

Greatest of the Great Lakes—A Medley of Model Lessons



COSEE GREAT LAKES
CENTERS FOR OCEAN SCIENCES
EDUCATION EXCELLENCE

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Introduction

COSEE—A Network Linking Scientists and Educators to Collaborate on Ocean and Great Lakes Science

The National Science Foundation's Division of Ocean Sciences supports a network of coordinated centers that facilitate collaborations and communication between ocean science researchers and educators. These Centers for Ocean Sciences Education Excellence (COSEE) foster the integration of ocean research into high quality educational materials, allow ocean researchers to gain a better understanding of educational organizations and pedagogy, provide educators with an enhanced capacity to understand and deliver high-quality educational programs in the ocean sciences, and provide material to the public that promotes a deeper understanding of the ocean and its influence on each person's quality of life and our national prosperity.

The Newest Member—COSEE Great Lakes

Established in 2005, COSEE Great Lakes serves as the regional center for this amazing inland freshwater system. The Co-PIs represent existing education programs of the Great Lakes Sea Grant Network, including programs in Illinois-Indiana (a combined program), Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin. These educators collectively have over 150 years of fresh and salt water experience in the areas of curriculum development, internet programming, teacher education, field teaching, research, and evaluation. Each partner has experience in education, in science, and in reaching the underserved populations of the region, particularly through programs for teachers in our ethnically and economically diverse urban areas.

Our goal is to enhance marine education in Great Lakes classrooms, and at the same time to bring the inspiration and vital contributions of the Great Lakes to marine education, nationally. This comprehensive collection of activities provides students with insight into the uniqueness of the Great Lakes system and research-based understandings of issues affecting our environment and daily lives. This "medley" of model lessons is just one of many offerings through the COSEE Great Lakes initiative.

Why Teach Great Lakes Science?

Studies of middle school teachers in the Great Lakes states and Ontario, Canada, show that teachers believed water quality, environmental responsibility, water uses and conservation, and toxic chemicals to be most important for their students to learn. These teachers also wanted to know more about these topics in order to teach them well. (Fortner & Meyer, 2000; Fortner & Corney, 2001). Although their Great Lakes education priorities did not include many of the current science research topics such as dead zones and climate change, we might speculate that the topics are not well known to teachers, and teachers teach what they know.

Great Lakes science is poorly represented in textbooks that do receive curricular attention. Common treatment of the region in Earth science texts is to announce that "glaciers carved the Great Lakes," with only a cursory explanation of that process. Some very new texts introduce zebra mussels as a nonindigenous species. Thus, if the curriculum is to reflect local science, a textbook is probably not sufficient. Making the science available through supplemental curriculum activities could foster the teaching of more Great Lakes science.

Great Lakes Issues under Investigation

Great Lakes scientific research is conducted by coastal managers and ocean scientists who deal regularly with hydrologic characteristics and systems interactions, so curriculum dealing with Great Lakes topics can prepare classes for ocean learning. While there are many outstanding research facilities in the region, two Great Lakes research labs that participate directly in COSEE programs are the Cooperative Institute for Limnology and Ecological Research (CILER) and the Great Lakes Environmental Research Laboratory (GLERL). These laboratories conduct monitoring as well as cutting-edge science studies. CILER addresses climate and large-lake dynamics, coastal and nearshore processes, large-lake ecosystem structure and function, and remote sensing of large-lake and coastal ocean dynamics. GLERL conducts studies on harmful algal blooms, degree of anoxia (dead zones), interactive effects of system forces, fish recruitment, impact of nonindigenous species, con-

tamination in the biota, climate impact on fish growth, temperature, water levels and waves. These two COSEE Great Lakes partners and scientists affiliated with Sea Grant Programs, along with other research groups in the region, address issues such as wetlands (USGS), effects of land use on water quality (USGS), beach contamination/sewage issues (Great Lakes WATER Institute), urban coastal issues (Sea Grant), freshwater uses (USGS), and erosion and flooding (USEPA-GLNPO).

The COSEE Great Lakes Solution

Teacher education in COSEE Great Lakes focuses on a set of topics that blend Great Lakes and ocean science:

- Coastal processes
- Climate and weather
- Life in the water
- Hydrology and remote sensing
- Habitats (sand dunes, estuaries, connecting channels, wetlands, etc.)
- Great Lakes issues (botulism, invasive species, restoration issues, fish contaminants, etc.)

The topics encompass regional fields of science research and at the same time allow us to address the priorities that teachers express, those that deal with environmental issues and responsibility.

The Case for Supplemental Materials

What makes such supplemental materials so valuable for science learning?

Constructivism, not regurgitation. Generation 2 of instructional materials, with Generation 1 being traditional textbooks, is described by Nelson (2006, p.7) as introducing “innovations such as beginning instruction with guided observations, facilitating more open-ended experiments that often cleverly employ technology, and applying a learning cycle to guide instruction.” Constructivism is the underlying theory in Generation 2 materials—some activities in this *Greatest of the Great Lakes (GOGL)* collection incorporate this constructivist approach. What began with the “alphabet soup” curricula of the 1960s-70s has now evolved into standards-aligned materials, many of which are produced in modular format allowing mixing of disciplines and more flexible classroom structure.

Great Lakes Sea Grant educators have constructed such materials with the combined expertise of scientists, science educators, and classroom teachers. Some Sea Grant materials even approach Generation 3 – Cognitive

research-based materials, but the time required for assessing pre-existing student ideas and teaching metacognitive skills is greater than teachers can afford, given the constraints of high-stakes testing programs in the U.S.

Form, style and relevant substance. Unlike textbooks that are constrained by page format, long development time, and having to meet the demands of large national markets, supplemental materials such as those developed by Sea Grant marine and aquatic educators can offer innovative formats, imitate popular media styles, and provide easily updatable content. Board games, simulations, laboratory experiments, mapping and data interpretation, and active play scenarios can be used as appropriate. Teachers select materials to suit their grade level, school situation, and curriculum needs. They typically pay a small amount for one copy of a teacher’s guide or nothing at all for Internet access to instruction. Student backpacks are lightened, the curriculum is enlivened, and learning is locally relevant, even fun!

Integration of disciplines. Flexible supplemental modules can seamlessly bring together content from more widely separated discipline areas, such as science and social studies, or science and geography or language arts. In a study of geoscience educators from 15 countries, integration was the most preferred approach to K-12 science education for the 21st Century. “Integration can help students achieve understanding about disciplines, experience concepts and processes of the real world, and apply the principles to real world settings” (Lee & Fortner, 2005).

Criteria for Selection

The 41 activities that make up the *Greatest of the Great Lakes* collection were selected based on a distinct set of criteria, providing highly relevant and timely lessons for the classroom. These activities were carefully considered by the COSEE Great Lakes Curriculum Committee, comprised of education professionals from the University of Minnesota, The Ohio State University, Michigan Sea Grant Program, and Illinois-Indiana Sea Grant Program.

To “make the cut,” activities had to meet the following criteria:

- Enhance Learning Skills: Inquiry, hypothesis, synthesis, data interpretation, decision making.
- Offer Numerous Learning Applications: problem-based learning and authentic world experience.

- Provide grade level coverage in elementary, middle, and secondary schools. (The COSEE target range is grades 4-10.)
- Offer a good representation of different activity types; e.g., role playing, decision-making, data gathering, and experimentation.
- Represent a wide array of current issues addressed in the region, so students will better understand high profile Great Lakes problems that are cause for concern.
- Include activities that integrate science with other disciplines—math, social studies, geography, earth science, environmental studies, language arts.
- Provide students with keen insights into the uniqueness and influence of the Great Lakes on aquatic life and human populations.

Designed to be used by teachers in grades 4-10, these pre-existing Great Lakes materials have been rigorously reviewed and tested in schools. By referring to the alignment tables, educators can see how each activity is aligned with State and National Science Education Standards, Earth Systems Understandings, and Ocean Literacy Standards. This standards-based framework will enable educators to integrate the Greatest of the Great Lakes into classrooms and non-formal learning environments. Educators should use the Instructional Mode chart to identify the type of activity and its application to their curriculum. A Grade Level table has also been provided to facilitate the selection of age-appropriate activities.

Of course, this collection is only a sampling of the fine activities that cover Great Lakes topics. We have also provided an appendix that summarizes additional activities that are worthwhile and describes how to access them. This appendix will be updated over time on the COSEE Great Lakes Web site to include additional quality Great Lakes activities.

Enhancing Marine and Aquatic Science Literacy

Continuing involvement with COSEE programs and supplemental materials can make a difference to you and your students. Our high quality professional development for teachers will immerse participants in inquiry, questioning, and experimentation; therefore, modeling inquiry teaching. Teacher training workshops are both intensive and sustained. They engage teachers in concrete tasks, focus on subject matter knowledge, deepen teachers' content skills, and show teachers how to connect their work to specific standards for student performance.

Sea Grant educators in the Great Lakes region have demonstrated on local scales that their curriculum materials and teacher enhancement efforts make a difference in marine and aquatic science literacy. With the Great Lakes as our scale of operation, and a goal of enhancing science literacy, we begin now with a selection of the *Greatest of the Great Lakes*, upon which basis we will build a *Fresh and Salt* curriculum for learning about the world of water. Visit our Web site for curriculum updates and to learn how you can get involved, at www.coseegreatlakes.net.

DIVE IN AND ENJOY COSEE's GREATEST OF THE GREAT LAKES!

References Cited

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Activities Grouped by Instructional Method

Investigations

How do the GL Modify the Growing Season?

How Does the Temperature of the GL Change Over Time?

What Happens to Heat Energy Reaching the GL?

Experiments provide real-world experiences for students as they learn to use the scientific method, develop hypotheses, identify variables and control groups, compare solutions with others, review and understand their findings, interpret data, and draw conclusions based on results. Students learn the valuable lesson that there can be differing solutions to the same problem.

Data Interpretation

Where Should I Relocate in the GL Region?

What are the Characteristics of Some GL Fish?

What is the Ecological Role of an Estuary?
How Does the Estuary Serve as a Nursery?

How do the GL Modify the Growing Season?

How Does the Temperature of the GL Change Over Time?

Snowmaking GL Style

What Happens to Heat Energy Reaching the Great Lakes?

Great Lakes Triangle (set of three activities)

How Does Stratification Affect Water Quality?

How Did Rocks and Rivers Shape the GL?

What Evidence of Glaciation Exists in the GL Region?

How Fast Can a Shoreline Change?

Invader Species of the GL

Where Do the Toxins Go?

Is the Globe Warming? Is There Evidence in the Great Lakes Region?

Which Fish Can We Eat?

Indoor Dunes

Engaging in research and data gathering enables students to pose questions and use models to enhance their understanding. Research incorporates higher level thinking skills of analysis and synthesis. These activities will help to develop good organizational skills, as students must select the best approaches to present their information and organize their data and narrative information in a cohesive manner.

Decision Making

Where Should I Relocate in the Great Lakes Region? Great Lakes, Great Careers

Hydropoly Great Lakes Triangle

Rival for Survival Beach Mysteries

Whose Water?

These activities help to enhance students' creativity and can improve study habits and aid in classroom learning objectives. Decision making takes place throughout our lives and are instrumental in helping students to clarify their own values, solve conflicting objectives, and process through difficult choices. Students work in a collaborative environment with peers and learn skills that they can use in problems of personal health, safety, and employment or family decisions.

Simulations and Role Playing

How Big Is a Crowd? Whose Water? 200 Years of Change Seeing Purple

Wetland in a Pan Great Lakes Triangle Where Do Toxins Go? Your Great Lake

More Than Just a Lake Don't Stop for Hitchhikers Invader Species of the Great Lakes

How Well Do You Know the Great Lakes? Making Great Lake Connections

Role playing and simulation activities are an extremely valuable method to help students learn in a concrete way what is more difficult to learn and envision in the abstract. They encourage critical thinking and creativity, let students develop and practice new language and behavioral skills in a relatively non-threatening setting, and can generate the motivation and involvement necessary for learning to occur.

Manipulatives

How Big is a Crowd? How Well Do You Know the Great Lakes?

Wetland in a Pan Making Great Lake Connections Invader Species of the Great Lakes

Manipulatives include actual physical representations of the concepts covered by the program. Research indicates that by providing students with objects that can be touched and moved to introduce or reinforce a learning concept, students will become actively involved and the learning environment is greatly enhanced.

Board Games

Who Can Harvest a Walleye? Hydropoly Rival for Survival Exotic Puzzle

Students have many different learning styles and levels of interests. Therefore, it is important to incorporate multiple teaching techniques into the classroom experience. These activities use board games to engage students as they master new concepts using an interactive and cooperative learning approach.

Art and Language Arts Extensions

200 Years of Change	Ojibway-Early Immigrants to the Great Lakes Region	Great Lakes, Great Careers
Don't Stop for Hitchhikers	Invader Species of the Great Lakes	Whose Water?

Art and language arts extensions help students to develop collaborative skills, technological competencies, communicate ideas and to develop an appreciation for diversity. Using journal pages, role playing, and problem solving, these activities generate excitement and enthusiasm for the scientific principles being explored. Students are provided with a number of ways to express themselves and to demonstrate the dynamics of things that are happening in our changing environment.

Calculation/Measurement

Who Can Harvest a Walleye?	Seeing Purple
How Does the Temperature of the GL Change Over Time	Great Lakes Triangle
What Happens to Heat Energy Reaching the Great Lakes?	Your Great Lake!
How Does Stratification Affect Water Quality?	Water Quantity
How Did Rocks & Rivers Shape the Great Lakes?	How Fast Can a Shoreline Change?
What Evidence of Glaciation Exists in the Great Lakes Region?	Is the Globe Warming?
How do the Great Lakes Modify the Growing Season?	

These inquiry-based activities provide an opportunity to practice valuable math skills and help to motivate students and involve them in their own learning.

Sampling

What is the Ecological Role of an Estuary?	Seeing Purple
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These activities teach students valuable observation and data gathering skills as they do the work of scientists in a classroom lab setting. Important concepts including wetlands, life cycles, and ecosystems are explored as students determine the methods used by ecologists to sample populations of plant and animal life in aquatic ecosystems.

Problem Solving

Hydopoly	Great Lakes Triangle	Beach Mysteries
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The health of the environment is discovered through issues involving land use, economic growth, and water quality. Discovering that things are not always the way they appear, learners develop an understanding that individual and group decisions can have a direct impact on the outcome.

Service Learning

Beach Mysteries

[Note: Educators will find that many other GOGL activities can be extended to provide service learning opportunities for their students. This is particularly relevant for activities found in the Great Lakes Issues section.]

Service learning activities are an educational method by which participants learn and develop through active participation in service that meets the needs of a community. Students develop a range of new skills that are integrated into and influence their lifelong learning. This activity invites students to take action to improve beach health in their community. Participating in service learning projects enables students to create positive change and includes structured time to reflect on what they learned about themselves and their relationship to the community around them.