Water Quality and Increasing the Survival of Aquarium Fish

Subject: Environmental Quality

State Objectives:

S.IP.M.1 Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.
S.IA.M.1 Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

S.RS.M.1 Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history and within society.

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Purpose: Students will learn how to test water quality. Students will learn what kinds of fish survive in what kind of conditions. Students will discover how human activities affect water quality

Grade: Target grade is seventh but can be adapted

Background knowledge: The activity is meant to accompany the Salmon in the Classroom project but can be adapted to meet other needs as well. Students will monitor water quality in two fish tanks (one containing salmon and the other a classic classroom fish tank) weekly over a several month period. Students will use that data and observations to assess the water quality of the fish tank and the fish within it. Students will then use the information to make predictions about the body of water where the salmon are release and the chances of the survival of the fish. Students will learn how to conduct different water quality tests and make adjustments to the water based on those results. Fish need oxygen, clean water and nutrients to survive. To measure these requirements in a lake, river or stream, biologists look at water quality parameters such as temperature, dissolved oxygen, pH and nitrates. Each of these parameters is a limiting factor. If the level of each is too high or too low, fish can be negatively affected. These factors determine what kind of habitat a body of water can support. Habitat is directly related to the different species of fish that are found in a body of water. Hatchery biologists can use these parameters to decide what types of fish are stocked into different bodies of water.

Anticipatory Set:

The teacher reads the story A River Runs Through it to the students.

Lesson:

Part One

Freddy the Fish Activity. See **Appendix One**

Part Two- Reading Activity See **Appendix Two**

1. Students read information on the different tests that they will be conducting in groups jigsaw style.
2. Each group taking a different test. Each group will make a poster on the key information from their reading. Each group will then share out their poster. Posters will be displayed near the fish tanks as a reminder throughout the year

Part Three: Testing Water Quality. This is will take several months but could be shortened

Materials

Vernmier Lab Quest with probes for turbidity, Ph, temperature, dissolved oxygen,

Observation logs

Computer with Excel and projector so students can monitor the results.

1. Students will be monitoring a tank as part of the Salmon in the Classroom program. That is newly established. Students will also be monitoring a classroom aquarium that has been established for several years but does not require the cold temperature that the Salmon aquarium does.
2. Students will create a table to record their data. For differential education students could use the table in **Appendix Three**.
3. As a class students will create a table in Excel that will graph ongoing water quality tests in each aquarium.
4. Students conduct tests weekly. If you have multiple sections you could rotate having a different conduct the testing each week and them share the results weekly with the other groups. Discussions should be held about trends in water quality as observations of the fish. Through these discussions it should be determined if adjustments should be made. The discussions should also include a comparison of the two tanks. This discussion should only take about 10-15 minutes per week if student are ready with their logs.
5. Students should note in their observation logs fish behavior, feeding schedules, filter changes and water changes,

6. Conducting the tests- Tests are conducted weekly. The first test before introducing the salmon eggs and then once a week after. For the classroom tank begin monitoring at the same time,
    A. Test one temperature
    B. Test Two Ph
    C. Test Three Dissolved Oxygen
    D. Test Four Turbidity
    E. Test Five Nitirites
    F. Test Six Nitrates

Part Four- Salmon Release

Materials

Vernier Labquest and probes

Test strips

Observation logs

1. Students take one last reading of the aquarium before salmon are collected for the release.
2. Students record their observations at the salmon release site. They should include current weather conditions.
3. In their journals students record the tests on the water in the river/stream where they will release the eggs.
4. Salmon are released an observations recorded
5. Teacher and students discuss on the bus ride home the experience including a comparison of the aquarium in the morning to the release site. Include in the discussion how the students think the salmon will do in their new homes.

Assessment:

Formative: Observation logs and discussions, ongoing tables and graphs

Summative: In groups students create a PowerPoint on the importance of monitoring water quality, how humans affect water quality, and how water quality affects fish.

References:

Image from: http://www.elmhurst.edu/~chm/vchembook/184ph.html

http://www.thefishingnut.com/articles/watertemp.html
http://www.michigan.gov/documents/dnr/SICcurric2172011_346031_7.pdf

Appendix One

The Story Of Freddie the Fish

The Story of Freddie the Fish

Subject: Science

State Objective: E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Duration: one class period

Materials

Per group

• *Freddie:* A weighted fish lure (with hooks removed)
• Clear gallon jar or small fish tank
• Gravel for bottom on jar (tank)
• 9 containers of pollutants (film canisters work well):
° Sediment: soil
° Manure: raisins
° "Grass Fertilizer": green drink mix
° Weed Killer: pink drink mix
° Road salt
° Litter: paper cup
° Atmosphere pollution: red water, in spray bottle
° Contaminated industrial site: cracked film canister filled with stones and instant coffee sludge
° Used motor oil: maple syrup

Lesson Part 1: Overview

Students investigate the habitat requirements for fish, and the different ways that humans have impacted water quality and aquatic habitats, as well as ways that they can keep streams healthy for fish and other aquatic life.

Essential Questions

What is pollution?

How does pollution affect humans and other aquatic wildlife?

Objectives

Students will be able to:

1. Describe fish habitat needs.
2. Explain how pollution can affect the health of fish populations and other aquatic life.
3. Give examples of pollution and possible sources.
4. Give examples of ways to prevent aquatic pollution.

Introduction

This is my friend, Freddie. He is a healthy eight-year old brook trout. What do trout need to have a healthy home to live in?

1. Cool water (holds more oxygen. **Students pour in water**
2. Gravel and/or rocky stream floor to lay eggs (reproduction needs.) **Students add gravel**
3. Bushes and trees along the stream (to keep water in the shade & therefore cool, with lots of oxygen, plus food falls off shrubs/trees [insects, leaves).

Procedure Teacher reads the story to the students. Students should answer questions throughout the activity in their journals

Activity: The Journey

Freddie is happy with his home, the stream he lives in. He is healthy, with lots of energy and curiosity. The water and stream banks which make up his home are perfect for him.

Freddie has everything he needs right here. The water is cool, which is good because cool water holds more oxygen, so Freddie can breathe more easily. The trees and shrubs along Freddie's stream shade the water and keep it from getting too warm. Food for Freddie, like insects and leaves, fall off of the shrubs, so Freddie always has something to eat. While Freddie likes this stream, he's a little bored with it, and would like to go on an adventure. Do you think he should leave this part of the stream and see what's out there in the world? Freddie decides to leave the shady, cool waters and heads downstream on his adventure…..

***Canister #1*: Sediment, at the clear-cut.**

After a while, Freddie notices that the sun is shining and it's no longer so cool and dark in the water. He looks out of the water and notices that all the trees have been cut down. Sprinkle some sediment (dirt) over the water and allow it to slowly settle over Freddie. How does it feel to get sediment into your gills, and into your eyes, Freddie? Explain how fish breathe and how sandy grit hurts fish gills. Also explain how sediment gets into a stream when all of the trees and shrubs along a stream are removed due to logging or building stores and houses. Without vegetation covering the soil, it washes (erodes) into the stream and covers the rocky floor of the stream, where fish lay their eggs. Should Freddie go home? NO! So Freddie continues on his way downstream.

***Canister #2*: Cow Manure (Raisins)**

Freddie pokes his snout out of the water and sees some BIG black and white animals coming down to visit the water, and they are stirring up the sediment in the stream. Oh my, they are also leaving some presents. Sprinkle a few raisins into the water and let them dramatically sink in the water, leaving brown trails. Let the students observe and draw their own conclusions on what the cow "presents" really are. Freddie doesn't like the taste or smell of these presents. Should Freddie go home?" NO!

So Freddie continues on his way downstream.

***Canister #3*: "Green Grass Fertilizer"**

Freddie notices a golf ball floating (add a golf ball) …Hmm, what is this green stuff running off the golf course? Bleck! Too much fertilizer! How do you feel Freddie? Explain that people should not use too much fertilizer on their lawns, or apply it before a heavy rain. (Tell older students that fertilizer contains nutrients like nitrogen, phosphorous and potassium. They accelerate the growth of aquatic plants, which may not seem like a big deal. But when the plants die and decay the decaying process uses most of the oxygen in the water, leaving very little for creatures like Freddie.) Should Freddie go home?" NO! So Freddie continues on his way downstream.

***Canister #4*: "Weed-Free Grass"**

Repeat #3 above, but with weed-killer (red drink mix). Weed-killer in a stream or lake can kill all of the good plants that feed the fish and other aquatic organisms. Should Freddie go home?" NO! So Freddie continues on his way downstream.

***Canister #5*: Road Salt**

Freddie notices that the river has taken on a salty taste. [Add salt into the water.) Explain that road salt is good for traffic safety in the winter; but bad for wildlife in general, including trees along the roadside, which may die from too much salt; and bad for groundwater as well. Have you ever had salt get into an open cut? Ouch! How do you think Freddie feels? Look, Freddie is swimming faster in an attempt to get away from the salt, but the saltiness seems to be everywhere in the water. Freddie may be missing the cool, shady pool back upstream. Should Freddie go home? NO! Freddie swims on.

***Canister #6*: Litter**

Continuing on, Freddie passes a picnic site… some campers left their rubbish behind: dirty plastic dishes, and empty bottle of charcoal lighter fluid and a used disposable diaper. We would never do this, would we? Freddie must feel disgusted with this mess, wouldn't you? He tries to push the litter out of the water. Lets remember to keep litter in its proper place and dispose of used diapers in a trash can! Yuck! Should Freddie go home? NO!" Freddie swims on.

***Canister #7*: Air Pollution in the rain (acid rain)**

Freddie hears the distant rumbling of some thunder. Are you afraid of thunder? Well, Freddie is brave, he's not afraid of a little thunder. [Spray in rain.] Oh dear, Freddie is noticing that something is wrong with the rain water. You might expect rainwater to be very clean, but this is not always the case. Pollution that gets into the air can be dissolved in the rain water and end up in Freddie's river. Should Freddie continue his journey, or should Freddie go home? Things are getting rough on Freddie, but then he's a tough kind of guy who is still up for adventure. Should Freddie go home? NO!" Freddie swims on.

***Canister #8*: Contaminated Industrial Site**

Place the leaking industrial waste canister into the water. Freddie passes a leaky, rusty, old barrel full of unknown chemicals from an abandoned factory. The barrel is leaking. As Freddie swims by he sniffs at the barrel. OH! Bad choice Freddie. That barrel was filled with toxic pollutants. He better get out of here as fast as he can, if he is able. Freddie swims on.

***Canister #9*: Used Motor Oil on the Ground**

A person is changing the motor oil in their truck. They pour the used motor oil on the ground. The oil seeps down into the ground and moves through the groundwater to the stream. Did you know that just one cup of oil can poison a tank of water twice the size of this classroom? Freddie gets his gills clogged with oil and he starts having trouble breathing. (Presenter: gasp a little and hold your throat). Life is getting pretty tough for Freddie. Poor Freddie has come through so

much. Even though Freddie is a tough fish, this is more than Freddie can withstand. He takes his last breath.

Summary

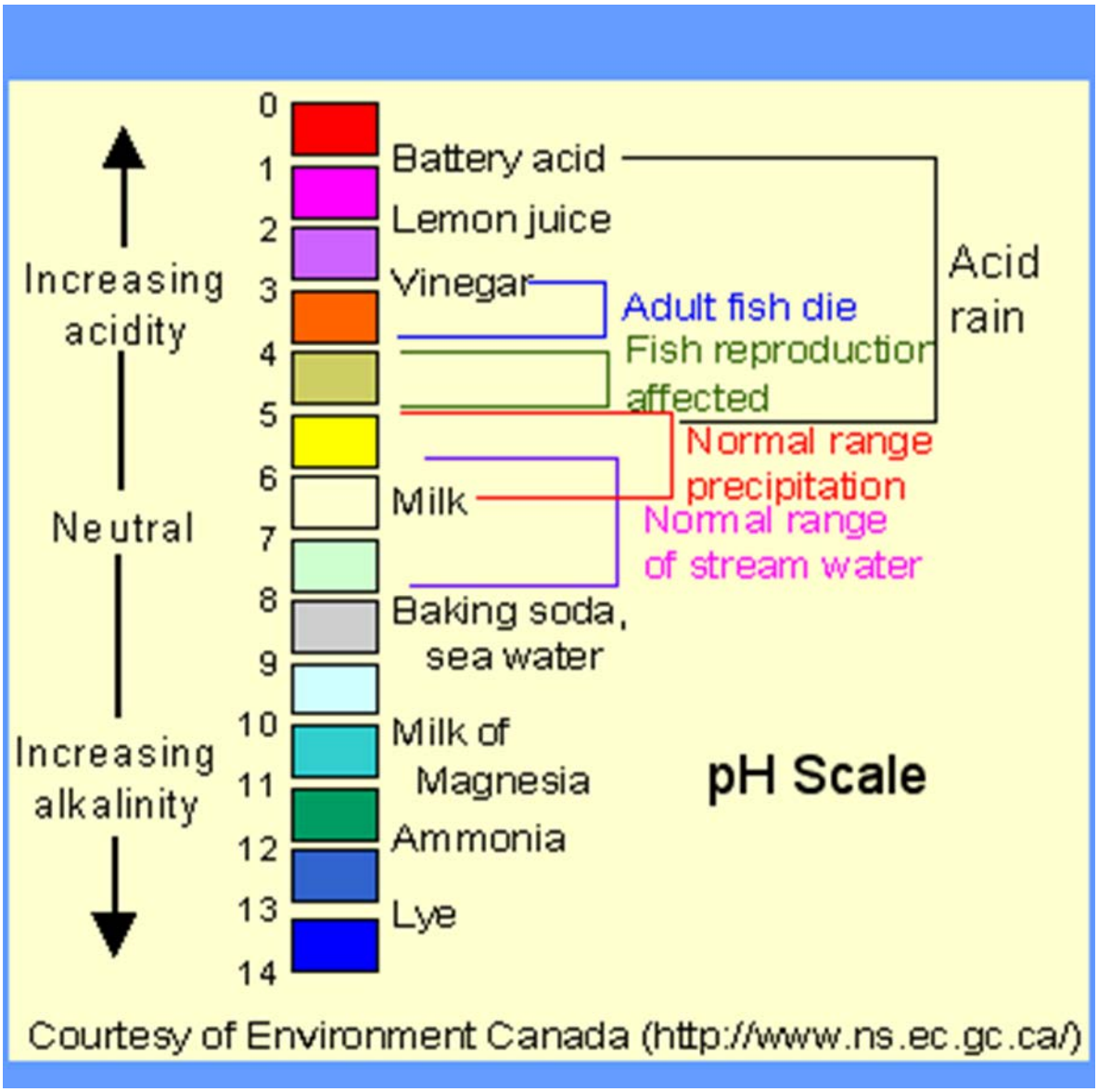
After everyone has settled down, pull Freddie out of the water. Explain that Freddie was just acting, he'll be alright. But Freddie is trying to make a point here. What do you think Freddie is trying to teach to us? All living things need a clean, healthy environment to thrive. Fish need a suitable place to live. If their homes become polluted, fish will have trouble. A stream that becomes polluted, and then flows into Lake Superior, can affect all of Lake Superior. If we want to healthy fish populations, if we want to have a healthy Lake Superior, we must act wisely. What could have been done to keep Freddie's stream a healthy place to live?

1. Leave shrubs and trees along streams.
2. Don't allow cattle and other livestock animals to wander into streams. Pump water out of the stream and put it in a large trough for the livestock to use away from the stream.
3. Follow label directions on fertilizers and pesticides. Do NOT use too much!
4. Do not use road salt near streams.
5. Don't be a litterbug. Remove litter from streams.
6. Support efforts to clean up industrial sites.
7. Recycle used motor oil drained from your car.
8. Acid rain comes from air pollution. It can hurt trees, plants and lakes, and kill animals

Appendix Two

pH

pH stands for "the power of hydrogen" and measures how much hydrogen is in a solution, such as water. A scale of 0-14 is used to measure pH. Lower levels are considered acidic and have a pH of less than 7. Readings greater than 7 are considered basic. A pH of 7 is considered neutral -- it is neither acidic nor basic. Different organisms have different pH requirements. Some organisms are able to survive in environments with a very high or very low pH. Most fish, however, prefer water with a pH that is close to neutral. Immature stages of aquatic insects, such as mayfly nymphs and stonefly nymphs as well as snails, tadpoles and crayfish are very sensitive to changes in pH and prefer a range of 6-8. Many things can affect the pH of a body of water. For example industrial emissions from factories can cause acid rain. Acid rain lowers the pH of a body of water. Different household items also have different levels of pH. For example, lemon juice is acidic and has a low pH whereas ammonia is basic and has a high pH.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11
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13
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Battery acid
Lemon juice
Vinegar
Milk
Baking soda,
sea water
Milk of
Magnesia
Ammonia
Lye
Increasing
acidity
Neutral
Increasing
alkalinity
Acid
rain
Adult fish die
Fish reproduction
affected
Normal range
precipitation
Normal range
of stream water
pH Scale
Courtesy of Environment Canada (http://www.ns.ec.gc.ca/)

Dissolved Oxygen

Oxygen that is dissolved in water and is available to aquatic plants and animals is called dissolved oxygen (DO). Oxygen enters the water by absorption from the atmosphere and by photosynthesis. When water travels over riffles in a stream, the water droplets are broken up into smaller droplets and are able to absorb water from the atmosphere. Slowly moving water has less dissolved oxygen than more rapidly moving water. DO levels vary based on temperature and the rate of decomposition occurring in a body of water. If DO levels are too low, fish and other organisms will not be able to survive.

Turbidity

Turbidity refers to the clarity of water. The more solids that are suspended in water, the cloudier the water is and the higher the turbidity. Some factors that contribute to turbidity are rainstorms, pollution and bottom feeders (i.e. carp) that stir up sediment.

If waters are too turbid, photosynthesis can be slowed and there is an overall negative effect on fish health. Turbid water also causes water temperature to rise.

Nitrogen (nitrates/nitrites

Nitrogen is essential for many biological processes. In plants, it is essential for photosynthesis and growth. Algae and other plants use nitrogen as a source of food. If algae have an unlimited supply of nitrogen, their growth will continue unchecked and water quality can decline. Fish need nitrogen to build protein. They are able to get nitrogen by eating plants or by eating other protein (such as other fish or insects). Some forms of nitrogen can be harmful to fish when there is too much in the water. However, in general, levels of DO and pH have a more direct effect on aquatic organisms than levels of nitrate and nitrites.

Temperature

Different fish have different temperature requirements. Salmon are a cold water fish. They have an ideal temperature range of 50°F to 60°F. Largemouth bass are warm water fish that have an ideal temperature range of 70°F to 85°F. Cold water holds more oxygen than warm water, thus salmon require colder water and more oxygen than largemouth bass which require warmer water and less oxygen.

Species	Lower Limit F (C)	Thermal Optimum F (C)	Most Active F (C)	Upper Limit F (C)
Largemouth Bass	**50** (10)	**73** (23)	**62-75** (17-24)	**85** (29)
Smallmouth Bass	**58** (14)	**68** (20)	**58-73** (14-23)	**85** (29)
Lake Trout	**42** (6)	**55** (13)	**50-57** (10-14)	**60** (16)
Musky	**55** (13)	**63** (17)	**55-72** (13-22)	**72** (22)
Pike	**55** (13)	**66** (19)	**55-74** (13-23)	**74** (23)
Walleye	**50** (10)	**67** (19)	**55-74** (13-23)	**76** (24)
Striped Bass	**50** (10)	**65** (19)	**55-65** (13-23)	**75** (24)

Appendix Three

Salmon Tank

Date	Ph	Temperature	Turbidity	Dissolved Oxygen	Nitrite	Nitrate
Initial						
Week One						
Week Two						
Week Three						
Week Four						
Week Five						
Week Six						
Week Seven						
Week Eight						
Week Nine						
Week Ten						
Week Eleven						
Week Twelve						
Week Thirteen						
Week Fourteen						
Week Fifteen						
Week Sixteen						
Week Seventeen						

Week Eighteen						
Week Nineteen						
Week Twenty						
Week Twenty One						
Week Twenty Two						
Week Twenty Three						
Week Twenty Four						

Classroom Aquarium

Date	Ph	Temperature	Turbidity	Dissolved Oxygen	Nitrite	Nitrate
Initial						
Week One						
Week Two						
Week Three						
Week Four						
Week Five						
Week Six						
Week Seven						
Week Eight						
Week Nine						
Week Ten						
Week Eleven						
Week Twelve						
Week Thirteen						
Week Fourteen						
Week Fifteen						
Week Sixteen						

Week Seventeen						
Week Eighteen						
Week Nineteen						
Week Twenty						
Week Twenty One						
Week Twenty Two						
Week Twenty Three						
Week Twenty Four						