businesses licensed 1023 captains. The growth of marine facilities accompanies the growth of charter fishing but on a larger scale. About 380 marinas are located on the shoreline. Small unprofitable marinas are being turned into multi-million dollar complexes that have space for 500 or more boats. They feature stores, restaurants and swimming pools. Ahoy, Ottawa county, with a population of 40,000, swells to 120,000 on weekdays and 250,000 on weekends during summer months.
1985

<table>
<thead>
<tr>
<th>Lake</th>
<th>Population in Basin (thousands)</th>
<th>Annual Fish Catch (metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>13,971</td>
<td>10,200</td>
</tr>
<tr>
<td>Huron</td>
<td>2,372</td>
<td>2,670</td>
</tr>
<tr>
<td>Erie</td>
<td>12,967</td>
<td>23,580</td>
</tr>
<tr>
<td>Ontario</td>
<td>6,642</td>
<td>975</td>
</tr>
<tr>
<td>Superior</td>
<td>739</td>
<td>3,630</td>
</tr>
</tbody>
</table>

**Economic Impact**

The cost of moving grain by ship from one end of the Great Lakes to the other is half as expensive as the same trip by rail. The shipment of iron ore is four times cheaper. In 1984, a ton of iron ore could be transported on the Great Lakes from Two Harbors, Minnesota to Conneaut, Ohio for $7.41. The same trip would cost $29.87 by rail. It is estimated that international shipping generates $3 billion for the region's economy.

Water-based recreation and tourism is estimated to generate $12 billion for the region's economy. Sport fishing alone produces almost $1.5 billion. The Great Lakes Fishery Commission reported that 54.9 million angler days spent on the Great Lakes in 1981 generated $766.2 million. Michigan's Department of Natural Resources reports that pleasure boaters in the state spent $1 billion in 1981. Income from pleasure boating along Lake Erie's shore generated almost $113 million. The 63 million people who visited national, provincial and state parks on the Great Lakes' shores in 1983 are estimated to have spent $3.7 million. Estimates of revenue from Great Lakes related tourism generally range from $8 to $15 million.

Construction along downtown Toledo, Ohio's Maumee River waterfront, which began in the 1970's, has totaled well over $200 million in completed projects and provided over 4000 new jobs in the 1980's. Cleveland, Ohio's reshaping of its Municipal Stadium-lakefront area with its major retailing and restaurant center, aquarium and maritime education center is expected to generate $118 million in revenues and create 1,380 permanent jobs. In Buffalo, N.Y., a $50 million waterfront project is already completed and has generated many new jobs.

Every industry has an economic interaction with other industries. Each $100 of demand for charter fishing produced a positive impact of $224.13 (1978 dollars) on other industries including marine dealers, financial, insurance, electric, gas, and sanitary services, boat and ship building, hotels, other transportation, and food and drink. Commercial fishing nets nearly 25 million dollars per year in revenues.

**Advantages of Using Lake Water**

Uses of freshwater drawn from lakes, rivers and groundwater include:

- **public use** 12 percent
- **industry** 46 percent
- **agriculture** 42 percent

Lake water has a number of advantages for these uses:

1. The lower turbidity of the water (the fact that it doesn't move as fast nor stir up as much mud as stream water) means that fewer deposits cling to pipes and processing equipment in steel mills. Because the Great Lakes are low in salts, minerals and other impurities, lake shore plants can save up to $1 million a year in equipment maintenance, chemical cleansing applications and parts replacement.

2. Paint companies find the low turbidity and low mineral content of the Great Lakes ideal for making latex (water-based) paints.

3. Petroleum industries take advantage of Great Lakes' locations to make by-products such as ammonia, which require fresh water and cannot be produced as cheaply at marine, coastal refineries.

4. Manufacturers of quality paper do not have to invest in costly methods to treat discolored water or water contaminated with bacteria or other impurities before allowing the water to pass over the paper during the manufacturing process.

5. Reliability of water has become increasingly important in site location decisions of many industries, especially since many sections of the U.S. are experiencing water shortages. Supplies of Great Lakes' water flow at consistent, stable rates unlike those of streams or groundwater, affected more immediately by rain or short-term drought.
Procedure:

Part A - Water Use

Read the sections entitled "Drinking Water Supplies," "Industry" and "Agriculture." Use the information in those sections and in Tables 1 and 2 and Figure 1 to answer these questions:

1. Compute the gallons of water needed to publish one Sunday newspaper each week for one year. How many gallons would be required to publish a newspaper for a city with one million people?

2. Which of the industries listed in Table 2 are most likely to locate near lakes or rivers? Explain your answer.

Table 2 (page 20) shows how much water certain industries use for production in one year. The first column shows the total used for that industry all over the U.S., and the second shows how much is used in the Great Lakes. The percent column tells what portion of the total U.S. water used for the industry is Great Lakes water.

3. Name the top seven water using industries which get more than 25 percent of their water from the Great Lakes for production. Where would you expect these industries to be located? Why?

4. Identify the three industries which depend the least on Great Lakes water.

5. Which four industries require the greatest amount of water, regardless of source?

6. List four major uses of Great Lakes water. (Fig. 1)

7. Over 50 percent of Great Lakes water is used to produce what commodity? (Fig. 1)

8. Compare the agricultural use of water in the U.S. and just the Great Lakes. Give a possible explanation for this difference.

Part B - Shipping

Read the sections entitled "Shipping" and "Economic Impact." Use the information in those sections and in Figures 2 and 3 to answer these questions.

1. Identify the four major types of cargo transported on the Great Lakes.

2. Which cargo accounts for the largest percentage of material transported? How can you tell?

3. In what year was total tonnage the least? The greatest?

4. How many tons of bulk products were transported in 1985?

5. Compare the bulk commerce with total seaway revenues. Describe the pattern that you see. Based on this pattern, describe the relationship that exists between bulk shipping and seaway revenues.

Part C - Shoreline and Basin Land Uses

Read the sections entitled "Industry," "Agriculture," "Recreation" and "Economic Impact." Use the information in those sections, and in Table 3 and Figure 4 to answer these questions:

1. List four uses of the Great Lakes shoreline.

2. Why do you think no information on shoreline use of Lake Superior is available? (Look at basin use.)

3. Why is there no Canadian information for Lake Michigan?

4. Which U.S. lake has the greatest shoreline use for recreation?

5. Which two lakes use shore land for agricultural purposes the most?
6. List the two lakes which have experienced the greatest population growth in the last 100 years. State three reasons for the high populations in these two lake basins. (Hint: Compare information on land/shoreline uses.)

7. Which two lakes have shown the least population growth in the last 100 years? State one possible explanation for this lack of growth. (Refer to Table 3, Land Use.)

8. Describe the rate of recent population growth of lakes Michigan and Erie. Based on the current growth trends, what would you predict for population growth in the future?

9. Create a bar graph to compare the information of basin shoreline land use. Select one lake to compare Canadian information with U.S. information. Use different colored pencils to represent the two countries. Write two conclusions you can draw from your graphs.

10. Create pie graphs of total basin uses for any two lakes. Describe what the graphs reveal about potential problems for those lakes from human activity.

**Evaluation:**

Have students identify at least four kinds of Great Lakes industries which employ a large number of employees. They should state evidence from the tables and graphs to support their choice of industries. List ways they use products created by these industries in their own lives.

**Going Deeper:**

Use the information in tables 1, 2 and 3 and in figures 1, 2, 3 and 4 for the following activities.

1. Create a table comparing the cost of moving the following amounts of iron ore from Two Harbors, Minnesota, to Conneaut, Ohio, by rail and by ship.

<table>
<thead>
<tr>
<th>Amount (tons)</th>
<th>Rail Cost</th>
<th>Ship Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 tons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 tons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 tons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 tons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 tons</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. If the charter fishing industry generated nearly $300,000 in revenues per year, compute the financial impact on related industries. Calculate the total money generated by both charter fishing and related industries in a five year period.

3. Assume that the total number of fishing days was reduced to one-half of the normal days. Calculate the loss of income for year 1981.

4. Discuss how lake uses may impact the quality of Great Lakes water? Complete activities in “Great Lakes In My World” that discuss pollution problems. (see pages 9, 24, 70)
HOW MUCH WATER DOES IT TAKE
TO MAKE...

ONE TON OF BOOKS 184,000 GALLONS

ONE GALLON OF GAS 10

ONE SUNDAY NEWSPAPER 150

ONE TON OF STEEL 32,000

Source: Decisions for the Great Lakes, Shoup, p. 331
*Sanchez, Robert, pp. 1-2

TABLE 1

Lake Michigan Federation
TABLE 2: Water Intake by Industrial Type (in billions of gallons)

<table>
<thead>
<tr>
<th>Industry</th>
<th>U.S.</th>
<th>G.L.</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products</td>
<td>739.6</td>
<td>104.9</td>
<td>14%</td>
</tr>
<tr>
<td>Textile Mill Products</td>
<td>162.9</td>
<td>7</td>
<td>0.4%</td>
</tr>
<tr>
<td>Lumber and Wood Products</td>
<td>156.9</td>
<td>2.8</td>
<td>0.2%</td>
</tr>
<tr>
<td>Furniture and Fixtures</td>
<td>24.0</td>
<td>1.2</td>
<td>0.0%</td>
</tr>
<tr>
<td>Paper and Allied Products</td>
<td>1,963</td>
<td>219.7</td>
<td>11.0%</td>
</tr>
<tr>
<td>Chemicals and Allied Products</td>
<td>4,325</td>
<td>476.5</td>
<td>11.0%</td>
</tr>
<tr>
<td>Petroleum and Coal Products</td>
<td>1,172</td>
<td>154.3</td>
<td>13.0%</td>
</tr>
<tr>
<td>Rubber, Misc. Plastics Products</td>
<td>187.0</td>
<td>49.7</td>
<td>27.0%</td>
</tr>
<tr>
<td>Stone, Clay, Glass Products</td>
<td>206.6</td>
<td>55.1</td>
<td>27.0%</td>
</tr>
<tr>
<td>Primary Metal Industries</td>
<td>3,392</td>
<td>1,297</td>
<td>380%</td>
</tr>
<tr>
<td>Fabricated Metal Products</td>
<td>90.0</td>
<td>22.9</td>
<td>25.0%</td>
</tr>
<tr>
<td>Electric, Electric Equipment</td>
<td>116.0</td>
<td>16.9</td>
<td>14.0%</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>234.5</td>
<td>71.6</td>
<td>31.0%</td>
</tr>
<tr>
<td>Instruments, Related Products</td>
<td>35.5</td>
<td>15.6</td>
<td>44.0%</td>
</tr>
<tr>
<td>Leather and Leather Products</td>
<td>8.5</td>
<td>2.6</td>
<td>31.0%</td>
</tr>
</tbody>
</table>

Source: 1973 Census of Manufacturers, Vol. 1

Comparison of daily water use—U.S. and Great Lakes region

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>83%</th>
<th>Manufacturing</th>
<th>8%</th>
<th>Domestic and Commercial</th>
<th>1%</th>
<th>Power</th>
<th>1%</th>
<th>Agriculture</th>
<th>51%</th>
<th>Great Lakes</th>
<th>1%</th>
<th>Other</th>
<th>1%</th>
</tr>
</thead>
</table>


Figure 1.
Figure 2.

Bulk Commerce Components
1900-1990 (by 5 yr intervals)

(Data compiled from Lake Carriers Association annual reports)

Figure 3.

Total Seaway Revenues
1959-1986

(Data from St. Lawrence Seaway Traffic Report 1985)
Table 3.
Great Lakes Factsheet
Land and Shoreline Uses

<table>
<thead>
<tr>
<th></th>
<th>Superior</th>
<th>Michigan</th>
<th>Huron</th>
<th>Erie</th>
<th>Ontario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BASIN LAND USE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td>0.5</td>
<td>21</td>
<td>80</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>0.5</td>
<td>21</td>
<td>80</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>6.0</td>
<td>44</td>
<td>40</td>
<td>66</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>3.0</td>
<td>44</td>
<td>27</td>
<td>67</td>
<td>39</td>
</tr>
<tr>
<td>Residential</td>
<td>0.1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>0.1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>3.0</td>
<td>9</td>
<td>6</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>1.0</td>
<td>9</td>
<td>2</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Forest</td>
<td>98.7</td>
<td>75</td>
<td>15</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>98.7</td>
<td>75</td>
<td>15</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>80.0</td>
<td>41</td>
<td>52</td>
<td>23</td>
<td>53</td>
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<tr>
<td>Total</td>
<td>91.0</td>
<td>41</td>
<td>68</td>
<td>21</td>
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<tr>
<td>Other</td>
<td>0.7</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>0.7</td>
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<td>3</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>11.0</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>6</td>
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<tr>
<td>Total</td>
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<td>6</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>SHORELINE USE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>n/a</td>
<td>34</td>
<td>39</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>n/a</td>
<td>34</td>
<td>39</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>39</td>
<td>42</td>
<td>45</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Recreational</td>
<td>n/a</td>
<td>6</td>
<td>8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>n/a</td>
<td>6</td>
<td>8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>24</td>
<td>4</td>
<td>13</td>
<td>12</td>
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<tr>
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<td>4</td>
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<td>30</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
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<td>4</td>
<td>21</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>20</td>
<td>15</td>
<td>14</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>n/a</td>
<td>35</td>
<td>10</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>n/a</td>
<td>35</td>
<td>10</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>12</td>
<td>32</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>n/a</td>
<td>19</td>
<td>22</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>n/a</td>
<td>19</td>
<td>22</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>5</td>
<td>7</td>
<td>18</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>


n/a: not available
Great Lakes Library:


Area of the Great Lakes (Great Lakes Homepage for Kids)

Falls

A8.1 Effectively uses a variety of strategies in the problem-solving process
   i. Represents real-world problems using visual representation
   ii. Follows a general model for solving real-world problems that
       includes making some basic assumptions about the problem

EE

A.4.3 Develop answers, draw conclusions, and revise personal understanding as
       needed based on investigations

Have each student find the answer to each question on the area of the lakes

   • Use www.50states.com/wisconsin.htm for current data
   • The Great Lakes An Environmental Atlas and Resource Book for
     information on the lakes
Area of Great Lakes

Which of the Great Lakes has the smallest area?

What percentage of Wisconsin would be covered by this lake?

How many times the area of Wisconsin would it take to cover the entire Great Lakes?
Wisconsin
Say, just a Little Bit Longer

- Admission to Statehood: May 29, 1848
- Area: 65,503 sq.mi, 23rd Land 54,314 sq.mi, 25th Water 11,190 sq.mi, 4th Great Lakes 9,355 sq.mi, 2nd
- Area Codes: 262, 414, 608, 715, 920
- Biographies: Famous Wisconsinites
- Bird: Robin 50states List
- Border States: Regional List Illinois Iowa Michigan Minnesota
- Cam World: Live Web Cams
- Classified Ads: Shop50states Classifieds NEW
- Climate: Wisconsin
- Colleges, Universities: 50states List
- Community Colleges: 50states List
- Community Pages: 50states List
- Constitution: 30th State
- County Profile: Text List 72 Counties
- Courts: Judicial System
- Current Events: News Headlines
- Department of: Education Licensing
- Driving: DMV
- Economy:
  - Agriculture: cheese, dairy products, cattle, hogs, vegetables, corn, cranberries.
  - Industry: Machinery, food processing, paper products, electric equipment, fabricated metal products, tourism.
- Editorial Cartoons: Cartoonists Index
- Fast Facts: 50states List
- Flag:

![Wisconsin Flag]

Starting at the top of a shield on a dark blue field is the state motto "Forward." Below it is a badger, the state animal. A sailor and miner show that the people work on water and land. The shield in the center shows Wisconsin's support for the United States. In four sections surrounding the shield are representations of the states main industries: Agriculture, mining, manufacturing and navigation. The cornicopia and pile of lead represent farm products and minerals. The flag law was amended in 1979 to include the name of the state and the date of statehood. Fly this Flag
- Flower: Wood Violet Viola papilionacea
- Genealogical Resources: Cyndi's List Historical Societies
- Geographic Center: Wood, 9 miles southeast of Marshfield
- Governor: Scott McCallum (R)

Capital City: Madison
City Links: Community Pages
Location: 43.044N, 089.409W
Capitol Tour

http://www.50states.com/wisconsin.htm
1/22/2002
<table>
<thead>
<tr>
<th>Great Lakes Factsheet No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Features And Population</td>
</tr>
<tr>
<td>Superior</td>
</tr>
<tr>
<td><strong>Elevation</strong> (feet)**</td>
</tr>
<tr>
<td>(metres)</td>
</tr>
<tr>
<td><strong>Length</strong> (miles)*</td>
</tr>
<tr>
<td>(kilometres)</td>
</tr>
<tr>
<td><strong>Breadth</strong> (miles)*</td>
</tr>
<tr>
<td>(kilometres)</td>
</tr>
<tr>
<td><strong>Average Depth</strong> (feet)**</td>
</tr>
<tr>
<td>(metres)</td>
</tr>
<tr>
<td><strong>Maximum Depth</strong> (feet)*</td>
</tr>
<tr>
<td>(metres)</td>
</tr>
<tr>
<td><strong>Volume</strong> (cu. miles)*</td>
</tr>
<tr>
<td>(kml)</td>
</tr>
<tr>
<td><strong>AREA</strong> (sq. mi.)*</td>
</tr>
<tr>
<td>(km²)</td>
</tr>
<tr>
<td><strong>Land Drainage Area</strong> (sq. mi.)*</td>
</tr>
<tr>
<td>(km²)</td>
</tr>
<tr>
<td><strong>Total</strong> (sq. mi.)*</td>
</tr>
<tr>
<td>(km²)</td>
</tr>
<tr>
<td><strong>Shoreline Length</strong> (miles)*</td>
</tr>
<tr>
<td>(kilometres)</td>
</tr>
<tr>
<td><strong>Retention Time (years)</strong></td>
</tr>
<tr>
<td><strong>Population: U.S. (1990)</strong></td>
</tr>
<tr>
<td>Canada (1991)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
</tr>
<tr>
<td><strong>Outlet</strong></td>
</tr>
<tr>
<td>Notes:</td>
</tr>
<tr>
<td><strong>Land Drainage Area for Lake Huron includes St. Marys River.</strong></td>
</tr>
<tr>
<td><strong>Lake Erie includes the St. Clair-Detroit system.</strong></td>
</tr>
<tr>
<td><strong>Lake Ontario includes the Niagara River.</strong></td>
</tr>
<tr>
<td><strong>Including islands.</strong></td>
</tr>
<tr>
<td><strong>These totals are greater than the sum of the shoreline length for the lakes because they include the connecting channels (excluding the St. Lawrence River).</strong></td>
</tr>
<tr>
<td>Sources: * Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, COORDINATED GREAT LAKES PHYSICAL DATA. May, 1992</td>
</tr>
<tr>
<td><strong>EXTENSION BULLETINS E-1866-70, Michigan Sea Grant College Program, Cooperative Extension Service, Michigan State University, E. Lansing, Michigan, 1985</strong></td>
</tr>
</tbody>
</table>

As industrialization intensified agriculture settlement, and wastes of early industrial river after another. The that accompanied indu added to the degradative creating nuisance cond contamination, putresce debris in rivers and near some situations, the re- drinking water and poll contributed to fatal hur waterborne diseases. Nonetheless, the prob as being local in nature.

As industrialization agriculture intensified a century, new chemical use, such as PCBs (polychlorinated biphenyls) and DDT (dichloroethane) in the fertilizers were used to make fertile soils to enhance the combination of synthetically produced nutrient-rich such as fertilizers and phosphate detergents. The lakes were subject to pollution from illegal dumping of toxic materials into the lakes.

In the 1960s, concern about the depletion of oxygen in the Great Lakes led to the establishment of the Great Lakes Water Quality Agreement between Canada and the United States. Major reductions in pollutant discharges were visible. However, the problems persisted.

**The Evolution of Economic and Environmental Management**

In the late 1960s, concern about the depletion of oxygen in the Great Lakes led to the establishment of the Great Lakes Water Quality Agreement between Canada and the United States. Major reductions in pollutant discharges were visible. Nonetheless, the problems persisted.

---

**INDUSTRIA**

Industrialization facilitated agrarian settlement, and the growth of cities along the Great Lakes. The construction of canals and locks facilitated trade and commerce, and the development of the lumber and mining industries led to significant economic growth. However, the impact of industrialization was not without its consequences.

---

**THE EVOLOVING MANA**

In the late 1960s, concern about the depletion of oxygen in the Great Lakes led to the establishment of the Great Lakes Water Quality Agreement between Canada and the United States. Major reductions in pollutant discharges were visible. Nonetheless, the problems persisted.
Using Water Activity (Water Activities to Encourage Responsibility)

Falls

6.5 constructs, reads, and interprets data charts

EE

B.8.5 examples of human impact on various ecosystems

Complete the section titled “How much water do you use?”

• Have each person complete for their own water use.

• Go over how to find how much of their family’s water is their own usage.

• Each student creates a bar graph showing their own water usage

• Complete a class graph on personal water usage for each category.

Please using grading rubric and place in student portfolio
<table>
<thead>
<tr>
<th>Attributes</th>
<th>Above Standard</th>
<th>At Standard</th>
<th>Still a Goal</th>
<th>Attribute Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Tables</td>
<td>(5)</td>
<td>(3)</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data tables are clearly completed. Correct total amounts are included.</td>
<td>Data tables are completed. Some errors in total amounts used.</td>
<td>Data tables are incomplete or have many errors</td>
<td>/5</td>
</tr>
<tr>
<td>Graphs</td>
<td>(5)</td>
<td>(3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graphs accurately represent the data. Accurate labels are included</td>
<td>Graphs closely represent the data. May (3) or may not (2) have accurate labels included.</td>
<td>Graphs are incomplete or inaccurate.</td>
<td>/5</td>
</tr>
</tbody>
</table>

Total Proposal Points Earned /10
USING WATER ACTIVITY

Humans need two to three quarts of clean water every day for their bodily functions. More than three quarts is used daily.

How much water do you use?

Study the charts below. Keep these two sheets with you for a day. Mark the sheet each time you use water. You can figure answers on the back or in margins. Remember this is only an estimate of how much water you use. Therefore, you can use the average amount given in the second column when you do your figuring. For example, if you get six drinks of water a day, you would estimate $6 \times \frac{1}{4} = 1 \frac{1}{2}$ gallons. (Note: the averages assume you let the water run to get hot or cold. You wouldn't, for example drink $\frac{1}{4}$ gallon of water each time you get a drink, but you would use that much if you let it run to get cold.)

<table>
<thead>
<tr>
<th>HOW YOU USE IT</th>
<th>AVE. AMT. FOR ONE USE</th>
<th>PUT X FOR EACH USE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking a bath</td>
<td>30 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking a Shower</td>
<td>20 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flushing a toilet</td>
<td>4 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing hand or face</td>
<td>3 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Getting a drink</td>
<td>$\frac{1}{4}$ gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brushing teeth</td>
<td>$\frac{1}{4}$ gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is your share of your family's water? Some water is used for the good of everyone in your family, such as water for cooking and cleaning. This chart can help you estimate your share of that water. Suppose, for example, there are five people in your family. If you estimate water for meals, cleaning and other family uses equals 100 gallons, your share is 100 divided by 5 or 20 gallons.

<table>
<thead>
<tr>
<th>HOW YOU USE IT</th>
<th>AVE. AMT. FOR ONE USE</th>
<th>PUT X FOR EACH USE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing dishes for one meal</td>
<td>8 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking a meal</td>
<td>5 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using Automatic Washer</td>
<td>32 gallons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
If you only marked one "x" for each kind of use, the total would be 80 gallons (using only the bath and not the shower). That's more than 100 times as much water as you need to keep your body alive. Where does all that water come from?

Ask your parents to help you find out where your household water supply comes from. Write it here ___________. Does someone pay for the water? ___________. How much? _______. Many other uses of water indirectly benefit you too. For example:

It takes 75 gallons of irrigation water to grow just one ear of corn!
... 130 gallons to produce one egg!
... 200 gallons to make the rubber for one car tire!
... 1,000 gallons to produce one quart of milk (figure for a gallon)!
... 650 gallons to produce the steel for one bicycle!
... 3,500 gallons to produce one pound of beef!

It's a good thing there's a lot of water on this earth, and that it doesn't get used up!

Water is never used up. When you drink water, it is later perspired or excreted away. When a plant draws water from the ground into its roots, water moves up into the leaves, stem and a fruit. Most of it is released into the air as water vapor through pores (transpiration). One important use of water for both you and the green plant is to carry away wastes. These stay is the water.

If all the water we now use has been used many times before in the history of the world, how is it possible that we have any clean water at all?

(To be used with Activity IV. Water Supply)

V. USE OR ABUSE?

CONCEPTS:
To explore decisions, values, and economics related to water pollution.

OBJECTIVES:
Participants will develop a better awareness of how people (and animals) depend on lakes.
Participants will develop a better understanding of the complexity of economic decisions faced by polluters of lakes.
Participants will develop a better understanding of how they, as individuals, can avoid polluting lakes.

MATERIALS NEEDED:
Large map of Lake Superior (15’ x 20’) including cities with dots and state/province borders with lines (do not identify them by name). 10 liter (or larger) bucket filled with clean
LA Standards

Falls

A.2.c identify characteristics of poems, myths
B.1.a writing an expository piece
B.1.e writing creative fiction
B.2.a plan, revise, edit, and publish clean and effective writing
B.3.a using words, phrases, and clauses effectively in sentences
B.3.c punctuation sentences correctly
B.3.d using capitalization correctly
C.1.b speaking from notes or an outline relating an experience in descriptive detail with a sense of timing and decorum appropriate to the occasion.
C.1.f employing an appropriate style of speaking, adjusting language, and volume.
C.2.a listen to and comprehend oral communications
C.2.c recalling significant details and sequence accurately

EE Standards

B.4.8 describe and give examples of natural resources
B.8.8 explain interactions among organisms or populations of organisms
C.8.1 define and provide examples of environmental issues explaining the role of beliefs, attitudes, and values
D.8.1 identify options for addressing an environmental issue and evaluate the
consequences of each option
Sea Shanties (Inland Seas Education Association)

Falls

A.2.c identify characteristics of poems, myths,
C.2.a listen to and comprehend oral communications

Material

Me for the Inland Lakes CD using song "The Bigler"

Art supplies for creating images of passages

Each group will take one passage of the sea shanty and create a visual representation of that passage. The team will then explain their visual representation and how it reinforces the theme and voice of the passage.

Grade activity using Listening to Song Lyrics Rubric
# Listening to Song Lyrics Rubric: "The Bigler"

**Name:** ___________________  

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>attention and</td>
<td>listens with little</td>
<td>listens somewhat</td>
<td>listens attentively for</td>
<td>listens critically for</td>
</tr>
<tr>
<td>purpose</td>
<td>attention and no</td>
<td>attentively for a</td>
<td>a specific purpose</td>
<td>a specific purpose</td>
</tr>
<tr>
<td></td>
<td>specific purpose</td>
<td>specific purpose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>voice</td>
<td>completed visual</td>
<td>visual representation</td>
<td>visual representation</td>
<td>Visual</td>
</tr>
<tr>
<td></td>
<td>representation</td>
<td>reinforces theme or voice</td>
<td>reinforces theme and voice</td>
<td>clearly reinforces theme and voice</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>comprehension</td>
<td>identifies ideas or feelings</td>
<td>identifies ideas and feelings</td>
<td>summarizes ideas</td>
<td>summarizes and comments upon ideas and feelings</td>
</tr>
<tr>
<td>imagery</td>
<td>identifies a few sensory images</td>
<td>describes sensory images</td>
<td>identifies the use of image patterns</td>
<td>explains how the use of imagery</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>reinforces the theme</td>
</tr>
</tbody>
</table>
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 forward 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.
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 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 *south'rd*, oh, we had to give her sheet

But the wind chopped 'round the *sou-southeast* 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 *courses wing and wing*.

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 steered her *full and by*
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 howlin' 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 *hove to* 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 *fore and aft*
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 *stem and stern* 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* 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
Water Wonders (Water Activities to Encourage Responsibility)

Falls

C.2.c recalling significant details and sequence accurately

EE

B.4.8 describe and give examples of natural resources

B.8.8 explain interactions among organisms or populations of organisms

- Follow the procedure in the activity
- If a recording of stream sounds is available play during the guided imagery.
- Optional to have students draw or make clay models of their favorite images
I. WATER WONDER

CONCEPTS:

Water is important to living things in many different ways. People have different perceptions of water and its cultural importance.

OBJECTIVES:

Participants will be able to describe habitat characteristics of riparian shoreline areas. Participants will be able to identify animals that inhabit riparian areas. Participants will be able to describe the importance of riparian areas to wildlife and humans.

MATERIALS NEEDED:

Water colors, acrylics, poster paints, crayons, drawing paper, tape player, cassette of stream or water sounds

EDUCATOR'S ROLE:

To generate an awareness of riparian zones through the use of guided imagery and art work. (See "Hints for Using Guided Imagery".) To increase the participants' appreciation of the importance of riparian areas.

PROCEDURE:

♦ Question the children about streams and river banks, the plants growing there, the atmosphere and the surrounding environment. Have them describe their experiences at streams or river banks.

♦ Explain what "riparian" means (see Background Information on page 4). Have the participants close their eyes as you read the Guided Imagery found on the next page while playing the tape recording of stream sounds quietly in the background. Ask them to pay close attention to their favorite images during the Guided Imagery.

♦ Ask participants to describe their favorite images.

♦ Have students draw or paint their favorite images on paper.

♦ Have students identify some characteristics of riparian areas. How was the environment near the water different than the area farther away? How was it similar?
Have students list, describe and discuss the values of riparian areas.

GOING FURTHER:

- Visit a riparian habitat and look for things encountered in the imagery. Note items that were not in the imagery.

- Write a story or poem expressing feelings generated by this activity.

GUIDED IMAGERY

"It's a hot summer day. You are walking in a meadow filled with knee-high grasses. Here and there are masses of tiny blue wild flowers. The ground beneath your feet is uneven, but you are in no hurry as you walk slowly toward a grove of trees. As you near the trees, you notice the changing colors of green. A breeze whispers through, showing first a shiny green, then a dull green underside of the leaves. As you step into the grove of trees, you are surrounded with a welcome coolness. You immediately feel the protection of the canopy of green above your head. A tap-tap-tapping sound breaks into your thoughts. Searching about among the rough-barked trunks, your eyes finally spot a bird, black and white with a touch of red on its head, clinging to a vertical tree trunk and bobbing its head in time to the rhythmic tapping. Your eyes fill with the beauty of the setting. Your skin welcomes the coolness. As you breathe deeply, the very scent of "green" comes to you. The aroma of earth and growing things is strong, you can smell the sweet perfume of the flowers. Now and then the strong, but pleasant odor of wet soil and last season's decaying leaves and grasses catches your attention.

"As you explore further, you notice that the tree trunks are not as crowded and close as before. Grass, which earlier reached to your knees, is overshadowed by chest-high bushes. Although these bushes have no thorns, they snag your clothing. Your arms are lightly scratched by the twig ends. Several of the bushes are covered with small berries, pink and pale green, ripening into red in the warm sun.

"The bushes become taller. You find yourself pulling aside thick, tangled willows taller than your head. You carefully choose a safe path along the trail beneath your feet. Suddenly, your left foot drops six inches. Looking down to examine the ground more closely you notice that where you stepped the tunnel of a burrowing animal has collapsed from your weight. Moving on again you feel the whisper of an abandoned spider web touch the side of your face. As you brush it aside, you notice the slope of the land is steeper. You pause, listening...listening.

"You can hear the high drone of insects... It has come upon you so gradually, you are surprised that you didn't hear it before... Now it seems almost frighteningly loud. Beneath the buzzing drone, and lower in pitch and volume, is the sound of water gently spilling over rocks.

"Above the place where the water must be, you see thousands of tiny spots milling before your eyes, the source of that high buzzing sound. The spots are hundreds of swarming
insects in a cloud too thick to imagine. A kaleidoscope of iridescent pinks and greens, darting here, pausing, darting there, pausing, snatching dozens of the dots, relishing a meal in an unending insect buffet.

"You step aside, ducking beneath the swarming insects. You smile as your eyes come to rest on the splashing waters of the stream a few feet below. As you proceed, you use your arms to open a space to walk between the graceful tan-green willows that bounce back undisturbed in your wake.

"As your eyes comb the scene for a place to rest, you notice a hip-high rock ahead of you--gray, warm, and not yet water-smoothed. You pause before reaching the rock and bend toward the water, gathering a handful of pebbles from the stream bed. One leg anchors itself on the ground between two willows while the other reaches over to the water. With the pebbles in your hand, you swing up onto the dry perch of the rock. You settle down and look at the still wet pebbles...gray, pink, tan and cool in your warm hand. After you examine them carefully, you toss the stones one at a time into the stream, listening to the pleasing plop of stone in water.

"Then your eyes drift downward to the waters of the stream near the base of your rock. You see a fish, hidden in the stone and silt, only the faint wave of a gill, a tail fin, showing any evidence of life at all.

"As you continue to look downstream you notice all kinds of small insects dancing across and above the water. A small ripple occurs in the water, then another and another. You realize that fish are rising up from below and feeding on the surface insects. Birds dart in and out of the tangle of vegetation. Some fly through.

"Downstream a frog begins to croak. Much nearer, another frog offers a reply. You look around quickly to see if you can find the nearer frog. For a moment you think you spot it, but then realize that, unless it sings again, you may never find it. Your eyes search for a moment as more frogs telegraph their messages back and forth. But now it's time to leave. You take one last sweeping look all around this beautiful setting. You slowly get up from your rock along the streamside and head back home."

HINTS FOR USING GUIDED IMAGERY

Guided imagery is a powerful way for students to create vivid experiences in their mind's eye. Many older people remember when the major form of entertainment was radio. With radio and its absence of visual images, many listeners were forced to create mental pictures of the way various characters looked and acted. It was common for listeners to see landscapes, cities and any number of exotic settings. Often one hears teachers and parents claim that radio helped make students more creative as it required the listeners to stretch their imaginations.

Research has shown that, with their eyes closed, people activate parts of their brain-mind systems that are left unstimulated without imagery. That is, imagery usually calls specific parts of the brain into activity that are unused in reading or writing. Studies show that imagery enhances a person's ability to enrich reading and to increase skill and
imagination in writing. Use of imagery enhances a person’s capacity to remember concepts, words, names and ideas.

BACKGROUND INFORMATION

Riparian areas are the green ribbons of life found on the edges of water courses (streams, lakes, ponds, etc.). Conditions there support plant communities that grow best when their root systems are near the level of high groundwater. These zones range in width from narrow ribbons in desert and mountain settings to wide bands on the plains and lowlands. Riparian areas provide space, shelter and food for the plant and animal communities with which they are associated. For example, leaf litter and terrestrial insects falling from vegetation may also provide shade from the sun for aquatic plants and animals and land-dwelling creatures at the water’s edge. Riparian areas are also transportation corridors, or highways, for animals that depend on water bodies for food and shelter. The riparian plant communities, especially shrubs and trees, provide shelter and food for animals as large as deer. Trees and marshy areas are shelter nesting birds and the stream banks are home to burrowing animals.

The riparian zone may serve as a buffer between the uplands and the water. For example, rainfall dropping on uplands and flowing downhill can be cleansed as it flows through a riparian zone. The banks of riparian areas store water during periods of high flow such as rainstorms or snow melt and release this water to the stream during low flow times. Riparian vegetation strengthens the stream banks. This tends to prevent erosion and maintains the stream channel, keeping the water clear.

Among the many benefits of riparian areas, are aesthetic and recreational values for humans, such as fishing, hiking, camping, picnicking and resting.

PROCEDURE:

✶ Ask the children to lay aside all objects.

✶ Instruct them to sit in a comfortable and relaxed position with their eyes closed.

✶ Wait until you see a general state of relaxation before beginning.

✶ Using a steady and paced reading or speaking style, begin the narrative. Remember to speak slowly. If you want the students to create rich mental images you must allow them time to do so. It takes about as much time to observe mental images as it does to carefully review actual physical settings.

✶ Once the narrative is finished, invite the students to review all of the images they saw in their minds. Again, try to allow enough time for an adequate visual review.

✶ After adequate time for mental review (at least one, possibly two minutes), ask the children to open their eyes.
Begin discussing the imagery in terms of the instructional purpose for its use. In some cases, the imagery serves simply to provide a visual review of some of the participants' past experiences. At other times, you are providing stimuli for the participants to create original images. In any case, it is important to realize that there are no mistakes in mental images. What a participant imagines is real. The images are data. If participants create images that are inconsistent with what you expect, consider the images to represent differing perspectives rather than wrong answers. Try to honor and nourish variety as a means to add richness to the topics being explored.

In addition to serving as a powerful and effective way to explore and remember concepts, regular use of guided imagery also tends to relax participants. When relaxed, they will frequently be more productive in other areas of study.

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II. CYCLING AROUND

CONCEPTS:

Water is continually recycled from earth to the atmosphere and back again through a process known as the Hydrologic Cycle.

OBJECTIVES:

Participants will be able to identify and describe groundwater and how the hydrologic cycle operates.

MATERIALS NEEDED:

Hot plate, pan of water, activity sheets (included), pan of ice cubes

EDUCATOR'S ROLE:

To demonstrate evaporation and condensation in a water cycle simulation.

PROCEDURE:

- Give each child a copy of page 7, "Nature's Water Wheel".
- Boil water on the hot plate.
- Hold the pan of ice cubes over the steam from the boiling water.
Unseen Movement
Science Experiment

Purpose:
Write what the purpose of the experiment in 1-2 complete Fifth grade sentences.

Hypothesis:
Write what you think will happen in 2-3 sentences.

Materials:
List of material you used.

Procedures:
Draw a diagram of what you did in the experiment. Label the parts and color.

Conclusion:
Write 2-3 sentences answering what happened in the experiment and what did you learn?
L.A.

So you want water from the Great Lakes? *(The Great Lakes in My World)*

Falls

C.1.b speaking from notes or an outline relating an experience in descriptive
detail with a sense of timing and decorum appropriate to the occasion.

C.1.f employing an appropriate style of speaking, adjusting language, and
volume.

B.1.a writing an expository piece

B.2.a plan, revise, edit, and publish clean and effective writing

B.3.a using words, phrases, and clauses effectively in sentences

B.3.c punctuation sentences correctly

B.3.d using capitalization correctly

EE

C.8.1 define and provide examples of environmental issues explaining the role of
beliefs, attitudes, and values

D.8.1 identify options for addressing an environmental issue and evaluate the
consequences of each option

- Read background information from page 29 to students
- Follow directions in the procedure on page 30
- Do the evaluation where each person will write a position paper
  about water diversion from the Great Lakes
- Use 6-trait rubric and place in portfolio
### Position Paper Six + I Scoring Rubric

<table>
<thead>
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<th></th>
<th>Your Score X 2</th>
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<tbody>
<tr>
<td><strong>Ideas &amp; Content</strong></td>
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<tr>
<td>Paper makes sense; supported</td>
<td>Your Score X 2</td>
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<td>details of position; reflects</td>
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<td>personal insight and</td>
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<td>understanding of water</td>
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<td>diversion</td>
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<td><strong>Organization</strong></td>
<td>Your Score X 1</td>
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<tr>
<td>How your ideas are put</td>
<td>Your Score X 1</td>
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<tr>
<td>together, one idea per</td>
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<td>paragraph, transition words,</td>
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<td>connecting ideas to support</td>
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<td>your position, easy to</td>
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<td>understand.</td>
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<td><strong>Voice</strong></td>
<td>Your Score X 2</td>
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<td>Shows how committed you are</td>
<td>Your Score X 2</td>
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<td>to your opinion, how real you</td>
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<td>sound in making your</td>
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<td>statement.</td>
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<tr>
<td><strong>Sentence Fluency</strong></td>
<td>Your Score X 1</td>
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<tr>
<td>Uses a variety of sentences</td>
<td>Your Score X 1</td>
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<td>correctly, for emphasis and</td>
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<td>effect</td>
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<tr>
<td><strong>Word Choice</strong></td>
<td>Your Score X 2</td>
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<tr>
<td>Uses powerful verbs, specific</td>
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<tr>
<td>precise nouns and adjectives;</td>
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<tr>
<td>words capture reader's interest</td>
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<tr>
<td><strong>Conventions</strong></td>
<td>Your Score X 1</td>
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<tr>
<td>Following directions; writing</td>
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<td>with few or no spelling,</td>
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<tr>
<td>punctuation or capitalization</td>
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<td>errors; correct grammar.</td>
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<tr>
<td><strong>Presentation</strong></td>
<td>Your Score X 1</td>
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<tr>
<td>Precisely follows format</td>
<td>Your Score X 1</td>
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<td>capitalized, but not</td>
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<td>underlined; proper heading.</td>
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**General Comments**

**Total:**

**Percent:**

---

**Name** __________________________  **Date** __________________________
SO YOU WANT WATER FROM THE GREAT LAKES?

Grade: Upper, 7-8
Subjects: Science, Social Studies
Concepts: Water diversion, political action
Skills: Role-playing, listening
Materials: Role play descriptions

Objectives:

After completing this activity, each student will be able to:

1. explain how water is being diverted from the Great Lakes at present; and
2. describe some problems associated with diverting more water from the Great Lakes.

ACTIVITY

Ninety-five percent of the fresh surface water in the U.S. is in the Great Lakes. The lakes have 20% of the fresh surface water available on the Earth, not including ice in glaciers and other ice sheets. This water is a tremendous resource. The International Joint Commission (IJC) is a group of U.S. and Canadian people who are responsible for advising the federal governments from those two countries about the management of this resource.

When water is taken out of a stream or lake and transported somewhere else, it is called a water diversion. There are five diversions in the Great Lakes at present. Two of them divert water into the Great Lakes, through streams flowing into Lake Superior from its north shore. Two are internal to the system, with no net diversion in or out of the Great Lakes. These two take water out of Lake Erie near Buffalo, through the Welland Canal and the New York State Barge Canal. The water is used for ships and barges and for generating electricity. It flows back into Lake Ontario. The fifth diversion, flowing out of the Great Lakes, is probably the best known. Water is taken from Lake Michigan at Chicago and used for boats on the Chicago River for water supply and for the transport of sewage to the Mississippi River.

Since the early 1980s, the southwest and high plains part of the United States have proposed a water diversion from the Great Lakes that would supply them with much-needed water. These areas have experienced tremendous growth in population since the 1950s. Their own water supplies are beginning to dry up. The Ogallala aquifer (a source of groundwater) is a major source of water in the high plains. It is being overused and, without new conservation measures, could be depleted early in the 21st century.

Most proposals to divert water from the Great Lakes suggest tripling the diversion from Lake Michigan at Chicago and taking the extra water out of the Mississippi River. Experts estimate that this would supply the additional water needed by only three western states. A diversion of this size would lower the levels of Lakes Michigan, Huron and Erie by about 9 inches on average. Lakes Superior and Ontario would be lowered less than 9 inches.

This activity is a role-play in which the students will take a variety of viewpoints in expressing opinions about the diversion of water from the Great Lakes for use in the western U.S. They will present their views to a panel from the IJC who is trying to decide what to do about the proposed diversion.
Procedure:

Randomly assign the students to 8 groups. Give each group a role to play. Each group will need about 15 minutes to read their role description and to prepare to present their viewpoint to the IJC. Each group should use no more than 5 minutes to give their presentation.

The teacher should play the role of the IJC. The question at hand is: Should the western states or the U.S. be allowed to divert water from the Great Lakes for their use? It may be helpful to write this question on the board so that all may keep it in mind. You will decide the order in which the presentations will be made.

The teacher need not make a decision about diversion. This activity is just a forum so that all may present their points of view and provide the IJC with information so a decision can be made in the near future.

Evaluation:

Have each student write a position paper that includes a personal decision about water diversion from the Great Lakes. Make sure he gives reasons for those decisions.

Going Deeper:

Find out what your source of water is and what plans your community has for times when your water supply is running low.

Great Lakes Library:

Baker, Dale, 1985, Great Lakes Water Diversion, IN Seiche, Minnesota Sea Grant, Winter.


Canadian Politician

You are a politician from Canada. Your job is to protect the rights of Canada and Canadians and to preserve the use of water in the Great Lakes. Environmental groups are putting pressure on you to make sure that these rights are secured.

The Boundary Waters Treaty of 1909 between the U.S. and Canada guarantees that any decision about diversion of water from the Great Lakes must have the approval of both governments. The problem is that Lake Michigan is not on the Canadian border and is not covered by the treaty.

Mayor of a City in the Southwestern U.S.

Your city has doubled in size in the last 20 years and because its beautiful weather and scenery, it is expected to double again in the next fifteen years. The water supply is getting low. There are no other supplies of water in your area. You and your Planning Commission must somehow develop a way to ensure a sufficient water supply for your growing population. You can point out that the expected increase in consumption of water from the Great Lakes by the Great Lakes states themselves over the next 20 years will lower lake levels more than diversion ever would.

Farmer from the High Plains

Eighty-five percent of the water used in the United States is used by 17 growing western states. Most of this water is used by farmers for growing food and raising livestock. The Ogallala aquifer has supplied you with water for many years, but you have had to drill deeper and deeper wells to get the water out. Someday the aquifer will dry up. With the expected increase in population, the demand for food will also increase. You feel you must have water from the Great Lakes to meet this demand.

Economist

If the water levels of the Great Lakes were lowered, the value of shoreline property could increase because it would be less likely to be flooded and eroded during storms. It is difficult to say how recreation around the lake would change. Fishermen may not visit the lake as much because fish habitat may be reduced, hence fewer fish. This could offset the possible increase in property values. Marinas would have difficulties with their dock facilities if the water is lower. This would further discourage fishing. Ships would have greater difficulty getting into and out of ports and so this may affect the economy of the region.

In the southwest and high plains, the economy is dependent upon water. With projected increases in population, the water supply will be severely strained. The overall population increased 18% in all the west from 1975 to 1980.
United States Great Lakes Politician

You must make sure that the rights of the people of the United States are preserved. Most of the Great Lakes states either already have or will soon have laws that guarantee no water will be diverted from the Great Lakes without the state's permission. You also know that water can be diverted from Lake Michigan without Canada's permission, something that is needed for diversion from the other Great Lakes. Industries and ship owners are putting pressure on you to ensure an adequate water supply for their activities.

Great Lakes Marina Owners

With lower lake levels that result from diversion, your dock facilities will have too little water to service most boats. You must either invest a great deal of money to build new docks, dredge around the old ones to make the water deeper or go out of business. You are also concerned that fishermen may stay away from the lake because lower lake levels may destroy fish habitat and result in fewer fish.

Great Lakes Ship Owners

If water is diverted from the Great Lakes, the lake level will be lower. Your ships will have great difficulty getting into and out of harbors. You may have to load less cargo on your ships so that they will ride higher in the water, or build a whole new fleet of ships with shallower drafts. The result will be higher costs and lower profits.

Scientists

You are really concerned because lower lake levels will cause wetland areas along the shores of the lakes to be drained. Wetlands are very important to the lakes. They act as a filter for sediment and certain pollutants that enter the lakes. They also provide a sheltered place for fish to spawn and for many other organisms to reproduce and live. Draining the wetlands could result in fewer fish and other organisms, and lower water quality.
When did the rocks in the Great Lakes Basin Form? *(The Great Lakes in My World)*

Going deeper

Falls

B.1.e writing creative fiction

- Each student needs a rock
- Read the section from chapter 2 on the Natural Processes in the Great Lakes from *The Great Lakes An Environmental Atlas and Resource Book*
- Have each student write a story about their rock and what it has seen.
APENDIX F

TEACHER EVALUATION FORM

159
Teacher Evaluation Form

Completed by: ________________________________

1. In what ways do you feel this program on the Great Lakes was beneficial to middle school students?

2. How has this program influenced your belief as to whether or not you can make a difference environmentally speaking in your teaching?

3. Is it worthwhile to continue this type of program? Why or why not.

4. Based on the material you taught what recommendations do you have in regards to rubrics, lesson material, or time requirements.
APENDIX G:

PERMISSION SLIP FOR FIELD TRIP
Dear Parents,

On **June 3**^rd^ your child will have a wonderful learning opportunity available to them. The seventh grade class will be traveling to Milwaukee to visit Discovery World with the opportunity to participate in the Extreme Environments and You activity lab. We will also be sailing on the Tall Ship of the State of Wisconsin, the S/V Denis Sullivan. The vessel, a 138-foot re-creation of the 19th century Great Lakes cargo schooners, is a U.S. Coast Guard inspected vessel and meets or exceeds U.S.C.G. regulations. This vessel specializes in taking students on educational sailing experiences.

We will be leaving school at 8:15 and will leave Milwaukee approximately at 4:00. We hope to return to school around 5:00. Please plan on picking your child up at school after 5:00. Your child will need to pack a lunch and warm clothing for sailing. The following are recommendations from Wisconsin Lake Schooner on what to bring and personal gear.

**What to Bring**
In general, for the sessions conducted aboard the *S/V Denis Sullivan*, we advise that you dress in layers. If the temperature is 50° to 70° F on shore, then jackets, sweaters, and hats will almost certainly be needed on the ship. The ship’s captain has the ultimate authority in determining if we sail. Shipboard sessions will be canceled in the event of high winds, thick fog, or lightning; however, rain and cold will not deter us.

**Recommended Personal Gear**
- Tennis shoes or deck shoes / NO SANDALS
- Hat
- Long-sleeved shirt
- Light jacket
- Sunscreen
- Motion sickness bracelets (optional)- These work very well for many people and are applied to acupressure points in the wrists. Available at most pharmacies, the bracelets with the fabric band and pressure buttons are preferred over other kinds.
- Camera/camcorders (optional) – Please note, however, that Wisconsin Lake Schooner is not responsible for any damages or loss of these items.

Please sign and return the permission slip located at the bottom of this page with payment of **$10.00** to Mrs. Gerend or Mrs. Wodach. Please make checks out to SFMS.

Thank you for your support for this extraordinary educational opportunity.

Please return this slip with payment by **May 21**

Please permit my son/daughter(print) ___________________ to participate in a supervised field trip to Wisconsin Lake Schooner and Discovery World Museum on Tuesday, **June 3 2003**.

Parent/Guardian signature ____________________________

Date ____________________________

Fee required: **$10.00**
Senior memories shared by youth

It was a coming together of two distinct age groups — Sheboygan Falls Middle School students and seniors from the Sheboygan Falls Food & Fellowship Site.

The students chatted with visitors from the site at primary sources about Sheboygan County history.

Students of Karen Woschale and Trevor Allen's seventh grade social studies classes found out more about Shcheygan Falls. One-room school social studies classes taught a lot of history. They learned about Sheboygan County and wrote, "The Schielkes live in Sheboygan Falls Middle School as primary students and seniors from the Sheboygan Kuhlow, Fred and Marge Falls Food & Fellowship Site. Cicorcc Lui,. lclcn and wrote, "The Schielkes live in "Back in 1955, letter mail was mentioned how everyone knew everyone in Sheboygan Falls. Their school memories include taking train cars to school, having all eight grades in one room with 20 to 30 kids in each room, having very good teachers and not a lot of homework."

She continued, "They commented how everyone knew everyone in Sheboygan Falls and now, we're grown apart.

Sometimes, especially now, we need to come together. Thanks to the Schielkes I've realized that." Craig Williams spoke with Kuhlow who told how the winter of 1936 was one of the worst winters ever in Sheboygan Falls.

Williams wrote, "The roads were closed because there was so much snow. Back then the post office used to be where Rick's House of Flowers is now and Firehouse Pizza used to be city hall. The streetcar depot used to be across from the insurance building. Mike Terma's Sweet Shop was a popular place and was where The Villager is now."

He continued, "The Municipal Building, M & I Bank, Wells Fargo, the liquor store and the Memorial Library weren't around in the 1930s. In the 1920s cars didn't have trunks and could only go about 45 miles per hour. A good car was about $500. In the 1930s cars could go about 70 miles per hour."

"Back in 1955, letter mail was one cent. Christmas and holiday cards were two cents in Sheboygan Falls and movies cost 25 cents. In fact, prices for everything were low until after World War II. Airplane rides were $2 and an apartment cost $17 a month." George Lartz shared with student interviews: Jenni DePagter spoke with Kuhlow who told how places have changed around the Sheboygan City. Erma made $2.50 a day. In the village, she worked at the pea canning factory and her about Sheboygan Falls when she was young.

Olson continued, "Sarah Spratt was their kindergarten teacher. Some said that she came with the school. Erma made $2.50 a week and worked eight hours a day. In the summer when school was out, the pea canning factory would let anyone work if they were old enough. "When Mr. Visser was little, he went away with it because his dad was the state senator."

Olson continued, "Horses and buggies delivered milk and ice in those days. There was a box you would put in your window sill and you would put up a sign of how much ice you wanted. People didn't have refrigerators, so they would put their food on the basement floor in the summer to keep it cool and fresh. In winter, sleds made deliveries. Ice was
Block wrote, "Helen told us about the stores that were there. Evens was here for as long as she could remember, but it was a dime store then. She told us it was the main clothing store, besides a men's clothing store, which is now Firehouse Pizza. There was no McDonald's, but there were hamburgers for 15 cents, which she said tasted great! Bob's Lunch was around too.

"She remembered apples being planted in the window at Mike Ten's where The Villager is now. Most people got paid 50 cents an hour. Women were just starting to get jobs. Some men didn't even allow their wives to get jobs. For fun there were a lot of dances. There weren't any parks, but there was an occasional picnic.

Block concluded, "Most kids played with dolls or played outside. A lot of kids played baseball. You could see black and white movies for 10 cents." Halley Thimmig also visited with Rotsted and wrote, "After Helen moved to Sheboygan Falls, she met Edgar Rotsted at a high school dance and got married later. Mr. Rotsted didn't pass first grade because he still spoke mostly German. Later, Helen went to summer school to learn German and speak it often with Edgar.

"The creamery where Edgar started work in 1946 used to be where Austin's old store was. Cheese was made from cottage cheese and tasted very good. The creamery also washed the empty milk bottles when the delivery man dropped them off. The first milk cans were tall and straight and later on got the form of a warped bottle so cream could be poured out easily.

"School was a lot different in the 1930s than today. There were rarely any snow days, but when the weather turned rough, the students still had to walk to school. There wasn't any bus service, but some parents had time to drive their children to school. Everyone that went to school helped out by clearing snow, washing the floors, starting the stove, sweeping the floor and more.

"Helen said they were the juniors at school. There weren't any indoor toilets in schools during the 1930s until World War II was over. A similarity of the schools is that they both had musical instruments, bands, choirs and music classes like today." Thimmig continued, "Helen's mother loved to bake cakes and pies. She can remember one afternoon when her mother set a pie out on the windowsill to cool and her brothers took the pie and ate the whole thing!

"Helen and Edgar ate a lot of maple syrup from the woods near the Sheboygan River. There weren't any cameras or refrigerators in the 1930s. Some people didn't have electric lighting in their homes. They used wood stoves to cook instead of electric stoves.

Helen brought coal to heat her stove. Only family doctors came to your home whenever someone was ill. Babies were born at home, usually on the couch or on the table. Helen and her sister and two brothers were all born at home. "During World War II things like sugar, flour, shoes, school supplies and more were rationed. If you could afford to, you could buy tokens for certain items. The tokens were off-red and were smaller than a coin.

Thimmig concluded, "Helen worked in a tannery where they tanned sheep hides all the way from Australia. The 1930s had its good times and its bad times, but it all came out just fine into the end. As Helen concluded, 'We were very simple back then.' According to Wodach, "As part of the Great Lakes unit that all subject areas are coordinating in seventh grade for fourth quarter, this Sheboygan Falls history assignment was meant to show students how important water transportation and resources were to Sheboygan Falls and Sheboygan County settlement." She added, "The culmination of the unit is the sailing trip on the Dennis Sullivan Great Lakes schooner."