

**Salt Marshes and Global Climate Change:
Temperature and Salinity Effects on Brine Shrimp**

Student Activity Sheet

Name _____ Date _____ Class _____

The global climate is changing at a rate never seen before. **Wetlands** are endangered throughout the world for various reasons, including global climate change. Changes in precipitation and temperature will dramatically affect the survival of wetlands. Wetlands play a key role in moderating climate change because their vegetation takes up carbon dioxide (CO₂) and acts as a large **carbon sink** (Mitchell 1992). If wetlands are destroyed, the carbon (as CO₂) is no longer tied up and causes the CO₂ level in the atmosphere to rise .

Salt marshes are a type of wetland found along the ocean coasts and are very productive **ecosystems**, second to **tropical rain forests** in **biodiversity** and biological productivity. The amount of plants and animals (**biomass**) that is produced naturally on an acre of salt marsh is greater than what is produced on fertilized crop lands. Salt marshes act as nurseries and feeding grounds, playing an essential role in the life cycle and food chain of many marine organisms. Any change that effects salt marshes would put organisms that spend part of their life in the salt marsh at risk.

With climate change, salt marshes face increases in saltwater **salinity** and temperature as well as sea level rise. These factors combine with disastrous results for these coastal wetlands. A delicate balance between salinity, **dissolved oxygen**, **turbidity**, **bottom composition**, and temperature exists within a salt marsh. Organisms need specific conditions in order to thrive or survive. Scientists predict that these conditions will be altered when the global climate changes. A change in salinity and temperature could lead to an organism's death, **migration**, or poor health. A rise in global sea level could drastically alter or drown salt marshes depending on their location.

The loss of salt marshes will be felt far beyond the coastal communities that will witness this loss. Two-thirds of the Atlantic's harvested food fish and half of the Pacific's spend part of their lives in estuaries (Pringle 1973). The importance of estuaries extends beyond seafood. Products

from menhaden, a fish that feeds and matures in salt marshes, include oil, fertilizer, and pet foods (Pringle 1973).

This activity looks at the effects of global climate change, specifically increasing temperature and salinity, on a salt marsh ecosystem. Salinities generally range from 30 to 35 parts per thousand (ppt) in salt marshes but the temperature depends upon the geographical location of the marsh. You will see what happens to brine shrimp, *Artemia salina*, when the normal ranges of salinity and temperature in a salt marsh are exceeded. You may be more familiar with brine shrimp by their other common names: fairy shrimp or sea monkeys. Brine shrimp are small crustaceans that live in salt ponds and lagoons that have high salinity levels. They are not found in the open ocean. Although brine shrimp don't actually live in salt marshes, they are used in this activity because they are very similar to organisms found in salt marshes and they are easy to work with. Brine shrimp eggs can survive long periods of dryness, but hatch in 24-48 hours in salt water. The larvae that emerge from their eggs are called *nauplii*. You will be working with both brine shrimp eggs and nauplii.

Objectives:

- Examine the effect of salinity on hatching brine shrimp eggs.
- Observe what effect temperature has on brine shrimp nauplii.
- Learn to weigh and measure and collect data (your observations).

Materials:

Brine shrimp eggs	Salt water (recipe included)
Beaker	Measuring spoon
Grease Pencil	Stirring rods
Graduated cylinder	Heat source-lamp (Teacher supplied)
Coarse salt	Thermometer
Eyedropper	Magnifying glass
Weighing Boats	Weighing Balance (Teacher supplied)

Procedure: The Effect of Increased Salinity

1. Divide into groups. Each group will be given a beaker number by your teacher. Your group will use one beaker and label it (use the grease pencil) with the beaker number your teacher assigned to you (1-5).
2. Pour 250 ml of salt water into your beaker.

- Find your beaker number on the table below and see how much salt you need to weigh out. Use the balance and weighing boats to weigh out the correct amount of coarse salt. Add the salt to your beaker. Stir to dissolve the salt. Beakers 4 and 5 may need extra stirring. Remember that ppt stands for parts per thousand and is the unit used for salinity values.

Beaker	1	2	3	4	5
Salt	0	3 g	6 g	9 g	12 g
Salinity	35 ppt	47 ppt	59 ppt	71 ppt	83 ppt

- Add about $\frac{1}{16}$ of a teaspoon of brine shrimp eggs to your beaker and mix slowly to avoid stranding the eggs on the side of the beaker. Eggs may sink, remain suspended, or float on the surface of the water.
- Place all the beakers in a warm, sunny spot if possible.
- Check the beakers every day for 4-5 days to see if the eggs have hatched and the nauplii have appeared. Use the magnifying glass to look at the eggs or nauplii. Conditions in your classroom determine how long it will take for nauplii to appear (temperature).
- Record your observations on the Data Table under Salinity Effects. Note whether all or part of the brine shrimp eggs have hatched and their activity level
- Your teacher will have written the Data Table on the board. Have someone from your group fill in the data for your beaker so that the whole class can copy it down. With this completed data table, answer the discussion questions.

Discussion Questions:

- Did the brine shrimp eggs in each beaker hatch? Why or why not?
- What happened when the salinity or saltiness of the water increased?
- At what salinity level (g of salt added) did the brine shrimp eggs not hatch?

Procedure: The Effects of Increased Temperature

1. Your group needs a beaker filled with 250 ml of regular salt water and brine shrimp nauplii. (Use the nauplii from Beaker 1 in the first part of this activity.)
2. Record the temperature of the water. To get an accurate temperature reading, gently stir the water before taking a reading. You can attach the thermometer to the side of the beaker to make reading the temperature easier. Record your observations (activity, location in beaker, etc.) about the nauplii on the Temperature Effects Data Table. You may want to use the magnifying glass to observe the nauplii and to see how active they are.
3. Place the beaker under a lamp which will act as a heat source.
4. Repeat step 2 every 30 minutes until the brine shrimp nauplii become inactive.
5. Answer the discussion questions.

Discussion Questions:

1. What happened to the brine shrimp nauplii as the temperature increased?
2. At what temperature did the nauplii appear to die (or stop all activity)?
3. Nauplii are a primary source of protein for many organisms. If the population of brine shrimp nauplii declines, what will the impact be on the food chain?
4. Brine shrimp are tolerant to extremes in salinity and temperature. Many organisms are not as tolerant. What would happen to sensitive organisms in a salt marsh?
5. How would a salt marsh's ability to act as a feeding ground and nursery be affected by salinity and temperature increases?

Salinity Effects Data Table

Beaker	Day 1	Day 2	Day 3	Day 4	Day 5
1 (35 ppt)					
2 (47 ppt)					
3 (59 ppt)					
4 (71 ppt)					
5 (83 ppt)					

Temperature Effects Data Table

Time	Temperature	Observations
0 min		
30 min		
60 min		
90 min		

Vocabulary

Wetlands: Swamps or marshy areas which contain fresh or salt water. Salt water wetlands are found close to oceans and often contain a mixture of salt and fresh water.

Carbon sink: A substance or area capable of absorbing large quantities of CO₂. Examples of carbon sinks are the oceans, peat bogs, and tropical rain forests.

Salt marshes: Low-lying areas near oceans that contain areas of sand, mud and salty water. Salt water grasses usually grow in these areas. They are very productive areas that act as nurseries for many ocean organisms.

Ecosystem: The combination of all living organisms and their nonliving environment in an area of any size. An ecosystem can be studied as a whole.

Tropical rain forest: A forest of trees that grows near the equator where the temperature is warm year round and the rainfall ranges from 100 to 400 inches a year. Broad-leaved trees (such as palms, tamarinds, and fig) are the most common type of tree found in tropical rain forests but between 100 to 200 different kinds of large trees may be found in a single acre. Although tropical rain forests grow in more than 50 countries around the world, about half of the total area of tropical forest is contained in three countries: Brazil (33%), Zaire (10%) and Indonesia (10%).

Biodiversity: Short for biological diversity or the variety of species in a particular ecosystem or the world in general. Biodiversity helps ensure species survival.

Biomass: The total weight or volume of organisms in a given area.

Salinity: The salt content of water. Seawater is generally 3.5% salt, 96.5% fresh water. This normal salinity is referred to as 35 parts per thousand or ppt.

Dissolved oxygen: The amount of oxygen that is soluble in fresh or salt water. This oxygen is necessary for most living organisms in oceans, ponds, lakes, and streams.

Turbidity: The cloudiness of a body of water caused by small or large solid particles that are suspended in the water.

Bottom composition: The rocks, sand, mud, or clay which make up the bottom of a body of water.

Migration: The movement of an organism from one area to another, usually for spawning or feeding.

Nauplii: The earliest larval stage of many crustaceans. This larval form has three pairs of legs. Larvae is one developmental stage in some animals life cycle.

Teacher Strategies

Preparation:

You must supply the heat source, such as a desk lamp. If you have access to more beakers, you can have each team look at all the salinity levels rather than just one. You will also need a weighing balance or scale to weigh out the coarse salt. Additional thermometers, if available, would also be helpful. Additional information has been included, such as photos of salt marshes, fact sheets on global change, and a map of the locations of salt marshes around the U.S.

The Effect of Increased Salinity

1. A small supply of Instant Ocean™ has been provided in the kit. To make normal salinity sea water, mix 1/4 cup of the Instant Ocean™ with 2 quarts of distilled water. Sea water can also be prepared by adding 70 grams of coarse salt to 2 quarts of distilled water (35 g to 1000 ml or 35 ppt/3.5 %). The container to mix the salt water in has been included in the kit. This amount (2 quarts), should be sufficient for the activity.
2. You may assemble materials such as beakers, 3.5% salt water, coarse salt, stirrers, scale/balance, weighing boats, spoons, and brine shrimp eggs at individual stations before the activity. The five beakers may be labeled in advance as well.
3. Divide the class into groups of 4-5 students. This activity is designed to have each group look at one salinity level, but if you have sufficient beakers in your classroom, you may want to have each group test all 5 salinity levels. Eggs will hatch more quickly in a warm, sunny spot. An aerator will also speed up the process.
4. Students may either weigh their own coarse salt out using triple beam balance(s) or this salt may be weighed out for each group and placed in containers(dishes) before the activity. Adding 3 extra grams of coarse salt to 250 ml sea water increases the salinity to 4.7% (Bkr 2), 6 g changes the salinity to 5.9% (Beaker 3), 9 g additional salt gives a salintiy of 7.1% (Beaker 4), and 12g raises the salinity to 8.3% (Beaker 5).
5. Students should realize that no visible activity in the nauplii indicates death or injury resulting from a toxic salt level. The approximate times that it should take for nauplii to appear are: beaker 1 (42 hours), beaker 2 (55 hours), beaker 3 (65 hours). After 5 days no nauplii should be observed in beakers 4 and 5. These times will vary depending on conditions.

The Effect of Increased Temperature

1. If this part of the activity is conducted second, the nauplii from beaker 1 can be used. The teacher or students can hatch eggs prior to the experiment if the sections of the activity are run at the same time. If a lamp and stand are not available from a science kit, a desk lamp with a 40 watt bulb will work for a heat source.
2. Have the students read the temperatures in Centigrade and Fahrenheit so that they may become used to both scales.
3. Students should realize that no activity in the nauplii indicates a toxic temperature, one resulting in injury or death to the nauplii.
4. Nauplii will die at a temperature of 36-38° C after about 90 minutes. If this method takes too much time, a stronger bulb or hot plate will heat the water more quickly.

Approximate Time: Salinity Section- One class period for set up. Ten minutes per class for successive 4-5 days. Temperature Section- Approximately 2 hours.

Target Audience: Science.

Extensions:

Grades 4-6

1. The teacher can demonstrate this activity to the class. Students may help in taking some of the readings and filling in the tables. Each student should have a copy of the tables and discussions questions. Students should be shown how to properly fill in a table and keep a lab notebook. It is important for students to understand the importance of properly performing a science lab.

Grades 9-12

1. Students change the salt level in smaller increments and create new concentrations (possibly 5). For example, if nauplii appear at beaker 2 but not at beaker 3 in the original experiment, concentrations in five new beakers could be: beaker 1=,75 g, beaker 2=3.25 g beaker 3= 3.75 g, beaker 4= 4.25 g, beaker 5= 4.75 g. Students can now determine more specifically which level of salt is toxic to brine shrimp.

2. Students can prepare a variety of solutions beginning with 3.5% salt solution. A range of solution concentrations could be 3.5% to 10%. Students may graph days to hatch eggs vs. concentration.

Questions:

- a. What is the optimum concentration range for nauplii hatching?
 - b. At what salt concentration do brine shrimp hatch?
3. Students prepare a 3.5% salt solution and hatch a group of brine shrimp eggs over a period of several days. Students count live nauplii. The beaker containing nauplii is heated over a period of time under a lamp. Measurements of temperature and number of live nauplii are taken every two minutes for a class period. Students graph temperature vs. number of live nauplii.

Questions:

- a. What is the optimum temperature range for nauplii survival?
- b. At what temperature do all nauplii die?

References:

Mitchell, John. 1992. Our Disappearing Wetlands. *National Geographic* 182, 2-45.

Pringle, Laurence. 1973. *Estuaries, Where Rivers Meet the Sea*. New York: The MacMillan Company.