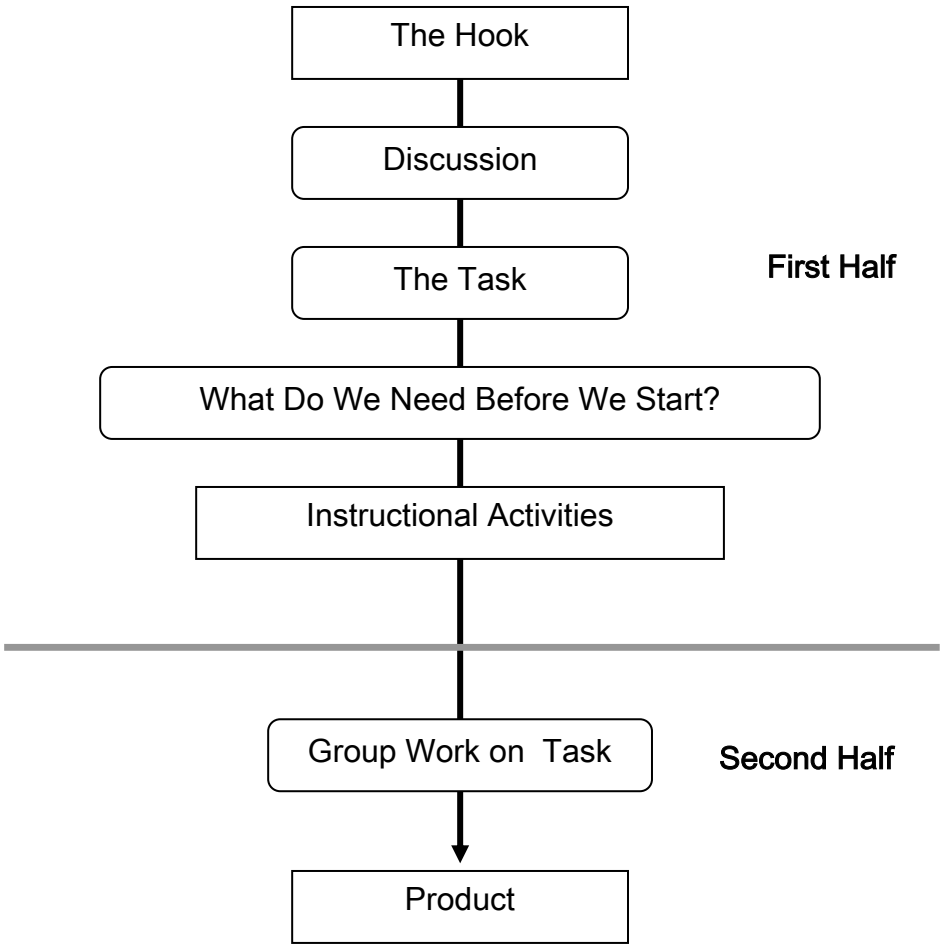
The Event-Based Science Model

This curriculum mini-unit follows the Event-Based Science (EBS) Instructional Model, as developed by Dr. Russell Wright. All EBS modules begin by having students watch television coverage of an actual event of scientific importance, and read newspaper and other media reports. This first step is called the "hook," because it catches students and holds their interest just as a hook catches and holds a fish. Discussion of the event reveals your students' prior knowledge of related science concepts. An authentic Task creates a need for teams of students to refine their knowledge and explore new concepts and processes. Student demands for needed information are met with hands-on instructional activities that prepare them to complete the Task. The Task leads to a final product that allows students to apply the science they have learned and to be assessed on the quality of their work.

Today, literate citizens must know how to analyze problems, ask critical questions, evaluate competing claims, and formulate and test tentative explanations of events. They also need to acquire scientific knowledge and apply it to new situations. An EBS model allows students to accomplish this by placing science in a meaningful context in which they see the role that science plays in the lives of ordinary people.



The schematic at left shows how each part of an EBS module leads to the next.

As a constructivist learning tool, EBS leads us to a new instructional paradigm: the students are the workers and the product is knowledge. In this framework, teachers are coaches, guides, and advisors who support students as they (the students) construct and test their knowledge.

Assessment in this paradigm consists of students exhibiting their knowledge through projects, reports, essays, and problem solving.

Continued on next page...

The Event-Based Science module includes a broad range of activities and strategies. Cooperative learning structures, open-ended laboratory investigations, guided discussions, statistical analysis, and performance assessments are included.

The take home message is this: Be careful not to succumb to the natural desire to pre-teach. Save your augmentation of the module for the discussions that will naturally follow EBS activities. Please note that this doesn't mean you may not help your students as they engage in their discoveries. Of course, you may use all the tricks of the science teaching trade, supplementing the words and activities of the text with your own insights, experiences, explanations, and demonstrations. The key to an Event-Based Science module is that whole-class instruction should be kept to a minimum. Once all EBS activities have been completed, and students are busy working on the Task, encourage them to find information from sources other than you. They can - and should - utilize all relevant media, from the Internet (using scientifically accurate websites) to daily newspapers. Other textbooks, encyclopedias, public health pamphlets, magazine and newspaper articles, maps and atlases are all fair game in their search. It is vital to the preparation of scientifically literate citizens that they become accustomed to finding information on their own.

Adapted from the Preface to Event-Based Science, by Russell Wright, Ed.D.

Migration in the Balance

A curriculum mini-unit addressing CT Science Standard 4.2

Developed by:
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David Heiser, Yale Peabody Museum
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Introduction to the Unit, for Teachers

Global environmental change is arguably the most important scientific and societal issues of the 21st century, and there is deepening concern about the lack of public understanding of its profound consequences. But how can we foster an informed and scientifically literate public, citizens who are able to engage with and begin to understand global environmental change and its impact on humans and other living and non-living components of Earth? While the media cover related topics every day, they often oversimplify the situation and perpetuate misconceptions, for example equating weather with climate. Education about these matters needs to rely on good, current science, and it needs to start early – it needs to start with you!

This event-based science mini-unit, "Migration in the Balance", was developed by Connecticut teachers and Yale Peabody Museum educators to provide an engaging new way to support Connecticut Science Standard 4.2: All organisms depend on the living and non-living features of the environment for survival. The standard is addressed with a focus on global environmental change, including climate change and its many associated effects on ecosystems and living things, enabling students to begin to connect abstract concepts like climate change and habitat destruction with real organisms that they are familiar with.

"Migration in the Balance" is written with 4th grade students in mind, but can be adapted for other grade levels. The mini-unit addresses some basic ecology, including biotic/abiotic factors and the way energy flows through food chains and food webs, but the primary focus is on human-caused environmental change and its effects on the lives of animals. In addition, it supports both of the CMT Expected Performances associated with Standard 4.2: "Describe how animals, directly or indirectly, depend on plants to provide the food and energy they need to grow and survive." and "Describe how natural phenomena and some human activities may cause changes to habitats and their inhabitants." Migration in the Balance is designed to take about two weeks in its entirety. We hope you enjoy it!

Funding for this curriculum was provided by a grant from the Institute of Museum and Library Services.

Migration in the Balance

A curriculum mini-unit addressing CT Science Standard 4.2

Hook

Watch:

http://www.cbsnews.com/video/watch/?id=50143012n

http://youtu.be/zNf-BQct7zs

If your school blocks YouTube, try:

http://www.nbcdfw.com/news/local/Southwest-To-Give-A-Butterfly-1900-Mile-Flight-177193891.html

Read:

http://news.yahoo.com/monarch-butterflies-drop-ominously-mexico-023630858.html

http://blog.mysanantonio.com/monikamaeckle/2012/11/are-monarch-butterflies-the-panda-bears-of-climate-change/

Discussion Questions

What is migration, and why do some animals do it?

What factors might disrupt animal migrations?

Imagine that you are the owner of Southwest Airlines. Would you have helped the monarch butterfly travel to Texas? Why or why not?

Do you think that one monarch butterfly makes a difference for the population of butterflies? Why or why not?

How do you think that monarch butterflies affect the environment?

What are some examples of human-caused global changes?

Migration in the Balance

A curriculum mini-unit addressing CT Science Standard 4.2

Task – Species Conservation Campaign

Teacher Version

Teachers:

The task is a key component of event-based science units. Students are introduced to the task early in the unit, but actual work on the task generally happens toward the end of the unit, after all of the classroom activities have been done. The task is meant to be accomplished in small groups, where each student in the group is assigned a role representing a real-life profession. Students will do independent research in order to supply the information or expertise required of their role. A suggested rubric is provided, but you are of course welcome to design your own! If you give your students a budget for their marketing campaign, you will probably want to come up with a mock menu for the cost of various things like television spots, newspaper ads, etc., but you can also require your students to find out for themselves.

The Task:

There are lots of big changes taking place around the world. Some of these changes are natural, like earthquakes, and have been happening for millions of years. But these days, many of the changes we see are caused by humans – things like pollution, deforestation, climate change, and others. These human-caused changes affect many of the living organisms on Earth – sometimes directly (like destroying an animal's home) and sometimes indirectly (like causing an animal's main food source to go extinct). A very special group of animal species is heavily affected by these global changes – animals that **migrate**. Animals that migrate spend part of their life in one place and another part in a different place – sometimes the journey between these two places is long and dangerous. Some animals, including many birds, actually make these long journeys twice a year, for as long as they live. Their environment includes the places on both ends of their migration plus the path between, and major changes in any of these locations can make life extremely difficult for these animals.

Your task, as a group, will be to choose one of the following ten migratory animal species and come up with a conservation campaign. You need to provide a convincing argument to the general public about why your species is at risk from one or more global changes, and why people should care and do something to help. A campaign can take many forms, but it should involve some type of **marketing** – a way of getting your message to the people you want to reach. This can include things like television, radio, social networks like Facebook and Twitter, brochures, posters, and articles or advertisements in

newspapers and magazines. Your teacher may give you a budget – the amount of money you can spend on your campaign. If so, your teacher will also help you figure out the cost of these different types of marketing.

The species:

- Atlantic Salmon
- Caribou
- Indiana bat
- Monarch butterfly
- North Atlantic right whale
- Osprey (bird)
- Polar Bear
- Red Knot (bird)
- Robin (bird)
- Spotted salamander

The roles:

Each member of the group will take on one of these roles – they represent real jobs in the real world, and the questions you need to answer will give you a sense of what these people do for their work. Please make sure you answer all of the questions completely – you will need to do some background research to accomplish this.

Wildlife Biologist

> **Wildlife biologists STUDY wild animals. They try to learn everything about the animals and what they need.**
>
> ***Guiding question: What does this animal need to have, and to do, in order to survive?***
>
> **Specific questions to answer:**
>
> 1. Where does your species live (both ends of the migration)?
> 2. What is the habitat like in both places?
> 3. How often does it migrate?
> 4. What is the journey like, and where does it stop during its journey?
> 5. What role does your species play in its ecosystems?
> 6. Why is it important? And to what, or to whom, is it important?
> 7. Which abiotic factors are important to your species?
> 8. Where does it fit into the food web? Draw a food web with your species in it, showing the flow of energy from the sun to the top carnivores. See Discovery File on Food Chains and Food Webs if you need help.

Environmental Scientist

Environmental scientists STUDY pollution and other human-caused environmental problems. They figure out what is in the air, water, and soil to find out if the environment is safe for humans and other species. They mostly OBSERVE, but may also give advice on how to clean the environment.

Guiding question: What are the most difficult human-caused challenges facing this species?

Specific questions to answer:

1. What are the global changes (problems or challenges) facing your species, specifically those caused by humans?
2. How are these human-caused changes actually affecting the species?
3. Are the changes affecting your species directly, indirectly, or both? Give specific examples.
4. Would it be possible to stop these changes so that your species was not affected anymore?
5. If so, how would stopping the changes affect humans, particularly the humans involved in causing the changes in the first place?

Conservationist

Conservationists DEVELOP PLANS to help species. They often do this by making a plan to protect the land, water or air that a species depends upon. They use the work of wildlife biologists and environmental scientists to TAKE ACTION.

Guiding question: What can be done to help this species overcome the human-caused challenges it faces?

Specific questions to answer:

1. What is already being done (if anything) to help your species? (see, for example: http://www.defenders.org/north-atlantic-right-whale/success-stories)
2. Are there any strategies that exist or have been proposed?
3. Think of ways to help your species survive if these global changes continue unchanged.
4. Think of ways of reducing the changes themselves.

Marketing Director

Marketing Directors DEVELOP PLANS to try to convince people to think a certain way about a topic or a product.

Guiding question: How can you convince the public to care enough about this species in order to help save it?

Specific questions to answer:

1. What is your public awareness campaign plan? (see, for example: http://www.ontarionature.org/protect/campaigns/woodland_caribou.php, especially the short video at the bottom of the page)
2. Who is your audience?
3. Lay out a detailed plan of action.
4. Write all necessary documents, using information gathered by your team members.
5. Find out the cost of what you are proposing, and keep your plan within the $2,000 budget. Make a list of everything that will cost money, and how much each of those will cost.

There is a Discovery File for each of these ten species that should help answer some of these questions. However, you need to use at least two additional online resources given at the end of the Discovery File to answer the questions that are required of your role. Even the Marketing Director should find and study at least two outside resources, such as taking a look at a current media campaign to protect other animal species that may be in danger.

Your final product should include written reports from the Wildlife Biologist, Environmental Scientist, and Conservationist, along with an outline of your campaign plan and all campaign documents from the Marketing Director.

Migration in the Balance

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Conservation Campaign Rubric

CATEGORY	4	3	2	1
Content- Wildlife Biology	Explains where and why it migrates, AND explains role species plays in food web and why species is important to food web with at least 2 specific details	Explains where and why it migrates, AND explains role in food web with 1 detail	Explains where and why it migrates but does not sufficiently explain its role in the food web	Attempt to explain migration and role in food web may be limited
Content- Environmental Science	Clearly explains problems and challenges species faces due to global changes	Identifies problems and challenges species faces due to global changes	Identifies problems and challenges but may not clearly connect to global changes	Attempts to explain problems and challenges and may not link to global changes
Content- Conservation	Explains what is being done to help species survive now with at least 3 accurate details and evidence of research	Explains what is being done with 2 details and evidence of research	Explains what is being done with 1 detail and evidence of some research	Attempt to explain may be limited and lacking research
Creativity and Originality (Marketing Director)	Product grabs audience with unexpected and novel techniques demonstrating creativity, originality, and imagination	Product engages the audience with imaginative design elements which enhance the original idea or message	Product demonstrates some imagination and may attempt to engage audience	Product lacks creativity
Effectiveness of Message – will audience be motivated to addressing global change issues and/or change their behavior?	Product makes convincing argument, will motivate audience to address global change issues to improve life of the species	Product makes a good argument for addressing global change issues for the sake of species conservation, but may not motivate audience	Product argues for addressing global change issues, but weak link between that and species condition; unlikely to motivate audience	Link between addressing global change issues and improvement of species condition is not brought out; product will not motivate audience
Conventions of English	There are no grammatical mistakes.	There are 1-2 grammatical mistakes.	There are 3-4 grammatical mistakes.	There are more than 4 grammatical mistakes.

Migration in the Balance

Informational Text: Key Ideas and Details - Migratory Animals

Animal species _____

Natural habitat

What does it eat?

Where in the world does it live?

Which ecosystem/biome (example: desert, rainforest, etc.)?

What climate does it prefer (think temperature and precipitation)?

Migration

From where to where?

How often?

Why does it migrate?

Challenges

Natural

Human-caused

Solutions

What can be done to help this species overcome the human-caused challenges it faces?

Migration in the Balance

an Event-Based Curriculum Mini-unit supporting CT Science Standard 4.2

Materials and Specimens Provided in the Kit

What's For Dinner? [Food Web Activity]

- Laminated deciduous forest organism cards (15) plus invasive species (1) plus sunlight (1)
- Blue tape for attaching to wall or whiteboard with minimal tape residue
- Specimens:
    - Red fox skull (real)
    - Raccoon skull (real)
    - White-footed mouse skull (real)
    - Wild Turkey feather (real)
    - Red fox track replicas

Caught in the Web [Food Chain/Bioaccumulation Game]

- 600 poker chips (300 white, 150 red, 150 blue)
- Paper lunch bags labeled with frog, bass and osprey
- Laminated images of a frog, bass and osprey
- Use same orange cones as Migration Game

123 Migrate [Migration Game]

- Laminated migration cards
- 18 hula hoops (3 different sizes, six different colors)
- 1 spinner, matching hula hoop colors
- 4 orange cones for marking boundaries

Global Warming in a Tray [Greenhouse Effect Experiment]

- 12 plastic food containers
- 12 thermometers

Postcards Along the Way

- Master copies of two versions of the postcard, with and without lines

Other materials and supplies

- Bird migration posters (1 laminated and rolled, 4 folded)
- *Red Knot: A Shorebird's Incredible Journey* (book), Nancy Carol Willis
- Osprey egg replica

Migration in the Balance

Peabody Museum Field Trip Assignment

Split the class into 4 groups, one group per section to answer the following questions about their section of the diorama.

The 4 sections are as follows:

#1- Coastal Region Left Section (up to the Hover Fly and Beach Grass- left drawn key section)

#2- Coastal Region Middle Section (from the Spotted Sandpiper to the base of the Osprey tree and Meadow Vole- middle drawn key section)

#3- Coastal Region Right Section (from the Yellowthroat to the Black duck and ducklings – right drawn key section)

#4- Forest Margin Full Section

Teacher Notes:

You might ask how the area would look different today than it does in this diorama. Certainly the beach has no litter/trash on it, but students may notice other differences as well.

Extension – older grades can turn around and consider Native American-related changes too. Note the Native American shell midden in the bottom right corner of the Coastal Region Right Section.

Name:_____ Date:_____

Peabody Museum Assignment:

Diorama Section #_____

1. List 5 biotic factors that you see. Biotic factors are living organisms, including dead organisms that were once alive.
    a.
    b.
    c.
    d.
    e.

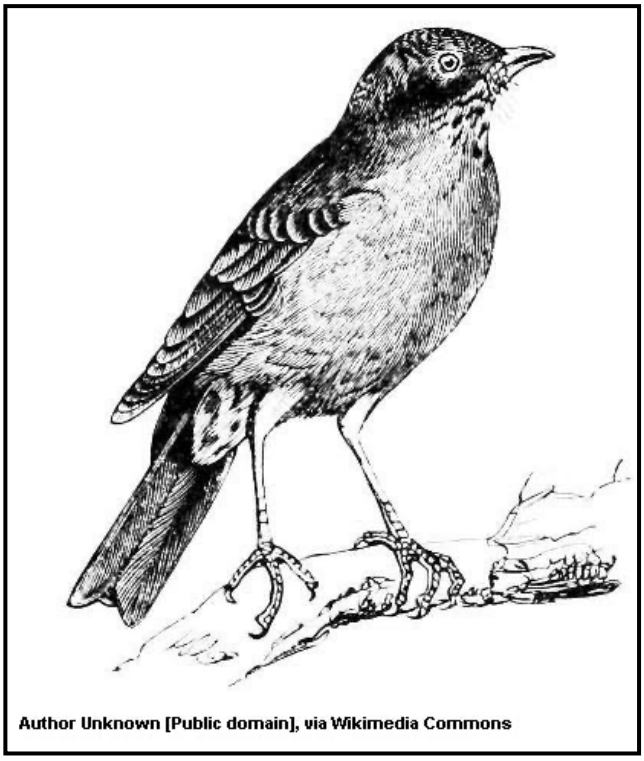
2. List 3 abiotic factors that you see. Abiotic factors are non-living parts of an ecosystem, things that were never alive.
    a.
    b.
    c.

3. Describe one part of the habitat that was changed from its natural state by humans:

4. Pick one animal and discuss how this human-caused change would affect that animal.

5. How could this change affect migratory animals passing through this area?

DISCOVERY FILE: American Robin



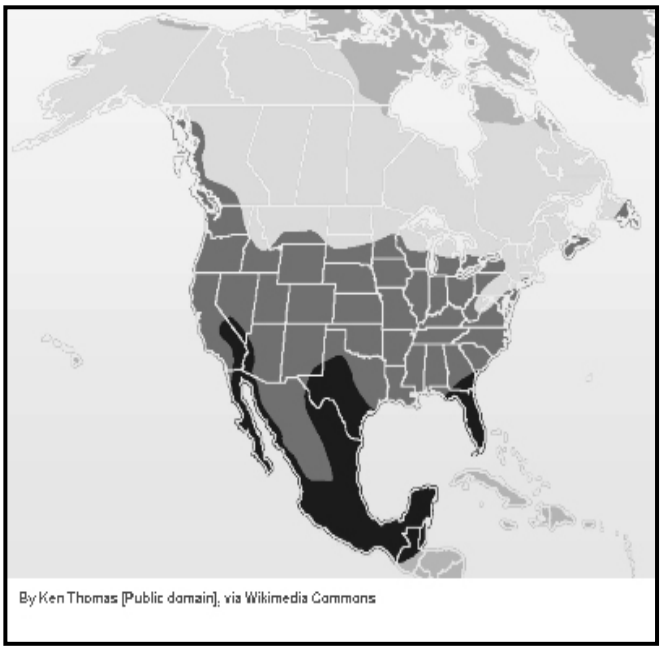
Author Unknown [Public domain], via Wikimedia Commons

Biology & Migration

The American Robin is a familiar sight to most people in Connecticut. American Robins are medium size birds that belong to a family of birds known as the thrushes. Another well-known thrush is the Eastern Bluebird.

Robins have a dark gray back and tail, with a darker head and rusty colored chest. Their beaks are yellow and they have a white ring around each eye. Robins are excellent flyers, but they are often seen on the ground hopping and running. Robins are known for finding and eating worms, but berries are also a very important part of their diet. This is especially true once the weather turns cold and worms move deep underground. When food becomes scarce, robins will migrate south to a place where they can find enough food.

The light gray areas on the map to the right show areas where robins can be found only in the warmer months. Birds that nest in this area must move south because the temperatures in this region are so cold in the winter. The dark gray areas are areas where robins can live all year long. These areas have a moderate climate in the winter and have a steady source of food for the robins



By Ken Thomas [Public domain], via Wikimedia Commons

Fun Facts about the American Robin:

The scientific name of the American Robin is *Turdus migratorius*, which means migrating thrush.

The American Robin is a popular symbol. It is the state bird of Connecticut, Michigan and Wisconsin.

The American Robin received its name from early European settlers who saw the bird and thought it looked like a bird they knew from Europe - the Robin Red-Breast or European Robin. The two species though are not closely related.

Robins can fly more than 30 miles an hour.

Robins don't eat seed, so you won't find them at a bird feeder. Their beaks are not adapted for cracking seeds, and they can't digest seeds either.

even in the winter months. The black areas on the map are places robins can be found only in the colder months of winter. These places are too hot in the summer for robins.

Environmental Science – Global Changes

It was once a rare sight to see a robin in the winter in Connecticut, but now many people see robins all through the winter. Scientific research supports these observations. Forty or fifty years ago, scientists could only find about 1000 robins in the entire state of Connecticut during the winter months. However, the number of winter robins has been growing quickly, especially in the past fifteen years. Now it is not unusual to find more than 40,000 robins in Connecticut in the winter!

Two factors are responsible for this dramatic change. The first is warming temperatures. A milder climate makes it possible for many plants that produce berries to be successful and produce more food for robins. Some of these plants have been here all along, but others have been introduced to the state from other areas. These plants can spread quickly by producing lots of seeds that are contained in their berries. Robins and other birds eat the berries and unknowingly spread the seeds wherever they fly. The second factor is habitat change. Humans have changed the environment by cutting down forests and building homes and buildings with lawns that provide habitat for robins.

Conservation – How to Help

There are more robins in North America than almost any other species of bird. While this is good for robins, having so many more robins than in the past can affect other species. There may be ways that we can change the habitat around us to make it less inviting to robins so they will return to their migratory ways and make room for other native species.

1. Protect forests from development. The forest is a complex habitat that supports a great variety of native plant and animal species.
2. Remove non-native plants that provide such an overabundance of food for the robins.
3. Replace areas of lawn with gardens that have a variety of plants that will help feed many species of birds and other wildlife.

Resources:

http://www.allaboutbirds.org/guide/American_Robin/lifehistory

http://www.learner.org/jnorth/search/Robin.html

http://animals.nationalgeographic.com/animals/birding/american-robin/

http://www.nhregister.com/general-news/20130223/robin-roulette-over-wintering-birds-gamble-that-they-can-survive-winter

ATLANTIC SALMON

Image: Tim Knepp, USFWS (Public Domain), via Wikimedia Commons

Biology and Migration

The Atlantic salmon is a fish that got its name because it spends part of its life in the Atlantic Ocean. It's an **anadromous** fish, a really interesting kind of fish that starts its life in a freshwater stream, then migrates downstream to the ocean, and then years later migrates back to the freshwater stream where it first hatched so that it can reproduce. Many Atlantic salmon (Latin name: *Salmo salar*) begin their lives right here in Connecticut, hatching out of their eggs in tributaries (smaller streams that flow into bigger rivers) on the Connecticut River. That was until humans got involved.

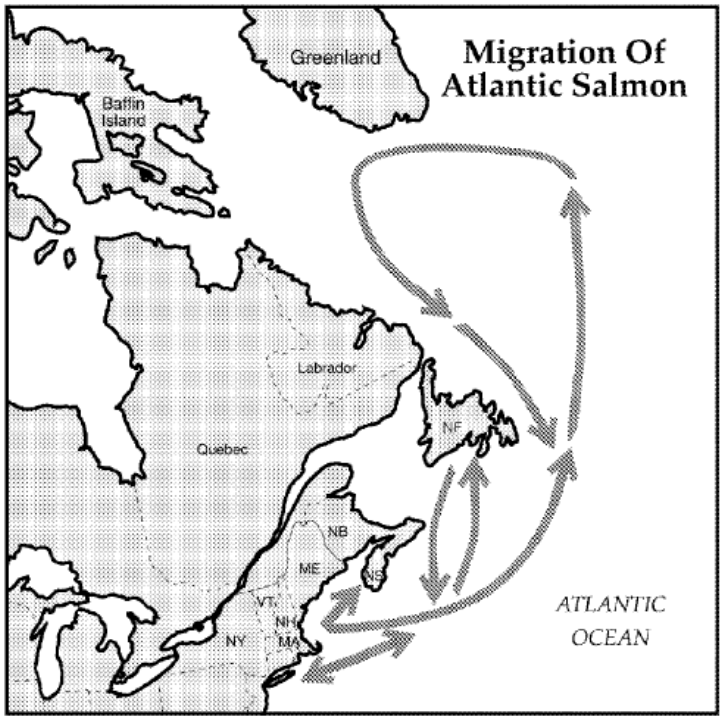


Image: USFWS (Public Domain), via Wikimedia Commons

Environmental Science - Global Changes

About 100 years ago, people who lived in Connecticut relied on the Connecticut River for many things. They relied on it for food (smoked salmon - yummy and healthy!) as well as for their livelihood and jobs. By building dams along the Connecticut River, factories were able to make all sorts of products with the energy produced by the water running through the dams. Great for us, but not so great for the salmon. Salmon are born here and then swim downstream and out to sea for much of their lives. They may swim over 1000 miles away but will always return to the same

Facts about Atlantic Salmon:

U.S. Atlantic salmon were once native to almost every river north of the Hudson River; wild populations are now known in only 11 rivers.

Female fish returning to spawn, after spending two winters at sea, will lay an average of 7,500 eggs, of which only about 15-35% will survive to the fry stage.

stream where they were born to spawn and lay their own eggs. When the salmon returned to find that they couldn't swim back because they were blocked by the dam, they could not finish their migration and lay new eggs. Water pollution and higher water temperatures have also made life difficult for the salmon. Within a short period of time, all the Atlantic salmon in the Connecticut River were gone.

Conservation – How to Help

It didn't take long for people to realize what had happened to the salmon. Many people were concerned about what was happening in the river due to human impact and decided to try and come up with a solution that worked for both humans and the salmon. Their solution was to leave many of the dams there, but to build special "fish ladders" for the fish to use to get over the dam. Fish ladders? How are fish going to climb a ladder when they have fins instead of arms and legs!? Well, with a little creativity and thinking like a fish, marine biologists developed a fish ladder that looks something like this. It really looks more like fish steps than a fish ladder! The salmon are good jumpers and can easily jump shorter heights like these steps, and they will work their way right up! With the creative thinking and devotion of many people to help our environment, we were able to come up with a solution to help the salmon.

Image: Nilfanion (Own work) [CC-BY-SA-3.0], via Wikimedia Commons

Sources:

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

http://www.nmfs.noaa.gov/pr/species/fish/atlanticsalmon.htm

http://www.fws.gov/R5CRc/Fish/visit.html (info about where to see salmon in Connecticut and Massachusetts)

http://www.loe.org/shows/segments.html?programID=11-P13-00038&segmentID=6 (this is a 10-minute audio segment about removing dams to benefit salmon on the Penobscot River in Maine)

http://www.arkive.org/atlantic-salmon/salmo-salar/ (reading level is higher than grade 4, but there are a lot of good photos and information here)

CARIBOU

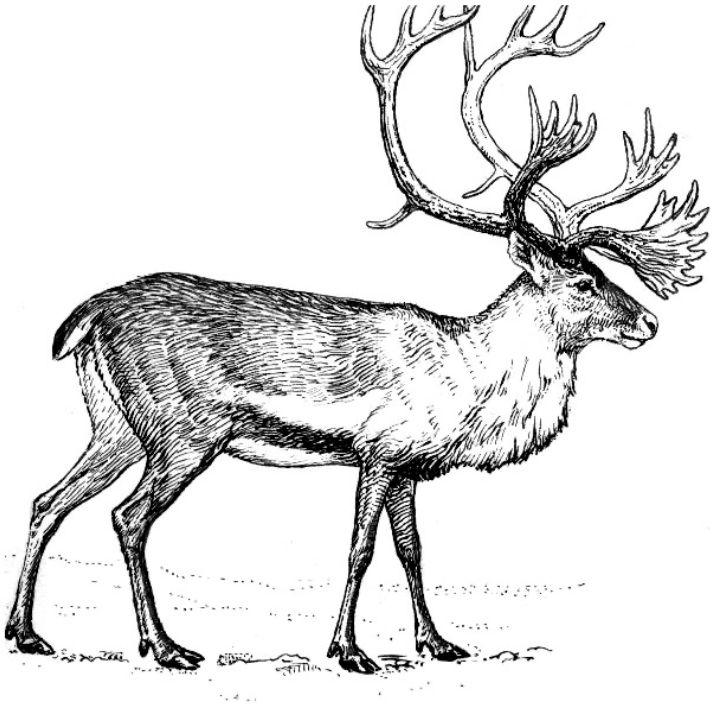


Image: By Pearson Scott Foresman (Public domain), via Wikimedia Commons

Biology and Migration

The caribou (Latin name: *Rangifer tarandus*) is a type of deer – they have hooves for feet and they grow a rack of antlers every year. With the deer you might have seen in Connecticut, only the male deer grow antlers, but with caribou both the males and females grow antlers. Their antlers grow each year and then are shed (fall off) in the fall or winter. Caribou eat only plants, especially a kind of lichen known as reindeer moss, but also grass and leaves from certain trees. They live in the Arctic tundra and the taiga (boreal forest), where they are well-adapted to the cold climate. This map shows the caribou range – where they live – in North America. The different shades are for different subspecies. Caribou also live in northern Russia, Norway, Sweden and Finland.

Map by Cephas (Own work) [GFDL or CC-BY-SA-3.0], via Wikimedia Commons

Fun Facts about Caribou:

Reindeer are actually caribou – they are called reindeer in some parts of the world. In some places, reindeer have been domesticated and are used to pull sleds.

Caribou win the prize for the longest-distance migration of any land-dwelling mammal, with some herds traveling 3,100 miles each year!

Caribou are fast – even a day-old caribou could outrun Usain Bolt, one of the fastest Olympic sprinters.

The largest male caribou can weigh up to 700 pounds!

CARIBOU

Although not all caribou populations migrate, most herds in North America spend the summer in the northern parts of their range, and then move to a different place for winter where the snow and cold temperatures are not so harsh. They migrate mostly for food – in the summer, there is plenty of lichen and other food for the herd in the north, but it becomes covered with snow in the winter. Some caribou herds are so large that they actually have to keep moving all the time so that they don't run out of food to eat!

Environmental Science – Global Changes

Caribou are facing a number of threats, mostly related to human-caused global changes. Climate change has probably affected them the most, with the following important effects on their well-being:

- The snow melts earlier in their summer range, and the young plants begin to grow earlier as well. Plants are easiest to eat and digest when they are very young. Even though the caribou herds are arriving at the same time of year as they always have, the plants are now harder to eat and digest.
- Caribou don't have a lot of natural defenses against biting and blood-sucking insects like blackflies and mosquitoes. Warmer summers have led to more biting insects, which disturbs their feeding and in some cases causes the loss of a lot of blood.
- Because winters are not as cold as they used to be, caribou often have to deal with freezing rain instead of snow. It is fairly easy to push snow aside to get to the lichen and plants underneath, but almost impossible to break through the icy layers left by freezing rain.

One of the other major threats to caribou, particularly in the boreal forest, is human and industrial development. Caribou often can't or do not want to cross major roads or other barriers that humans have created. For an animal that migrates, this can make it very difficult to get where you are trying to go!

Conservation – How to Help

Most conservation efforts have to do with providing a safe way for them to cross human-made barriers. In some places, people have constructed bridges over highways specifically built for wildlife to use to get across. In other cases, oil pipelines have been constructed far enough off the ground for caribou and other wildlife to pass safely beneath.

More generally, we can help the caribou by doing our best to limit global warming. There are lots of ways you can help – see Polar Bear Discovery File for some specific ways.

Sources:

http://kids.nationalgeographic.com/kids/animals/creaturefeature/caribou/

http://www.defenders.org/woodland-caribou/what-defenders-doing-help

http://www.ontarionature.org/protect/campaigns/woodland_caribou.php (this page includes a 30-second video at the bottom that shows an example of a conservation campaign strategy)

http://www.arkive.org/reindeer/rangifer-tarandus/ (reading level is higher than grade 4, but there are a lot of good photos and information here)

DISCOVERY FILE: Indiana Bat

U.S. Fish and Wildlife Service, via Wikimedia Commons

Biology and Migration

Indiana bats are quite small; they weigh 1/4 of an ounce, which is the mass of about three pennies. Their body is about the size of your thumb. In flight they have a wingspan of 9 to 11 inches. Their fur is dark-brown to black.

Indiana bats live an average of 15 years and produce only a single pup each summer. Female bats form maternity colonies and bear and raise their pups together from early May to late June. During the summer they roost (sleep) under the peeling bark of dead and dying trees. They eat a variety of flying insects found along rivers or lakes and in uplands. In the late summer and early fall, Indiana bats **migrate** (to move or travel to another area or region, sometimes at regular or annual times) to the place they will spend the winter. They hibernate during the winter season in **hibernacula** (caves, and occasionally abandoned mines bats use for hibernating).

Fun Facts about the Indiana Bat:

The scientific name of the Indiana bat is *Myotis sodalis*, which means "mouse-ear" and "companion". It has ears like a mouse and likes to roost with friends and family.

Bats help control insects, eating over 1,000 mosquitoes, moths, and other nighttime insects per hour!

Female Indiana bats group together in the summer under tree bark to care for their pups.

Indiana bats are sometimes called "the social bat" because they cluster tightly together during hibernation.

Environmental Science – Global Change

Indiana bats are found over most of the eastern half of the United States. Almost half hibernate in caves in southern Indiana. The 2009 population estimate is about 387,000 Indiana bats. This is less than half the bats that were living in 1967 when the bats were listed as an endangered species. Their numbers had increased between 2000 and 2005 thanks to conservation efforts, but then decreased again due to a disease caused white-nose syndrome.

USFWS midwest (Flickr: Indiana bat (*Myotis sodalis*)) [CC-BY-2.0], via Wikimedia Commons

The Indiana bat is an endangered species, partly due to people disturbing hibernating bats in caves during the

winter. Indiana bats are vulnerable to being disturbed because they hibernate in large numbers in only a few caves. Other threats include using caves for tourism. When humans change cave entrances, they also hurt the bat's ability to move freely in their caves. These changes to caves cause change in air flow, temperatures, and humidity levels. Loss of summer habitat, exposure to pesticides and other contaminants, and the white-nose syndrome (see below) all contribute to the Indiana bat's endangered status.

White nose syndrome (WNS) is an illness that has killed over a million bats since 2006, when dead and dying bats, with a distinctive "white nose" were first observed.

Conservation – How to Help

Humans can manage forests to maintain and create Indiana bat habitat. Indiana bats like to live in older forests that have large dead and dying trees, so cutting down mature forests is not good for the future of Indiana bats. Keeping forested land at least 25 feet wide along streams, ponds, lakes, and wetlands will help the bats survive.

Resources

ArKive – Explore Endangered Species
http://www.arkive.org/indiana-bat/myotis-sodalis/

Indiana Bats, Kids and Caves, Oh My! An Activity Guide for Teachers:
http://www.whitenosesyndrome.org/sites/default/files/resource/inbakidscavesohmy.pdf

BioKids Indiana Bat fact sheet
http://www.biokids.umich.edu/critters/Myotis_sodalis/

Indiana Bat fact sheet from the US Forest Service:
http://www.fs.fed.us/r9/wildlife/tes/indianabat.htm

DISCOVERY FILE: Monarch Butterfly

Ryan E. Poplin [CC-BY-SA-2.0], via Wikimedia Commons

Biology and Migration

The Monarch butterfly is a **pollinator** (an insect that carries pollen from one flower to another). It has four life stages: the egg, the **larva** (caterpillar), the **pupa** (resting stage or **chrysalis**) and the adult butterfly.

Adult Monarch butterflies lay eggs in March and April on milkweed plants. The eggs hatch after about 7-10 days. Dry conditions and temperatures above 95°F (35°C) can be deadly to the development of the butterfly and to milkweed plants as well. When the eggs do hatch, the caterpillars will feed on the milkweed plants.

Milkweed contains **toxins** (poisons) that are harmless to the Monarch. However, these toxins remain in the adult Monarch's body making poisonous to its predators. An adult Monarch will feed on nectar from a variety of flowers including milkweeds.

In spring, summer and early fall Monarchs can be found wherever there are milkweeds. Monarchs cannot survive freezing temperatures and neither can milkweed. So in the winter, Monarchs from the east of the Rocky Mountains **overwinter** (spend the winter) in the Oyamel fir forests in central Mexico.

An adult Monarch typically lives four to five weeks, but each autumn a special group emerges. These special butterflies will live seven to eight months, and they are born to make an incredible journey. When the days begin to get shorter and the air gets colder, the butterflies sense it is time to **migrate** (to move or travel to another area or region, sometimes at regular or annual times).

Derek Ramsey (Ram-Man) (Own work (Own Picture)) [GFDL 1.2], via Wikimedia Commons

Fun Facts about the Monarch butterfly:

The scientific name of the Monarch butterfly is *Danaus plexippus*, which means "sleepy transformation", referring to its amazing life cycle.

A Monarch butterfly can travel up to 3,000 miles to reach its wintering ground in Mexico.

Scientists track the Monarch migration by putting a sticky tag on the wings of the butterflies.

A Monarch caterpillar will increase in size 3,000 times from the day it hatches to when it becomes a chrysalis.

A Monarch's bright orange color tells predators "Don't eat me, I am poisonous!"

DISCOVERY FILE: Monarch Butterfly

Early fall, as many as 100 million monarch butterflies migrate from northern parts of North America to California and Mexico. Monarchs can fly up to 3,000 miles (4,500 km) just to reach their overwintering place. It may take monarchs up to two months to their winter place. This place is cool and moist. Monarchs will gather on trees forming clusters to stay warm. The temperature ranges from 32°F - 60°F (0°C - 16°C). When warmer temperatures arrive in March, this will signal the monarchs to begin the journey back north. The Monarchs that overwintered in Mexico will make it about halfway to their summer habitats before they lay their eggs and die. It will take about four more generations of their shorter-lived offspring to complete the journey.

Environmental Science – Global Changes

Although the monarch butterfly is not on the endangered species list, their yearly migration is considered an endangered event. Monarchs are in danger of losing their summer and winter habitats. Summer habitats and milkweed are destroyed as more houses, roads and businesses are built. In many places people use chemicals to kill milkweed. Winter habitats have been damaged and lost as the land is **logged** (to cut down trees). Lastly, climate change has also been threatening the monarch's migration. Colder, wetter winters could be deadly to the butterfly and hotter, drier summers could shift suitable habitats north. Unusual patterns of drought and rainfall could have an effect on milkweed plants.

Conservation – How to Help

To help, people in many places are planting milkweed plants in their gardens, yards and schoolyards. These plants provide places for Monarch butterflies to lay their eggs, food for caterpillars and nectar for adults. Other flowers that are planted will also provide important nectar for these butterflies.

Resources

BioKids
http://www.biokids.umich.edu/critters/Danaus_plexippus/

Monarch Watch
http://www.monarchwatch.org/

Journey North
http://www.learner.org/jnorth/tm/monarch/jr/KidsJourneyNorth.html

Exploring Nature Educational Resource
http://www.exploringnature.org/db/detail.php?dbID=32&detID=1209

National Geographic Kids
http://kids.nationalgeographic.com/kids/animals/creaturefeature/monarch-butterflies/

DISCOVERY FILE: North Atlantic Right Whale

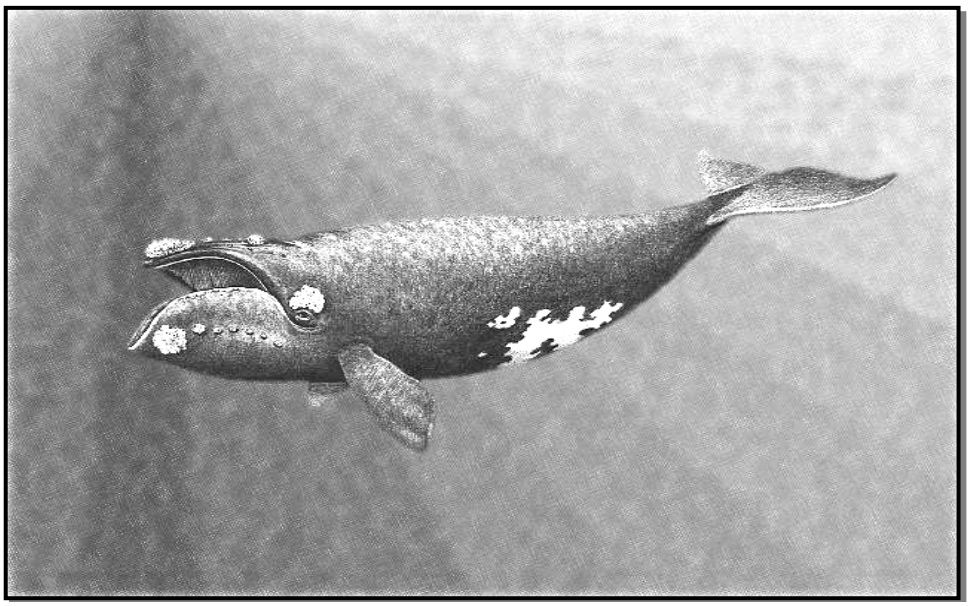


Image: Public Domain: http://swfsc.nmfs.noaa.gov via Wikimedia Commons

Biology & Migration

North Atlantic right whales are large marine mammals measuring up to 60 feet in length and weighing up to 80 tons. Scientists believe they can live up to 100 years. North Atlantic right whales can be identified by their overall dark color, "upside-down smile," V-shaped water spout, paddle-like flippers, smooth back (no dorsal fin), and white rough patches on the head called callosities.

North Atlantic right whales feed on tiny organisms such as krill and copepods. They filter these tiny organisms out of seawater using long fringed strips of a fingernail-like substance called baleen. The baleen hangs from the roof of the whale's mouth when it is open. Right whales often feed on the surface, scooping up mouthfuls of food and then pushing out the seawater through the baleen strips.

Illustration by E. Paul Oberlander©Woods Hole Oceanographic Institution (with permission)

Many North Atlantic right whales migrate along the coast of North America. They spend the summer feeding in the coastal waters of New England and eastern Canada, while their wintering grounds are located off the coast of Georgia and Florida.

Facts about Right Whales:

The scientific name of the North Atlantic right whale is *Eubalaena glacialis,* which means "true whale of the ice".

The right whale received its common name from whalers because it was the right whale to catch. Right whales swim slowly, migrate near the coast, and contain a large amount of oil.

The callosities on a right whale's head are different on each animal. Scientists use the size and shape of the patches as a way to recognize each whale they study.

Female North Atlantic right whales give birth to one baby – called a calf – every three to 5 years. Calves weigh about 1 ton at birth and measure 15 feet long!

DISCOVERY FILE: North Atlantic Right Whale

Environmental Science – Global Changes

North Atlantic right whales are an endangered species. Scientists estimate there are only 300 to 500 remaining in the world. Even though the species is protected, it is difficult for the population to grow because very few calves are born each year. And human activities are still a danger to the whales even though they are no longer hunted. Large ships sometimes collide with North Atlantic right whales traveling to busy ports such as Boston, New York and Halifax in Nova Scotia. Collisions often kill or serious injure the whales.

Whales swimming in coastal waters can also get tangled in long fishing nets and are affected by chemical pollution and litter that enters the ocean from rivers onshore. Changes in ocean temperatures caused by warming global climates are also making it more difficult for North Atlantic right whales to find enough food to stay healthy and have healthy calves. Because of all these challenges, scientists are concerned that the North Atlantic right whale may become extinct within 100-200 years, even though it is a protected species.

Conservation – How to Help

People are working hard to find ways to save these ocean giants. Scientists and concerned citizens from around the world have formed an organization called the North Atlantic Right Whale Consortium to guide the research, conservation and management actions. Together, they are working to ensure the long-term conservation and recovery of right whales in the North Atlantic. We can also do our part to help protect their habitat by preventing water pollution and litter in waterways that lead to the ocean.

Changes that have been adopted to help North Atlantic right whales include:

1) protecting important whale habitat
2) new rules that require ships to slow down while they pass through areas where North Atlantic Right Whales are known to feed
3) guidelines that prevent fishing vessels from setting their nets in known whale migration and feeding areas

Resources:

http://www.nmfs.noaa.gov/pr/pdfs/education/kids_times_whale_right.pdf

http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northatlantic.htm

http://www.whoi.edu/page.do?pid=14938&tid=3622&cid=28507

http://www.narwc.org/index.php?mc=2&p=2

http://www.learner.org/jnorth/search/RightWhale.html

DISCOVERY FILE: Osprey

By NASA [Public domain], via Wikimedia Commons

Biology and Migration

Ospreys are large black and white fish-eating raptors. Their average length is about two feet and their wingspan is between 58 and 72 inches, or around five to six feet. Adult ospreys weigh between 2 and 2 ½ pounds. They can live 15 to 20 years in the wild. When flying, Ospreys hold their wings back in an "M" shape.

Ospreys eat almost entirely fresh-caught fish. When ospreys hunt, they hover 30 to 50 feet over water near shore, looking beneath the surface for fish. Once they spot their prey, they dive feet first to catch fish. If successful in grabbing a fish, they carry the fish with its head pointed in front. This helps the osprey to fly easier.

In Connecticut, Ospreys live mostly along the coast. They build nests usually at the end of March. Often the male finds the site before the female arrives. Nest building continues through the middle of April.

Ospreys nest in tree tops, poles, towers, sometimes roof tops, chimneys, navigation buoys, rock pinnacles, stick piles, and even on the ground. They never build nests far from water. Materials include sticks, grass, seaweed and mud.

Ospreys begin their long journey south for the winter starting in September. The ospreys that nest in Connecticut migrate to spend

Fun Facts about the Osprey:

The scientific name for Osprey is *Pandion haliaetus* and comes from the mythical king of Athens, Pandion, whose daughters were turned into birds; "haliaetus" is Greek for sea eagle.

An Osprey may travel more than 160,000 migration miles during its 15-to-20-year lifetime.

Scientists track Ospreys by strapping satellite transmitters to the birds' backs. During 13 days in 2008, one Osprey flew 2,700 miles—from Massachusetts, to French Guiana, South America.

Ospreys mate for life, but will often find another mate if one of the pair dies.

Males and females in a pair bond migrate separately and reunite at their nesting sites each spring.

the winter along the Gulf of Mexico, the Caribbean, as well as Central and South America. Parents don't teach their young where to go, because they migrate first.

Environmental Science – Global Changes

About fifty years ago, ospreys were almost wiped out because of the use of DDT -- a poison that was sprayed on crops to kill insects. This poison became concentrated in the bodies of ospreys. Scientists discovered that DDT prevented birds' eggshells from forming properly and hardening. Many of the eggs would break when the mother birds sat to incubate them, so their offspring never hatched. Numbers of ospreys declined at an alarming rate. Partly because of a famous scientist and writer named Rachel Carson, DDT was banned from being sprayed on crops to kill insects.

Wildlife biologists have been concerned that Ospreys get other poisons in their tissues. High levels of mercury have been found in Ospreys. Mercury cause many health problems in animals. Other problems for Ospreys include getting caught in rope in the nest and not having dead trees to nest in. People have removed tall trees that Ospreys chose for their large nests. Recent storms have brought down many of the remaining trees.

Conservation – How to Help

Conservationists have helped Ospreys by building nesting platforms. Partly because of this, Osprey populations have grown. There are many organizations who teach the public about Ospreys. By protecting marshes and keeping beaches unspoiled, Ospreys will do better.

Resources

Here is a link to the real time "Osprey Cam" at Milford Point in Connecticut. Ospreys can be seen in the nest in the spring and summer.
http://www.ctaudubon.org/2011/04/osprey-cam/

Websites

http://www.biokids.umich.edu/critters/Pandion_haliaetus/

http://www.allaboutbirds.org/guide/osprey/lifehistory#at_behavior

http://animals.nationalgeographic.com/animals/birds/osprey/

http://www.arkive.org/osprey/pandion-haliaetus/ (reading level is higher than grade 4, but there are a lot of good photos and information here)

POLAR BEAR

Image: USFWS Headquarters (Polar bear with young, Arctic NWR) [CC-BY-2.0], via Wikimedia Commons

Biology and Migration

Long before humans ever lived near the Arctic Circle polar bears have been roaming the sea ice, hunting, or making dens for their cubs to be born in. They spend some time on land but the sea ice that expands in the winter is critical for their survival. The life of a polar bear goes in yearly cycles that are directly related to their environment. Polar bears depend on the sea ice as a platform for hunting seals, an essential part of their diet.

During summer months the polar bears will move on land when the sea ice has melted but will move back out onto the ice for the winter and spring to hunt.

Polar bear range – they are only found in the Arctic regions of the world
By maplab; kvarki1 [CC-BY-SA-3.0], via Wikimedia Commons

Fun Facts about Polar Bears:

They keep their eyes open, ears flattened to their heads, and close their nostrils while swimming.

They can stay underwater for up to two minutes.

They are capable of leaping out of the water seven to eight feet to catch seals or other prey!

These remarkable bears have an additional transparent eyelid (nictitating membrane) that we don't have. It works like sunglasses to help filter out the brightness of snow and sun, and like waterproof goggles underwater.

Polar bears are surprisingly fast. On land, they can outrun almost any arctic animal (even caribou) for short distances, moving at speeds of 25 miles per hour. Polar bears can swim for long distances at a speed of up to 6 miles per hour.

The record for the **biggest polar bear** is 2,209 pounds. That's as much as 25 fourth graders!

POLAR BEAR

Environmental Science – Global Changes

As it turns out, the biggest, strongest predator in the arctic has a problem that needs your help? So, what's the problem? Isn't the arctic really cold and icy? It is, but not quite as cold as it used to be. Over the last several years scientists have been watching the sea ice as it forms in the winter and have noticed that there is not as much sea ice for the polar bears to hunt on as there used to be. Many scientists believe that our Earth is getting a little warmer each year, causing our climate to change. As this happens, there is less and less sea ice for the polar bears to hunt on every year. Ultimately, the future of polar bears hinges on how warm the climate gets. Scientists have predicted that polar bears will probably be able to survive in the far northern parts of the Canadian Arctic and northern Greenland until around the year 2100.

Scientists have shown that greenhouse gases are one of the main causes of this climate change, especially carbon dioxide (see Global Warming and the Greenhouse Effect Discovery File). Carbon dioxide is released into our environment when we produce energy, drive cars, and make products in factories. If we can reduce our greenhouse gas emissions, then we can help slow the melting of the sea ice for the polar bears.

Conservation – How to Help

Many scientists think that the problem of shrinking sea ice in the Arctic is extremely serious but not hopeless. Their research shows that there is still time to save polar bears and the arctic ecosystem if we act soon. So what can you do to help the polar bears? As it turns out, there are lots of ways you can help. Think about all the ways you use energy in a single day. Every time you turn on a light, open the refrigerator or use the microwave, turn on a faucet, or ride in a car you are using energy. When this energy is made, some carbon emissions are given off. Could you use a little less energy every day? If we all used a little less every day, that would make a huge difference for our environment.

Here are some other ways you can help to reduce your carbon emissions:

- Avoid products with too much packaging
- Buy products created closer to home: for example, if you live in the U.S. or Canada, purchase goods made in North America instead of those shipped from far away.
- Buy and cook only what you'll eat. Don't waste food.
- Consume foods that are minimally processed and packaged (e.g., potatoes vs. potato chips)
- Use no more water than needed
- Let your electricity company know that you want to subscribe to green power
- Avoid drive-through businesses; don't idle (having the car stopped with the engine running) for more than 30 seconds
- Walk or ride a bike when possible instead of riding in a car

Sources:

http://kids.nationalgeographic.com/kids/animals/creaturefeature/polar-bear/

http://kids.discovery.com/tell-me/animals/mammals/polar-bears

http://www.polarbearsinternational.org/for-students/polar-bears-for-kids

http://www.timeforkids.com/news/polar-bears-peril/86701

http://www.arkive.org/polar-bear/ursus-maritimus/ (reading level is higher than grade 4, but there are a lot of good photos and information here)

DISCOVERY FILE: Red Knot

Biology & Migration

The Red Knot is a bird often seen along the shoreline. Knots are members of a family of birds known as sandpipers. The red knot gets its name from the rusty color of its feathers in springtime. After the breeding season is over, these feathers are replaced with drab feathers of gray and white for the rest of the year. Red Knots search for food in the tidal area of the beach, where they probe the sand and rocks with their narrow pointed bill, looking for food such as small clams, snails, crabs and other invertebrates.

Image: Public Domain: US Fish & Wildlife

Like many birds, the Red Knot migrates south in the winter and north in the summer. However, few birds travel as far. The Red Knot makes a migratory round trip of over 20,000 miles each year! It travels along the Atlantic coast from wintering grounds in the most southern part of South America to its breeding grounds near the Arctic Circle. What makes this migration even more amazing is that the Red Knot only stops 2 or 3 times to rest and refuel during this journey, sometimes flying for days at a time without sleep!

After reaching the Arctic tundra, Red Knots make a nest on the ground. The female lays eggs that hatch within 3 weeks, and the baby birds are ready to leave the nest and follow their parents around, finding food within a day! By early August, when Connecticut is still in the middle of summer, Red Knots are already beginning their migration south.

Red knots have lived this way for a long time, probably thousands of years. But recently, something has changed, and it is affecting these birds in a very serious way. In the past twenty-five years, the number of Red Knots has dropped almost 70%, and scientists are so concerned that they want to have the Red Knot added to the national list of endangered species. What can explain the decline of the Red Knot?

Fun Facts about the Red Knot:

The scientific name of the Red Knot is *Calidris canutus* which refers to being a sandpiper of the tides.

It's estimated that 90% of the population of Red Knots (sub species C. c. *rufa*) can be present in a single day in the Delaware Bay during spring migration!

Within two weeks of its springtime arrival at Delaware Bay, a Red Knot will have doubled its weight from eating as many as 18,000 horseshoe crab eggs each day!

Red Knots fly four straight days without stopping during their migration from Brazil to the Delaware Bay in the United States.

DISCOVERY FILE: Red Knot

Environmental Science - Global Changes

The migration of the Red Knot is a very stressful journey. Because it has so far to travel, and it travels this distance so quickly, it is extremely important that each Red Knot finds enough food and shelter wherever it stops along its migration route. Scientists studying the Red Knot have discovered a cause for the dramatic drop in their population. It is a lack of food at a key refueling stop. The Delaware Bay, which divides Delaware from southern New Jersey, is one of the most important stops for Red Knots during spring migration. It is here that they look for the energy to complete their journey to the breeding grounds in the Arctic. That energy comes from horseshoe crab eggs, which are deposited at the same time the Red Knots arrive each spring. Scientists studying the Red Knot discovered that the number of horseshoe crab eggs had also dropped, and this meant less food for the migrating birds. They found that humans have been collecting large numbers of horseshoe crabs for bait and for medical research. Scientists also found that the sandy beach habitat where horseshoe crabs lay their eggs was being replaced by beachfront homes and resorts. Often, stone or concrete walls were built along the shore to protect these buildings from erosion and flooding. The walls prevent horseshoe crabs from crawling up on the beach to lay their eggs.

Conservation – How to Help

Once biologists and wildlife managers began to discover the important ecological link between horseshoe crabs and red knots, they urged the local, state and federal government to put strict regulations in place. Laws were passed to limit the number of horseshoe crabs that can be caught for bait and medical research. Also, much of the remaining shore habitat is now protected from development. These controls may help the red knot and the horseshoe crab.

Resources

http://www.allaboutbirds.org/guide/Red_Knot/lifehistory

http://www.fws.gov/northeast/climatechange/stories/redknot.html

http://www.pbs.org/wnet/nature/episodes/crash-a-tale-of-two-species/why-save-the-red-knot/597/

http://www.nytimes.com/2012/06/06/nyregion/red-knots-horseshoe-crabs-and-fight-to-survive-in-delaware-bay.html?_r=0

DISCOVERY FILE: Spotted Salamander

Credit: Camazine at en.wikipedia [CC-BY-SA-3.0], via Wikimedia Commons

Biology and Migration

During springtime in eastern North America, an **amphibian** (an animal capable of living both on land and in water) known as the Spotted salamander emerges from its hiding place in burrows, under rocks or logs. It waits until nightfall, following the first heavy rain of the season, to **migrate** (to move or travel to another area or region, sometimes at regular or annual times) to the place where it will mate and lay eggs.

The salamander knows which way to go; it will make its way along the same route it uses every year. Where is the spotted salamander going? It is journeying through forested areas to an important wildlife habitat, called a **vernal pool.**

A **vernal pool** is a shallow freshwater pond that fills up with snow and rain during the winter and spring months and is usually dry through most of the summer and fall. Vernal pools are important for wildlife including amphibians, turtles, and many invertebrates because they don't have fish that might prey upon them.

After reaching the vernal pool and mating, the female spotted salamander will lay a milky egg mass, up to four inches across, which she attaches to underwater sticks or plant stems. Salamander larvae will hatch in a month or two, depending on temperatures. Larvae are about 1/2 inch when they are born. They look a lot like tadpoles except for the feathery gills branching out from their heads!

Environmental Science – Global Changes

But what happens when the salamander's route has been changed by a brand new road or highway? Spotted salamanders that are forced to travel across roads can be killed by passing cars.

Fun Facts about the Spotted Salamander:

The scientific name of the Spotted salamander is *Ambystoma maculatum*, which means "spotted salamander with a big appetite."

Spotted salamanders return to the same mating pool via the same route every year!

When threatened, Spotted salamanders secrete a sticky white poison from their backs and tails that helps to prevent predators from eating them!

On average, Spotted salamanders measure about 18 cm (7 in.), but they can reach lengths up to 23 cm (9 in.) long!

Spotted salamanders can live up to 20 years!

The Spotted salamander uses its sticky tongue to catch and eat worms, insects, spiders and snails.

Or, imagine that the vernal pool has disappeared altogether, due to a newly constructed housing community. Vernal pools are at risk to development because builders can sometimes overlook them in the drier months. Even the construction of houses or new lawns and lawn chemicals can change the habitat and lifecycle of the surrounding species. In serious cases, a population of local Spotted salamanders can be eliminated altogether!

Conservation – How to Help

People are finding ways to help spotted salamanders. If you live in or near forested area in the eastern North America, then you can too! In many states, vernal pools can be protected once they are identified. Check your surrounding area for the evidence of vernal pools.

In some towns, people are getting together to protect salamanders during their spring migration to vernal pools. This involves identifying busy roads where salamanders must cross, and temporarily closing them. Groups also help salamanders cross the road. Always work with an adult, wear bright reflective clothing and use flashlights.

Resources

http://www.dgif.virginia.gov/habitat/vernal-pools-and-salamanders.asp

http://www.animalfactguide.com/animal-facts/spotted-salamander/

http://www.biokids.umich.edu/critters/Ambystoma_maculatum/

http://www.fcps.edu/islandcreekes/ecology/spotted_salamander.htm

http://kids.nationalgeographic.com/kids/animals/creaturefeature/salamander/

Global Warming and the Greenhouse Effect

Perhaps you have heard of the **greenhouse effect**. In a greenhouse, sunlight passes in through the glass and heats up the ground inside. The heat that rises from the warm ground cannot pass back out through the glass. The result is a build-up of heat inside the greenhouse from the captured energy from the sun.

Certain gases in Earth's atmosphere – especially water vapor and carbon dioxide – act in a similar way to the glass in a greenhouse. We call this situation the **greenhouse effect**, and we call these gases **greenhouse gases**, because they trap some of the heat that rises from Earth's surface when it gets heated up by sunlight. Think of this like an invisible but warming blanket. Most greenhouse gases occur naturally, but some are being added to our atmosphere because of human actions.

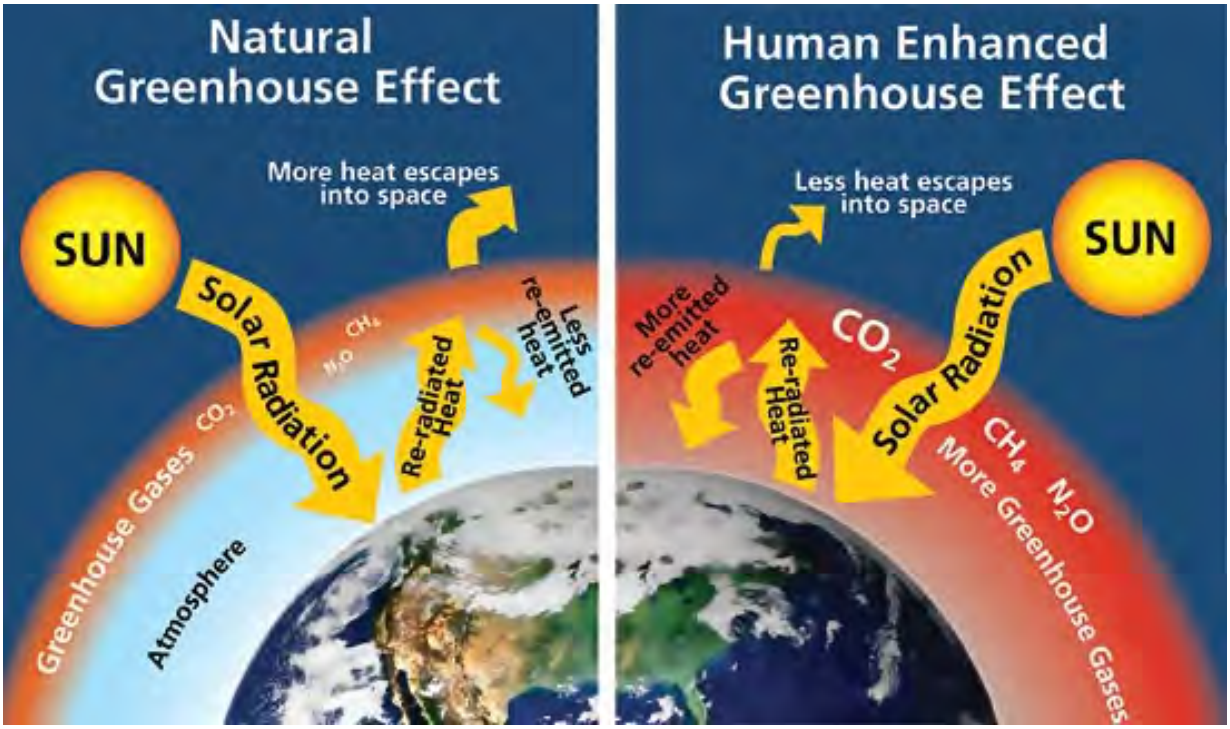


Image by Will Elder, National Park Service

Global warming refers to the rise in temperatures at Earth's surface and lower atmosphere over the last century. Most scientists believe that greenhouse gases produced by human activity are contributing to global warming. The danger in this warming is that it could change Earth's climate patterns, cause coastal flooding, and force major changes in the way people live. The more we are able to learn about global warming, the better prepared we may be to deal with the possible consequences of a changing environment.

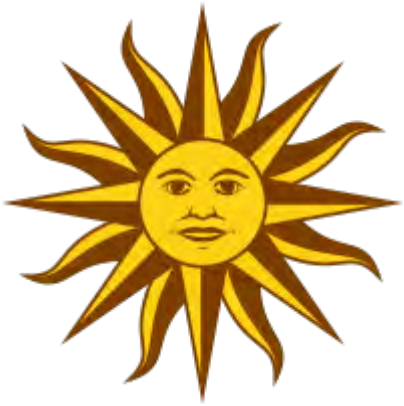
DISCOVERY FILE: Abiotic and Biotic Factors

Many factors influence every part of our environment: things like how tall trees grow, where animals and plants are found, and why birds migrate. There are two categories of these factors: abiotic and biotic.

Abiotic factors are the non-living parts of the environment that can often have a major influence on living organisms. Abiotic factors include water, sunlight, oxygen, soil and temperature.

Water (H_2O) is a very important abiotic factor – it is often said that "water is life." All living organisms need water. Plants must have water to grow. Even plants that live in the desert need a little bit of water to grow. Without water, animals become weak and confused, and they can die if they do not rehydrate. Think of how you feel after you take a long run. Do you feel thirsty? This is your body signaling to you that you must rehydrate.

By Jon Sullivan [Public domain], via Wikimedia Commons



Sunlight is the main source of energy on Earth, which makes it an extremely important abiotic factor. Sunlight is necessary for photosynthesis, the process by which plants convert carbon dioxide (CO_2) and water to oxygen (O_2) and sugar – food for the plants that later becomes food for animals. Without the sun, plants could not live, and without plants, animals could not live! The sun's heat is also extremely important – see the section on Temperature below.

Like water, **oxygen** (O_2) is another important abiotic factor for many living organisms. Without oxygen, humans would not be able to live! This is true for the many other living organisms that use oxygen. Oxygen is produced by green plants through the process of photosynthesis, and is therefore directly linked to sunlight.

Soil is often considered an abiotic factor since it is mostly made up of small particles of rock (sand and clay) mixed with decomposed plants and animals. Plants use their roots to get water and nutrients from the soil. Soils are different from place to place – this can be a big factor in which plants and animals live in a certain area.

Credit: USDA [Public domain], via Wikimedia Commons

Credit: Don from USA (Flickr) [CC-BY-2.0], via Wikimedia Commons

Temperature is an abiotic factor that is strongly influenced by sunlight. Temperature plays an important role for animals that cannot regulate their own body temperature, such as reptiles. Unlike humans, whose normal body temperature is usually around 98.6°F, reptiles (such as snakes and lizards) cannot maintain a constant body temperature. Reptiles are usually found in warm regions around the planet. To regulate their body temperatures, reptiles will sun themselves on rocks, which absorb heat from sunlight and then radiate heat back into the environment.

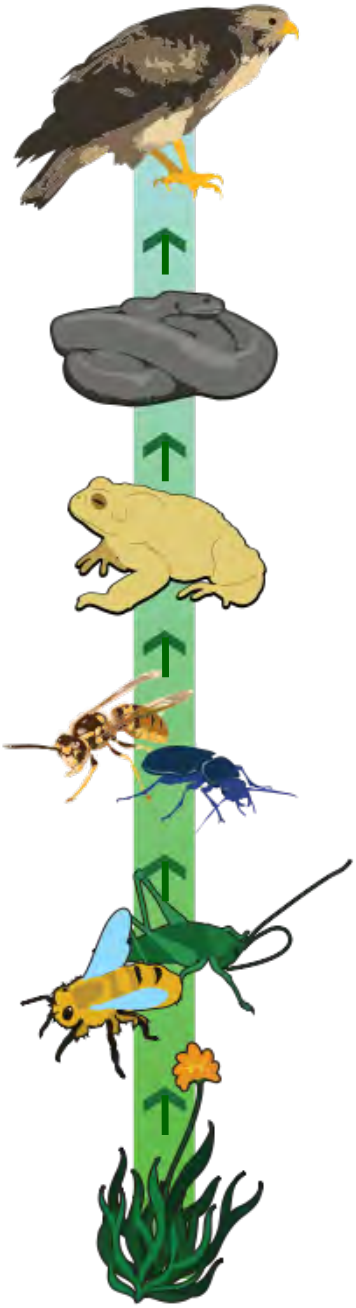
Biotic factors are all of the living things in an ecosystem, such as plants and animals. These living things interact with one another in many ways. Biotic factors and their interactions can be broken down into three groups:

1. **Producers**. All plants, such as grass and trees, are producers. These organisms absorb the sun's energy and convert the energy into food for themselves, allowing them to grow larger, make flowers and seeds, etc.
2. **Consumers**. These organisms, mostly animals, eat producers and/or other animals. They may also eat decomposers. Two examples of consumers are deer (eat plants) and wolves (eat animals). Consumers that only eat plants (herbivores) are often known as primary consumers.
3. **Decomposers**. These organisms break down dead material (such as a fallen tree) into soil and return nutrients to the soil so they can be re-used by producers to create food. An example of a decomposer is a mushroom.

DISCOVERY FILE: Food Chains and Food Webs

All animals need energy to run, breathe, and hunt, and they get this energy by consuming food. Think about what you ate today: that is helping you walk, think, and read! Food chains and food webs are similar to each other, but they are not the same. We will explore the differences here.

A food chain shows a single, connected path of energy flow through an ecosystem. Some animals only eat plants while some animals eat other animals. A food chain shows the different levels of eating within an ecosystem. The arrows show the flow of energy from one organism to the next. Most food chains begin with the sun at the bottom. Let's examine the example on the right.



By LadyofHats (Own work) [CC0], via Wikimedia Commons

There are three types of organisms in a food chain: producers, consumers and decomposers.

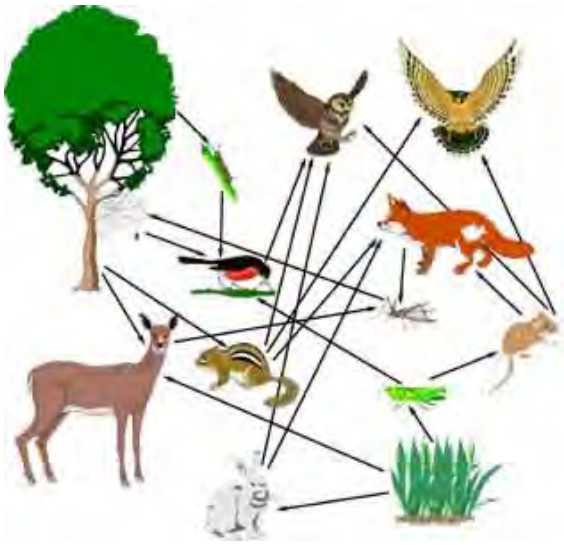
1. **Producers**. These organisms absorb the sun's energy and convert the energy into food for themselves, allowing them to grow larger, make flowers and fruit, etc. An example of a producer is a plant, such as the flower in the picture.

2. **Consumers**. These organisms, mostly animals, can be split into a few categories:

- **Primary consumers** only eat plants, so they are called **herbivores**. The primary consumers in the picture are the bee and grasshopper.
- **Secondary consumers** eat primary consumers. Many secondary consumers also eat plants, which makes them **omnivores** (meat and plant eaters). The secondary consumers in the picture are the wasp and beetle.
- **Tertiary consumers** eat the secondary consumers and are usually **carnivores** (meat eaters). The tertiary consumers in the picture are the frog and snake.
- **Quaternary consumers** eat the tertiary consumers and are **carnivores**. The quaternary consumer in the picture is the hawk. In this picture, the food chain ends with the hawk, which claims the title as the top carnivore.

3. **Decomposers**. These organisms turn dead material (such as a fallen tree, or a dead hawk) into soil and recycle nutrients so they can be re-used by producers to create food. Decomposers are not shown in this picture, but they live underground where the flower's roots are. Decomposers include earthworms, small soil beetles, fungi, and bacteria.

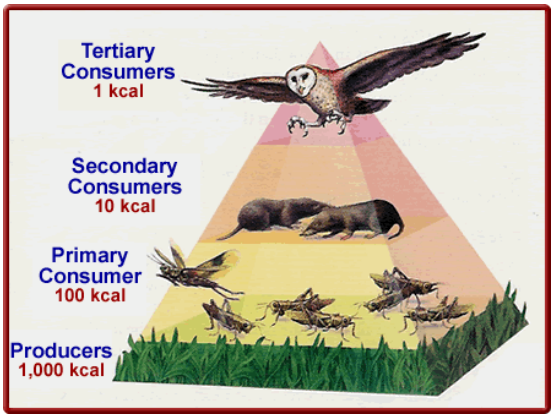
A food web shows how food chains overlap. The same three types of organisms are in food webs: producers, consumers and decomposers. Good food webs should also include the sun as the initial source of energy. We can get a very good idea of how plants and animals interact with one another by looking at, or constructing, a food web. How is the picture at the right different from the food chain picture above?



http://www.bigelow.org/edhab/images/food_web.jpg

In the picture to the right, there are multiple lines from one organism to another. We see that the grass in the bottom right hand corner is eaten by more than just the grasshopper; it is also a food source for the rabbit and the deer. In this food web, we see that there are many top carnivores, not just one. We can identify three: the owl, the hawk and the fox. We can also note the owl, the hawk, and the fox are shown as secondary and tertiary consumers in this food web. The deer is a primary consumer because it only feeds on plants, which makes it an herbivore. As you can see, food webs are more complex than food chains, but they represent what goes on in real life much better than a food chain!

An energy pyramid shows how energy moves throughout an ecosystem. As you move up the pyramid levels, approximately 90% of the food's original energy is lost from level to level because animals must use their own energy to consume and digest food. The consumers at the top of the pyramid do not have as much energy available to them because their food, another animal, is simply not very good at converting the food it eats into energy in its body.



http://www.mlms.logan.k12.ut.us/~mlowe/Energy Pyramid.gif

In the picture above, we can see that energy (shown here as kilocalories (kcal)) is lost as we move up the pyramid from producer to tertiary consumer. This diagram also gives you an idea that it takes a lot of plants to support the predators at the top of the pyramid, such as this owl.

Animal Migration

Animal Migration is when animals travel a certain distance to a different or new habitat.

Who migrates?
Most animals that migrate live in areas with definite seasons, where it gets cool or cold part of the year and warm for another part. Some animals in tropical areas migrate during the dry season or wet season. Many birds, such as warblers, migrate. Hawks, including the osprey, migrate. Mammals that migrate include some kinds of bats, caribou, right whales and more. Some insects migrate, including the green darner dragonfly and the monarch butterfly. Amphibians such as the spotted salamanders migrate a short distance to shallow woodland pools in the spring to reproduce and lay their eggs.

What triggers animals to migrate?
It depends on the type of animal, but triggers could include changes in air or water temperature, how available food is, changes in day length and more. Fish usually migrate because of changes in available food or in order to reproduce. Birds often migrate to new areas with more food and available space to set up a territory.

Why do animals migrate?
Usually animals are trying to find places where there is plenty of food and/or space for nesting.
How do animals migrate?

Fun Facts about Migration

A monarch butterfly can migrate up to 3,000 miles to reach its wintering ground in Mexico.

The sooty shearwater has the longest migration of any bird, traveling 40,000 miles each year!

Some animals, such as elk, migrate up mountains in spring and back down in the fall.

The Bar-headed geese migrate over the Himalayas at heights of over 25,000 feet!

Caribou migrate the longest distance of any land mammal, traveling over 700 miles.

Many birds can follow landmarks and changes in the land while they are flying. Some birds follow the position of the stars at night to find their way. Hawks and monarch butterflies use warm air currents which help to rise up high in the air. Some insects, birds and crabs can even find their way on cloudy days. They can look at the light that is "scattered" through small particles. Salmon migrate from the open ocean back to the stream where they were born in order to breed. They find their way by smelling minerals in the seawater.

There are even animals, including birds, butterflies, salamanders, lobsters, bats, whales, turtles, and sharks that know how to find their way using Earth's magnetic field. Earth acts like a giant magnet and animals can sense the magnetic poles and how strong the forces are.

Credits

Caribou: By Alexandre Buisse (Nattfodd) (self-made) [GFDL or CC-BY-SA-3.0-2.5-2.0-1.0 via Wikimedia Commons

Canada geese: By Moxfyre (Own work) [GFDL or CC-BY-SA-3.0-2.5-2.0-1.0], via Wikimedia Commons

Salmon: By U.S. Fish and Wildlife Service [Public domain], via Wikimedia Commons

Humpback Whale: By Cornelia Oedekoven, ([1]) [Public domain], via Wikimedia Commons

Resources

Journey North – A Global Study of Wildlife Migration and Seasonal Change
http://www.learner.org/jnorth/

Dialogue For Kids: Going Places --- Migration
http://idahoptv.org/dialogue4kids/season13/animal_migration/facts.cfm

Kids Discover – Migrations
http://www.kidsdiscover.com/spotlight/animal-migrations-for-kids/

Ducksters –Animal Migration
http://www.ducksters.com/animals/animal_migrations.php

What's For Dinner?

Teacher Version

Purpose: Develop the concepts of food chains and food webs, and compare the two.

Materials:

- Species flash cards
  - fifteen cards representing animals and plants from the deciduous forest
  - each species card has an associated photograph
  - on the front of each card, the species is identified as "producer," "herbivore," "carnivore," "omnivore" or "decomposer"
  - each consumer card also indicates what the animal eats
  - there will also be a sunlight card and an invasive species card
- Blue tape for attaching cards to whiteboard
- Dry erase markers for drawing arrows between organisms
- Assortment of museum specimens representing deciduous forest organisms
- Diagrams of a food chain and a food web – see Discovery File

The Story:

Every ecosystem/biome has its own, unique food chains and food webs. What would happen if a species was removed from the ecosystem? What would happen if an invasive species was introduced into the ecosystem?

Procedure:

- Students will receive and read the "Food Chains and Food Webs" Discovery File. Students will have five minutes to read, but are encouraged to refer to the Discovery File throughout the lesson.
- Students are each handed a species flash card, including the sunlight card (Note: the invasive species card is NOT given out at the time). If there are more than sixteen students, those without a card can pair up with someone to help them.
- Specimens should be displayed on a nearby table, or they could be held and shown by "extra" students who are not holding cards.

- After examining the specimens and cards, students will be challenged to sort the cards into one food chain. At least five cards must be used in the food chain. In this part of the activity, not all of the cards will be used, and it may work best for the teacher to start by asking the person with the sunlight card to tape it onto the whiteboard, and then help suggest each successive step. There are a number of possible chains that could be created with the 16 cards, but the thing to remember is that in a food chain there is no branching – it is just a single path from sunlight to top predator (and you can include a decomposer at the end if you want). Students must **draw the arrows that show the direction of energy flow**.
- Students will then create a food web using all of the cards. They will have 10 minutes to create their food web, again **with arrows showing the direction of energy flow**. **All of the cards** must be used in the food web.
- Optional: One student is given the invasive species card. The student should add it to the food web, and the teacher can lead a discussion about how it will affect the rest of the organisms. The teacher will need to give a bit of background about the Asian Longhorned Beetle and the level of damage it can cause to trees. Over time, it could kill off entire populations of tree species, and you can represent that by having the students who put the trees on the whiteboard go up and remove them. Then, if any other organisms rely entirely on trees, you can have those students also remove their organisms from the board. In reality, most animals that feed on trees (nuts, leaves, shoots) will probably be able to find other things to eat if one tree species disappears, but what students should understand is that this and other invasive species often cause severe disruptions of food webs.

Assessment and Conclusion:

Teacher will facilitate a class discussion comparing food chains and food webs. What can we learn from a food chain? Which one (chain or web) is more representative of real life? Students will be encouraged to use the food chain and food web they created as evidence for their comparison.

Extension:

Interactive Food Web Activity: Teacher will open up the following website: http://www.gould.edu.au/foodwebs/kids_web.htm Students may then work individually or as a group, matching individual species to their food web category.

Deciduous Forest Biome

Credit: James Appleby, USFWS

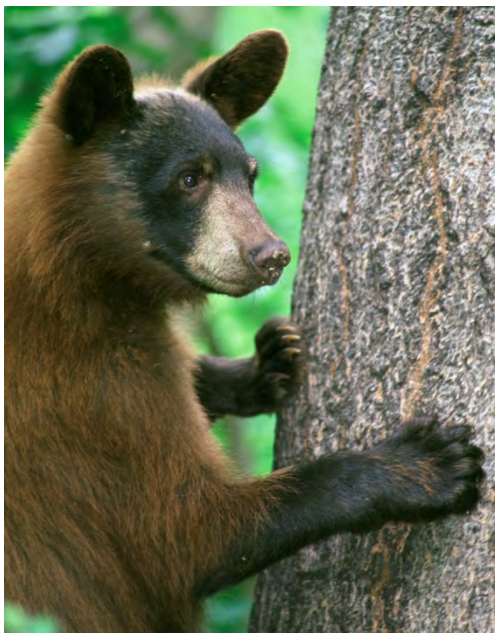
Asian Longhorned Beetle

(invasive)

primary consumer (herbivore)

eats wood from trees

Deciduous Forest Biome



Credit: Steve Maslowski, USFWS via Wikimedia Commons

American Black Bear

consumer (omnivore)

eats berries, insects, small mammals, carrion, occasionally deer

Deciduous Forest Biome

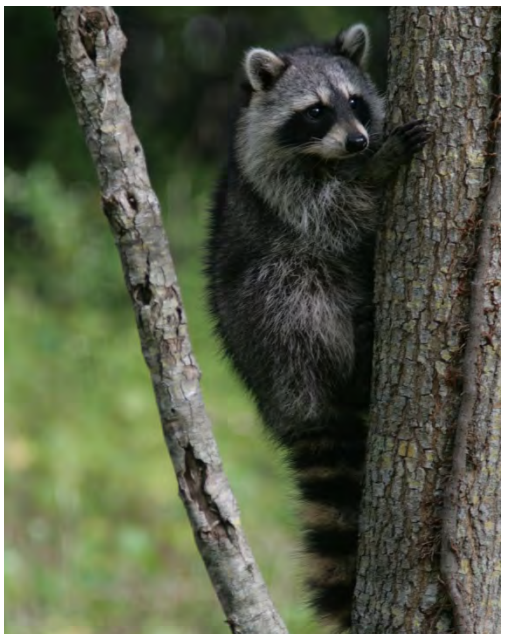
Credit: Ontley [CC-BY-SA-3.0] via Wikimedia Commons

Wood Frog

consumer (carnivore)

eats insects and other small invertebrates

Deciduous Forest Biome



Credit: Korall [GFDL or CC-BY-3.0], via Wikimedia Commons

Raccoon

consumer (omnivore)

eats fruits, nuts, insects, rodents, birds, eggs, fish

Deciduous Forest Biome

Credit: Keven Law [CC-BY-SA-2.0], via Wikimedia Commons

Least Weasel

consumer (carnivore)

eats small rodents, bird eggs and nestlings, insects and small invertebrates

Deciduous Forest Biome

Credit: Gilles Gonthier [CC-BY-2.0], via Wikimedia Commons

Eastern Chipmunk

consumer (omnivore)

eats seeds, nuts, fruits, mushrooms, insects, frogs

Deciduous Forest Biome

Credit: CDC/Jim Gathany (2003)

Mosquito

consumer (omnivore)

eats mostly plant juices – blood is not for food

Deciduous Forest Biome

Credit: William H. Majoros [CC-BY-SA-3.0], via Wikimedia Commons

Cooper's Hawk

consumer (carnivore)

eats a variety of smaller birds

Deciduous Forest Biome

Credit: I, Malene [GFDL, CC-BY-SA-3.0 or CC-BY-2.5], via Wikimedia Commons

Red Fox

consumer (omnivore)

eats mice, chipmunks, fruits, amphibians, reptiles

Deciduous Forest Biome

Credit: Quartl [CC-BY-SA-3.0], via Wikimedia Commons

Milk Cap Mushroom

decomposer

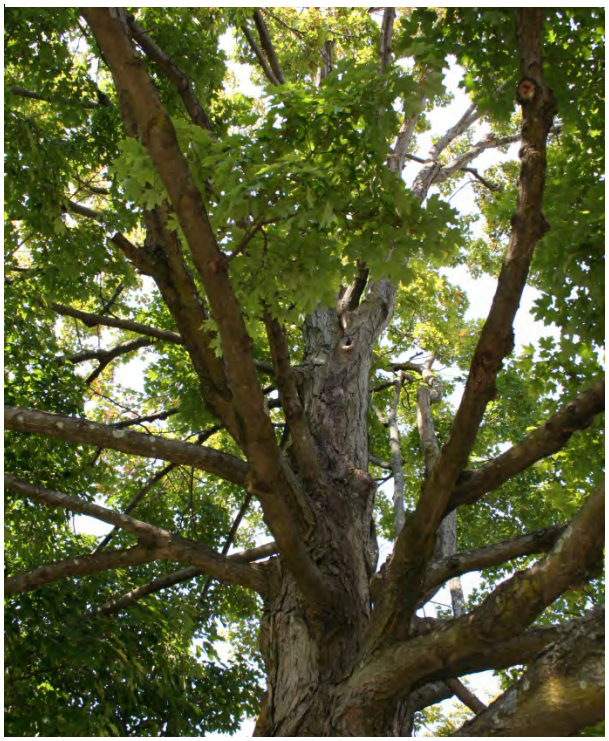
Deciduous Forest Biome

Credit: Manfred Morgner [GFDL or CC-BY-SA-3.0], via Wikimedia Commons

Moss

producer

Deciduous Forest Biome



Credit: D Heiser, Yale Peabody Museum

Sugar Maple tree

producer

Deciduous Forest Biome

Credit: CDC

White-footed mouse

primary consumer (herbivore)

eats seeds, nuts and other plant matter

Deciduous Forest Biome

Credit: Nicholas [CC-BY-2.0], via Wikimedia Commons

Hayscented Fern

producer

Deciduous Forest Biome

Credit: Ken Thomas [Public domain], via Wikimedia Commons

White-tailed deer

primary consumer (herbivore)

Eats plants, including nuts and tips of branches

Deciduous Forest Biome

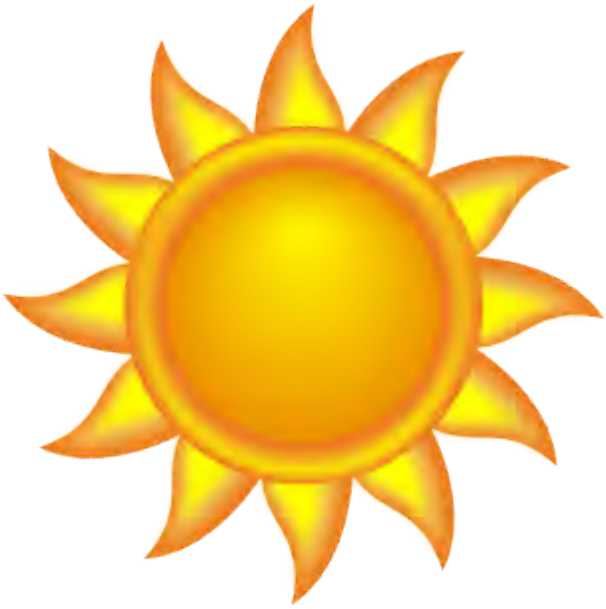
Credit: USFWS

Wild Turkey

consumer (omnivore)

eats nuts, seeds, berries, insects, a few reptiles

Deciduous Forest Biome



Sunlight

Caught in the Web

CT Science Curriculum Content Standards addressed:

4.2: - All organisms depend on the living and nonliving features of the environment for survival.

6.2 - An ecosystem is composed of all the populations that are living in a certain space and the physical factors with which they interact

Objectives:

After participating in this activity, students will be able to:

- Describe how food (energy) moves from one level of a food chain to another
- Give examples of ways in which pesticides enter food chains
- Describe the process and consequences of pesticide concentration in food chains

Materials:

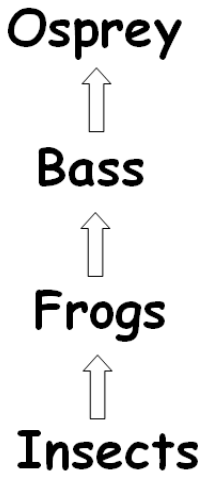
- 4 Orange cones (to mark off playing area)
- 600 red, blue and white plastic chips
- One paper lunch bag per student

Vocabulary:

pesticide, food chain, accumulate, toxic, chemicals, organic, inorganic, food chain, trophic level, predator, prey, bio-accumulation, bio-magnification

Background for the teacher

This activity can be used in its most basic form to demonstrate the functioning of a food chain. The example illustrated in this activity is based on the real life example of an aquatic food chain that includes insects, frogs, bass and osprey.



In this example, insects provide food energy for frogs; frogs provide food energy for bass (a large predatory fish), and bass provide food energy for osprey (a bird of prey that eats fish almost exclusively). Positioned at the top of the food chain, adult osprey have no predators.

The osprey has been chosen intentionally because its recent life history provides an opportunity to explore the concepts of bio-accumulation, bio-magnification, extinction and endangered species as they relate to the discussion of food chains.

History

Osprey are fairly common today along the Connecticut coast. However, at the time the Endangered Species Act of 1973 was passed by Congress and signed into law by President Richard Nixon, only nine pair of osprey were nesting in Connecticut. Prior to the Second World War, more than 1000 osprey nests had been counted along the coast from New York to Boston. The osprey population, along with the population of bald eagles and peregrine falcons - all predators at the highest level of the food chain - was dropping rapidly, and osprey were threatened with extinction. This rapid decline of many wildlife populations in the 1950's and '60's is explored in Rachel Carson's *Silent Spring.*

Scientists began to study the problem and identified two issues. The first was easy to see. Increased development along the shore was reducing the available nesting habitat. Development resulted in many dead trees being cut down. These dead trees, also called snags, are used by osprey and eagles for nesting locations. Disruption caused by human activity also kept the birds from nesting.

The other issue had to do with a pesticide commonly known as DDT (dichloro-diphenyl-trichloroethane). This pesticide was developed to reduce the incidence of diseases such as malaria and yellow fever that are often carried by mosquitoes and other aquatic insects. It was very effective at doing this and was sprayed extensively along the coast and in marshes to kill the insects. It was also sprayed in forests to protect spruce and elm trees from insect pests. Unfortunately, it had unintended side effects on other wildlife populations.

The study of DDT provides a clear example of bioaccumulation and biomagnification of chemicals in the environment. Bioaccumulation is the accumulation of higher and higher concentrations of potentially toxic chemicals in individual organisms. It occurs in the case of chemicals that are ingested but cannot be broken down or excreted. Biomagnification is the bioaccumulation occurring through several levels of a food chain.

DDT can last up to 15 years in the environment, and then decomposes into other dangerous chemicals. Once introduced into the environment, the concentration of DDT increases at each level of the food chain – a term known as “bioaccumulation.” Frogs, living in contaminated water and eating insects containing DDT, soon began to accumulate these toxins in their tissues. Bass, and other predators preying on frogs, ingested these toxins from the frogs, concentrating the DDT in fewer individuals.

Finally, osprey ate the bass, further concentrating the DDT and magnifying its effects (biomagnification).

In top-level predators such as the osprey, DDT reached levels high enough to impact reproduction. DDT, which prevents adequate calcium absorption, caused eggshell thinning in contaminated birds. When adult osprey began to incubate these thin-shelled eggs, the eggs cracked under the weight of the adults. Few new birds were being added to the population.

Once DDT was identified as a threat to the future of osprey and other birds of prey, it was quickly banned as a pesticide in the United States in 1972. This action, and the construction of osprey nesting platforms where previous habitat had been destroyed, has led to a steady increase in the osprey population throughout Connecticut and the United States. While the numbers are a cause for optimism, osprey are still exposed to pesticide contamination at wintering grounds in the West Indies, Central America and northern South America. Therefore, careful monitoring of the osprey population continues to be important.

Activity:

Set-Up:

Prior to beginning the activity, students will each receive a paper or plastic bag that will serve as their "stomach" - where they will keep the chips they collect during the activity. These bags will need to be marked FROG, BASS or OSPREY before beginning the activity. This can be done for the students, or can be an activity they perform. The marking can be just text, or text accompanied by a drawing or any other way to denote which animal this student is portraying in the activity. In a class of 20 students, 15 bags will be marked FROG, 4 bags will be marked BASS, and 1 bag will be marked OSPREY. The proportions represent the declining number of individuals that are supported with each step up the food chain because of energy loss at each level to heat and decomposers.

To set up for this activity, choose an outdoor area (if possible) or large indoor area (cafeteria or gym) at least 25 to 30 feet square, or large enough so that your students can line up single file along one edge of the area. Mark off the area with cones or some other means. This area is the "pond".

Distribute all the red, blue and white plastic chips randomly throughout the "pond". The total number of chips should be approximately 30 for each student. The chips represent the insects in this ecosystem.

Once the area is marked and the chips have been distributed, the activity can proceed.

1. Line the students up single file along one side of the area. Tell them that this is an activity about a pond ecosystem. They will be participating in an activity that demonstrates how energy moves up a food chain in the pond. Discuss the term food chain with them and explain that in this food chain, frogs eat insects, bass eat frogs, and

osprey eat bass. In real life, each animal eats many other things. This can lead to a discussion of food webs afterwards.

2. Pass out the marked bags to your students. Explain to them that the chips in the pond are insects, and that there are lots of them. Ask the students who are frogs to raise their hands and count how many hands are raised. Ask them why there are fewer frogs than insects (each frog requires many insects to survive).

Tell the students who are FROGS that they will be going first in this activity and will be "eating" the insects. To eat an insect, they will pick up a chip and place it in their bag (stomach). To capture the insects, they will have to move about the pond, and because they are frogs, they will move by hopping (or taking baby steps if hopping is not practical).

3. Next, ask the students who are BASS to raise their hands and count how many hands are raised. Ask them why there are fewer bass than frogs (each bass requires many frogs to survive). Explain to the bass that they will go second in this activity, and they will be eating the frogs. Because they are large fish and fast swimmers, they can move by taking giant steps (not running) to catch a frog. When a bass taps a frog on the shoulder, the frog is considered eaten, and must dump the contents of their bag (stomach) into the bass's bag (stomach). The bass then moves to catch the next frog. "Eaten" frogs stay in the game and can continue collecting chips (and being eaten by additional bass).

4. Next, ask the student who is the OSPREY to raise his or her hand. Ask why there is only one osprey (each osprey requires many bass to survive). Explain to the osprey that he/she will go last in this activity, and will be catching and eating the bass. Because osprey can fly, the student can run to catch a bass. When the osprey taps a bass on the shoulder, the bass is considered eaten, and must dump the contents of their bag (stomach) into the osprey's bag (stomach). The osprey then moves to catch the next bass. "Eaten" bass stay in the game and can continue eating frogs.

5. The activity ends when all the chips have been picked up. At this point, ask all the students to come together in a circle, bringing their food bags with them. They will be sharing the contents of their bags as a way to present visual evidence of bio-accumulation and bio-magnification of the DDT.

6. Ask one of the frogs to share the contents of their bag with the class. Most frogs will have very few chips since bass have been preying on them regularly. Have the student count the chips by color. If this frog has no red chips in its stomach, choose a second frog to share the contents of their bag. Again, have them count the chips by color. Explain to the class that the white chips are mosquitoes and the blue chips are dragonflies. These provide energy that the frog uses to move and grow.

7. Now tell them that the red chips are insects that contain a pesticide - a chemical called DDT. Ask the students where the chemical may have come from. They may guess runoff, acid rain, or perhaps that humans dumped the chemical in the pond. Explain that

DDT was developed in the 1940's and was sprayed on wetlands, marshes and ponds in the 1940's, 50's and 60's to kill the insects that were spreading diseases such as malaria and yellow fever in humans. The chemical did not break down in the environment and got into the food chain. Most frogs will not have many red chips, and it can be presented that the levels of chemicals in the frogs may not have killed them. But they will pass the DDT to the bass when they are eaten.

Ask one of the bass with a good number of chips to share the contents of their bag with the class. A hungry bass will have a moderate number of red chips in their bag. Have the student count the chips by color. Explain that the DDT is being accumulated in the bass because it does not break down. The nutrients (blue & white chips) from the frog break down to provide energy for the bass to swim and grow, but the DDT is stored in the meat and fatty tissue of the bass. Sometime the levels can get so high that the bass might die. But if it doesn't, the DDT will be passed to the next level.

Now ask the osprey to share the contents of his or her bag with the class. There should be lots of chips including many red ones. Ask the students where all the DDT came from (the lower levels of the food chain) and what all this DDT may mean for the osprey. You can provide them with the details of the osprey's population plunge due to egg shell thinning and habitat loss and how correction of these two issues has succeeded in returning the osprey to a stable population in our area. You may also have them investigate the osprey's story on their own through the Osprey Discovery File in this kit.

8. Talk with students about what they just experienced in the activity. Ask them for their observations about how the food chain seems to work and how toxic substances can enter the food chain, with a variety of results. The students may be able to give examples beyond those of the frog-bass-osprey food chain affected by the pesticide in this activity.

Extensions

- Discuss ideas on how to keep contaminants out of aquatic habitats
- Identify other threats to osprey and how they can be prevented
- On the internet, view an osprey nest on a web cam (April-June)
- Take a field trip to see osprey and nests in the wild

Adapted from:

Project WILD, Deadly Links, p. 270. 1992 Western Regional Environmental Education Council.

Perilous Journey (1-2-3-Migrate)

Objectives:

After participating in this activity, students will be able to:

- Describe the risks to migrating birds from man-made and natural causes, in particular from human induced global changes
- Gain an understanding of the impact of natural and human selection on populations of migrating birds
- Understand that migrating birds need suitable habitat at every stop along their migration route

Materials:

- 4 Orange cones (to mark off playing area)
- 18 plastic hoops (3 each: red, orange, yellow, green, blue and purple)
- 6 Color Spinner
- Set of Migration Cards

Vocabulary:

- Migration
- Habitat
- Predator
- Neo-tropical

Summary of the Activity

This activity illustrates the many factors that can affect the success or failure of migratory birds each spring and fall. The Migration Cards have been written to highlight the consequences of many human related global changes such as climate change, pollution, habitat loss and non-native invasive plants and animals. You may add your own cards to highlight other topics associated with migration that may make the activity more relevant to your students.

In the activity, your students will become neo-tropical migrating birds. They will begin their migration at their winter habitat in Mexico and move north in a series of steps to their nesting habitat in Connecticut. Along the way, they will have to stop in the plastic hoops, at which time the Migration Cards and six color spinner come into play. The cards will present challenges to migratory birds that will eliminate some of your students from their migratory flight. Once the remaining birds in the flock reach the nesting grounds, the students who have been eliminated during the northward journey will rejoin the game as young and participate in the migration south.

Background for the teacher

Migration is a seasonal movement from one area to another, usually a breeding and a non-breeding area. Migration allows birds to take advantage of the seasons. Most migrant birds spend only two to four months of the year on their nesting grounds. The majority of the year is spent elsewhere.

Not all birds migrate. Some find the resources they need throughout the year; others switch to different food sources as the seasons change, and a few become inactive during periods of scarce resources. Migration is not optional for the species that do migrate. Birds that migrate to nest in Connecticut will not be able to find sufficient food in the winter months if they do not fly south. Likewise, there are not sufficient resources on the wintering grounds for all the young birds that will hatch in the spring, so migration to locations in the north where those resource needs can be met is mandatory for the survival of the next generation.

Migration is not a behavior without risk. It is estimated that more than half of all birds that leave Connecticut in the fall do not return the following spring. Many birds fly thousands of miles to reach their destinations, and can encounter many man-made and natural obstacles. These obstacles often mean the difference between success and failure. Natural risks include weather such as heavy wind and rain, drought, natural variations in the food supply, and predators such as hawks, foxes, snakes, and weasels. Man-made or introduced hazards include habitat destruction, pollution, buildings, tall radio and cell phone towers, pets such as cats and dogs, and even wind turbines that produce "green" energy.

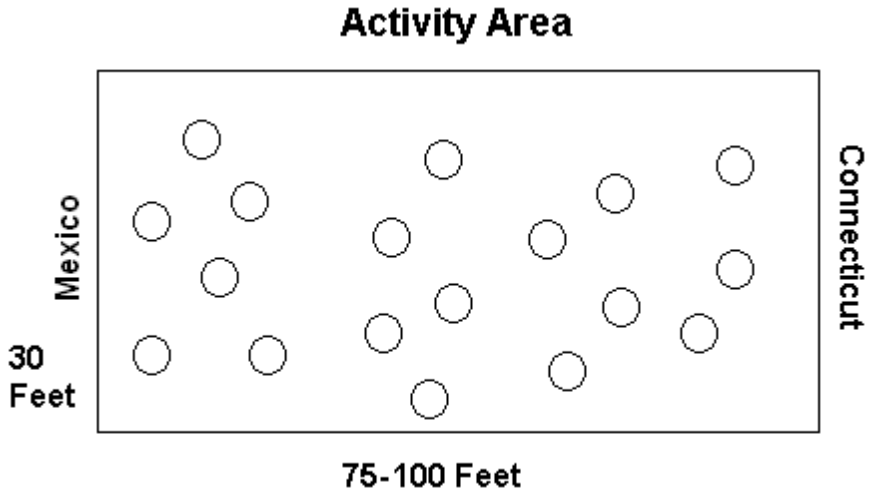
Migration is a behavior that has evolved over thousands of years. It is believed that length of day and other annual events provide the cue for birds to begin their migration. The route the birds will follow and the timing of the journey are specific to each species. Birds need to arrive in migration "hot spots" at a time when there will be plentiful food, water and shelter. Migrating birds can lose up top half their body weight during long legs of their migration route, so if these resources are not available, the bird's migratory journey will not continue, and the bird will die. Songbirds migrate at night because it is cooler, and there are less threats from predators. It is believed they follow a combination of geographic, topographic, celestial and magnetic and instinctive cues to find their way.

Global change adds to the risk of migration. Earlier springs with warmer or wetter weather can change the crucial timing of migration. Warmer ocean waters can supercharge weather systems, producing an increase in heavy downpours and damaging winds, both of which can impact the success rate of migration. Long term climate change can lead to changes in forest composition, including many species of plants and trees that are needed by migrants either along the way or at their nesting destination. Lastly, non-native invasive plants and animals may outcompete native species that are important components of the required habitat of certain migratory species.

Activity:

Set-Up:

To set up for this activity, choose an outdoor area (if possible) or large indoor area (cafeteria or gym) at least 25 to 30 feet on one side and 75-100 feet on the other. Mark off the area with cones or some other means. This area will encompass your migration route from Mexico to Connecticut.



Distribute the hoops in the playing area. It is important not to place the hoops too far away from each other. Your students will have to move through the migration route taking no more than 5 steps each turn. It also works better, and simulates real life more closely if the hoops are grouped, so that students will move from one group to another with each successive turn. Lastly, the color of the hoops does matter. It is best to include a variety of colors in each group, so that two hoops of the same color are not close to each other. See the activity instructions for an explanation.

1. Have your students line up along the short side of the activity area. Tell them that in this activity, they are a flock of migratory birds. They will begin their migration in their wintering grounds in Mexico, and they will be migrating to their nesting grounds in Connecticut. They have to migrate because there will not be sufficient food resources for all the young birds that will hatch later in the season.

2. Explain the rules of the activity to your students. Each turn will begin when you say "1-2-3-Migrate". The students may now take up to five steps toward their nesting habitat; however they must end their movement standing inside one of the hoops, which represent migration stops along the way. Students who do not end up in a standing in a hoop are considered lost during migration because they could not find adequate resources to refuel after their migration flight. When they "die", they leave the activity area and line up along the side. It is important for them to follow the activity and learn from the information on the Migration Cards.

3. Once the students have left the activity area, you will spin the 6-color spinner. The colors on the spinner match the colors of the hoops. The spinner will determine which hoop color will be affected by the information on the Migration Card. For example, if the spinner arrow points to Red, the information and actions on the Migration Card will apply to the students standing in the red hoop or hoops.

4. Read the first Migration Card, which will highlight an issue birds encounter during migration. Many times these impacts will be negative, because many birds are actually lost during migration, but sometimes the information on the cards will lead to a loss of turn (delay in migration) or have a positive effect such as plentiful food resources or excellent weather conditions for migrating.

5. After following the instructions on the card, the birds are ready to migrate again. Explain to your students that each turn does not necessarily represent a day. Birds will stop, rest and refuel until they are prepared for the next leg of their journey. This can sometimes be a week or more. Turn 2, and each successive turn, will begin when you say 1-2-3-Migrate, and the students can move further along their migration route. Again, any students who end their move not in a hoop are out of the game. Spin the spinner again and read the next Migration Card. Continue until all remaining birds have reached the nesting habitat.

6. Now the students who have been eliminated from the game during the spring migration may join the students in the nesting habitat of Connecticut as the young birds that have hatched and fledged in Connecticut. They will join their parent birds in the fall migration to the wintering grounds.

7. Fall migration proceeds the same as spring migration, with you beginning the first turn by saying "1-2-3-Migrate" and the students moving up to five steps and ending up in a hoop. Again, those not able to find a hoop within five steps are out of the game. Spin the spinner to select the color of the hoop to be impacted by the information on the Migration Card, and read the Migration Card. Continue until all the remaining birds arrive in their wintering grounds.

8. Talk with students about what they just experienced in the activity.

a) Ask them for their observations about the migration experience and the many issues – natural and manmade – that can affect the success of a migrating bird.

b) Ask them to think of ways humans can make migration less dangerous for birds. Some ideas might include:

- protecting natural resources in important migration routes
- using less pesticides (or applying pesticides after migrating flocks have already passed through an area)
- keeping house cats inside
- planting native trees and shrubs that help provide food and shelter for migrating birds (such as oak and cherry trees, berry-bearing bushes, and nectar plants for hummingbirds such as bee balm and cardinal flower)

- taping decals on windows to help keep birds from colliding with the glass

c) Some common birds such as cardinals and mockingbirds that now live in Connecticut all year were migratory as late as the 1950's. Ask your students to think of explanations for this behavioral change.

Extensions

- Take a field trip to see migrating birds in the spring or fall
- Do an in-depth study of a common neo-tropical migrant species that nests in Connecticut. Examples include:
  - Baltimore Oriole
  - Scarlet Tanager
  - Yellow Warbler
- Investigate native plants that can be used in the landscaping around your school
- Using Journey North (http://www.journeynorth.org/), have your students follow the spring migration of hummingbirds each week until they arrive in Connecticut
- Have your class follow the migration movements on a map of the Americas

Some Possible Variations

1) You can limit the number of birds that can successfully nest once reaching Connecticut. This will reflect the fact that even the migration destination does not have unlimited resources. After a certain number of students arrive on the nesting ground, the migration is over, and any student still in the process of migrating is out of the game (they will come back as your birds in the next round). This may also encourage the students to take greater risks with each move and to think strategically about choosing the next landing site.

2) During the fall migration, you can start the adult birds one turn before the young birds, reflecting the fact that in some species – particularly long distance migrants - the adults begin migration before their young. Or you may start the young birds first, because in other species, the young birds migrate first while the adults need more time to replenish their energy reserves before beginning migration.

Resources:

Migratory Bird Center: Smithsonian National Zoological Park
http://nationalzoo.si.edu/scbi/migratorybirds/fact_sheets/default.cfm?fxsht=9

Cornell Lab or Ornithology
http://www.birds.cornell.edu/

Adapted from:

Utah Education Network, Lesson Plan TRB 4:5 - Wetland Adaptation

Spring Migration
Card 1 – Global Warming
You have finally left the Yucatan Peninsula in Mexico and are heading over the Gulf of Mexico for the southern coast of the United States. Warmer than usual ocean temperatures create severe storm conditions that include strong winds. You have to use a lot of energy to fly against the wind. Smaller birds without enough energy reserves to complete the flight become exhausted and fall into the ocean. Only the tallest bird in this area survives.

Spring Migration
Card 2 - Pollution
You see the Louisiana coast in the distance. You have made it across the Gulf of Mexico. But when you land on the beaches to rest and find food, your feet and feathers become coated with sticky black oil from a leaking oil drilling platform offshore. The first two birds to this migration spot are out of the game. Other birds lose a turn while animal rehabilitators capture you, clean your feathers and release you again to continue your migration.

Spring Migration
Card 3 – Agricultural Chemicals
You are busy feeding along the edge of some farm fields in the southeastern US when you hear a loud buzzing sound. A crop-dusting airplane flies by and drops chemicals on the fields to control the insects and weeds. The first two birds to arrive in this migration area are out of the game. Any others are sick and lose a turn while they recover.

Spring Migration
Card 4 – Habitat Preservation
You have landed in a wildlife refuge where there is plenty of food, water and shelter for you to recharge your energy. You can take an extra step on your next turn.

Spring Migration
Card 5 – Development - Human Obstacles
On a foggy night, your migration takes you near Washington D.C. where there are many tall radio and cell phone towers. The first bird in this area collides with a tower and is out of the game.

Spring Migration
Card 6 - Resource Management Issues
You change course and head for the Delaware Bay shore. This is costly in terms of your energy budget, but in past years you were able to find an easy, high protein meal along the coast in the form of horseshoe crab eggs. But commercial fishermen have over-harvested the horseshoe crabs in this area and only enough eggs exist to feed the first bird to arrive. All other birds in this migration area are out of the game.

Spring Migration
Card 7 - Runoff (Non-Point Source Pollution)
Runoff from the parking lot of a large shopping mall next to your migration stop has polluted it with oil, anti-freeze and litter. The first bird to this location is out of the game. The others become sick and lose a turn.

Spring Migration
Card 8 – Habitat Loss - Housing
Houses have been built where your migration rest stop was last year. There are not enough resources for you here anymore, but you are low on energy after a long migration flight. You may take two additional steps to find another rest stop. If none are available, you are out of the game.

Global Change Institute
Fall Migration Game Cards

Fall Migration
Card 1 – Unpredictable Weather
An early fall snowstorm in New England blankets much of the available food resources - seeds and berries - with six inches of snow, while the cold temperatures mean you need to eat more to stay warm. The last two birds to arrive at this migration stop cannot find enough food and are out of the game.

Fall Migration
Card 2 – Light Pollution/Development
Light pollution from a large city confuses your instinctive navigational skills and causes you to change your route. You fly above the city, until a large building suddenly appears. The first two birds in this area collide with the building and are out of the game. Other birds change course, narrowly miss the building, and survive.

Fall Migration
Card 3 – Predators
As dawn approaches, you look for someplace to land. You see a large patch of green in the distance and head for it. You land at a national park where there is no hunting and you are protected by federal law. While you are busy feeding, a hawk appears out of nowhere and catches you in her talons. She is also protected here and needs to eat. The tallest person at this migration stop is out of the game.

Fall Migration
Card 4 – Native Plants
You have landed in a neighborhood where the homeowners have planted lots of native plants that can provide food for your migration journey. The additional food energy means you can take an extra step next turn.

Fall Migration
Card 5 – Habitat Loss - Forest Fire
A forest fire started by lightning has burned thousands of acres of forest that had been an excellent migration stop. There are no resources available so you have to find another place to land. Take three steps to find another stop.

Fall Migration
Card 6 – Limited Resources
The migration stopover you used last year has been developed into a golf course. There are few resources here to replenish your energy. Only the first bird to arrive can stay. The others must find another stop within two steps, or they are out of the game

Fall Migration
Card 7 - Pets
You have landed in a neighborhood of large houses with lots of trees and shrubs. There are also a lot of bird feeders and bird baths. You think you are very lucky to find such a good rest stop. The first bird to arrive is taking a drink of water from the bird bath when a roaming house cat catches you unaware and eliminates you from the game.

Fall Migration
Card 8 – Habitat Loss – Lumber Harvesting
You look for the forest you left in Mexico last spring, but find instead that it has been cut down for timber and to create grazing land for cattle. Only the first bird to arrive can find enough resources to survive. The other birds are out of energy and out of the game.

Some other possible card ideas

Stormy Weather

Strong winds and heavy rain from a hurricane in the Gulf of Mexico keep you from migrating next turn.

Favorable Winds

Winds from the north provide an extra push on your journey. You may take an extra step on the next turn.

Drought

Due to a long drought in the area, you cannot find a source of water. All birds in this area are out of the game.

Habitat Loss

Flying all night, you look for a place to land in the early light of the morning. Last year this area was an apple orchard and provided you with plenty of insects and cover. While you were away, the orchard was sold and has now become a shopping mall. This migration stop is removed from the game, and you may take two more steps to try to find another migration stop. If no space is available, you are out of the game.

Chemical Pollution

At first light, you spot some good cover and dive for it. There are lots of caterpillars around and you quickly fill up on them. But they contain small amounts of pesticides, which make you sick. The first bird to this migration stop is out of the game. The remaining birds are sick and lose a turn while they recover.

Climate Change - Phenology

You have landed in habitat that usually has lots of yummy caterpillars to give you energy, but this year unusually warm weather has caused them to hatch earlier than before. By the time you arrive, many of the caterpillars have already become adults and flown away, or are safely encased in their chrysalis. The last two birds to arrive at this spot cannot find enough food and are out of the game.

Global Warming in a Tray

Teacher Version

Adapted from "Global Warming in a Jar" from the McAuliffe-Shepard Discovery Center http://www.starhop.com/ Used with permission.

CT Science Standard 4.2, Grade Level Expectation #5: Distinguish between naturally occurring changes in ecosystems and those caused by human activity.

CMT Expected Performances B11: Describe how natural phenomena and some human activities may cause changes to habitats and their inhabitants.

Objective: Students will simulate the greenhouse effect in an experiment. Students will predict and contrast changes in air temperature in open and closed trays.

Materials: Two large plastic deli trays, two thermometers, timer or clock, Question Sheet, Data Sheet, and Graph Sheet.

Preparation: This activity requires a location where there is direct sunlight for a long period of time. The experiments use two different models for Earth's atmosphere. Each of the models represents a different set of conditions in Earth's atmosphere.

Model A: A thermometer is placed inside a large plastic tray which is left open. It represents Earth's atmosphere without greenhouse gases to trap energy from the sun.

Model B: A thermometer is placed inside a large plastic tray which is snapped shut. **Model B** has a closed lid that helps to capture energy from sunlight. The cover acts like greenhouse gases in Earth's atmosphere. Ask students this key question: **What do you predict will happen to the air inside this closed tray?**

Procedure:

1. Have students read the "Global Warming and the Greenhouse Effect" Discovery File.

2. Place each model in direct sunlight, with the thermometers facing the same way. Have students read and record the temperature of each thermometer immediately (see Student Version for Data Sheet). Repeat this measurement every 5 minutes for the first 30 minutes. If you have additional time, after the first 30 minutes readings may be taken and recorded at 15-minute intervals.

3. Have students make a line graph of the temperature data for the experiment (see Student Version for Graph Sheet). There will be two graphed lines on the sheet. Each line should be labeled, Open or Closed.

4. Students should complete the Question Sheet for the experiment.

Extensions for Older Students
Please see original Global Warming in a Jar, which includes two experiments. As above, plastic trays can be used instead of jars.

Student Questions

1. What happened to the temperature of the air in Model A, the open tray?

   _____

   _____

   _____

2. What happened to the temperature of the air in Model B, the closed tray?

   _____

   _____

   _____

3. What caused the temperature in the closed tray to change?

   _____

   _____

   _____

4. How was this experiment similar to the warming of Earth?

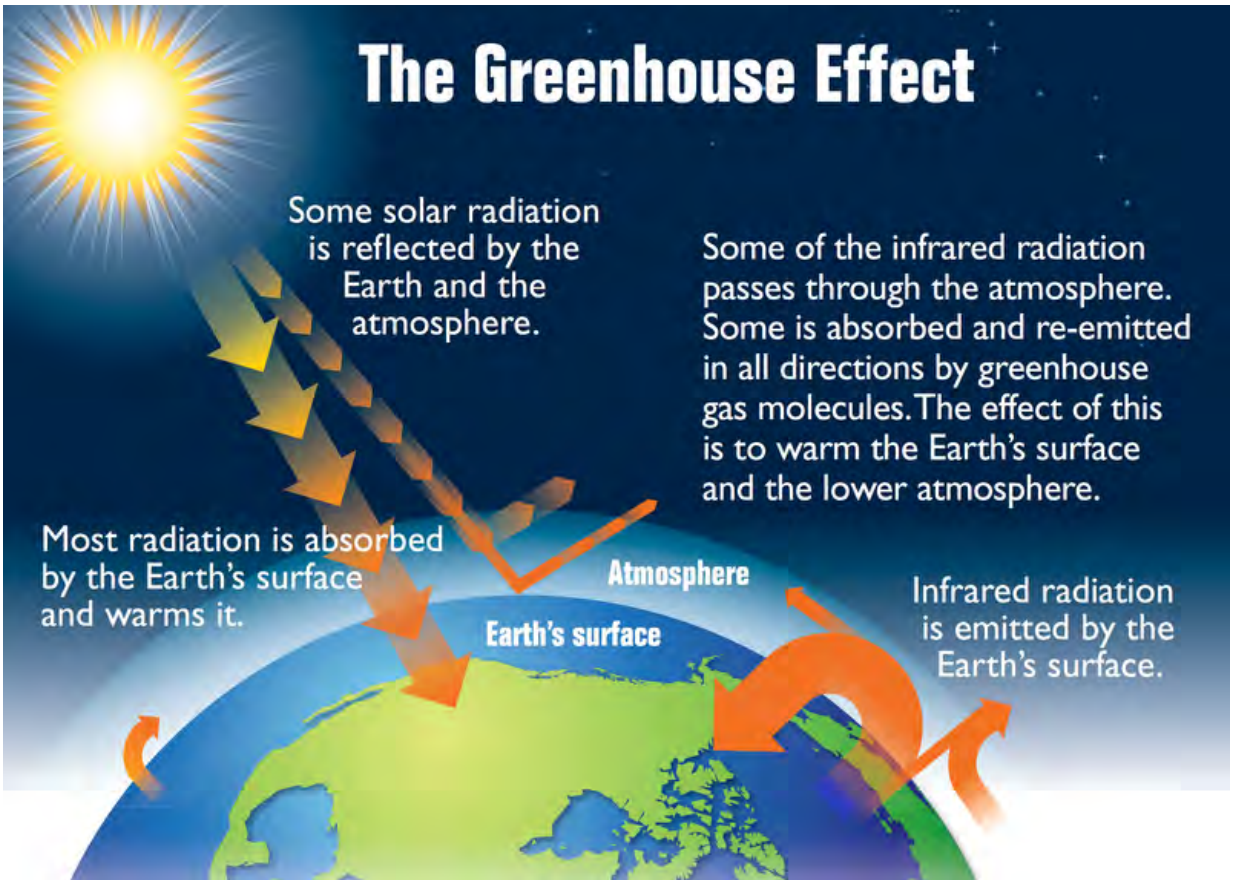
   _____

   _____

   _____

Teacher Background Information

The so-called greenhouse gases in our atmosphere – especially water vapor (H_2O) and carbon dioxide (CO_2) – have helped to warm Earth and make it hospitable to life as we know it. If not for this warming effect, Earth would be approximately 33°C (59°F) cooler than it is. About half the solar energy reaching Earth is short-wave radiation, most of which occurs in the form of visible light. Most of the remaining solar energy is infrared, a form of long-wave radiation. A high percentage of the short-wave radiation is absorbed by Earth's surface, where it is converted to infrared radiation (this is basically heat energy). The greenhouse gases warm Earth's surface and lower atmosphere by absorbing and re-emitting infrared radiation.



US EPA, 2012

While almost all of the greenhouse gases present in the atmosphere are the result of natural processes, human activity has produced incremental changes in both the composition of Earth's atmosphere and the concentrations of greenhouse gases. In the last century, the average concentration of carbon dioxide has increased about 40 percent, from 280 parts per million (ppm) to more than 400 ppm, and is still rising. This increase has been attributed to such practices as large-scale deforestation and the burning of fossil fuels. The cultural ("anthropogenic") enhancement of atmospheric CO_2 is suspected as a major cause of global warming in the last hundred years. Average global temperatures have risen over 0.6°C (1.0°F), over this timeframe.

Global Warming in a Tray

Adapted from "Global Warming in a Jar" from the McAuliffe-Shepard Discovery Center http://www.starhop.com/ Used with permission.

Objective: Students will simulate the greenhouse effect in an experiment. Students will predict and contrast changes in air temperature in open and closed trays.

Materials: Two large plastic deli trays, two thermometers, timer or clock, Question Sheet, Data Sheet, and Graph Sheet.

Preparation: This activity requires a location where there is direct sunlight for a long period of time. The experiments use two different models for Earth's atmosphere. Each of the models represents a different set of conditions in Earth's atmosphere.

Model A: A thermometer is placed inside a large plastic tray which is left open. It represents Earth's atmosphere without greenhouse gases to trap energy from the sun.

Model B: A thermometer is placed inside a large plastic tray which is snapped shut. **Model B** has a closed lid that helps to capture energy from sunlight. The cover acts like greenhouse gases in Earth's atmosphere.

Key question: **What do you predict will happen to the air inside this closed tray?**

Answer: _____

_____

_____

Procedure:

1. Read the "Global Warming and the Greenhouse Effect" Discovery File.

2. Place each model in direct sunlight, with the thermometers facing the same way.

3. Read and record the temperature of each thermometer on your Data Sheet immediately.

4. Repeat this measurement every 5 minutes for 30 minutes.

5. Plot the temperatures for the open tray on the Graph Sheet, and then connect the dots to make a line graph. Repeat with the data for the closed tray. Each line should be labeled, Open or Closed.

6. Answer the four questions on the Question Sheet.

Global Warming in a Tray

Question Sheet

1. What happened to the temperature of the air in Model A, the open tray?

   _____

   _____

   _____

2. What happened to the temperature of the air in Model B, the closed tray?

   _____

   _____

   _____

3. What caused the temperature in the closed tray to change?

   _____

   _____

   _____

4. How was this experiment similar to the warming of Earth?

   _____

   _____

   _____

Global Warming in a Tray

Data Sheet

Names _____

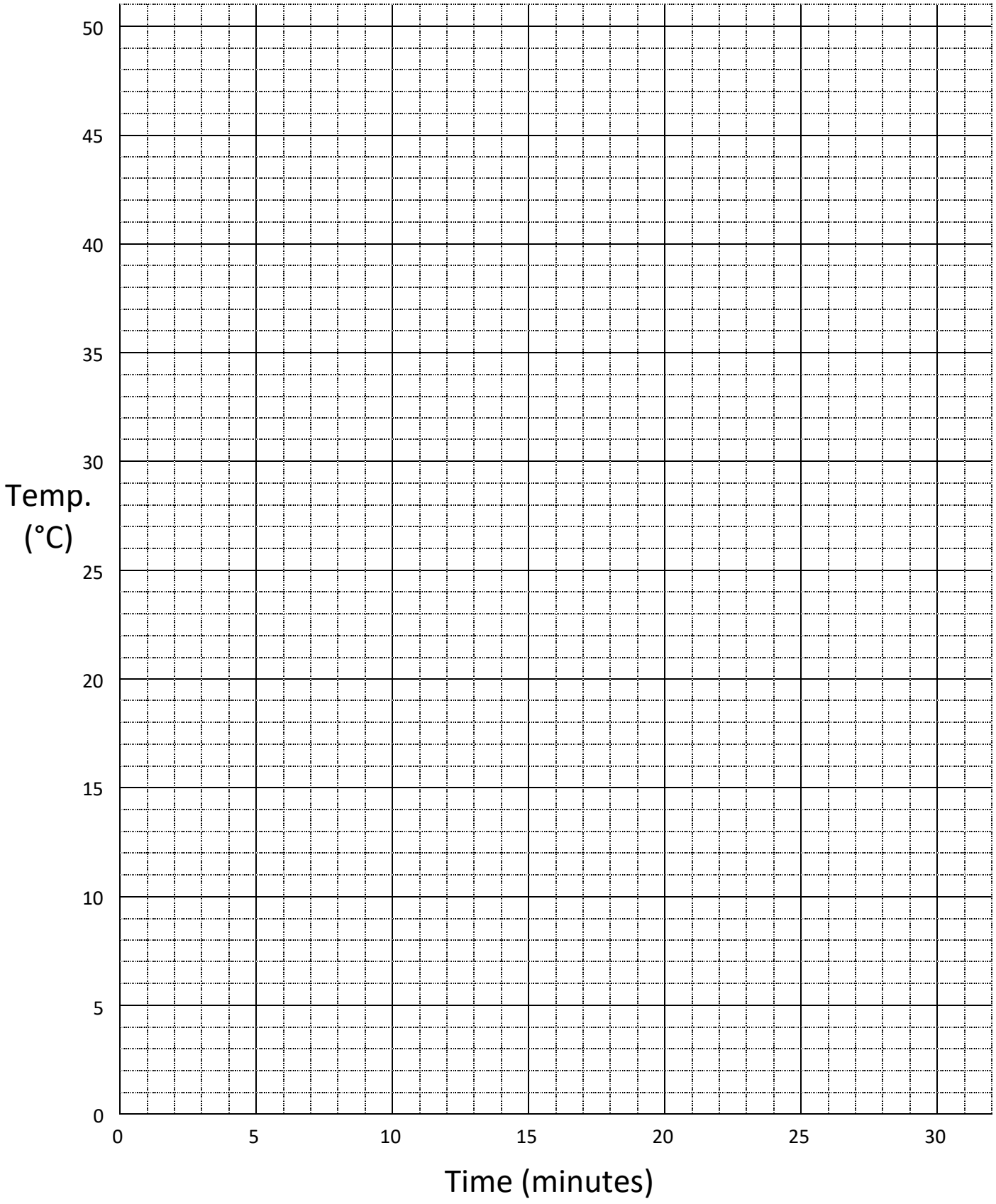
_____

Time	Air Temperature in Open Tray (°C)	Air Temperature in Closed Tray (°C)	Notes
Start			
5 minutes			
10 minutes			
15 minutes			
20 minutes			
25 minutes			
30 minutes			

Global Warming in a Tray
Graph Sheet

Names_____

_____



Postcards along the Way

Teacher Version

Students will receive the following instructions:

Write a postcard to a friend or family member as if you were one of the animal species from our Discovery Files on a migratory journey.

- **Describe** what you did on your trip so far.
- **Include** the sequence of events from your migratory journey up to this point.
- **Include** details of at least one human-caused global change and the problems it has created for you.
- **Illustrate** the blank side of your postcard, or a separate sheet of paper, with something you saw along the way.

MATERIALS

- Discovery Files
- postcard template
- colored pencils

TEACHER NOTES AND SUGGESTIONS

- If the postcard seems limiting, feel free to call this “Communication along the Way” and have them compose a letter on their own paper, or record a “phone message” on a suitable device. You could also do more of a migration journal, modeled after the book Red Knot: A Shorebird’s Incredible Journey.
- If you have students illustrate the back side of their postcard, keep in mind that it might bleed through and it will be more difficult/impossible to display both sides.
- You might suggest that they **label** their illustrations as well.
- For low-level writers, consider supplying the first few words of each sentence and having them complete the rest.
- For middle school or older, consider adding the following bullet point to the requirements:
    - **Compare or Contrast** your journey to the migratory journeys taken by your ancestors.

Postcards along the Way

Write a postcard to a friend or family member as if you were one of the animal species from our Discovery Files on a migratory journey.

- **Describe** what you did on your trip so far.
- **Include** the sequence of events from your migratory journey up to this point.
- **Include** details of <u>at least</u> one human-caused global change and the problems it has created for you.
- **Illustrate** the blank side of your postcard, or a separate sheet of paper, with something you saw along the way.

MATERIALS

- Discovery Files
- postcard template
- colored pencils

Post Card

Place Stamp Here

Address:

Post Card

Place
Stamp
Here

Address:

_____

_____

_____

Name _____

Migration in the Balance

Student assessment

1. Imagine you're a mountain lion, one of the top carnivores in your ecosystem. Now imagine that all the plants in your ecosystem suddenly die. One year later, would you be able to survive in that ecosystem? Why or why not?

Ecosystems are made up of abiotic factors and organisms.

2. Which of the following is an abiotic factor of an ecosystem?
   a. Tree
   b. Water
   c. Mouse
   d. Dragonfly

3. Abiotic factors play important roles in most ecosystems, including _____.

   a. Food for herbivores
   b. Food for carnivores
   c. Helping plants produce their own food
   d. None of the above

4. Which item in this picture is the primary source of energy on Earth?

   a. Water
   b. Tree
   c. Sun
   d. None of the above

5. Which of the following is an example of a producer?
    a. Monarch butterfly
    b. Chicken
    c. Horseshoe crab
    d. Milkweed plant

6. An animal that eats plants AND other animals is called:
    a. An herbivore
    b. An omnivore
    c. A consumivore
    d. A carnivore

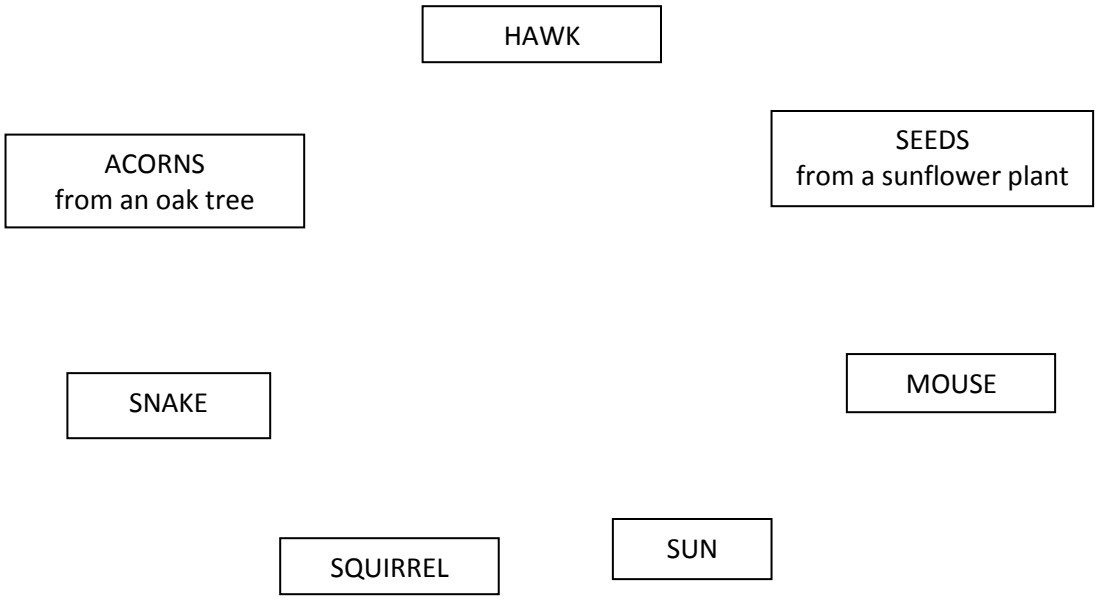
7. Some animals migrate – they spend part of the year in one area and the other part of the year in a different area. Sometimes the journey between those two places is long, exhausting and dangerous. Give one reason why migration helps these animals survive.

8. Which <u>TWO</u> of the following describe ways that Monarch butterflies depend on plants?
    a. The caterpillars eat milkweed leaves
    b. The caterpillars build their homes out of dead leaves
    c. The adult butterflies eat milkweed seeds
    d. The adult butterflies drink nectar from flowers

9. Food chains and food webs can be affected by _____.
    a. Climate
    b. Landscape
    c. Water quality
    d. All of the above

10. When a coyote eats a mouse, _____ is transferred from the mouse to the coyote.
    a. Knowledge
    b. Carbon dioxide
    c. Energy
    d. A burrito

11. Connect these seven items with arrows to show the flow of energy through a food web. Make all possible connections.



12. Now imagine removing the mouse from your food web model, and predict the effect it has on the remaining organisms. Explain your thinking about the change or lack of change in your food web.

13. Pesticides are chemicals that are used to kill insects, and they are often sprayed around ponds, ditches and wetlands where insects breed. Scientists have found these pesticides in the bodies of carnivores like the Osprey, also known as the fish hawk because of this bird's main food source. We also know that Osprey don't go around eating pesticides straight off the ground or out of the water. Explain how the pesticides get into the Osprey's bodies.

14. Which is NOT an example of a naturally occurring change to the environment?
    a. Eruption of a volcano
    b. Disease outbreak
    c. Applying chemicals to lawn and crops
    d. Forest fire caused by lightning

15. Most of the energy humans use to run our cars and heat and cool our homes, comes from burning fossil fuels such as gasoline, oil and coal. When we burn fossil fuels, carbon dioxide (CO_2) and other greenhouse gases are released into the atmosphere. Why is carbon dioxide called a greenhouse gas?

    a. It is slightly greenish in color when it goes into the atmosphere
    b. It acts like a greenhouse, letting sunlight through and then trapping the heat
    c. All plants need it to survive and grow, and plants are mostly green
    d. It was made for the first time inside a greenhouse
    e. The person who invented it had always wanted a greenhouse when she was a kid

16. Which <u>TWO</u> of the following are possible consequences of rising air temperature due to global changes?

    a. The arctic ice sheet gets smaller every year and freezes for a shorter amount of time in the winters, causing polar bears to lose important seal hunting grounds.
    b. Monarch butterfly populations decline due to chemicals used to destroy milkweed, their main food source when they are caterpillars.
    c. Humans overharvest horseshoe crabs to use for fishing bait, resulting in less horseshoe crab eggs for Red Knots (a bird) to feed on during migration.
    d. Sea levels rise, resulting in flooding of marshland needed by migratory birds for feeding and resting during their migration.