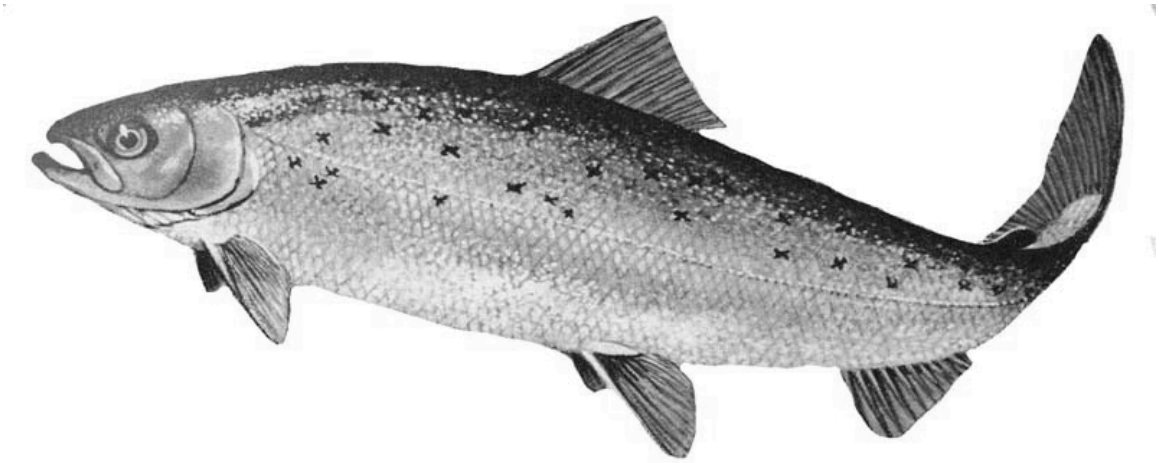
Atlantic Salmon Egg Rearing Program

Companion Curriculum Guide



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Mount Holyoke College
Fall 2012

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Introduction

Salmon disappeared from the Connecticut River at the beginning of the 19th century, and modern restoration attempts have only been underway since 1967. The restoration of the Atlantic salmon to the Connecticut River and other historic salmon streams has been contentious, and the future of such projects is always a question. State and federal hatcheries have been releasing millions of fish into the Connecticut and its tributaries in an attempt to restore the once mighty salmon runs, and the results remain to be seen. The Atlantic Salmon Egg Rearing Program, or ASERP, was started in 1997 as a collaborative effort between the Connecticut River Coordinator's Office and the U.S. Fish & Wildlife Service as a way to connect students with their environment through involvement with the husbandry and release of young salmon. Since then, over forty schools have participated in the program.

Mission Statement

Our goal is to bring awareness to this project, which is an excellent experiential science learning opportunity for students living in the Connecticut River watershed. We hope that by providing a complete curriculum, which could be taught in 4th-6th grade classroom over the course of a year, teachers will be able to integrate it into their established curriculum. By providing learning objectives derived from Massachusetts Department of Education science standards, as well as complete lesson plans that can be taught in a short amount of time with cost-effective resources, we hope that more schools will see the benefits of participating in ASERP.

More Information

ASERP website: http://www.fws.gov/r5crc/Salmon/

MHC Community-Based Learning Program website: https://mtholyoke.edu/cbl

Questions? Email Caitlin Kidder, MHC Class of 2013: kidde22c@mtholyoke.edu

About this Project

Five senior Environmental Studies majors from Mount Holyoke College collaborated to create this curriculum guide to be freely available to teachers who may be interested in participating in ASERP. We have written five lesson plans for five major themes we identified as critical to salmon education, using our own teaching and science backgrounds as guides. We offer this guide to be freely distributed throughout New England and beyond to anyone who wishes to utilize it. We are in no way associated with the U.S. Fish & Wildlife Service, the Atlantic Salmon Egg Rearing Program, or any school besides Mount Holyoke College. We would like to thank Dr. Timothy Farnham, Dr. Alan Bloomgarden, Angelica Castro, Dr. Rachel Fink, Mrs. Nancy Gagnon, the Department of Environmental Studies and the Mount Holyoke Community-Based Learning Program for their support.

Mapping and Spatial Analysis: Connecticut River

Age group: 8-14

Venue(s): Within the classroom

Materials: photocopy of Connecticut River map (provided), ruler, colored pencils/pens

Time: 45 minutes

Setup: Gather materials

Lesson Summary

Through mapping and spatial awareness, students will have the opportunity to visualize the flow of the Connecticut River and situate themselves in the region. They will mark major cities that have developed along the river and will discuss some environmental problems that might be associated with this development pattern

Enduring Understanding

- Learning to visualize concepts as a way to fully understand topics
- Ability to define and recognize complex problems as a result of visualization/spatial analysis
- Development of cities typically occurs along water sources and therefore development of cities is linked to the health of a water ecosystem
- Begin thinking about people as part of their environment rather than separate from it

Knowledge and Skills Developed

- Students will know how to read a map legend, scale, and compass
- Students will know the approximate location of their town on the map
- Students will know that cities tend to develop near water sources
- Students will know that development is linked to the environment
- Students will know how to think critically in spatial terms

Introduction

Our overarching theme for the semester, the Salmon Relocation Project, is taking place right here in the Connecticut River Valley. Before we can start learning all about the salmon, let's take some time to learn about the Connecticut River and its history.

The Core Lesson

The main goal of this lesson is to develop mapping and analytical skills using the Connecticut River for reference.

All students will be handed a ruler, several colored pencils, and their own copy of the map of the Connecticut River. The Connecticut River flows 407 miles (655 km) in a North-South from the north of Vermont to the mouth of the Atlantic

Ocean in Connecticut. It defines the border between Vermont and New Hampshire and is the birthplace of nearby cities such as Hartford and Springfield. Begin by asking for student's first observations about the map. Where in the United States might this be located? Have they seen the Connecticut River before? Did they realize how large it is?

Ask students to complete the map and the associated worksheet. They may work alone or in small groups. The students should label the following using different colored pencils for each topic:

- All states that the river runs through
- Canada
- Atlantic Ocean
- North, South, East, and West on the compass
- Their town or city on the map (the teacher will show them where they are located and the students will label this with an X)

The students will then be asked to complete the associated worksheet. The worksheet takes students through basic skills such as identifying cardinal directions, using reference scales, and noticing the place of humans as part of the surrounding environment.

Assessment/Conclusion

After working individually or in small groups on the mapping activity, students will all come together to discuss some interesting things they noticed. Create a list of ideas on the blackboard so that students remain engaged and interactive. Why are there so many cities located around the river? What services might the river provide to people looking to colonize North American (i.e. transport, food, water, etc.)? Where are the students located along the river? If you have already completed the lifecycle lesson, challenge students to think about what this indicates about the life cycle of the salmon. Ask students leading questions such as: if the population of a city goes up, what might happen to the salmon population in the river? This will allow students to use their applicable skills for complex thinking and analysis.

Alternative Extension

For added challenge, ask students to make an attempt at discovering the approximate longitude and latitude of their town or city using the latitude and longitude lines provided on the map. After students have given this a try, the teacher can use Google Earth to show the students the actual coordinates and they can see how close their approximations were.

First Steps
On the map, first label:

- All states that the river runs through
- Canada
- Atlantic Ocean
- North, South, East, and West on the compass
- Your town or city on the map (mark the spot with an X)

Where in the World Are We?
Where does the Connecticut River begin?

What ocean does it open up into?

How many states does the Connecticut River flow through? Name each state

Approximate where our town is on the map. Mark it with an X

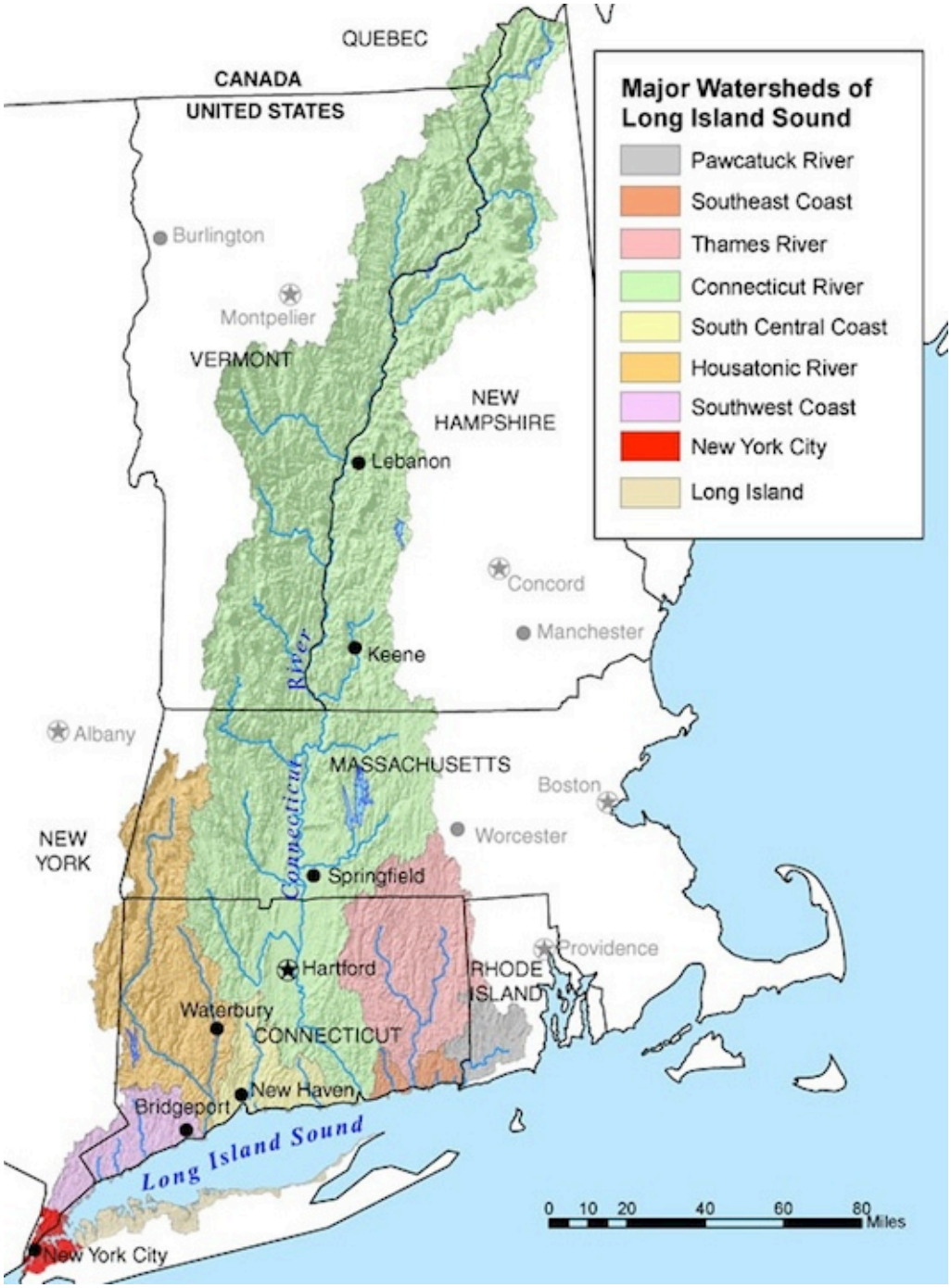
Cardinal Direction Questions
What direction does the river flow in?

Which of the states that you identified above are located to the East of the river? To the West?

Mapping Application
Using the scale on the map and your ruler, approximately how long is the Connecticut River?

How many cities are located along the Connecticut River?

Image: US Geologic Survey



Lesson by: Hannah Khouri

The Flood of 1936 and Connecticut River Perspectives

Age group: 8-18

Venue(s): Within the classroom

Materials: 2 blank sheets of paper per group, pens and pencils

Time: 45 minutes

Setup: Gather materials

Lesson Summary

Large flooding and natural disasters can act as a reminder to humans that we cannot control every aspect of our natural environment. After learning about the flood as an important historical event, students will have a chance to reflect on how perspectives on the Connecticut River have changed throughout time.

Enduring Understanding

- Perspectives in the environmental narrative have changed throughout time
- It is impossible to have full control over nature
- Flooding events are necessary for the farming in the region

Knowledge and Skills Developed

- Students will know what caused the flood of 1936
- Students will be able to explain benefits of major flooding events
- Students will be able to explain problems associated with major flooding events

Introduction

The flood of 1936 serves as a reminder that floods and other similar natural disasters are vital in restoring. While it devastated homes located too close to the river's banks, it also helped to replenish nutrients necessary to ensure soil health for farming. The purpose of this lesson is both to understand background on the Flood of 1936, see how it might shape farmers perspectives on the river, and then compare various perspective of the Connecticut river over time.

The Core Lesson

In March 1936, the most recent major flood to hit the Connecticut River Valley. That year yielded a particularly hard winter followed by an early thaw and torrential rainstorms, the conglomerate of which devastated the valley from Vermont to Connecticut. The flood was particularly devastating economically, as it corresponded with the height of the American Great Depression (1930-early 1940s). The flood left behind silt and mud that was as high as 3 feet in some areas. The severe flood damage led to the Flood Control Act of 1936 between Connecticut, Massachusetts, New Hampshire, and Vermont. It granted the federal government

jurisdiction over rivers and tributaries. This act was edited in 1944 so that it allowed the U.S. Army Corps of Engineers to oversee all water development projects in the region.

The Great Flood left behind a legacy that reminds us the strength of water sources and the importance of natural cycles. It shows that while floods can be destructive, they are also extremely important, since "floods provide opportunities for nutrients and organic matter to be recycled and redistributed. Floodplains, where soil development is flood dependent, and the ocean, where it provides a subsidy for fish production, flourish during and after floods" (Murray-Darling Freshwater Research Centre, 2). While the flood brought many hardships to the region, it also played a vital role in replenishing nutrients to soil for the many farms and helped to restore fisheries.

After learning about the Great Flood of 1936, the students will have a chance to reflect upon the pros and cons of major flood events. Students will be broken up into groups of 4 and will have a chance to create a list of flood benefits and a list of problems that result from flooding. After all groups are done, they will write their lists up on the blackboard and have a conversation about their discoveries.

Assessment/Conclusion

Though environmental perspectives have inevitably changed over time, there may be some overarching uses for a water way that allow it to remain as a valuable resource throughout time. Though humans may try to control nature in order to optimize comfort and survival, it is important to recognize that we do not have control over all natural processes. Humans exist symbiotically with their environment rather than as a separate entity.

Alternative Extension

Students will create a debate about whether or not we should dam rivers (which would result in less flooding). Should humans repress the natural migration patterns of rivers if flooding helps replenish soil health? Should all rivers be dammed so that we can continue to live close to water sources without fear of a large-scale flooding event?

Sources

http://www.erh.noaa.gov/nerfc/historical/mar1936.htm
http://doddcenter.uconn.edu/asc/exhibits/snet/beyondthecall/1936flood/
http://www.crvfcc.org/
Murray-Darling Freshwater Research Centre:
http://www.mdfrc.org.au/news/basin/images/Imporatance_Of_Floods.pdf

Water Pollution and River Cleanup

Age group: 8-18

Venue(s): In classroom

Materials: 4-5 266 mL clear plastic cups, pea-sized gravel to fill cups ¾ way full, 12-15 small paper cups, pump dispenser, 12 liters of water, food coloring

Time: 45 minutes

Setup: Gather materials

Lesson Summary

This activity will allow students to understand how pollution affects waterways and the difficulties faced during clean up projects. It will raise awareness of water pollution and will allow students to connect this knowledge to the history of the Connecticut River and the importance of keeping a clean water way for the salmon population.

Enduring Understanding

- Visualize the connection between surface water and groundwater
- Experience the difficulty in cleaning polluted water

Knowledge and Skills Developed

- Students will be able to follow directions for science-based projects
- Students will be able to understand the difference between ground water and surface water
- Students will be able to indentify parts of the water cycle
- Students will develop an understanding of the difficulties of cleaning a water source
- Students will be able to connect the concept of pollution to the overall health of the water cycle

Introduction

Salmon rely on healthy water sources for their ability to survive and reproduce. The water cycle shows that water is interconnected; rain becomes surface water, which can drain into water sources (rivers, streams, lakes, ponds, etc.) or becomes ground water. This water in turn may travel to new water sources or evaporate. If some portion of the water cycle becomes polluted, this pollution can affect all parts of the water cycle. Though human activity is not the only source of water pollution, our actions can influence the water cycle and all organisms that rely on the water cycle for survival. Through the following activity, students will be able to visualize that is it much easier to pollute a water source than to clean it up.

Lesson by: Hannah Khouri

The Core Lesson

Students will be divided into groups of three or four. Each group will be provided with: one clear plastic cup ¾ full of pea sized gravel, one paper cup with holes in the bottom, one paper cup with no holes punched in the bottom, one paper cup ¾ full of water, and one pump dispenser. The students will hold the 240-ml cup with holes in the bottom over the cup containing the pea-sized gravel. They will then be asked to add water from the small paper cup. Explain to students that this simulates rain, which is an integral part of the water cycle. As the rain enters the gravel, it becomes groundwater. This process is called infiltration. The students will then be asked to dig a hole in the center of the gravel. In this case, the hole simulates a lake or pond (while the river is an open source, this activity relies upon closed sources). Ask students how the level of water in the lake corresponds to the level of water in the gravel. The students will then add two drops of food coloring (to simulate pollution) to their lake. Have the students place the pump dispenser in the gravel beside the lake and pump water into the paper cup with no holes and ask students to observe and record the color of the water. This will show that point-source pollution heavily impacts water sources.

To simulate pollution clean up, students will add small amounts of clean water to their models while pumping. Tell them to continue to add water and pump out polluted water until it becomes clear and record how long it takes them to clean the water source.

Assessment/Conclusion

After completing the activity, the students will come back together as a group to reflect on what they have learned. The teacher should ask leading questions such as: where does the pollution pumped from the ground water come from? How can pollution from a lake get into the ground water? Was it easy to clean up all the pollution in the water?

Alternative Extension

For added challenge, ask students to make a list of sources of water pollution. Are there any types of pollution they can prevent? How can others reduce pollution? What might the impacts of pollution be on the salmon and other fish that live in a river?

Sources

Adapted from Midwest Research Institute's "Surface Water and Groundwater Pollution Activity" (http://www.stormwater.ucf.edu/toolkit/vol3/Contents/pdfs/Student%20Activities/student_activities.pdf) December 3, 2012

Pre-Colonization and Colonization of the Connecticut River

Age group: 8-14

Venue(s): In classroom

Materials: 4-5 short copies of the short poem (provided)

Time: 45 minutes

Setup: Gather materials

Lesson Summary

Understanding the history of a region is vital in drawing parallels to its current state. This lesson focuses on the history of the Connecticut River from pre-colonization to colonization. It will use anecdotes and narratives to help students remember the Native American and colonial history of the region.

Enduring Understanding

- Students will be able to identify Native American tribes in the Connecticut River region
- Students will be able to understand differing relationships with the river between colonists and Native Americans
- Students will be able to relate past histories with the current state of the river environment

Knowledge and Skills Developed

- Students will be able to relate when Europeans began to explore the Connecticut River
- Students will be able to relate how and why the colonists clashed with Native Americans
- Students will understand how the Native Americans and the colonists view the Connecticut River and what benefits it provides.

Introduction

In 1614, the Dutch navigator Adriaen Block conducted one of the earliest explorations of the Connecticut River. He was not, however, anywhere close to the first person to view its benefits; the river was already teeming with life, from the lush forests to the many Native American communities. By 1633, the Dutch and the English had set up trading posts and were battling for control of the region. The English eventually established Springfield in 1636, followed by Northampton 1653, Hadley in 1661 and Northfield in 1673. For some time, the colonists coexisted with their Native American counterparts, relying upon them for furs and other goods native to the region. However, by the mid-17th century, market values shifted. Trade with the West Indies for fish, lumber, molasses, and goods for rum production became more profitable than fur. Native Americans could no longer thrive in the

market-based economy and were rendered obsolete. 1675-1698 brought on an era of clashes between the Native Americans and the colonists along the Connecticut River. Colonists were moving farther and farther up the river and establishing cities, while the Native Americans were getting pushed further and further away from their homelands.

Of particular importance to the region is King Phillip's War. Phillip was the English name given to a Wampanoag tribe sachem named Metacom. He was the son of Massasoit and banded together several Indian tribes in attempts to protect Native American independence. He was slain in 1976, leading to the inevitable loss of Native American rights in North America.

A major factor that led to clashes between the Native Americans and the colonists was access to the Connecticut River. The river is a water source, which means that it guarantees access to food and water and healthy soils for food production. In addition, the colonists could use the waters for trade and transportation. It is much more difficult to transport goods across the country than it is to move them using a waterway. Access to various survival and economic needs forced both groups to fight violently for their needs and the colonists won out.

The Core Lesson

Students will be divided into small groups of three or four. Each group will be provided with the short poem that details information about the history of the Connecticut River. Students will take turns reading the poem to their group out loud. After learning pre-colonial and colonial history, each student will be assigned to one of two categories (Native Americans or colonists) and will be asked to create a list of the major values each group may associate with the Connecticut River. Students will describe their relationship to the river: how they see the river, their uses for it, how it may be different in different historical contexts, etc.

For example, the group assigned to the Native American category may write that the river is a source of sustenance for survival and transportation. It supports organisms that they may hunt and also holds intrinsic value. After each group has a chance to brainstorm the value of the river from different perspectives, have the class come together and write their lists on the blackboard. Then, ask students leading questions about where the categories are similar and where they differ.

Poem:

Long ago, when the glaciers retreated
The Earth blossomed with flora as the climate it heated
And in it's wake was born the river you know
Connecticut by name with its North to South flow

Communities sprang from the banks of its route
While nomads tailed salmon in hot pursuit
As they swam down the river to the Long Island Sound
Where food for themselves and their offspring abounds

But everything changed in 1614
When Adriaen Block came onto the scene
Leading a band of haphazard Dutch men
Locals helped the newcomers begin again

For twenty short years they did live in peace
With benefits doled out to each party a piece
The natives brought furs and tilled the land
While the Dutch brought goods to lend a hand

But things grew tense when the English appeared
Building up cities with dense forests cleared
Springfield came first, then Northampton and Hadley
But who could foresee that things would end badly

Trade with far lands, molasses for rum
Rendered natives useless with profit of that sum
This brought on an era of quite a few clashes
King Phillip's war began, destroying the masses

Their leader Metacom, or King Phillip as we say
Brought the natives together to combat the foray
But Metacom fell and the native cause crumbled
A new world was born as the old one tumbled

Assessment/Conclusion

Perspectives and values may be different for different groups of people. Differing perspectives and values may lead to different usage of resources. While the Native Americans had to live symbiotically with the Connecticut River to survive, the colonists tended to view resources as areas to expand into and utilize. Discourse and rhetoric will greatly influence views, which in turn will dictate the future use of a resource.

Alternative Extension

For added challenge, ask students how they think city-dwellers may have viewed the river once major cities began to develop. Is this different from or similar to the perceptions they have already identified and how?

Sources

http://www.bio.umass.edu/biology/conn.river/furtrade.html

Industrialization and the Connecticut River Cleanup

Age group: 8-18

Venue(s): Within the classroom

Materials: paper and pencils

Time: 45 minutes

Setup: Gather materials

Lesson Summary

Students will examine the environmental and economic impacts of industrialization on the Connecticut River in a historical context.

Enduring Understanding

- Relate concepts of development with habitat change and environmental degradation
- Identify important aspects of the Industrial Revolution and how it relates to the Connecticut River

Knowledge and Skills Developed

- Students will be able to identify when the Industrial Revolution occurred and why it is so important in US History
- Students will know when clean up efforts began on the Connecticut River
- Students will be able to identify positive and negative impacts of the Industrial Revolution

Introduction

The Industrial Revolution has greatly shaped New England, transforming it from a primarily agricultural center to an urban development project. This change brought with it a host of environmental and economic changes, some of which were positive and some negative. This lesson will help students connect human history with environmental change, placing them within their environment to better understand the causes of fishery depletion.

The Core Lesson

The American industrial revolution spanned from 1750-1850. The Connecticut River Valley, in particular, developed into a source for new technologies that aided development. According to Learning Collaborative, "While the barter and work exchange economy still flourished, cash exchange became more common. Growing commercialism created greater inequality as farmers were stretched to pay cash for goods they had never had before, and new wage-earning laborers sought to make a living". The industrial revolution as we know it is said to have stemmed from the creation of interchangeable parts by Robbins and Lawrence factory in Windsor, Vermont. While they developed interchangeable parts for guns, this technique

spanned all disciplines and aided farming communities as well as factory work. At this time, railroads were being developed which allowed for access to areas further away from the river. Societies began to expand, as did economic development. However, while the stage was set for a growing economy, there were little to no policies in place to protect the environment. Industrial waste was dumped into rivers, making them virtually uninhabitable. While industry boomed, it would not be until 1972 that the government would create the Clean Water Act to set standards for water quality and restrictions for big business. In 1952, the Connecticut River Water Council was created and began a source to sea clean up program in order to mitigate the habitat and biodiversity loss associated with pollution. Through the work of the CRWC, salmon and like endemic migratory fish are finally able to be reintroduced to the waters they had once called home.

With this lesson in mind, students will be broken into two groups: environmentalists and industrialists. Both sides will develop a debate about which is more important in 1750: economic development or environmental protection. Students will present their arguments in a semi-formal debate setting.

Assessment/Conclusion

After completing their debate, students should be given a chance to reflect on the positive and negative aspects of the Industrial Revolution. While it may be connected to environmental degradation, it also spurred technological innovations and was the first step in creating the lifestyle we have come to enjoy. This is getting into very complex concepts, so let students know that there is no right answer about what should be sacrificed for what.

Alternative Extension

For added challenge, ask students to develop their debate in a more formal format. Students may develop their opening arguments and then create counterarguments while the other group is debating. This may entail an extra class slot in order to have a full debate.

Sources

The Learning Collaborative:
http://www.flowofhistory.org/ir_toolkit/essays/overview.html

Salmon in the River

Age group: 8-18

Venue(s): classroom

Materials: coloring sheet and color pencils

Time: 45 min

Setup: print out coloring sheet

Lesson Summary

Through this lecture and activity lesson, students will develop an understanding of what a river is and how rivers provide a habitat for salmon.

Enduring Understanding

- Rivers provide an essential habitat for many fish including salmon.
- Conservation of these rivers is vital for the survival and growth of salmon populations.

Knowledge and Skills Developed

- Students will know that rivers provide salmon with an essential habitat.
- Students will know the key components of a healthy river ecosystem.
- Students will know that salmon use the river ecosystem during the early and ending stages of their life cycle.
- Students will know what characteristics of a river salmon favor.
- Students will be introduced to the idea that rivers are an important ecosystem that must be conserved in order for salmon to survive.

Introduction

In order to help salmon populations continue to thrive, we must first clearly understand the river habitat that is so central to its survival.

The Core Lesson

Where do salmon live? In oceans, or rivers are both great answers. Today we're going to be learning about rivers and how they provide a habitat for salmon. Have the students close their eyes and picture a river. What do you see? Look for answers such as water, rocks, fish, plants, birds or frogs (etc). There are all great responses. Introduce the idea that all of these things work together to create a healthy river ecosystem that we'll come back to later on. What exactly is a river? A river is a flowing channel of freshwater that ultimately empties into the ocean. The water needs to be moving in order for it to replenish more oxygen. Explain that replenish mean that because the oxygen is being used, more oxygen needs to be put *back into* the river. Like humans, animals that live in the water also need oxygen to survive. What can you imagine would happen if the river wasn't able to flow properly and no new oxygen was able to get into the river? Nothing would be able to survive. The bottom (or floor) of a river has rocks of all sizes, from larger boulders to pebbles and even sand. These smaller pebbles and stones are very important to the salmon because female salmon deposit their eggs underneath the pebbles in order to keep

them protected while they grow. After they hatch in the spring, the fry emerge from the gravel and continue to live in the river habitat for up to 3 years before migrating to the ocean and finally returning to the same river where they hatched. (The same river where the eggs hatched is called the 'natal' river.) The depth of the water is really important to egg survival as well. Remember earlier we talked about how rivers need flowing water in order to replenish oxygen levels. What do you think would happen to the eggs if the water were moving *too* fast? They would probably float away and not be able to grow and hatch. Therefore, salmon usually choose shallower areas of the river. So do you think it's important to protect our rivers? I think it's safe to say that if we let our rivers get polluted or destroyed, the salmon will not have a very good change of surviving.

Assessment/Conclusion

Make sure students are comfortable with the knowledge and skills developed discussed earlier. Chances are the kids will be a little antsy after listening to a lecture. Hand out the coloring sheet and have the kids complete the assignment (finding and labeling the fish eggs). The kids can then color the sheet in as a relaxing and concluding exercise.

Alternative Extension

If there's time, have the students add more organisms they think they would find in the river habitat after listening to the lesson to the coloring sheet.

A Riparian Habitat

Age group: 8-18

Venue(s): classroom

Materials: identification cards

Time: 45

Setup: Print identification cards (each group of 3-5 students should have one set)

Lesson Summary

Through this lecture and activity lesson, students will develop an understanding of how salmon use riparian habitats.

Enduring Understanding

- Riparian habitats are the place of key growth for salmon.
- Conservation of this habitat is key to the survival of salmon.

Knowledge and Skills Developed

- Students will know that riparian habitats are integral to salmon growth in the early stages of life.
- Students will know what organisms and vegetation are found in the area.
- Students will know what salmon feed on in this habitat.
- Students will be introduced to the idea of natural selection and the survival of the fittest.
- Students will be introduced to the main threats to this ecosystem.

Introduction

It is in the riparian habitat that salmon first undergo rapid biomass increase before migrating to the ocean and it is essential to under the habitat and its relative importance to the salmon's survival.

The Core Lesson

What do you need to make you grow? Food!! The riparian habitat is where salmon find their food. It is the zone of interaction between terrestrial (explain that this means land) and aquatic (explain that this means water) ecosystems. This mixing of ecosystems makes the riparian habitat a very rich (not money rich! Rich in plants and animals) place to live. It provides ample amount of food, cool temperatures from tree shading and protection from larger predators. In fact, in this ecosystem, salmon are usually among the largest predators. Salmon feed mostly on insects like the mayfly or stonefly during this time. During their time in the riparian habitat, salmon learn how to actively forage. (Explain that this means they go 'hunting' for food rather than feeding on their egg sac like they had before.) As the salmon continue to grow, they begin to compete for food resources. Some salmon may not be as good at finding food as others, and those salmon will not be able to survive. This idea is referred to as "natural selection" or "survival of the fittest". This means that only the salmon that are the *best* at foraging (do we all remember what foraging is? Finding food!) will survive to migrate to the ocean. Like we discussed when we

learned about rivers, it is very important for the survival of salmon to protect these ecosystems.

Assessment/Conclusion

Let's play a little identification game! Divide the students into groups of 3-5 (depending on the size of the class. You don't want too many groups but you also don't want the groups to be too big. Everyone should get the opportunity to contribute in this game.) Give each group a set of identification cards and have them work *together* to pair each picture to a term.

Alternative Extension

After the students have finished pairing all the identifications, have them arrange them spatially on the table like they would be found in the habitat itself. For example, the bird would be at the top because it would be in the sky and the trees on the side because they're on the land. (Hint: identifying the mayfly and the caddisfly may be difficult. Note that the caddisfly is more like a moth than a fly.)

Identification Names

Bald Eagle

Great Blue Heron

Atlantic Salmon

River Otter

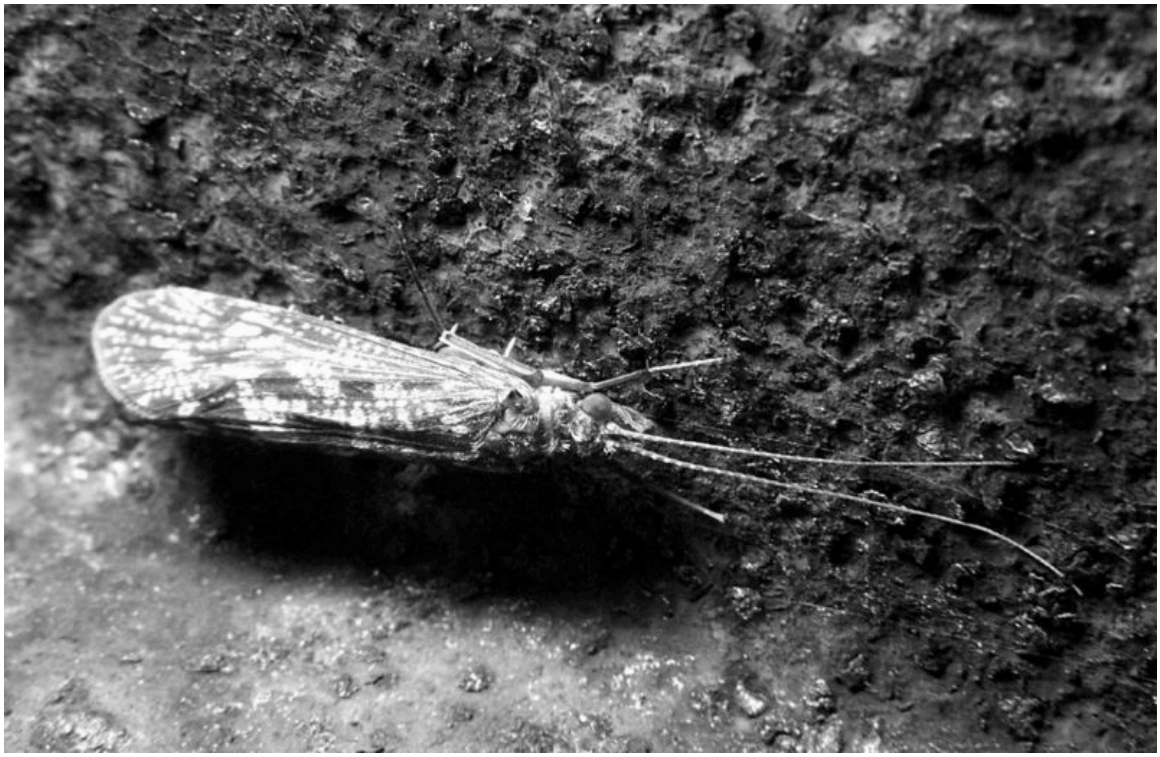
Grand Fir Tree

Blackberry Bush

Mayfly

Caddisfly

Identification Photos



Salmon in the Ocean

Age group: 8-18

Venue(s): open space

Materials: 3 different colored flags or distinguishable items

Time: 45 min

Setup: Put each flag in a different area of the open space

Lesson Summary

Through this lecture and activity lesson, students will develop an understanding of the ocean and how it provides a habitat for salmon.

Enduring Understanding

- Oceans provide an essential habitat for salmon to grow before returning to the river to spawn.
- Oceans are the habitat where salmon face the greatest predation.

Knowledge and Skills Developed

- Students will know the main characteristics of the ocean that salmon favor.
- Students will know that salmon migrate to the ocean in order to forage.
- Students will know the oceans pose a great threat to salmon due to predation.
- Students will be introduced to the idea of overfishing and subsequent decline in salmon populations.

Introduction

As salmon spend 1-4 years in the ocean, understand ocean characteristics key to salmon survival is integral to maintaining their populations.

The Core Lesson

We've already learned about rivers and riparian habitats. Oceans are the final habitat that salmon rely on during their lifetime. Have the students close their eyes and think about the ocean. What do you see? The beach, sea gulls or fish are all great answers. Just like a river, all of these things work together to create a healthy ocean ecosystem. Who can think of the biggest difference between a river and an ocean? (Help them along if they're hesitant: Has anyone ever been to the beach? What does the water taste like? Do you remember what kind of water we learned rivers have? Etc.) The biggest difference between the two is that oceans have a higher salinity than rivers. (Explain that salinity is the amount of salt in the water.) Because the salmon were born in freshwater, they have to undergo a process called **smoltification** that allows them to live in the new salty environment. Why do you think salmon migrate to the ocean? To eat (or forage)! (Explain that to forage means to feed.) What do you think salmon eat? They feed on shrimp, squid, eels and smaller fish. During this foraging time in the ocean, the salmon increase dramatically in size. While oceans may offer more food for the salmon, it also offers more threats to the salmon's survival. Can you think of anything that might threaten

the salmon? Bigger fish! Fishermen! Sharks! There's one more very important difference between rivers and riparian habitats and oceans that make oceans pose a larger threat to the salmon. (Help them along by telling them to think about size and vegetation cover.) Rivers and riparian habitats are smaller so there are fewer larger predator species. Also, rivers and riparian habitats have vegetation that the salmon can use to hide from prey. And most importantly, oceans have the greatest human threat because of the number of fishermen. Salmon populations are quickly being overfished and populations are decreasing.

Assessment/Conclusion

As a conclusion to the lectures on river habitats, riparian habitats and ocean habitats, we will play a game. Make sure the open space is set up with three flags; one area for the ocean, one area for the river and one area for the riparian habitat. Have the students count off by threes. The first group is salmon eggs (or alevine). The second group is juvenile salmon (or fry). The third group is the adult salmon (or parr). Ask the students to go to their respective areas of the classroom depending on which group they were in.

Alternative Extension

To make this game more of a review, you can ask each group a series of questions. Have them work together to come up with the answers. Giving the students time to discuss and including a spokesperson makes it more fun. For example, my adult salmon in the ocean, what do you like to eat? What are the biggest threats living in the ocean? How long do you live in the ocean? To my juvenile salmon in the riparian habitat, what kind of vegetation do you have? What do you eat? To my salmon eggs, what kind of river floor do you like? Why does the river water need to be moving in order to maintain a healthy ecosystem?

Climate Change and Salmon

Age group: 8-18

Venue(s): classroom

Materials: word search

Time: 45 min

Setup: none

Lesson Summary

Through this lecture and activity lesson, students will develop an understanding of climate change and the impact on salmon.

Enduring Understanding

- Climate change is a global phenomenon that is being felt all over the world in multiple ecosystems.
- Climate change is having both direct and indirect effects on salmon populations.

Knowledge and Skills Developed

- Students will know what climate change is and the causes (both natural and anthropogenic).
- Students will know that salmon are impacted by climate change.
- Students will know means of mitigating the effects of climate change on salmon populations.

Introduction

Not only is climate change becoming an increasing topic of conversation, it is directly related to the survival of salmon populations. By understanding the role we as humans play in climate change, we can be a part of ensuring the survival of salmon populations.

The Core Lesson

Who has heard of climate change before? Does anyone want to try and tell us what it is? Let's try and take apart the term. There's climate and there's change. What is climate? What is change? Climate refers to temperature, wind patterns and precipitation (explain that precipitation is when rain, sleet, snow [solid forms of water] fall from the atmosphere). Change is any observed difference in something. So let's put it all together and we get that climate change refers to major observed differences in the temperature, wind patterns or precipitation. Over the past several decades, evidence shows that the earth has been getting warmer. When greenhouse gasses (for example carbon dioxide) are released into the atmosphere (If you'd like to go into more detail here you can explain that burning fossil fuels [like coal] releases carbon dioxide into the atmosphere), they form a blanket around the earth, which traps all of the heat. It's just like a sleeping bag! When you first get in it's cold because of all the cold air but the longer you sleep in it and warm the air the hotter it gets until you wake up in the morning and realize you kicked it off in the middle of

night because it was too hot! The only difference is that the earth can't kick off the blanket so it just keeps getting warmer. This changes the amount of rain we have and how hot or cold it gets. Temperature is very important to salmon especially when they're eggs. If the temperature is too high or too low, they won't be able to develop and salmon populations will decrease. Does anyone remember what we said about how fast salmon like rivers to move? Fast enough that they're getting enough oxygen but not too fast that the eggs float away. If the number of rain events increases, you can imagine that rivers would begin flowing a lot faster. Does everyone see how all of these things link together? Even though we're sitting in a car driving to school and releasing carbon dioxide into the atmosphere, it is the salmon that will be hurt by this. So how can we help protect salmon from climate change? We can reduce the amount of fossil fuels we burn by walking to places as much as we can. We can tell other people about this too so they can also learn about climate change and saving salmon.

Assessment/Conclusion

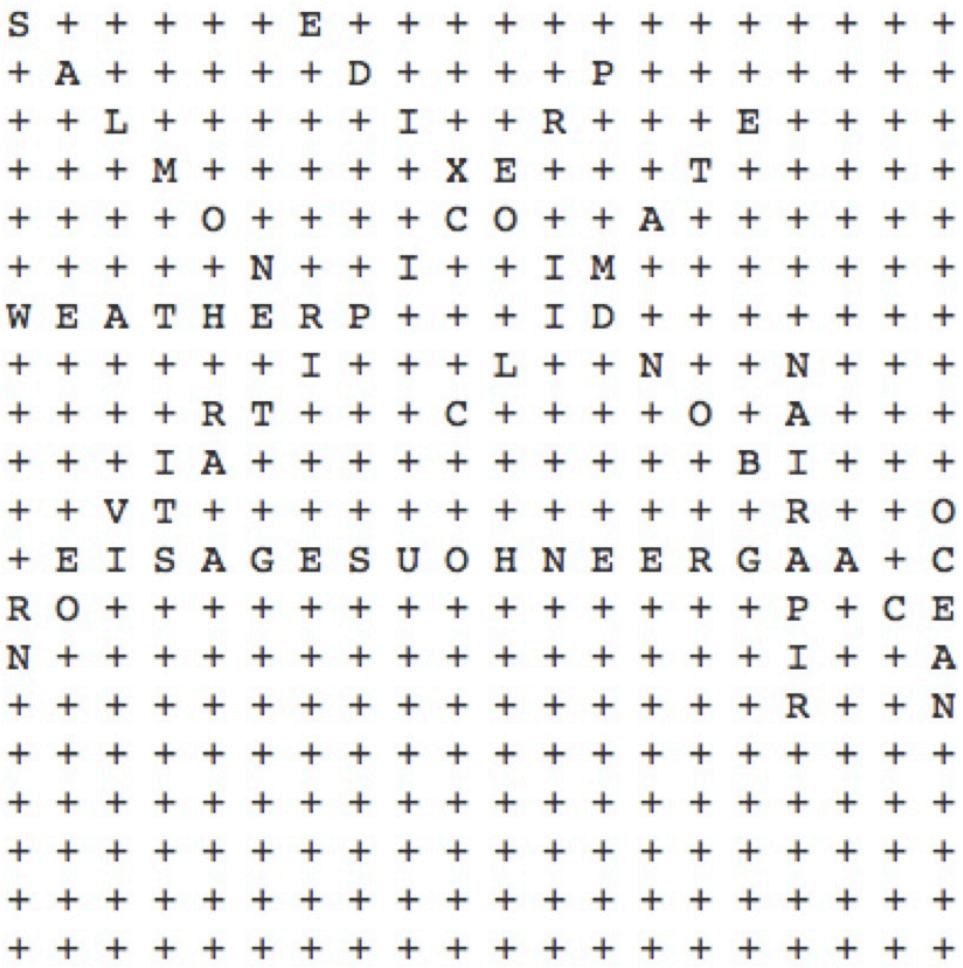
As an ending activity, hand out the word search and have students complete the worksheet. This will also act as a review if they can't remember some of the terms.

Salmon & Climate Change Word Search

S T P X H M E H N O J Q O Q W H N I P A
R A X R K Y F D X V Q M P J V T A H O K
T C L M R Z T Q I F T R I N W E B W Y V
O I R M M O D J F X E W O A T W P R F Y
L H G L O S N T T C O N B A H X D H Q Z
P D T W O N O P I D P I M B M J K N S K
W E A T H E R P P F A I D H M H A A G E
C Y J N D Y I G F E L M B N W M N G X B
V O G N R T Z R O C A L O D O T A N Z F
V O K I A O F L S W U L U U R B I B N C
R N V T X Y J C Q P X Y T K O F R N E O
D E I S A G E S U O H N E E R G A A T C
R O K B Q E Q Z C E O Q J V L B P C C E
N V F Q B H A Y D F C J E N Y K I J I A
T R R F Y Y R B C L M A F K D R R V A N
Y L A J M I Z V K Y H Q U O K T Q S A V
S V H S J C R V C X Q E U B Y H P O V P
Z Q A B Y W B X P Q D V S W U D C X E N
O X J T O A C W Y H M I X O J U J R O V
M W P A G P M I S K Y P B B V L J F R G

CARBONDIOXIDE
CLIMATE
GREENHOUSEGAS
OCEAN
PRECIPITATION
RIPARIAN
RIVER
SALMON
WEATHER

Word Search Solution



(Over,Down,Direction)
CARBONDIOXIDE(19,13,NW)
CLIMATE(10,9,NE)
GREENHOUSEGAS(16,12,W)
OCEAN(20,11,S)
PRECIPITATION(13,2,SW)
RIPARIAN(17,15,N)
RIVER(5,9,SW)
SALMON(1,1,SE)
WEATHER(1,7,E)

Putting It All Together

Age group: 8-18

Venue(s): classroom

Materials: 3 pieces of poster paper and lots of drawing utensils

Time: 45 min

Setup: Three tables each with a piece of poster paper and some drawing utensils

Lesson Summary

Through this activity lesson, students will put all the complex material they've learned about salmon habitats into one cohesive image.

Enduring Understanding

- Ecosystems are complex and many organisms live together to create a healthy ecosystem

Knowledge and Skills Developed

- Students will know that there are three main ecosystems that salmon rely on during their life cycle including rivers, riparian habitats and oceans.
- Students will know that these ecosystems are all different and complex.
- Students will be able to visualize the three habitats.
- Students will develop teamwork and presentation skills.

Introduction

There are three main ecosystems that salmon use during their life cycle (rivers, riparian habitats and oceans).

The Core Lesson

Set up one poster and various drawing utensils at three different tables. Divide the class into three groups and assign one group the river habitat, one group the riparian habitat and one group the ocean habitat. As k that the students work together as a team to draw their habitat including what organisms live in the habitat besides salmon. They can refer to last lessons for reminders. (The riparian habitat lesson activity is a good source for images.)

Assessment/Conclusion

Once completed, each group will present their drawing to the class explaining the significance of each of the pictures they've drawn. This is also an opportunity for other students to ask questions about each other habitats.

What's in a Name?

Age group: 8-11

Venue(s): classroom

Materials: Plant, stuffed animal (fish), candle, depictions of some that are unavailable, either chalkboard or whiteboard

Time: 45 min

Setup: Gather materials

Lesson Summary

In this lesson, students will begin to understand how scientists think of organisms and how they categorize the world around. Children will be able to utilize this new understanding to complete a taxonomic scavenger hunt

Enduring Understanding

- Scientists utilize categorical classification to understand the world and make connections
- All living things can be classified based on the framework of the taxonomic classification system

Knowledge and Skills Developed

1. Children will understand how nature is classified, and understand that they are part of this organizational structure themselves
2. Children will be able to gather information about the natural world based on where things belong in a taxonomic hierarchy
3. Children will begin to develop an understanding of how things are related based on taxonomic classes

Introduction

Begin by demoing the different types of organisms you have brought. Use a plant, a stuffed fish, a picture of a bacteria, some dirt, and if available, a candle. Go through each object and ask the children if it is alive, and whether or not they consider it an organism.

Then, invite students to think about what they would define as characteristics of living things. Allow them to compile the list on the board. Once the ideas have stopped flowing, go through their list and ask them what kinds of organisms do these things. Push them to think about organisms besides what they already know (bacteria, protists, fungi, etc)

The Core Lesson

Using one of the organisms on the list (humans is generally easiest), walk students through taxonomic classification. Give them a worksheet so they can fill it out as we go along. General notes for each step are below.

Domain

- Bacteria
    - Live within the ecosystem, simple organisms, can make people sick, but not always
- Archaea
    - Non-traditional life—no need for sunlight, may be able to live in areas with extreme cold, heat, salt, methane based life
- Eukaryotes
    - Basically everything else

Kingdom

- Within Eukaryotes—there are 4 widely used kingdoms
    - Animalia
    - Plantae
    - Protista
    - Fungi
- Others exist, but for our purposes, these are the most important

Phylum

- So many different phyla
    - Humans belong to chordata, as do fish
    - Also cnidarians (jellyfish), porifera (sponges), arthropods (lobsters and spiders), Echinodermata (seastars) and ctenophores (sea combs)

Class

- Humans are Mammalia—what else is Mammalia? How are we related to them?
- Salmon are Osteichthyes—generally meaning bony fish

Order

- Kind of like your cousins
    - Human cousins? What do we call all of our cousins? (Primates)
    - Salmon belong to Salmoniformes
        - Includes pacific salmon

Family

- Often used to explain broad evolutionary trends
- Humans are Hominidae—great apes
    - Chimpanzees, Bonobos, Gorillas & Homo
- Salmon—Salmonidae

Genus

- When you look at the scientific name of an organism, the first word you see it it's genus
- Humans—Homo
- Salmon—Salmo
- Always italicized when it's typed, underlined when it's written

Species

- Smallest taxonomic unit
- Humans—sapien
- Salmon—salar
- Always lowercase

Conclusion

Draw the connection between how scientists use this system and how it can help us understand our natural surroundings. Talk about the sense of confusion between common names that can frequently occur. Discuss how this standardized system can help scientists from all over the world discuss the same organism.

Have the children pick random slips of paper, each with an organism on it that the salmon may encounter on its life cycle. For homework/if additional time, have each child look up the taxonomic classification and fill out a worksheet with it for homework.

Alternative Extension

Have children try to develop the connection between related organisms between each level. Instead of walking them through the taxonomy of salmon and humans, have them develop it on their own.

Which Fish is Fish?

Age group: 7-9

Venue(s): Classroom

Materials: Cutouts of a variety of fish, basket for slips of paper, info cards, whiteboard and markers

Time: 45 min

Setup: Gather materials

Lesson Summary

We will be building on the principles that we built within our last lesson on taxonomy and trying to encourage understanding of the diversity of fish in the ocean and streams of New England. Throughout this lesson, we will work to dismantle the typical assumptions that children have about fish, as well as get a lger understanding of what fish lives are like.

Enduring Understanding

1. The ocean is home to a large variety of organisms that are all interconnected
2. The coastal river system helps feed into the oceanic system, which helps create a larger system of global biodiversity.

Knowledge and Skills Developed

1. Understand the difference between Atlantic Salmon and other fish, including an understanding of how these fish are able to live in two very different environments
2. Understand the basic needs of all fish, the different types of fish

Introduction

Review with students the different taxonomic units; ask them to turn in say what they learned about their organisms and how they interact with our fish. Remind students about the taxonomic classification of salmon, but then go up a few levels and begin talking about other types of organisms.

The Core Lesson

Divide the group into pairs and have each of the pairs pull a piece of paper with an organism on it out of a basket. The slips of paper will have various "actors" on it—in this case, different fish. Have the pairs take 3-4 minutes to read the info card (provided) for their organism. Each of the partners will be required to present the "case" for their organisms—state why they think their organism qualifies as a fish. Each of the suspects will then be judged and sentenced—either as fish or not fish.

After each pair has gone, look physically divide the class into the fish and the not fish. Invite the children to look at what the pairs have in common, and ask them to complile a group list of what they all have in common.

As a class, go through the lists and correct any misunderstandings.

Lesson by: Caitlin Lewis

Fish: Cichlids, Clownfish, Mudskipper, Sharks, Electric Eel, Seahorse, Stingray

Non-fish: Walrus, Starfish (Echinoderm), Green Sea Turtle, Dolphin, Blue Whale, Jellyfish, Octopus, Clam

Conclusion

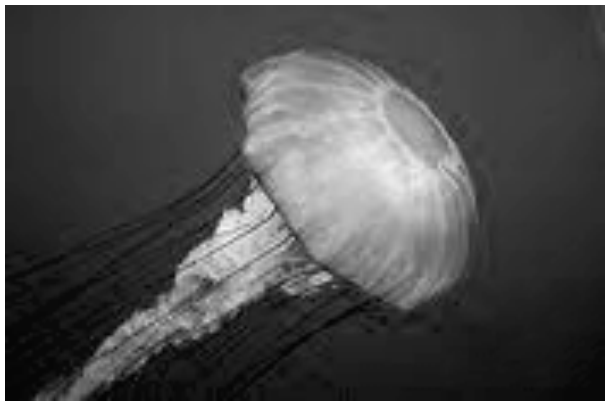
After the discussion has subsided, bring it back to the point of what it means to be a fish. Move towards the understanding that fish are all varied, but they are all cold-blooded, and live in water.

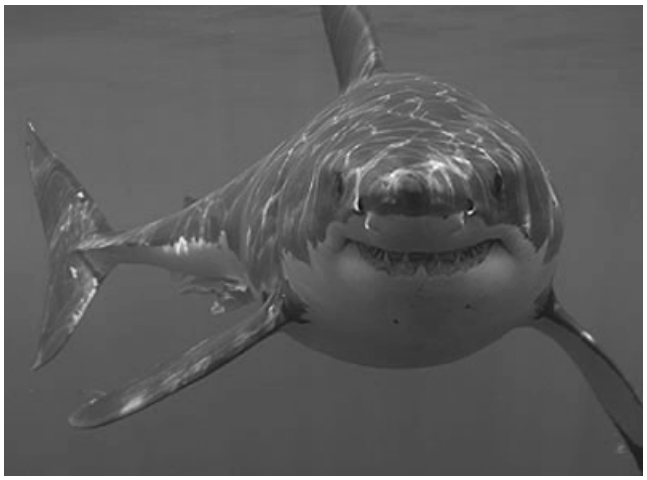
Alternative Extension

Building off of the animals listed, invite students to think about what phyla these organisms could belong to.

Cichlids *We live in lakes all over the world. We eat a variety of things, including plankton, other fish and algae. We have a lot of different colors. We live in warmer water and take in oxygen from the water.*	**Octopus** *We have 8 legs and are very intelligent. We have sharp beaks, and live on the bottom of the ocean but can also swim. Our eyes are very developed and we have been known to fit into small areas.*
Clownfish *We live in anemones. We live there without being hurt by their stinging cells. We only live in the Pacific Ocean and eat small animals.*	**Stingray** *We do not have any bones. We live just above the sea floor in warmer waters. We also have barbs which we can use if we're feeling threatened.*
Green Sea Turtle *We are the last of our family. We live in warm waters and can migrate very far across the ocean. We have a giant shell on our backs. Our young hatch from eggs buried in the sand.*	**Sharks** *We have a reputation for being a ferocious group of animals. We have no bones, and can swim very fast. We live in every ocean, and not all of us are ferocious fish eaters. Most of us only live in the ocean.*
Seahorses *We live in shallow waters and like areas with a lot of places to hide. We do not have scales, but do have bones. We swim upright as opposed to on our stomachs like most swimming creatures.*	**Dolphins** *We are the most playful sea creatures! We like to swim in warm waters, and eat other fish and squid. We are also known as the most intelligent creatures in the ocean.*
Jellyfish *We are found in every ocean, and can come in a variety of colors and shapes. We use our long tentacles to catch food, and we use the top of our bodies to help move us throughout the water column.*	**Clams** *We have hard shells and do not live on the surface of the ocean. We only live in the sand and mud at the bottom of the ocean. We open our shells and feed off the small organisms floating by.*
Walrus *We enjoy living in cooler climates, preferably where snow is a main component of the weather. Generally, we like to eat small fish, but have been known to also eat seabirds. We like to be on the beach, but enjoy swimming as well.*	**Starfish** *We live attached to rocks and on the bottom of the ocean. We eat mussels and clams, but aren't really picky. We don't have eyes and can't swim, but we move around slowly and hang out with some tough friends.*

Electric Eel *We are capable of generating an electric current. We will use our electric voltage to stun our prey. We live in South America. We live on the bottom of rivers, swamps, creeks and other freshwater.*	**Mudskippers** *Sometimes, you'll see us walking on land on our fins. We live in muddy areas that may not have water for part of the day. We do not like to live in cold areas.*
Blue Whales *We are the largest animals and the fastest swimmers on the planet. We eat tiny food, but eat a lot of it. We can travel the entire world very easily. We often communicate with each other by speaking whale.*	





Lesson by: Caitlin Lewis

What is a Fish?

Age group: 8-11

Venue(s): classroom

Materials: printed worksheets and coloring supplies

Time: 45 min

Setup: Gather materials

Lesson Summary

Students will be exposed to the anatomy of fish. In this activity, they will learn the internal & external anatomy of the Atlantic Salmon, as well as learn the terminology associated with the organisms.

Enduring Understanding

1. Organisms that live in both the ocean and the river have to have specific adaptations to living in different salinity environments
2. Students will understand how fish are different from other organisms as taxa.

Knowledge and Skills Developed

1. Understand the various adaptations that fish need to have to live in different environments
2. Understand the anatomy and the proper identification of Atlantic Salmon anatomy

Introduction

Atlantic Salmon are anadramous fish, meaning that they live in both the marine and freshwater environment. In order to understand how to raise these organisms, we must be aware of the various parts of their bodies. In this lesson, students will be taught the various body parts of the Atlantic salmon and given an explanation as to their function.

The Core Lesson

Using the worksheet from the ASERP project webpage on external and internal anatomy, this lesson will be a lecture on the anatomy of the salmon. (http://www.fws.gov/r5crc/Salmon/workbook/index.htm)

In order to make the class less lecture based, the definitions of each of the parts of the anatomy can be printed out onto slips of paper. A more interactive version of this lesson can include utilizing an outline of the fish on a board that matches the worksheet and using that to help fill in the worksheet.

Utilize the definitions worksheet and go through the various parts of the salmon. Additional information has been taken from (http://www.pac.dfo-mpo.gc.ca/education/documents/sicprimary-secprimaire/english/sic_primary_unit_3.pdf).

Key Points to Expand Upon

- Lateral Line—helps fish detect movement and vibration in the water. They work similarly to how human hair cells work—if you've ever felt a cool breeze move past you, for example, you've felt the vibration of air particles on your epithelial cells
- Vent—place where excretion occurs
- Teeth—tell us that our salmon eat other fish and small invertebrates. Fish that don't have teeth are generally herbivorous
- Salmon have 6 bony fins—they are bony fish, so this makes perfect sense
- Scales—comparable to human finger nails—they protect the soft parts of the fish
- Swim Bladder—helps control buoyancy of salmon without having them waste energy in changing depth. Similar to lungs, but more dorsal
- Gills—help filter oxygen out of the water. Very close to the heart to help make it easier to use the oxygen effectively

As you go through the lesson, draw the connections to other human anatomy features, giving a general overview of them, and helping students begin to understand their own bodies as well as the bodies of the fish they will be working with.

Conclusion

Use the parallels that the students have created to help them understand fish, and understand the organisms they will be working with in more detail. By the end of the day, students should be able to identify basic external anatomy of the fish.

Alternative Extension

Use a venn diagram to go through the body parts to help draw the parallels between humans and fish throughout the entire lesson. Then have the students brainstorm what types of adaptations some fish-like organisms have developed to help be more human-like (i.e, amphibians, reptiles)

The Science Behind Science

Age group: 8-11

Venue(s): classroom

Materials: 5-10 brown paper bags with mystery objects inside

Time: 30 min

Setup: Gather materials

Lesson Summary

Students will be assigned the task of designing an experiment and carrying it out in order to develop a fundamental understanding of how scientists work. In this lesson, students will be given a brown paper bag with a mystery object, and by using the experiments they develop, they will help to determine what the object is in the bag.

Enduring Understanding

1. In order to reach logical conclusions, scientists must use a methodical and easily replicated experimental procedure and methodology, which can be reached using the scientific method
2. All scientific questions should be answered in a similar manner to create consistency throughout the scientific community

Knowledge and Skills Developed

1. Students will understand and be able to use the scientific method
2. The foundation of how to conduct scientific experiments will be instrumental in helping the students raise their salmon eggs

Introduction

Start students off by asking them to assert some of the assumptions they know about the natural world—Why is the sky blue, Why does the rain fall from the clouds, Why the grass is green, Why fish don't live on the land etc. In general, these questions should push students towards a place where they know these things because someone did an experiment to find the answers. Introduce them to posing questions and developing methods to discover the answers. As they progress towards this idea, start writing down the steps to answering their questions on the board.

Students should be able to see that they are defining a question, making observations, forming a hypothesis, collecting data though defined methods, analyzing and interpreting their data. Introduce them to this as the framework for answering scientific questions, and cite examples of difficult questions that scientists have answered by using these methods.

The Core Lesson

Once students have the framework of the lesson, it is time to put it to the test. They will be split into small groups and given a brown paper bag with a mystery

object inside of it. Using the scientific method, have students try and figure out what is in their bag. They should walk through the entire process—making a hypothesis, writing down their methods and drawing conclusions. Encourage them to use the "If…Then… Because" formula for writing their hypotheses, so as to encourage consequential thinking and rationalization. The conclusions the students draw should be rational conclusions based on the evidence they have collected from their paper bags. Their methods will likely be qualitative, as opposed to quantitative, so they will not be able to perform a data analysis.

Conclusion

Once the students have gone through their experiments and made the conclusions about what they think is in their bag, and then have them present their findings to the class. Once they have prepared for their presentation, each group will go up and present their findings, as well as explain their methods to their peers. Then, when they have concluded what they believe to be in their paper bag, they will open their bags and see what they found.

Feeding Frenzy: Food Webs

Age group: 9-13

Venue(s): classroom

Materials: food web cutouts, Jenga blocks (optional)

Time: 1 hour

Setup: Gather materials

Lesson Summary

In this lesson, students will be exposed to the concept of creating a food web. The best way to examine the impacts of human interference is to examine the impact of removing a link from the food web. In the lesson and demo, students will be asked to create the food web, and then they themselves will make the connection between human action and environmental impacts.

Enduring Understanding

1. For each action, there is a far-reaching reaction, which even though is not felt by humans, is still felt into the natural world.
2. Human impacts in marine ecosystems can lead to the entire collapse of a food web.

Knowledge and Skills Developed

1. Cause and Effect Relationships
2. Reasoning Skills

Introduction

Humans have lived interactively with the natural world for a very long time. In this time, we have made many changes to the natural makeup of the world, such that the so called "human impact" will be felt for generations after our species dies out. The natural progression of the environment moves at a much slower pace than what human interaction has done to it. Over the course of the last 150 years, human interference into natural processes, by industrialization and mass production of goods and services, has created tumultuous environmental issues. In order to demonstrate this point, a short powerpoint introduction could be prepared comparing and contrasting the world from the pre-industrialization era to the world today.

Another key concept to introduce here are trophic levels. Each organism that makes up a food web occupies some trophic level, which will be demonstrated in the core lesson. For now though, introduce the terms.

- **Producer:** an organism that utilizes either light or chemical energy to combine simple sugars and turn them into complex carbohydrates
- **Primary Consumer:** generally herbivorous, consume solely primary poducers
- **Secondary Consumers:** Eat herbivores
- **Tertiary Consumers/Apex Predtors:** Higher level carnivores who eat other carnivores. Apex predators are the highest level consumer in a food chain

- **Decomposers:** Generally organisms that are able to break down the dead animal and plant matter—often referred to as scavengers

The Core Lesson

At the beginning of the lesson, hand out the different organisms in the food web (below). Have the class put the animals in the best order possible. Ask them to construct a giant food web on the board (pieces of paper can either be magnetized or written on the board) using the slips of paper. This activity should be simple, and connections can be drawn between the organisms relatively easily. The type of food web demonstrated can be interchanged—instead of using cod as in the one provided here, salmon can be done.

As students develop the food web, they can also build the Jenga tower concurrently. By building the tower as they create the links on the board between the organisms, the students will be able to understand and figure out the role of each of the links in the food web. Work though the food web, by asking the students what each link of the food web is. A detailed outline of the model food web is below.

Primary Producer: Phytoplankton
Primary Consumers: Zooplankton (Copepods, Krill)
Secondary Consumers: Small Fish (Capelin, Juvenile Cod, Herring), Birds
Tertiary Consumers: Whales, Seals
Decomposers: Bacteria, Benthic Organisms

Once the food web is constructed, the students will then begin disassembling it with anthropogenic influences. Some anthropogenic influences and their results are below.

Industrial Fishing: knocks out Cod, Herring, Capelin
Oil Spill: Knocks out birds
Blubber Harvesting: whales
Seal Hunting: seals
Dredging: destroys benthos

As the sea creatures are knocked out, take blocks out of the Jenga tower. As it goes down, the tower will ultimately fall. Eventually, all that will be left in the food web are the plankton, driving home the point that human interference in the marine environment will ultimately lead to the destruction of the ecosystem.

Conclusion

Following the discussion, students will likely have a lot of questions regarding the “human problem” in the environment. Allow students to ask questions, but try to get them to understand that the impacts that humans make on the environment are not always so catastrophic, and can be reversed and slowed in order to protect the marine systems.

Fish in a Box

Age group: 8-11

Venue(s): classroom

Materials:
- 1 shoebox per group
- Clear plastic strips ~3 inches wide, one per shoebox
- Elmer's glue (teacher may glue plastic to bottom 1/3 of shoebox ahead of time)
- Pebbles or gravel, and sand for the stream bed
- Jelly beans to represent eggs
- White play dough to form alevins if desired

Time: 2 days (1 for lesson, 1 for diorama)

Setup: Gather materials

Lesson Summary

Students learn about parental investment of Atlantic Salmon and how it affects offspring. After learning about the different roles each parent plays, and how this affects their offspring for the first 6 weeks of life, student should use their knowledge, and working as a group or in pairs, build a diorama portraying the stream environment and one of the 2 primary life stages of the Atlantic Salmon. Dioramas can then be displayed and be used for a discussion about what the different groups portrayed.

Introduction

How does life start? All life requires at least one parent to start, most require two. Understanding how much investment each parent puts in to rearing young is the beginning of understanding how different species have different life history strategies and life cycles. With guidance from the teacher students can also discuss what they already know about particular species parental investment and compare these to the Atlantic Salmon. Is one way better than another? Does the environment determine investment or is it something else?

The Core Lesson

Atlantic Salmon are capable of spawning several times over the course of their lives. The maternal investment, which can also be explained as the amount of energy the mother uses to produce offspring, is greater than many other fish. The investment of both parents is shown by the effort of the return trip to the spawning grounds, which they prepare for in the ocean by feeding as much as possible. During the migration upstream the potential parents don't eat. They must swim long distances and sometimes overcome large obstacles such as dams, by way of jumping, fish ladders, or fish elevators, using only the calories (energy) they have already stored in their bodies.

Once the salmon reach their spawning grounds the females prepare the nests, which are called reds, by digging a pit in the stream bed, usually in gravel. The female then lays her eggs in the red, and the males compete with each other to fertilize the eggs. Once the eggs are fertilized the females cover the eggs lightly in gravel so that the eggs are protected, yet water can still flow through bringing both nutrients and oxygen. The egg is the first life stage of the Atlantic Salmon.

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The eggs of the Atlantic Salmon are larger than many other fish eggs. The larger the size of the egg, the greater the maternal investment, because it takes more energy to make a bigger egg than it does energy to make a small egg. What are some other animals that lay eggs? Would it make sense for a chicken to lay an egg that was as big as a baseball? How big would the chick be if it did? What is the relationship to egg size and the size of the offspring at hatching? It can be beneficial to be big sometimes at hatching, and sometimes it can be beneficial to be small? As a class, think of some examples of benefits for each size. For example, smaller offspring may hide from predators more easily, and larger offspring may be better able to compete for food if necessary.

After hatching the offspring are called Alevin. This is the secondn life stage of the Atlantic Salmon. Alevin salmon still have the yolk sac attached to their bodies so that they can feed from that and do not yet need to compete for food. They are still covered and protected by the gravel that lightly covers the red. The water flowing through the red is an important source of oxygen at this point. Why is it important that the alevin are not buried deep in gravel or sand at this point? What would happen if they were? How are alevin unique? Do other species such as birds or snakes still have a yolk attached after they hatch? Why do alevin? Alevin are still too small and undeveloped to compete for food at the time of hatching.

Conclusion:

Fish have unique life history traits that are very different than many other types of animals. The first 2 stages of the life history of the Atlantic Salmon are different from many other kinds of fish because they build reds, lay large eggs, can spawn several times throughout their lives, and after hatching are still attached to the yolk sac. The reds protect the alevin until they are large enough to feed on their own and compete in the stream environment.

Activity

At least one day ahead of the activity, to allow time for drying, the teacher should glue the plastic strip across the bottom 1/3 of the shoebox. The plastic should be attached to 3 of the 4 sides of the box so that student can fill with gravel without it spilling out.

On the day of the activity have students should break in to pairs or small groups and fill the box with gravel up to the top of the plastic strip to represent a side view of the stream bottom. They can then decide how deep they want to make their red, and add either eggs of alevin to the red, and cover loosely with more gravel. After all of the dioramas are complete the teacher should display them and have students discuss the decisions that they made during the construction. These can include how many eggs/alevin they chose to represent and why, how deep the red is, and how well covered the eggs/aelvin are.

Strong and Growing

Age group: 10-16

Venue(s): classroom

Materials:
- 1 ½ notecards per student with a number on the blank side and a multiple choice question about growth and competition on the lined side
- Every fourth card for number 3s should have no question, but indicate the student has been predated (eaten). For number 2s it should be every third card, and for number 1s every other card.
- Stripes, stars, some physical reward to represent parr stripes to hand out to the groups for each correct answer.

Time: 2 days (1 for lesson, 1 for discussion & activity)

Setup: Gather materials

Lesson Summary

Students learn about growth, feeding strategies, and competition of Atlantic Salmon as they grow from frys to smolts. Both large and small fry have costs and benefits that are determined by population density, nutrient availability in the natal stream, and growth rate. This activity has students working together in teams to answer questions based on the lecture. With correct answers students receive their "parr stripes". After answering six questions correctly students have completed their parr stage and are smolts ready to migrate.

Introduction

What factors can we examine to predict the potential success of a young Atlantic Salmon? The speed or rate at which a young salmon grows has both pros and cons, and can be positively or negatively affected by their stream environment. Factors in their environment that may have an affect include population density (how many other young salmon are present in the environment), and the presence of potential predators. The productivity level in the stream (nutrient availability) is also a factor in determining growth and success of young salmon.

The Core Lesson

When Atlantic Salmon are able to feed on their own, they are called Fry. In this stage of life the primary activity of the salmon is to eat and grow as much as possible. Juvenile salmon can be very competitive and territorial when it comes to feeding. During this time they are also vulnerable to predation by other fish and species in the streams.

When the salmon begins to acquire vertical markings known as, parr marks, the young salmon is called a Parr. Parr can stay in the streams feeding and growing for up to 8 years, but the average is two years.

One benefit of growing large quickly is that the salmon reduces its chances of being eaten by a gape-limited predator. Most fish are gape-limited. This means that they can only eat prey items that are smaller than the widest gap they can create with their mouths. As the salmon become larger, smaller predators are unable to eat them. Another benefit of growing quickly is that bigger juvenile salmon are better

Lesson by: Elizabeth Dickinson

able to compete with other fish for food. This is because if there is a nutrient rich area of the stream or current the larger juvenile is able to fight or scare the smaller juvenile away from that area. Also, being gape-limited feeders themselves, larger juveniles are able to consume a wider variety of prey. For example, juvenile salmon often eat zooplankton, and juvenile or adult invertebrates. A small fry may be unable to eat an adult invertebrate because its mouth is too small. If there is an abundance of adult invertebrates the salmon who grows large enough to eat them the quickest, have little to no competition from the other juvenile salmon in the stream. This can result in the salmon being able to eat more, and continue to grow at a more rapid rate than its peers. This is called a positive feedback loop. As the juvenile salmon grow they also increase their swimming speed and may be better able to escape certain predators.

Some negatives of growing quickly are that as the salmon grow bigger they require more nutrients than the smaller salmon and must eat more often. Foraging for food more frequently, exposes the larger juveniles to predation more so than their smaller peers. Also, for species that are selective about their prey, they may tend to only go after the larger salmon because they will provide more food than the smaller ones.

Conversely, smaller salmon must compete with more of their peers and may not be able to access the nutrients it requires for successful smoltification. The smaller juveniles are also exposed to predation from other species in the stream and have a harder time accessing nutrients. This becomes especially difficult if their natal stream is polluted or nutrient poor.

Eventually, if the salmon is successful to some degree, it will gain its parr stripes. When the salmon is in the parr stage it may stay in its natal stream for as little as 1 year or as many as 8 years before it makes its first migration to the ocean. The length of time that the parr stays in the stream is an individual decision that each fish makes.

When the salmon becomes a smolt, it begins the process in the autumn before its migration at which point it goes through changes. These changes include taking on a silver color, completing development of a forked tail, and orienting its body downstream. This is different than its upstream orientation during feeding. After reaching the ocean, the salmon are referred to as post-smolts.

Conclusion

The growth and success of salmon hatchlings comes down to their ability to compete for food and to grow quickly in a safe environment. If the environment is poor due to lack of nutrients or high rates of predation the salmon may not be able to be successful at entering the next life stage. In poor conditions, competition and growth rate can be important determinants of success.

Activity

This activity is intended to show the competitive advantage larger juvenile salmon have over smaller salmon. Group 3 represents the largest salmon, they will be predated the least and have a “feeding” advantage with the card distribution

rules. Group 2 represents the average salmon, and group 1 represents the smallest salmon. While this activity is designed to represent competitive advantage it is important that all students participate and complete the activity. Afterwards, there should be a discussion on what the students thought the groups represented and what if anything was unfair about the way the groups cards were distributed. Then, discuss how this relates to juvenile salmon.

Have students count off in threes, so that in the end there will be three groups each with about 10 students. For smaller classrooms (less than 15 students) this activity can be done with two groups if desired. Put cards labeled 1 in one pile, all the cards labeled 2 in another pile, and all the cards labeled 3 in another pile. All students in group 3 should take 1 card (without reading it) from the 3 pile, all students from group 2 take from the 2 pile, and students in group 1 take from the 1 pile. As a group student should work together to answer 6 questions correctly, for each correct answer the group should receive a "parr stripe". Students who have been predated may still participate in working with the group to answer the questions. If questions overlap or students wish to get another card to try a different question they may do so. Group 1 can pick one card and return to the group, group 2 can pick 2, and group 3 can pick 3. When the group answers 6 questions correctly and has 6 "parr stripes" they are ready to become smolts. All groups should complete the 6 required questions. Follow up this activity with a lively discussion about competition of juvenile salmon. How might other species compete? Is it always good to be big? When is it good to be small?

Migration

Age group: 10-16

Venue(s): classroom

Materials:
- 5 of each of 5 strongly smelling things. These can include items such as oranges, cinnamon, rosemary, rose, etc.
- Enough blindfolds for half the class
- Paper to list the order of migration on
- Prizes of your choosing (enough for everyone)

Time: 1 day
Activity can immediately follow lecture

Setup: Gather materials

Lesson Summary

Students learn about the migration from stream to sea. They will learn about why the salmon migrate to more nutrient rich waters, what the costs and benefits of this migration are, and about some of the challenges salmon face along the way. They will also learn that the kidney function of the salmon changes to make the transition from fresh water to salt water possible.

Introduction

Unlike Pacific Salmon, which must migrate, male Atlantic salmon may choose to migrate to the sea, or to stay in their natal stream until maturity. Most males choose to make the migration. Female Atlantic salmon will migrate to the sea unless they are in a landlocked body of water or are unsuccessful at becoming smolts. The reason for the migration is that the sea (in temperate regions) is much more productive than freshwater environments. This higher productivity provides a larger food base for the salmon and means that they will be able to grow at a rate that is faster than they would grow in the stream environment.

The Core Lesson

Changes in young salmon from parr to smolt begin in early spring. These changes prepare the salmon for life in a marine environment while it is still living in freshwater. These changes include the following: Scales become larger and the salmon takes on a silvery appearance which conceal parr marks. Fins become larger in proportion to the salmon's body and the pectoral and caudal (tail) fins darken to a blackish color. The changing salmon begin to change body position in the stream from a position of facing against the current, to facing downstream for short periods of time. Lastly, the salmon's kidneys begin to change in preparation of needing to filter more saline out of the body.

There is no widespread agreement amongst scientists about any single cause that signals the salmon to change, but it is thought that water temperature may play an important role in signaling the beginning of change.

The age at which parr begin the process of smoltification has been shown to be correlated with the latitude of the natal stream. Smoltification can occur as early as 2 years or as late as 8 years. The farther north the location of the natal stream, the older the parr usually is before the process of smoltification occurs.

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Once the parr becomes a smolt, the salmon begins its long migration to the sea. The start of the migration can occur as early as the beginning of spring, to as late as June. Some smolts begin their migration passively while maintaining an up stream orientation and allowing the current to take them, while others actively swim downstream.

From the time they leave their 'home' area of the stream, it is widely thought that the smolts use their olfactory senses (which are one million times more powerful than humans) to imprint the migration route in to their brains. This imprinting is how the salmon find their way back to their natal streams to breed after living in the ocean. Rarely, salmon get confused on their migration back to their natal streams. These salmon can sometimes colonize new streams and add genetic diversity to local streams.

During their migration salmon face many challenges including predation from birds and other aquatic species, and man-made obstacles such as bridges and dams. Once the smolt makes its way to the sea it is known as a post-smolt and begins its life in the ocean.

Conclusion

The migration of young salmon is no easy task. Their bodies must undergo a variety of changes in order to insure success in reaching the sea, and also to prepare for living in a highly saline environment. The 'choice' to migrate is made on an individual level by each parr, and can happen at a variety of ages and during the course of several months. While this journey is long and dangerous, the post-smolts who make it to the sea have an opportunity to greatly increase their rate of growth.

Activity

Students will migrate from their streams to the sea, and back again, using their sense of smell to lead the way. Before the activity begins the teacher should pass around the five smells so that students can become familiar with them. Then, in pairs, students should assemble on one side of the room. The teacher will set up 25 smells in a grid pattern (5 x 5 rows). Then, one pair at a time, the seeing student will lead the blindfolded student on a migration route to the other side of the room, stopping five times to allow the blindfolded student to smell each of the five stops. The seeing student should record these stops along the way. Once all students are on the other side, the roles are reversed and the other student is led through the migration route. After all students have been led through, they will try to retrace their individual routes one at a time. Students who are successful can receive a prize for making it home. Students who are not successful may receive a prize for successfully diversifying or recolonizing a new stream.

Life at Sea

Age group: 8-11

Venue(s): classroom

Materials: 3 pieces of paper per group, colored pencils, writing utensil

Time: 1 hour

Setup: Gather materials

Lesson Summary

Salmon living in the ocean have very different lifestyles than salmon in streams. Additionally, they face different risks and acquire new strategies for survival and migration. The amount of time spend at sea before the salmons return to the natal stream is an individual choice that seems to be predetermined by choices made as a smolt and post-smolt.

Introduction

Once at sea salmon travel great distances and face a variety of new predators and prey. Not a lot is known about a salmon's life at sea, but it is thought that they tend to feed in large groups in cold waters. Usually after two or more years at sea the salmon uses the Earth's magnetic field and ocean currents to find its way back to the river mouth before migrating upstream.

The Core Lesson

Once at sea, salmon travel great distances. Atlantic salmon that enter the ocean from the western Atlantic such as the US and Canada, and may travel to Greenland, Iceland, and Europe before returning. Eastern Atlantic salmon may travel from Europe to Iceland and the Norwegian sea, some head as far west as Greenland. Not all salmon coming from the same locations take the same route. It is thought that some salmon ride the current of the ocean and move from place to place in this way. Some may follow other salmon, or actively swim to popular feeding areas.

Some salmon do not travel far from the coast after reaching the sea. These salmon tend to return to spawn after only one year; they are called grilse. There is an interesting correlation between the age of salmon at smoltification and the number of years spent at sea before returning to spawn. Scientists have found that the older the smolt is, the less time it spends at sea. Therefore, the median age of salmon spawning for the first time is relatively similar across the board. If a salmon becomes a smolt after only a few years, it tends to spend more time at sea before returning to spawn. There also seems to be some correlation between sea surface temperature and the age of salmon returning to spawn. Some scientists have found that the years where the SSTs are higher, fewer grilse, relative to multi-year salmon, return to spawn.

While at sea salmon forage on small fish, squid, euphausids, amphipods, and eels. Conversely, they are predated by larger fish such as skate, halibut, and cod, seals, and sharks, and of course, humans. When they first reach the sea as smaller post-smolts, fish such as Pollock and squid are able to predate them. This is

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different from the stream environment in that in the stream the main predators lived in terrestrial environments, these include kingfishers and other birds. Salmon are thought to be able to return to the streams by using the currents, chemical signals, and the Earth's magnetic field. Once they reach the stream they rely on the map they created using their olfactory senses on their migration downstream.

Upon entering the stream the salmon undergo changes once again. The males develop a hook on the end of their jaw and both male and female modify their kidney function to process nutrients in the freshwater environment. Although Atlantic salmon are able to spawn multiple times in their lives, many die after the first spawning event. The ones that do migrate back to sea and have undergone the physical changes are protected by law and fishermen must throw them back if they are caught.

Conclusion

As the salmon change their environment, they also change their behaviors to suite the new environment. Additionally their bodies go through physical and chemical changes to acclimate to the new environment. The ability to change both behavior and physiology is different than many other species. What are some species that do not change environment or physiology? What are some species that do? (One example of a species that does would be bears going in to hibernation.) Generally, all anadromous fishes change both behavior and physiology as they move between stream and marine environments.

Activity

Have children work in groups of four to draw 3 Venn diagrams. One should compare the activities of salmon while in the freshwater environment, including movement, eating habits, and social behaviors. The second should compare salmon who migrate to grilse, the environments in which they live, and the dangers they face. The 3rd Venn diagram should compare the migration challenges the salmon faces in the stream to the migration challenges of the ocean? Are some of these more 'natural' or man-made than others? Which environment has what?

The Life of an Atlantic Salmon

Age group: 8-14

Venue(s): classroom

Materials:
- 3 notecards per person
- Tape (to attach cards)
- Yarn (to make boundaries)
- Object to mark the place of the fisherman

Time: 45 minutes

Setup: Gather materials

Lesson Summary

This is the culmination of previous lessons on life history strategies. The lesson is a broad review of the various life stages, followed by an activity which takes students through each stage in a sequential order.

Introduction

Salmon start life in their natal streams, migrate to the sea, and if all goes well, return to their natal streams to breed. Some Atlantic Salmon may not migrate to sea, which is different from Pacific Salmon and some other anadromous fishes. Strategies throughout the life of an Atlantic Salmon come down to individual 'choice'. The 'choices' are based on many factors including location of natal stream, number of individuals in a cohort, level of predation, productivity in both stream and sea environments, ability to migrate, and temperature of water. Atlantic Salmon face many dangers and many do not make it from one stage of life to the next. This activity shows students how difficult it is for each salmon to survive from birth to the first return to their natal stream.

Activity

Outside, in the hall, or in a large classroom the teacher should set up 3 areas that will function as a redd, a stream, and a sea. The boundries of each can be constructed with yarn or whatever may be most convenient. The sea area should be quite large. Students will draw a piece of paper each that tells them what roll they will play. The majority of the papers should say salmon, while others should say fisherman, and at least one ocean predator such as a shark.

Students who are salmon will start in the redd. Fisherman should be distributed along the stream with at least one at sea, and the ocean predator should be in the sea area as well. In the beginning students will move around collecting note cards. After students have collected 3 note cards they may move on to the migration portion and begin the trip downstream. Depending on the number of students there should be 1-4 note cards that have an indication that the student has been predated and that student is 'out'. The students who are moving on should turn in their cards to the teacher in exchange for 2 darkened pectoral 'fins' and 1 darkened caudal 'fin' which should be attached on their arms and back with tape (these can be made by attaching the 3 note cards with tape). The fisherman may 'catch' the salmon by removing 1 fin, if the fin is removed, that student is then 'out'. Students may wait if they want and migrate together as a large group to increase their chances of survival. Fisherman along the stream (1 to 2) must keep at least

Lesson by: Elizabeth Dickinson

one foot planted on a marked spot the entire time, and the migrating salmon must stay within the stream boundary.

Once at sea students are free to move about the area. The predator(s) are also free to move at this time, and should be visually distinct from the other students by unique hat, shirt, or other indicator. Students must make it to 3 different stations in the sea area where they will deposit 1 fin at each station. If a fin is removed by the shark or fisherman that student is 'out'. Students who successfully deposit all 3 fins may return upstream to the red area indicating successfully returning to spawn.

Conclusion

After the activity hold a discussion about it. How many students made it successfully? How many did not? What does that tell us about salmon populations? What skills or strategies did students use to avoid predation? How do those strategies relate to competition amongst salmon cohorts in streams?

Salmon, Insects, and Algae

Age group: 8-18

Venue(s): Outdoors if possible, or classroom

Materials: 15-20 bandanas, large white board + markers

Time: 45 minutes

Setup: Gather materials

Lesson Summary

Through a highly active learning activity, students will illustrate for themselves the dynamic nature of populations, food webs, and life as predator or prey.

Enduring Understanding

- Environment and community require many interconnected systems
- Choices people make can have positive impacts on their environment and community.

Knowledge and Skills Developed

- Students will know that living things need food, water, air.
- Students will know that organisms interact in various ways.
- Students will know that changes in an organism's habitat are sometimes beneficial and sometimes harmful.
- Students will know that systems are made up of subsystems and have inputs and outputs.
- Predicting, analyzing, interpreting, and representing information using creative, scientific, and verbal approaches

Introduction

In order to better understand how people and ecosystems influence one another, let's pause and consider how any population of a living organism influences the populations of other organisms within an ecosystem.

The Core Lesson

Have white board, recorder and dry-erase markers ready to count and keep track of the changing populations at the end of each round. This lesson works best with 20+ students, and it can apply to either ecosystems or watersheds themes. Begin with a brief review of producers, consumers, and decomposers and then focus for a moment on herbivores, omnivores and carnivores and how those groupings translate into predator-prey relationships. In this activity, you'll need one predator (salmon) for every 3 or 4 prey (insects) and every 600 algae (each child can be 100 seeds). Inform kids that their goal will be to STAY whatever organism they begin as, but that they may well become others in the multiple rounds of the activity.

Explain that you will have the salmon turn their backs. Then, you'll send the algae into the stream("algae, disperse!"). After a few seconds, you'll release the insects to find food ("insects, forage!") and then just a few seconds after, the salmon will go hunting for dinner ("salmon, hunt!"). Algae have until you say, "Algae,

bloom!" to find a suitable spot where they think the insects may not find them and eat them. Once the algae have bloomed they cannot move again until you call the group in for the end of the round. Salmon MUST wait until you release them to hunt. Give them time to try to catch an insect but they cannot catch an insect that already has food … that insect is hiding under a rock, eating its algae.

Use your designated call-back sound to bring all players back. They must stand in groups according to what they were at the beginning of the round. Then, ask which insects found algae before a salmon got it. They will remain as successful insects in the next round. Algae that were eaten also become insects, (since they provided food energy for an insect instead of blooming). Did any insects get eaten? They become salmon. (Salmon that caught an insect remain as successful salmon.) Did any insects starve in spite of not being caught by a salmon? Did any salmon starve? All starving animals become algae. Then, did any algae succeed in not getting eaten? They remain as successful algae, reproducing and creating more algae.

You can also add in pollutants that rise through the food chain, and ecologists working to reintroduce locally extinct populations (if salmon all die, it helps to do this to continue the game). This can also lead to some powerful discussions later.

Play five or six rounds of this -- the kids will not tire of it -- then get them in a circle, nice and tired and ready to focus. Review how the populations changed over time using the big graph white board (see below for an additional challenge for more advanced groups). Chances are good that the populations will go up and down and in fact follow each other in rises and falls in population.

Assessment/Conclusion

Once in a circle, have students turn to the person next to them and discuss at least three things that are realistic about this activity? Come back together and have some students share what they came up with. Next, give them a moment to turn to someone on the other side and discuss three things about the activity that are unrealistic. Again, discuss, but this time, when someone shares something they saw as not realistic, ask the group if anyone can think of it may be realistic, but just indirect (i.e. “a salmon doesn’t really turn into algae if it dies” is true, but it is decomposed and then returned to the earth that will provide nutrients to another algae someday). This is a great chance to reiterate, or introduce, interconnections. Was it hard or easy to be a ___? Who here succeeded in remaining the same organism throughout all of the rounds? Why do you think the populations went up and down so much? This is called *dynamic equilibrium* (ooh, big word!). Do the algae influence the insect population? Do the insects influence the algae population? Do the salmon (and so on, through all of the interactions)? In what other ways do plants and animals influence each other's success in an ecosystem? How about people? Are we part of that system?

Alternative Extension

For added challenge, give the students the numbers from the game and have them graph it themselves on the graph page in the journal. They will need guidance

with this most likely. You can also give them a chance to write or create a food web in their journals, then move around and see what they have created

Sources

Adapted from IslandWood's "Owls, Mice and Seeds" game (http://wiki.islandwood.org/index.php?title=Owls,_Mice_and_Seeds)

Zero Food Waste Challenge

Age group: 10-16

Venue(s): Classroom

Materials: butcher paper and markers, computer with internet connection and video projector, containers for holding waste, postal scale

Time: 45 min (initial), up to several weeks

Setup: Gather materials

Lesson Summary

By participating in a challenge to reduce food waste and packaging from lunches, students will learn of the impact their individual actions can have on the environment, as well as ways they can help.

Enduring Understanding

- Inputs and outputs from a system.
- Choices people make can have positive impacts on their environment and community.

Knowledge and Skills Developed

- Use of a scale to measure mass.
- Using charts to map concepts and ideas.
- Students will know that systems are made up of subsystems and have inputs and outputs.
- Predicting, analyzing, interpreting, and representing information using creative, scientific, and verbal approaches

Introduction

Begin by asking students how much trash they think they produce each day. Would it fit in their backpack? How much would their trash weigh? The US Environmental Protection Agency estimates that Americans produce 4.4 pounds of waste every single day, on average! Ask the students where they think their trash goes. The landfill? The recycling? What happens to it after that? Speak about the cycle of materials from natural resources, to consumer products, to landfills. Use "The Story of Stuff", a free online video (20 minutes long) to supplement: http://www.storyofstuff.org/movies-all/story-of-stuff/

The Core Lesson

Now that students have facts and figures about consumption in the United States, ask them how they can help reduce waste by creating brainstorm map on the whiteboard or on a piece of butcher paper. What types of waste do they throw out at school? Suggest waste from school and packed lunches. Ask students what types of things from their lunches get thrown away (possible answers: food scraps, plastic baggies, water bottles, foil, etc). How could the students figure out how much waste they are generating as a classroom? One way is to measure waste by weighing it. Have the class help you design a system to weigh their food waste and packaging waste (also draw out table below on large piece of paper for the classroom to use -- expand horizontally to accommodate days as needed). Be sure to establish how

much the container weighs ahead of time and explain to students that that weight will be subtracted from the number the scale gives

	Container weight	Food waste weight + container weight	(Food waste + container) - container waste = total food waste weight	Packaging waste weight + container weight	(Packaging waste + container) - container = total packaging waste weight	Total waste weight
Day 1						
Day 2						
Day 3						
Day 4						
Day 5						

Each day after lunch, have students separate their food waste and packaging waste into two separate containers to be weighed on a postal scale. Brainstorm with students ways in which they can reduce food waste -- if it's a school-provided lunch, did they eat everything they were given? If they bring lunch from home, could they ask their caretakers to use reusable lunch bags and reusable containers for things like chips, fruit, sandwiches, etc, instead of baggies? Could they bring water/juice to school in a reusable container instead of single-use containers?

As the week progresses, the amount of waste will hopefully drop as students become more conscious of their impact. For a reluctant classroom, a prize could be offered for achieving zero food waste, and/or keeping food waste at zero for a certain amount of time.

Assessment/Conclusion

At the end of the experiment, as students what they did to reduce their impact. Did they alter the packaging they used? Did they make an extra effort to only pack/order as much food as they would need, and no more? Have students brainstorm ways their families and communities could reduce waste -- what about composting? Reusing old containers? Buying recycled products? Emphasize how

students can play a role in reducing out impact on planet earth by starting with their own habits.

Alternative Extensions

Based on students' skill levels, math concepts such as decimal places, subtraction, and even division (how much did each student generate on average?) could be integrated into the lesson. If students are not ready for these challenges, the teacher can perform the math and students can (hopefully!) see the waste weight drop over time.

It is important to make sure no teasing of bullying over lunch contents is happening in the classroom, as students and their families of lower socioeconomic classes may have no control over things like lunches, and may consider themselves to be lucky to have lunch at all (which is true).

Water Drop Perspective Story

Age group: 8-18

Venue(s): Classroom

Materials: pencils and paper for writing, crayons/colored pencils

Time: 45 minutes

Setup: Gather materials

Lesson Summary

By writing a short story from the perspective of a water drop traveling through a watershed, students will learn the various stages of the water cycle and see how humans can impact it, as well as working on writing and storytelling skills.

Enduring Understanding

- Environment and community require many interconnected systems.
- Choices people make can have positive impacts on their environment and community.

Knowledge and Skills Developed

- Students will know that different aspects of geography come together to form an ecosystem.
- Students will know that an ecosystem consists both of biotic and abiotic factors.
- Students will know that changes in an organism's habitat are sometimes beneficial and sometimes harmful.
- Students will know that systems are made up of subsystems and have inputs and outputs.
- Predicting, analyzing, interpreting, and representing information using creative, scientific, and verbal approaches

Introduction

Begin by telling and illustrating your own brief story of a water drop by telling a story. Draw out the basic steps of the water cycle on the whiteboard, and as you tell your story draw arrows indicating where Wendy travels. For example: "This is Wendy the Water Drop. She began her life in the clouds and fell as rain on the forest. She seeped down, down, down through the soil on the forest floor until she met up with a giant group of her fellow water drops in the groundwater that collected under the dirt. Together they flowed down the hill to a tiny stream where insects frolicked -- it tickled when they swam through the water drops! The stream tumbled over a waterfall into a big river, and some of the water drops got flung into the air, creating a cloudy mist. The rest of them, including Wendy, continued their journey downstream. Wendy was swallowed by a swimming salmon, who used some of the oxygen she was carrying to help him swim faster to catch his dinner. Wendy floated by an old factory, where nasty chemicals were leaking into the river. Some of her fellow water drops got nasty chemicals stuck all over them, but Wendy managed to escape nice and clean. She continued down the river until it reached the

ocean, where Wendy met up with a bunch of other water drops that were all salty! Some of them were nice and decided to share their salt with Wendy, so she could be an ocean water drop too. She traveled for miles and miles until suddenly, she was off the coast of Africa! It was really warm at the surface of the ocean, and Wendy felt herself begin to float. What was happening?! Suddenly, she was rising in the air back up to the clouds -- Wendy had evaporated and was back in the clouds once more. Where might she fall next?"

Ask students, what if Wendy had fallen on a parking lot instead of the forest? Or their front lawn? Or on the back of a bear? What would have happened to her then?

The Core Lesson

Depending upon ability/age/grade, have students write for an appropriate amount of time (5-15 minutes) and imagine a story about what else could have happened to Wendy. Review the steps of the water cycle with students as necessary, and have them draw out their story as you had on the board to help them think of where Wendy will journey next. Students with less developed writing skills will be able to tell their story via their illustration if writing proves difficult, using crayons and colored pencils (students who chose to write can use any extra time to color, if they wish).

Assessment/Conclusion

Ask for student volunteers to read their stories aloud (or require each student to share their story, depending on the group dynamics). After each reading, ask the writer how humans might have impacted Wendy's journey, and ask them to explain how the impact could have been reduced -- ask the rest of the class if the writer is stumped. After all stories have been read, go over the stages of the water cycle once more and emphasize the importance of watersheds as ecosystems that humans, animals, and plants depend upon.

Connecting Art and Nature

Age group: 10-16

Venue(s): Classroom and outdoor space (ideally, woodland clearing)

Materials: computer with internet connection and video projector, digital camera for documentation

Time: 15 min inside, 1 hour outside

Setup: Gather materials

Lesson Summary

By using objects from the natural environment, students will develop a better appreciation for the intrinsic value of nature and how it is shaped by humans.

Enduring Understanding

- Beauty and nature go hand in hand.
- Choices people make can have positive impacts on their environment and community.

Knowledge and Skills Developed

- Using art to express thoughts and emotions.
- Manipulating objects and the development of fine motor skills.

Introduction

Begin by introducing students to the work of Andy Goldsworthy, a British environmentalist and artist: https://www.youtube.com/watch?v=AT3lveJmjY8 Ask students: how does Andy make his art? Is he using materials that you usually use in art, like paper and paint or crayons? What is he using instead? How do you think what he's doing impacts the environment? What does looking at his works make you feel?

The Core Lesson

Take students to the outdoor venue and have them stand silently and close their eyes for 15 seconds. What did they hear? The wind? Birds chirping? Cars going by in the distance? Now ask students to cover their ears and observe their surroundings for 15 seconds. How many living things did they witness? Likely, they won't be able to count all of them (be sure to point out how the very ground they're standing on is crawling with life). What does being in nature make them feel? Many will say "happy" or "peaceful", some may say "cold" or "I don't like bugs!" Ask them to create a piece of art using only what they find in their surroundings to create a piece of art that reflects their own positive feelings about nature. Be sure to state that they should use the "Three D's" rule -- they may only use things that are dead, down (fallen), or detached in their art. Give students twenty minutes to create their art, and have a "gallery walk" afterwards, where the entire class observes their peers' work while the creators explain their work -- make sure to give positive reinforcement through "snaps" or polite clapping after each presentation.

Lesson by: Caitlin Kidder

Assessment/Conclusion

Back in the classroom, ask students how they liked the activity. How did it make them feel to be outside? Why does nature matter to humans -- only so we can use it in some way, or so we can appreciate its beauty as well?

Alternative Extensions

Older students could spend more time outside, sketching their work or taking digital pictures of their favorite pieces if there are enough cameras to go around.

Lesson by: Caitlin Kidder

Competing Compost Critters

Age group: 8-11

Venue(s): classroom

Materials: 10-20 gallon aquarium (empty), organic waste, soil (not potting soil), thermometer, trowel, 1-2 dozen earthworms

Time: 45 minutes for initial lesson, up to 1 year for composting

Setup: Gather materials

Lesson Summary

Students will learn how various decomposers work together to break down organic waste and create a rich soil additive that they can make at home.

Enduring Understanding

- Environment and community require many interconnected systems.
- Choices people make can have positive impacts on their environment and community.

Knowledge and Skills Developed

- Students will develop better observation and recording skills
- Students will learn how systems have both inputs and outputs
- Students will learn how decomposers function and work together to create something new from waste

Introduction

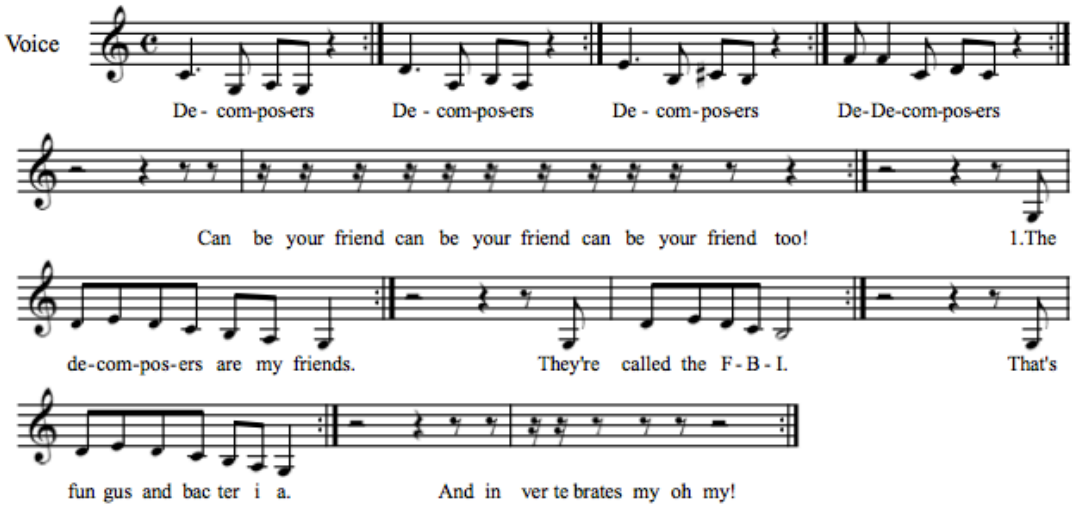
Composting is the oldest form of recycling. It is based on the scientific principle that nothing ever really dies, but just changes shape and takes on new forms. When a leaf falls and begins to decompose, it is broken down by time, weather, insects, and worms into the original materials from which it was made. The same is true for waste we throw away every day, such as grass clippings, banana peels, eggshells, and apple cores. These materials can be set aside for use as fertilizers in gardens and farms

Compost is formed through the action of certain decomposing microbes that proliferate when mixed organic refuse receives sufficient air and water. These bacteria, which generate a temperature of 150 degrees, literally cook the wastes. The finished product, called "compost" or "humus," is an excellent fertilizer and looks just like soil. It is high in carbon and nitrogen, which are important sources of food for plants and vegetables. In addition to being clean, safe, and thrifty, composting can significantly reduce the volume of solid waste generated by a household.

Sing a song about how decomposers!

Lesson by: Caitlin Kidder

Decomposers
(Repeat After Me Song)



Verse 2: The decomposers are my friends.
They turn things into dirt.

And if you do not do your wash,
They just might eat your shirt!

(From IslandWood -- hear a recording of the song: http://islandwood.org/school_programs/school-overnight-program/songs/songs)

The Core Lesson

1. Have the students bring in a variety of organic wastes such as green grass clippings, sawdust, wood ash, leaves, and kitchen food scraps. (Avoid meat scraps, dairy products, fats, and oils, which inhibit decomposition, cause odors, and can attract pests.) Tear or chop the materials into small pieces, leaving a few larger pieces of each type of waste for comparing rates of decomposition. Ask the students if they think there will be a difference.
2. Begin to fill the aquarium, alternating layers of the materials as follows (amounts are approximate): 1 inch of soil; 2 inches of dry, carbon rich, organic waste (i.e., leaves); 1 inch of green grass clippings; and sprinkle of water. Repeat several times.
3. Cover the last layer with a half-inch of soil and water the pile so it is moist, but not soggy-like a damp sponge.
4. Have the students add the earthworms and observe their behavior.

5. Place the compost pile where it will be at room temperature (but not in direct sunlight). Once a week, have a student test the temperature of the pile and vigorously mix the pile to aerate it. For consistency, take the temperature at the same location, depth, and time each week. Make a temperature graph and have each student enter his or her reading.
6. As the class starts to see changes in the pile, discuss the process of composting. How does it reduce the amount of waste thrown out? What happens to organic wastes that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there problems with placing large amounts of organic material in landfills?

Assessment/Conclusion

Have the children write and illustrate a story that explains what they have learned about composting. Where applicable, encourage them to construct a compost pile at home, where they can use the finished compost on the family garden or flowerbeds.

Have the class begin a school garden or "adopt" a particular flowerbed. Have them add the compost they made and plant some flowers or vegetables.