

1. Title: The effect of temperature of the respiration of the Striped Killifish *Fundulus majalis*. (This lab was modified from a version originally published by Project Oceanology)
2. Concept: Understanding the relationship between physical properties of water (temperature) and biological activity of organisms.
3. Connecticut Science Standards
 - a. Scientific inquiry
 - b. Scientific numeracy
 - c. Science and technology: measuring tools
 - d. Structure and Function: Responses to Stimuli (5.2)
 - e. Science and Technology in Society Measuring Tools (1.4)
 - f. Science and Technology in Society Water Quality (6.4)
4. General Goal: Students will gain and understanding of how temperature affects the respiration rate of the Killifish, a common near shore fish found in Long Island Sound.
5. Required materials:
 - Long Island Sound aquarium or 15 killifish in seawater
 - Thermometers
 - Sea test or other instrument that can measure salinity
 - Large test tubes(1.5 cm diameter x 15 cm)
 - Beaker or container to hold test tube
 - Ice& Warm water
 - Stop watch
6. Background: Long Island Sound is a temperate estuary with a range in temperature from 0 to 25 +/- Celsius. Many marine organisms are year round residents of LIS. Using a simple and non-lethal experiment, students can determine how temperature affects the respiration rate of marine fish. Results of this experiment Other Species can also be used such as the Common Mummichog (*Fundulus heteroclitus*) or the Sheepshead Minnow (*Cyprinodon variegatus*). It is not suggested to use more fragile species such as the Atlantic Silverside (*Mendia mendia*). In an emergency or if marine fish are not available, feeder goldfish can be used, but the maximum temperature should be limited to 25°C

7. Specific objectives: Students will:

- Investigate the relationship between temperature and respiration rate of fish
- Collect, graph & analyze data scientific data
- Draw scientific conclusions and link those conclusions to Long Island Sound
- Write a scientific lab report

8. Engagement techniques

- Work with students while measuring data
- Review data as it is collected and encourage student to repeat trials to get 3 sets of data that are close together.

9. Specific Outline of the Lesson:

- a. Discuss how LIS is a temperate estuary and organisms that do not migrate have to adjust to the changing temperature.
- b. Have students state a hypothesis about how temperature affects the respiration rate of the fish. The discuss how this experiment can be tested using the procedure below.
- c. Fill test tube $\frac{3}{4}$ with sea water
- d. Place 1 fish head down in test tube
- e. Allow fish to remain in test tube for approximately 2 minutes to calm down. During this time observe gill movements of fish. Students should see operculum or gill cover moving. Each time gill cover moves (opens and closes) is “1 gill count”
- f. Place the test tube with the fish into a beaker of warm water. Measure the temperature of water in the beaker. The warm water should not be more the 40 °C. DO NOT add warm water to the test tube!
- g. Measure the temperature of the water in the test tube without touching the fish. When the temp is no more the 30 °C, remove the test tube from the beaker.
- h. Have students record the exact temperature of the water in the test tube then count the number of “gill counts” in 20 seconds.
- i. Repeat this 2 more times or until the students have 3 readings within 10% of each other.
- j. Place the test tube with the fish into a beaker containing ice water. DO NOT place ice in the test tube. Monitor temperature in the *test tube constantly & carefully*. When the temperature of the water drops in the test tube 5°C, remove the tube from the ice water and repeat steps f & g.
- k. Repeat step g until the temperature of the water is close to 1°C. Make sure the fish is still breathing. Stop the experiment and warm tube up in your hand if gill movements drop below 5 per minute
- l. After reaching the lowest temp, warm tube up in your hand until you reach the starting temperature. Gently release the fish into he aquarium or bucket.
- m. Have students graph data
- n. Students write a scientific lab report.

10. Extensions (see background) Students can also measure and weight their fish and calculate gill movements per gram or cm of fish. Additional experiments can be conducted on the exact amount of dissolved oxygen used by the fish. Various species of fish can also be tested. This lesson can be related to the problem of hypoxia in coastal waters of Connecticut.

11. Assessments:

- Check student during experiment
- Check completed data table
- Students write a scientific lab report.

12. References

- a. Connecticut Sea Grant: <http://www.seagrant.uconn.edu/> CT Sea Grant is linked with NOAA and provides information about grants and education opportunities
- b. Project Oceanology, 1084 Shennecossett Rd, Groton, CT 06340
<http://www.oceanology.org/>. Provides literature and help setting up marine aquariums. Field, lab and teachers manual available on CD.
- c. Long Island Sound Study: <http://www.longislandsoundstudy.net/> Information about a variety of issues dealing with Long Island Sound. Links to many other sites & organizations
- d. The Do it yourself Long Island Sound Biotype aquarium.
<http://borntoexplore.org/aquarium/index.html>
- e. Connecticut College Arboretum. Tidal Wetland Ecology of Long Island Sound.
<http://arboretum.conncoll.edu/publications/34/CHP3A.HTM>
- f. National Wetlands research Council: <http://www.nwrc.usgs.gov/>