

Great Lakes Maritime Transportation Lesson Plan

“Ballast and Invasive Species on the Great Lakes”

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LESSON OVERVIEW

This lesson is constructed for a high school science or biology class and integrates technology into the curriculum. This lesson introduces invasive species of the Great Lakes Region, addresses the impact of ballast water as a vector of transmitting invasive species to the Great Lakes Region and presents an opportunity for students to investigate government(s) regulations regarding ballast water in the Great Lakes. This unit can be incorporated into the curriculum while studying ecosystems, economics or as an extension to planning an investigation. Alternative methods for implementing this lesson are provided and suggestions are provided for classrooms with limited access to computers.

Day One involves reading in advance, online activities, teamwork and class discussions.

Day Two involves reading, online activities, teamwork, oral synopses and class discussions.

Day Three involves reading, online activities, teamwork, class discussion and explanation of writing assignment.

LEARNING OBJECTIVES

Students will:

1. determine through the investigation of online resources such as; articles and journals, the meaning of terms used in reference to the general term “species”, such as the following: invasive, indigenous, non-invasive, non-indigenous, native, exotic, introduced, extirpate, extinct, threatened, and introduced. Other terms students will define: ballast, BOB, NOBOB,
2. classify invasive species of the Great Lakes region by determining kingdoms of select species using the Linnaean system of taxonomic classification.
3. explore different vectors or paths invasive species must travel to arrive at their non-native habitat and specifically investigate ballast as a major vector in the Great lakes.
4. list actions being taken to lessen or eliminate the introduction of invasive species in ballast in the Great lakes region.

SCIENCE CONTENT BENCHMARKS ADDRESSED

E1.2 Scientific Reflection and Social Implications

E1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

E1.2D Evaluate scientific explanations in a peer review process or discussion format.

B3.4 Changes in Ecosystems

Although the interrelationships and interdependence of organisms may generate biological communities in ecosystems that are stable for hundreds or thousands of years, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution. The impact of the human species has major consequences for other species.

B3.4C Examine the negative impact of human activities.

B3.5 Populations

Populations of living things increase and decrease in size as they interact with other populations and with the environment. The rate of change is dependent upon relative birth and death rates.

B3.5C Predict the consequences of an invading organism on the survival of other organisms.

SOCIAL SCIENCE CONTENT BENCHMARKS ADDRESSED

VI. Public Discourse and Decision Making

Content Standard 2: All students will engage their peers in constructive conversation about matters of public concern by clarifying issues, considering opposing views, applying democratic values, anticipating consequences, and working toward making decisions. (Group Discussion)

1. Engage each other in elaborated conversations that deeply examine public policy issues and help make reasoned and informed decisions.

Content Standard 3: All students will compose coherent written essays that express a position on a public issue and justify the position with reasoned arguments. (Persuasive Writing)

1. Compose extensively elaborated essays expressing and justifying decisions on public policy issues.

VII. Citizen Involvement

Content Standard 1: All students will consider the effects of an individual's actions on other people, how one acts in accordance with the rule of law, and how one acts in a virtuous and ethically responsible way as a member of society. (Responsible Personal Conduct)

1. Act out of respect for the rule of law and hold others accountable to the same standard.
2. Plan and conduct activities intended to advance their views on matters of public policy, report the results of their efforts and evaluate their effectiveness.

ENGLISH LANGUAGE ARTS CONTENT BENCHMARKS ADDRESSED MEANING AND COMMUNICATION

Content Standard 1: All students will read and comprehend general and technical material.

5. Respond to a variety of oral, visual, written, and electronic texts by making connections to their personal lives and the lives of others.

Content Standard 2: All students will demonstrate the ability to write clear and grammatically correct sentences, paragraphs, and compositions.

1. Write fluently for multiple purposes to produce compositions, such as personal narratives, persuasive essays, lab reports, and poetry.

Content Standard 3: All students will focus on meaning and communication as they listen, speak, view, read, and write in personal, social, occupational, and civic contexts.

8. Express their responses and make connections between oral, visual, written, and electronic texts and their own lives.

INQUIRY AND RESEARCH

Content Standard 11: All students will define and investigate important issues and problems using a variety of resources, including technology, to explore and create texts.

3. Organize, analyze, and synthesize information to draw conclusions and implications based on their investigation of an issue or problem.

REFERENCES

Introductory Material: Day One

<http://connectingthecoast.uwex.edu/Investigate/aquaticNuisanceSpecies.html> Connecting the Coast - the importance of sustainable communities. University of Wisconsin Extension 2007

http://anthro.palomar.edu/animal/animal_3.htm CLASSIFICATION OF LIVING THINGS: An Introduction to the Principles of Taxonomy *Kingdom to Subphylum*
[Dennis O'Neil](#). July 17, 2007.

<http://www.usoe.k12.ut.us/curr/science/sciber00/7th/classify/sciber/intro.htm> Introducing Classification. Utah State Office of Education. June 15, 2000

http://www.great-lakes.net/teach/pollution/ans/ans_1.html Great Lakes Information Network November 1, 2006

List of Invasive Species: Day One

http://www.glerl.noaa.gov/res/Programs/ncrais/great_lakes_list.html NOAA National Center for Research on Aquatic Invasive Species, Great Lakes Environmental Research Laboratory

<http://www.glerl.noaa.gov/pubs/brochures/ANSlist/ANSlist.pdf> NOAA Great Lakes Environmental Research Laboratory Ann Arbor, MI 734-741-2235 www.glerl.noaa.gov May 2003

Sample of Great Lakes Aquatic Nonindigenous Species List found on GLERL's website as of 5/30/03:<http://www.glerl.noaa.gov/res/Programs/invasive/>

Brochures: online <http://www.glerl.noaa.gov/pubs/brochures/>

Exotic, Invasive, Alien, Nonindigenous, or Nuisance Species: No Matter What You Call Them, They're a Growing Problem online

<http://www.glerl.noaa.gov/pubs/brochures/invasive/ansprimer.pdf> NOAA, Great Lakes Environmental Research Laboratory 2205 Commonwealth Blvd. Ann Arbor, MI 48105 734-741-2235 June 2007

Aquatic Invaders and the Great Lakes: Simple Questions, Complex Answers online

<http://www.glerl.noaa.gov/pubs/brochures/invasive/AIS.pdf> NOAA, Great Lakes Environmental Research Laboratory | 2205 Commonwealth Blvd. | Ann Arbor, MI | 734-741-2235 | June 2007

Definitions: Day One

<http://www.invasivespecies.org/resources/Glossary.html> National Resource Council - site under construction online <http://www.invasivespeciesinfo.gov/> . linked from <http://www.invasivespeciesinfo.gov/> NISIC Nov 09, 2007

<http://www.ipaw.org/definition.htm>

Ballast Information/Articles: Day Two

http://www.epa.gov/owow/invasive_species/bal_links.html August 31st, 2007 United States Environmental Protection Agency, Oceans, Coasts, & Estuaries

http://www.glerl.noaa.gov/res/Task_rpts/2001/nsreid10-1.html NOBOB-A: Assessment of Transoceanic NOBOB Vessels and Low-Salinity Ballast Water as Vectors for Nonindigenous Species Introductions to the Great Lakes [David Reid](#) et al

http://www.glerl.noaa.gov/res/Task_rpts/2004/aisreid04-1.html NOBOB-B: Identifying, Verifying, and Establishing Options for Best Management Practices for NOBOB Vessels 2007-10-11 [David Reid](#) et al

http://wcbop.blogspot.com/2007_09_01_archive.html West Coast Ballast Outreach Project 2007

Government Action: Day Three

Michigan

<http://www.healthylakes.org/category/threats/aquatic-invasive-species/> Aquatic Invasive Species. Healthy Lakes, Healthy Lives. 2007. Healing Our Waters - Great Lakes Coalition

Minnesota

http://news.minnesota.publicradio.org/features/2005/11/22_hughesa_invasive/ *Lawmakers Propose Ship Inspections to Stop Exotic Species.* [Art Hughes](#), Minnesota Public Radio. November 22, 2005

National – United States

<http://www.anstaskforce.gov/default.php> Aquatic Nuisance Species (ANS) Task Force. 2005 - United States Federal Aquatic Nuisance Species Task Force

<http://www.protectyourwaters.net/> Protect Your Waters and Stop Aquatic Hitchhikers! U.S. Fish and Wildlife Service. June 29, 2007

<http://www.lakesuperior.com/news/070918.html> Isle Royale National Park Prohibits Untreated Ballast Water Release 070918 *Lake Superior Magazine*

National – Canada

http://www.shipfed.ca/eng/library/other_subjects/ballats_water/BallastWaterBestPractices.html The Shipping Federation of Canada Code of Best Practices for Ballast Water Management *September 28, 2000*

Day One: Introduction to Invasive Species in the Great Lakes Region

Rationale: Students will engage in using online resources to investigate invasive species the Great Lakes Region and the diversity of these species. They will visit several internet sites to discover what types of scientific research and data are available from reputable online sources. It is suggested that the computer room be reserved in advance for all three days and the introductory reading material is assigned about one week in advance (or use the previous class period for the students to read introductory material). The teacher can also place the links on a document on the computer desktop for easy access for the students.

Materials Needed:

- Computer access for the whole class with links to websites
- -or- handouts for each students of the three NOAA brochures
 - <http://www.glerl.noaa.gov/pubs/brochures/invasive/ansprimer.pdf>
 - <http://www.glerl.noaa.gov/pubs/brochures/invasive/AIS.pdf>
 - <http://www.glerl.noaa.gov/pubs/brochures/ANSlist/ANSlist.pdf>
- Whiteboard or chalkboard
- Individual student notebooks

Activity:

1) Students should be assigned the following reading approximately one week in advance. They may print the pages or read online. The teacher may print some copies in advance to have students check out to 'read and return'.

<http://connectingthecoast.uwex.edu/Investigate/aquaticNuisanceSpecies.html>

Connecting the Coast - the importance of sustainable communities. University of Wisconsin Extension 2007

http://anthro.palomar.edu/animal/animal_3.htm

CLASSIFICATION OF LIVING THINGS:
An Introduction to the Principles of Taxonomy *Kingdom to Subphylum*
[Dennis O'Neil](http://anthro.palomar.edu/animal/animal_3.htm). July 17, 2007.

<http://www.usoe.k12.ut.us/curr/science/sciber00/7th/classify/sciber/intro.htm>

Introducing Classification. Utah State Office of Education. June 15, 2000

http://www.great-lakes.net/teach/pollution/ans/ans_1.html

Great Lakes Information Network November 1, 2006

2) Have students team up into groups of 2 or 3. Have students go online to visit the NOAA brochures site or pass out NOAA hardcopy brochure. Assign "Exotic, Invasive, Alien, Nonindigenous, or Nuisance Species: No Matter What You Call Them, They're a Growing Problem" to half of the students and NOAA brochure "Aquatic Invaders and the Great Lakes: Simple Questions, Complex Answers" to the other half.

3) Write on the board: "Be prepared to share at least 3 major points and 4 "species" definitions from your brochure with the class". Give the students 20 minutes to compile their lists.

4) For each brochure – have the teams take turns writing points and definitions on the board and briefly discuss each. Have the students copy the points and "species" definitions in their individual notebooks. If any "species" terms listed in the learning objectives are missing please add them to the list now.

5) Have the students stay in teams, then go online or use a hardcopy handout of “Great Lakes Aquatic Nonindigenous Species List”. Give them fifteen minutes to compile a list of species from as many kingdoms as they can find from the species on the given list which is found at <http://www.glerl.noaa.gov/pubs/brochures/ANSlist/ANSlist.pdf> . If some students need more challenge they can visit http://www.glerl.noaa.gov/res/Programs/ncrais/great_lakes_list.html for a more extensive list of invasive species in the Great Lakes region.

They may use a taxonomic (dichotomous) key such as:

Sample Key To The 5 Kingdoms

- 1 A. only 1 cell.....go to 2
- 1 B. More than 1 cell.....go to 3
- 2 A. No nucleus.....Monera
- 2 B. Has a nucleus.....Protista
- 3 A. Autotrophic.....Plantae
- 3 B. Heterotrophic.....go to 4
- 4 A. Mobile.....Animalia
- 4 B. Immobile.....Fungi.

<http://www.usoe.k12.ut.us/curr/science/sciber00/7th/classify/sciber/taxokey.htm>

6) Write the journal question on the board: “Are there invasive species represented from all five kingdoms? Why do you think this is?” Have students respond to journal question during the last 5 minutes of class.

Assessment:

25 % of grade for lesson. Grade students based on participation in their group, on completion of notes copied from the board and a 3 sentence, meaningful response to the journal question.

Rationale: Students will engage in using online resources to investigate how ballast acts as a vector in the transport of invasive species to the Great Lakes Region. They will visit several internet sites to discover what types of scientific research and data are available from reputable online sources. It is suggested that the computer room be reserved in advance. The teacher can also place the links on a document on the computer desktop for easy access for the students.

An extension to this exercise would be for the teams to design a model(s) representing how residual mud can be left in the ballast tank of NOBOB vessels and/or what happens to this mud during ballast water exchange.

Materials Needed:

- Computer access for the whole class with links to these websites:
- -or- handouts for students of the articles from these websites:

http://www.glerl.noaa.gov/res/Task_rpts/2001/nsreid10-1.html NOBOB-A: Assessment of Transoceanic NOBOB Vessels and Low-Salinity Ballast Water as Vectors for Nonindigenous Species Introductions to the Great Lakes [David Reid](#) et al

http://www.glerl.noaa.gov/res/Task_rpts/2004/aisreid04-1.html NOBOB-B: Identifying, Verifying, and Establishing Options for Best Management Practices for NOBOB Vessels 2007-10-11 [David Reid](#) et al

http://wcbop.blogspot.com/2007_09_01_archive.html West Coast Ballast Outreach Project 2007

- Whiteboard or chalkboard
- Individual student notebooks

Activities:

- 1) Students can remain in the same teams as yesterday. Assign 1/3 of the class to each website/article. Assign terms; ballast, BOB and NOBOB.
- 2) Write on the board "Be prepared to write 4 highlights of your article on the board, define; ballast, BOB and NOBOB and give a brief (5 min) synopsis of your article to the class". Give the students 20 minutes to prepare. They should write their highlights on the board as soon as they are ready in order to save time and to be able to start the oral synopses promptly.
- 3) Have the class copy the highlights and terms in their notebooks.
- 4) Begin the synopses from the teams, covering each article completely before moving on to the next.
- 5) Write the journal question on the board. "What do you feel is the most important thing that you learned today regarding ballast water and Great Lakes shipping? Explain." Have students respond to journal question during the last 5 minutes of class.

Assessment:

25% of grade for lesson. Grade students based on participation in their group, on completion of notes copied from the board and a 3 sentence, meaningful response to the journal question.

Day Three: Protecting the Great Lakes Region from Invasive Species

Rationale: Students will engage in using online resources to investigate what actions government agencies are implementing in an attempt to eliminate the transport of invasive species to the Great Lakes Region. They will visit several reputable online sources to discover what types of scientific research, data and actions are being taken to address ballast and invasive species in the Great Lakes Region. It is suggested that the computer room be reserved in advance. The teacher can also place the links on a document on the computer desktop for easy access for the students. The teacher may need to schedule some classtime for students to work on final writing assignment.

An extension to this exercise would be for the teams to write to a government agency with concerns or recommendations regarding ballast regulations in the Great Lakes Region.

Materials Needed:

- Computer access for the whole class with links to these websites:
- -or- handouts for students of the articles from these websites:
 - <http://www.healthylakes.org/category/threats/aquatic-invasive-species/> Aquatic Invasive Species. Healthy Lakes, Healthy Lives. 2007. Healing Our Waters - Great Lakes Coalition
 - http://news.minnesota.publicradio.org/features/2005/11/22_hughesa_invasive/ *Lawmakers Propose Ship Inspections to Stop Exotic Species.* [Art Hughes](#), Minnesota Public Radio. November 22, 2005
 - <http://www.anstaskforce.gov/default.php> Aquatic Nuisance Species (ANS) Task Force. 2005 - United States Federal Aquatic Nuisance Species Task Force
 - <http://www.protectyourwaters.net/> Protect Your Waters and Stop Aquatic Hitchhikers! U.S. Fish and Wildlife Service. June 29, 2007
 - <http://www.lakesuperior.com/news/070918.html> Isle Royale National Park Prohibits Untreated Ballast Water Release 070918 *Lake Superior Magazine*
 - http://www.shipfed.ca/eng/library/other_subjects/ballats_water/BallastWaterBestPractices.html The Shipping Federation of Canada Code of Best Practices for Ballast Water Management *September 28, 2000*

Activities:

- 1) Students can remain in the same teams as yesterday. Assign 1/6 of the class to each website/article if possible.
- 2) Write on the board "Be prepared to write 4 highlights of your article on the board and give a brief (5 min) synopsis of your article to the class". Give the students 20 minutes to prepare. They should write their highlights on the board as soon as they are ready in order to save time and to be able to start the oral synopses promptly.
- 3) Have the class copy the highlights in their notebooks.
- 4) Begin the synopses from the teams, covering each article completely before moving on to the next.
- 5) Introduce the final assignment:
 - This is an individual assignment.
 - Topic - to be submitted to the teacher the following day for approval. Must apply to ballast issue and relative to resources and activities in this lesson.
 - Rough draft - due in three days

- Length and Format – 3 pages, double spaced, 12 pt Arial font
 - Final draft – due in one week – must contain cohesive thoughts and be free of grammatical errors.
- 6) Write journal question on the board. “Do you feel the various government(s) regulations regarding ballast water are effective toward controlling invasive species in the Great Lakes Region? Explain.” Have students respond to the journal question during the last 5 minutes of class.

Assessment:

25 % of grade for lesson. Grade students based on participation in their group, on completion of notes copied from the board and a 3 sentence, meaningful response to the journal question.

25% of grade for lesson. Final assignment should be scored on applicability of topic to lesson, timeliness of rough draft and final draft, formatting of paper according to specifications, references properly cited, must contain cohesive thoughts and be free of grammatical errors.