Lesson 2 Components

I. Presentation 2: Food Webs, Bioaccumulation, and Visualizing Data
II. Activity 2: Food Webs
III. Homework 2: The Range, Habitat and Niche of the Bald Eagle

I. Presentation 2: Food Webs, Bioaccumulation, and Visualizing Data

slideshow

Description

- Describes food webs with a focus on osprey and bald eagles.
- Introduces the terms bioaccumulation and biomagnification.
- Prepares students to graph the osprey and bald eagle data.

Goals

- Students understand the connection between food webs and biomagnification of toxic chemicals.
- Students learn how DDT is harmful to birds and other wildlife.
- Students learn about graphing different relationships in data.

Materials

Download Files from Lesson 2:

- "Presentation 2"
- "Lesson2_WB"
- "Lesson2_WB_KEY"
- "TeacherManual2"

Other:

- Copies of the student workbook for presentation 2 for all students
- Equipment to show slideshow or transparencies
- Copies of article "The range, habitat, and niche of the bald eagle" or access to link: http://www.pwrc.usgs.gov/educatnl/beyer/eagle1.pfd

II. Activity 2: Food Webs

group or class activity

Description

- Students consider how DDT biomagnifies in top predators of food webs.
- Student discover that even though birds of prey are at the top of their respective food chains, some food chains are shorter than others resulting in different amounts of DDT accumulation in different species.

Goals

- Students gain an understanding of DDT's complex movements through food webs.

Materials

Download Files from Lesson 2:

- "Activity2_FoodWeb"
- "Activity2_FoodWeb_KEY"

Other:

- Copy of Activity2_FoodWeb for each student.

III. Homework 2: The Range, Habitat and Niche of the Bald Eagle

Description

- Students will read the Patuxent Research Note, *The Range, Habitat and Niche of the Bald Eagle* and answer questions about the content.

Goals

- Students will be introduced to some aspects of the bald eagles' natural history.

Materials

Download Files from Lesson 2:

- "Homework2_BaldEagleHabitat"
- "Homework2_BaldEagleHabitat_KEY"

Other:

- Copy of Homework2_BaldEagleHabitat for each student
- Copy of article *The Range, Habitat and Niche of the Bald Eagle* or access to link: http://www.pwrc.usgs.gov/educatnl/beyer/eagle1.pfd

Introduction to Lesson 2

Lesson 2: Food Webs, Bioaccumulation, and Visualizing Data

The information presented in Lesson 2 introduces students to food webs, bioaccumulation and visualizing data. The presentation for Lesson 2 starts with opening questions to highlight some of the main points of the Lesson 1 activities. Following the opening questions, the presentation begins with a review of some important points about DDT. At this point the presentation introduces the movement of DDE through food webs and the concepts of bioaccumulation and biomagnification using osprey as an example. Finally, students will be shown a slide describing the relationship between two variables and the students will be asked to create the graph that would be drawn based on the description.

I. Presentation 2: Food Webs, Bioaccumulation and Visualizing Data

In the notes below, a ♣ indicates that students are asked to answer a question about this slide in their presentation workbook. Answers to these questions are given in these notes when it is advisable to discuss the answers with the class. Otherwise, answers are provided on the answer key for the student workbook. The slideshow notes in this outline can also be found in the notes section of each slide. To view the slides that these notes refer to, see the slide presentation, "Presentation 2".

Teacher Preparation

1. Download the files, "Presentation 2", "Lesson2_WB" and "Lesson2_WB_KEY".
   - "Presentation 2" contains the powerpoint presentation2.
   - "Lesson2_WB" and "Lesson2_WB_KEY" contain, respectively, the student workbook and key for Presentation 2. Students will answer questions and take notes about the presentation in their workbooks.

2. Print and copy enough handouts of the student workbook to give one to every student.

3. Prepare equipment for slideshow or transparencies. Make transparencies if needed.

Slide 1

Opening Questions

♣ 1. *Name two kinds of biases.*

♣ 2. *Name three sources of bias.*

♣ *3. What are some important aspects of DDT?*

Slide 2

This slide review points from Lesson 1 and provides the answers to the first and third opening questions above.

Slide 3

These are just a few examples of sources of bias.

1. *Applying results of a study too broadly (generalizing)* - This refers to the case when the results of an experiment are applied beyond the limits of an experiment. For example, if a scientist finds that drug X has no side effects in white males, it is incorrect for that scientist to conclude or report that drug X has no side effects in people in general.

2. *Taking research results out of context* – When the results of an experiment are reported without information about the conditions under which the experiment was conducted, this is a type of biased reporting. Such reporting of research results normally occurs when someone who did not themselves do the research wishes to misinterpret someone else's study. This is why it is important to know that you yourself can always go to the original study and check the results and their original interpretation.

3. *Not taking a random sample* – An important way scientists can avoid unintentional bias is by taking random samples. In Lesson 1 we give the example of finding the average height of the class, but only sampling the heights of students in the class who are on the basketball team.

4. *Taking too small a sample* – Scientists take samples in situations where the entire population being investigated is too large to sample. The number of samples that must be taken to get an accurate representation of a population is determined by the variability within the population that will be sampled. If a population is highly variable, then a scientist must take many samples to characterize that population. Lesson 1 provides an example of this type of bias.

5. *Measurement error* – In Lesson 1 we give an example of measuring the height of students in a class, but not having them take their shoes off. Because the shoes of different students have different thicknesses, this results in measurement error.

Slide 4

Lesson 2: Food Webs, Bioaccumulation, and Visualizing Data

The goal of Lesson 2 is to introduce the concepts of bioaccumulation and biomagnification and their importance in the environment. Additionally, Lesson 2 introduces students to the natural history of osprey and bald eagles in the context of

food webs. Finally, students will be encouraged to visualize what type of graph they can expect with various datasets.

Slide 5

What kind of damage can DDT cause to birds?

DDT breaks down in the body of animals to become a chemical called DDE. DDE tends to stay in the body, and at high concentrations can result in nervous system damage, immune system problems, thyroid problems, eggshell thinning and death. The slow decline of several kinds of birds of prey in the US largely reflects the effect of eggshell thinning caused by DDE bioaccumulation in female birds. Thin eggshells tend to break before embryos can fully develop and hatch.

Slide 6

DDE, a metabolite of DDT, stores in the fatty tissue of animals and causes eggshell thinning in some birds. From this slide on, DDE will be used to refer to the chemical found in animal tissue and DDT the chemical pesticide.

Slide 7

♣ 1. *Name three health hazards of DDE.*

- *Reproductive failure in birds* – when some species of bird have high level of exposure to DDE, they suffer from reproductive failure through the thinning of their eggshells. When birds have thin eggshells, the eggs break before they are able to hatch. Scientists have found that in bird species that are sensitive to DDE, the higher the concentration of DDE in their eggshells, the thinner their eggs are.
- *Immune system problems*
- *Nervous system damage* – Birds have been found to lose coordination when they have high concentrations of DDE in their tissue.
- *Death*

Slide 8

How does DDT move into lakes, streams and oceans?

Slide 9

After DDT is applied, some DDT residue remains on the plant material and some washes off the plant into the soil, eventually making its way to a body of water. The DDT that remains on the leaves of plants is ingested by primary consumers such as insects and rodents. As for the DDT that has washed into a stream, river or lake, it enters the food chain through consumption by bottom-feeding fish or by absorption through fish gills and skin.

Slide 10

Is DDT still being used today?

Slide 11

Yes. DDT is still used in some countries for insect control on crops. In countries where mosquitoes carry malaria, DDT is currently used for mosquito control.

Slide 12

What is a food web?

At this point a new, but related, topic is introduced. To transition to the explanation of food webs, ask students how the toxicity of DDE is related to food webs. Find out how much students know about food webs - if students have a good background in this material, you may want to go through slides 12-15 relatively quickly.

Slide 13

Food Web: A summary of the feeding relationships within an ecological community.

In Lesson 3 the students will work with an osprey dataset. To familiarize students with some of the feeding habits of osprey, the example food web focuses on osprey. For additional information about osprey, refer to the osprey information sheet cited in the bibliography.

The osprey is often mistakenly called the fish hawk or fish eagle. Historically, ospreys were reported as numerous, nesting in forested areas near water because they favored dead trees or trees with flat or dead tops. Unlike most birds of prey, ospreys are tolerant of human activities and will build nests on almost any suitable structure close to water with an abundant supply of fish. Ospreys are able to catch fish by first hovering, and then plunging up to three feet into the water to capture fish. Their dense oily feathers make them well-suited to repel water and quickly regain flight.

USGS. 2002. Osprey in Oregon and the Pacific Northwest. USGS FS-153-02.

- ♣ 2. *Students are asked to define food web.*

Slide 14

Food Chain: One thread of the food web.

Slide 15

This slide introduces vocabulary used when describing the plants and animals involved in the food web.

Tertiary consumer – Animals that eat animals that eat animals.

Secondary consumers – Animals that eat animals that eat plants.

Primary consumers – Animals that eat plants.

Primary producers – Plants and phytoplankton: organisms directly using the sun for energy.

- ♣ 3. *Students have a copy of the pyramid on their worksheet and are to identify primary producers, primary consumers, secondary consumers, and tertiary consumers.*

Slide 16

Why is food web knowledge important for understanding the impact of DDT on osprey and eagles?

Slide 17

In response to the question on slide 16 – Osprey and eagles feed at the top of the food web and this makes them particularly vulnerable to DDT because of **bioaccumulation** and **biomagnification**.

Slide 18

What is bioaccumulation?

- ♣ 4. *Students are asked to define bioaccumulation.*

Slide 19

Bioaccumulation is the accumulation of a contaminant or toxin in or on an organism from all sources (e.g., food, water, air). The result is an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted.

Chemicals that are soluble in fat, like DDE, are especially likely to bioaccumulate, compared to chemicals that are soluble in water. Chemicals that are soluble in water are removed from the body in urine, whereas those soluble in fat do not have a means to leave the body because the body does not willingly let fats go. Thus, chemicals that are soluble in fat tend remain in the body.

Slide 20

What is biomagnification?

- ♣ 5. Students are asked to define biomagnification.

Slide 21

Biomagnification is an increase in concentration of a contaminant or toxin as it passes through successive levels of the food web. DDE accumulates at higher levels in organisms that are higher in the food chain.

Slide 22

This slide gives an example of actual concentrations of DDE as it passes through the heron food chain. It is important for the students to notice the units in which DDE is measured and to become familiar with the relative amount of DDE that accumulate in organisms of different trophic levels. Students will also be given another example using osprey to demonstrate this point.

Slide 23

Considering biomagnification, how does DDE harm an osprey?

Slide 24

Ospreys are at the top of the aquatic food chain, and are thus exposed to many pollutants found in the environment. Toxic chemicals are present in water, air, sediments and aquatic creatures throughout osprey breeding and wintering ranges. Many of these contaminants bioconcentrate in fish, entering them from water passed through the fishes' gills, and bioaccumulate in the fish from their food. The efficient transfer of chemicals from food to consumer through two or more trophic levels results in biomagnification, a systematic increase in tissue residue concentrations from one trophic level to another.

USGS. 2002. Osprey in Oregon and the Pacific Northwest. USGS FS-153-02.

- 6. *Students are asked to fill in the animals and plants in the food web given on slide 24 and to record the relative concentrations of DDE.*

Slide 25

The *units of measurement* slide gives a quick introduction to the units of measurement that are used for measuring concentrations. Micrograms per gram (µg/g) is in several of the slides in Lesson 2 and will be important for Lessons 3 and 4. The concepts of wet weight and dry weight are also important in Lessons 3 and 4.

One microgram is equal to 10^{-6} grams (1 µg = 0.000001 g).

Wet weight is the weight of an organism, including the water in its tissues. If you stood on a scale right now, it would measure your wet weight.

Dry weight is the weight of an organism after it has been completely dried out. It measures the weight of all the parts of a body that are not water.

For additional information about units of measurement refer to:

http://www.unc.edu/~rowlett/units/index.html

Slide 26

The effects of DDE on reproduction

Because both bald eagles and osprey are at the top of the food chain, DDE biomagnifies in their tissue and this results in eggshell thinning. Slide 26 combines results from two different studies measuring the concentration of DDE in eggs and comparing it to the reproductive success of bald eagles and osprey.

Slide 26 shows the DDE concentration that results in total reproductive failure, and this DDE concentration would result in inevitable local extinction. In other words, if bald eagles or osprey were found to have the above this concentration of DDE in their eggs, within one generation these bird species would become locally extinct. It is important to note that concentrations between 3 and 16 µg/g impair reproduction. Intermediate DDE concentrations would result in a slow decline in the bald eagle and osprey populations, and this would likely lead to eventual extinction.

- ♣ 7. *Students are asked at what DDE concentration osprey and bald eagles were found to suffer from total reproductive failure.*

Slide 27

It is important that students understand from slide 27 that when there are high concentrations of DDE, female osprey will lay eggs with thin eggshells.

- ♣ 8. *Students are asked to answer two questions about this slide.*

Slide 28

How is the impact of DDE on osprey and bald eagle reproduction measured?

In Lesson 3 and Lesson 4 students will be working with actual data on osprey and bald eagles. Slide 29 introduces students to the methods used for collecting that actual data and to the reasons why it was collected.

Slide 29

Method for measuring the impact of DDE on osprey reproduction

- Collect eggs from abandoned osprey nests. (An adult osprey may abandoned its nest because of lack of food, disturbance, or injury and unable to return)
- Measure the thickness of the eggshells.
- Measure the amount of DDE in the egg.
- Determine the association between eggshell thickness and DDE residue.

Slide 30

Visualizing the data

The last part of the presentation focuses on data visualization. This exercise is included to encourage students to start thinking about how graphs of different types of datasets may appear. For advanced students, teachers can first put up the question and then let students independently draw the graph on their worksheets. For students less comfortable with graphing, teachers may want to guide students through the graphing process using the following steps:

1) Draw the axes on the board.
2) As a class, determine the labels of the axes.
3) As a class, work out the fist graph.

Slide 31

- 9. *If increased concentration of DDE causes increased eggshell thinning, how would you draw a graph showing the relationship between eggshell thinning and DDE concentration?*

Slide 32

The graph on slide 32 depicts data where eggshells with higher DDE concentrations are thinner.

Slide 33

- 10. *If DDE has no impact on eggshell thickness, what relationship would you expect to see between DDE concentration and eggshell thickness?*

Slide 34

Slide 34 depicts data where regardless of the concentration of DDE, eggshells have the same thickness.

Slide 35

- 11. *If increased concentrations of DDE are associated with increased eggshell thickness, how would you make a graph showing the relationship between eggshell thickness and DDE concentration?*

Slide 36

Slide 36 shows a situation where eggshells with higher concentrations of DDE are thicker than those with lower concentrations of DDE.

Slide 37

- 13. *DDE reduces reproductive rates at moderate concentrations. At high concentrations it causes total reproductive failure. How would you make a graph showing the relationship between DDE concentration and reproductive success?*

Slide 38

At a moderate DDE concentration there is slightly lower reproductive success than at low DDE concentrations and beyond a certain high concentration of DDE there is total reproductive failure.

II. Food Web Activity

In the Food Web Activity students will be asked to analyze a food web to determine which organisms are most likely to accumulate the greatest concentration of chemicals in their tissues. Students consider which organisms in a food web might be most affected by the introduction of a toxic chemical to their habitat. Students will need to refer to their class notes to complete this activity. The activity can be completed as either an in-class individual student activity or as a group activity.

Teacher Preparation

1. Download the file "Activity2_FoodWeb".
2. Print and copy one activity handout for each student.
3. Prepare a large piece of butcher paper and a set of markers for each group. (*For the group activity only*)

Student Preparation

1. Students will need to have their student workbooks available so that they are able to use the notes as a reference.
2. Have students silently read the directions on the first page of the Food Web Activity worksheet.

Individual Activity

Students individually label each plant and animal on the food web diagram with one of the following labels: primary producer, primary consumer, secondary consumer or tertiary consumer. Next the students rank the relative concentration of DDE in each plant and animal using the following scale: 1 = lowest concentration - 10 = highest concentration. Finally, students will answer the five questions following the food web diagram. After each student has completed the exercise, the class can review all or part of the activity.

Group Activity

Break students into groups of three or four students. Assign each group one of the food chains and have them reproduce the food chain on their butcher paper. The group will label each plant/animal with one of the following labels: primary producer, primary consumer, secondary consumer or tertiary consumer. Next they will rank the relative concentration of DDE in each plant/animal using the following scale: 1 = lowest concentration - 10 = highest concentration.

The group will decide if the top predator in their food chain has a higher or lower concentration of DDE compared with the top predators of other food chains. Then each group will present their food chain to the class and explain why they believe the top predator in their food chain has a DDE concentration higher or lower than top predators from the other food chains. Finally, students will do the questions on page two of the Food Web Activity as either an in-class activity or homework, depending on the time.

III. Homework 1: The Range, Habitat and Niche of the Bald Eagle

For the next two lessons the students will be working with data collected on bald eagles. As the students work with these data, it will be helpful to consider the range, habitat and niche of the bald eagle. In this homework the students will first read the USGS – Biological Resource Division, Patuxent Wildlife Research Center article, *The Range, Habitat and Niche of the Bald Eagle*, and then answer the questions that follow. Students will need to complete the homework before starting Lesson 3.

Teacher Preparation

1. Download the file "Homework2_Bald Eagle Habitat".

2. Download the file "USGS – Biological Resource Division, Patuxent Wildlife Research Center article, *The Range,Habitat and Niche of the Bald Eagle*" http://www.pwrc.usgs.gov/educatnl/beyer/eagle1.pfd

3. Make enough copies for each student of the homework worksheet and the USGS – Biological Resource Division, Patuxent Wildlife Research Center article, *The Range, Habitat and Niche of the Bald Eagle* or provide link: http://www.pwrc.usgs.gov/educatnl/beyer/eagle1.pfd