

Lesson #2: Why Is Salinity Value Important in Ballast Water Management?

Target Subject/Grade: Biology or Chemistry Grade 9/10

Lesson Overview: Using the student's prior knowledge of density, the students will research how to build their own hydrometer using a straw or Beral pipette. The students will measure the density of 3-4 different liquids using a graduated cylinder and balance. The students will then use their hydrometer and calibrate it using water as reference point. The students will use this activity of hydrometers to relate it to the ballast water management of achieving a salinity of 30 ppt (parts per thousand) during mid-ocean ballast exchange. The students will be asked to discuss why a difference of salinity can cause organisms to die (using hypertonic and hypotonic solutions and what does it do to cells).

Objectives:

The students will be able to:

- Design a hydrometer to relate density to specific gravity.
- Evaluate specific gravity graphs to determine salinity ballast water at varying temperatures.
- Explain how the graphs differ at various temperatures and be able to identify why temperature causes density to change.
- Explain the importance of ballast water management regulations on minimizing invasive species.

BENCHMARKS:

B2.2g Propose how moving an organism to a new environment may influence its ability to survive and predict the possible impact of this type of transfer.

B2.5h Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis – hypertonic/hypotonic).

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

C1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).

C4.7b Compare the density of pure water to that of a sugar solution.

Day One:

Questions of the Day: How does concentration of salt water affect density? How does temperature of the liquid affect its density?

Homework: Previous night's homework will be Web Quest on terminology of ballast water management.

Lab Activity: Students will research how to design a hydrometer. They will test it using water and other pre-made solutions of varying concentrations of salt in addition to a liquid with a lower density than water. They will use a permanent marker to mark their hydrometer to create increments.

Day Two:

Lab Activity Follow-Up: Using their calibrated hydrometer the students will identify the specific gravity of an unknown solution provided by the instructor.

Class/Homework: Students will complete activity questions that will include interpreting NOAA salinity graphs.

ASSESSMENT:

1. Survey 10 people using the Great Lakes questionnaire. (Choose people who are not currently in this class. Choose individuals of varying ages, twelve years old minimum – ie. parents, grandparents, siblings, friends, etc.)
2. Post survey – tabulate correct responses on survey data sheet.
3. Use a bar graph to display the data for all ten questions based on correct responses.
4. Write a reflection about your survey results. Include your own narrative that includes your response to the following questions - What surprised you most about the survey results? Overall, are Michigan residents knowledgeable about the waterway around us and how it affects them? Which of the survey questions do you feel is the most important for people to know about? For YOU, What was the most shocking fact about Great Lakes shipping? (Remember that reflections do not just answer the questions; a reflection should include explanations, thoughts, and/or opinions.)
5. After the survey is over, provide the answers to the questions to your participants; they may be very surprised at many of the answers!
6. Class Data: Using the following age brackets: 12-25, 26-40, 41-55, 56 and up to determine which age range is more “maritime knowledgeable”.

REFERENCES:

Survey Information:

Chadde, Joan. Education/Outreach Program Coordinator, Michigan Technological University.).

PowerPoint Information:

Haen, Dean. Manager of Port of Green Bay, July 23, 2013

Hawker, J. Scott and Winebrake, James. (September 2009). GLMRI University Affiliates Meeting, Duluth, MN.
[www.glmri.org/downloads/2009Reports/affiliates Mtg/Winebrake&Hawker.pdf](http://www.glmri.org/downloads/2009Reports/affiliates%20Mtg/Winebrake&Hawker.pdf)

Research and Traffic Group. (January 2013). Environmental and Social Impacts of Marine Transport.
www.greatlakes-seaway.com/en/pdf/Impacts-Full_En.pdf

Group Participants: _____

Specific Gravity and Hydrometer Activity

Pre-Lab Questions

1. What is the relationship of density to specific gravity?
2. How does a hydrometer measure specific gravity?
3. Compare the specific gravities of 10% salt solution to a 30% salt solution.
4. Explain the specific gravity difference of a 30% salt solution at 5°C to 25°C.
5. What procedure will you use to determine the density of a liquid?

Lab Procedure

1. Design a hydrometer.
2. Mark your hydrometer level in water using a black permanent marker.
3. Measure the density of solution #1 and record in your data table. Mark your hydrometer using a different color permanent marker. Measure the distance of this line in millimeters on the hydrometer from your baseline (water line). Record this distance in your data table.
4. Repeat step three for solutions #2 - #4.
5. Repeat step three of the liquid whose density is less than water.

Data Table

Solution	Volume of Liquid (mL)	Mass of Liquid (g)	Density of Liquid (g/mL)	Distance on Hydrometer +/- from Water line (mm)
#1				
#2				
#3				
#4				
#5				

Conclusion Questions

1. Use your hydrometer to determine the density of the unknown solution provided by your instructor. Include a diagram of your hydrometer and/or any calculations you have done to support your answer.
2. Which solution had the largest salt concentration, #1, 2, 3, or 4? Explain how you know.
3. Use the NOAA specific gravity-salinity graphs PDF on my web page to answer the following questions. (Use the closest temperature graph to answer the following questions.)
 - a. What is the salinity of a saline solution with a specific gravity of 1025 ($\times 1000 \text{ t/m}^3$) at 12°C ? _____
 - b. What is the salinity of a saline solution with a specific gravity of 1005 ($\times 1000 \text{ t/m}^3$) at 14°C ? _____
 - c. What is the salinity of a saline solution with a specific gravity of 1017 ($\times 1000 \text{ t/m}^3$) at 6°C ? _____
4. Is the 30 ppt salinity hypertonic or hypotonic to the cells of coastal or fresh water organisms? Explain how this type of solution will affect the cells.



Prevention of non-indigenous species (aka invasive species) in the Great Lakes

The following Web quest will be used to become familiar with terminology about best management practices on the Great Lakes to minimize aquatic invasive species on the Great Lakes.

<http://www.greatlakes-seaway.com/en/environment/ballast-water/index.html#LinkstoBallnit>

Read the following three sections at the website listed above. “What is Ballast Water and Why Ships Carry Ballast Water”, “Ballast Water is a Global Issue”, and “Ballast Water Regulations for the Great Lakes Seaway System”. **Answer the questions below as you read.**

1. What is ballast water? Why do ships need it?
2. What does ANS stand for?
3. What does NOBOBS stand for?
4. What is the salinity level expected in the residual ballast water? _____ppt (parts per thousand)
5. How far from shore does the US and Canada require ballast water to be exchanged before entering the EEZ (Exclusive Economic Zone)?

Search the following website and find the answers to the following questions.

6. What is mid-ocean ballast water exchange?

7. Identify the two methods of ballast water exchange.

a.

b.

8. How can mid-ocean ballast water exchange prevent or mitigate the spread of non-indigenous species? Explain the significance of having a minimum salinity level.

9. Provide 2-3 reasons why ballast water exchange is not 100% effective.

