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LESSON:

Wildlife Study Comparison

Summary: In this exercise, students compare two studies that examine the effects of environmental contaminants on animals. Students identify the experimental study designs and the hypotheses of each study.

EHP Articles: "Roe, Interrupted" and "POPs in Polar Bears"
EHP Student Edition, March 2005: A1010–A1011
http://ehp.niehs.nih.gov/docs/2004/112-17/ss.html

Objectives: By the end of this lesson, students should be able to:

1. Identify the important components of a research study.
2. Differentiate between a natural experiment and a laboratory experiment.
3. Compare the strengths and weaknesses associated with prospective versus retrospective study designs.

Class Time: 1 hour

Grade Level: 10–12

Subjects Addressed: Environmental Health, Life Science, Biology

Prepping the Lesson (15 minutes)

INSTRUCTIONS:

1. Obtain a class set of *EHP Student Edition*, March 2005, or download articles at http://ehp.niehs.nih.gov/science-ed/ and make copies.
2. Make copies of the student instructions.

MATERIALS (per student):

- 1 copy of *EHP Student Edition*, March 2005
- 1 copy of the student instructions

VOCABULARY:

DDT
Endogenous
Estrogen
Endocrine disruption
Hypothesis
Metabolites
Natural experiment
Northern atmospheric transport
PCBs
Persistent organic pollutants

BACKGROUND INFORMATION:

Science has a long history of using animals as experimental subjects, often in the service of protecting human health. As the field of environmental health grows, scientists are increasingly looking at wildlife as "sentinel species" to indicate long-term results of low-level exposure to industrial chemicals. Some of these chemicals are drugs, gasoline additives, and flame retardants, among other products. Many of these chemicals were not designed to be taken into the body and were therefore never safety tested for human consumption. Others were never intended for introduction into natural environments and were therefore not tested for environmental toxicity. It is becoming clear that once chemicals are introduced, they disperse far from their initial source and may have unintended effects.

Scientists must design studies carefully to identify some of these effects. While it is impossible for ethical reasons to experiment directly on humans (or even protected wildlife), scientists sometimes observe natural experiments. A natural experiment is a situation that arises in nature which scientists can observe and test hypotheses. The article "POPs in Polar Bears" is a good example of a retrospective study of a natural experiment. The term "retrospective" means "looking back" and is used to describe studies which use existing data from the past to examine outcomes in the present. Such retrospective studies are a good way to identify trends that began a long time ago. A retrospective study can suffer from bias, to take an example from the article, the skulls collected by researchers represented a sample of bears that were unusual in some way. The "gold standard" of experimental studies is the controlled laboratory experiment. The study described in "Roe, Interrupted" is a classic laboratory experiment in which fish were raised specifically for the purpose of determining the effects of exposure to low levels of environmental estrogens. Because this study is highly controlled it could be argued that it cannot reproduce the complex effects of a natural environment on wildlife. It is difficult to apply the findings of either study directly to humans, given differences in environment and physiology. For further information on the subject of environmental contaminants, see the resources below.

RESOURCES:

Environmental Heath Perspectives, Environews by Topic page. Choose Endocrine Disruptors, Persistent Organic Pollutants, http://ehp.niehs.nih.gov/topic

Schmidt CW. "The Lowdown on Low-dose endocrine disruptors." *Environmental Health Perspectives,* vol.109, Number 9, no.9, September 2001 pp. A420–A421, http://ehp.niehs.nih.gov/docs/2001/109-9/niehsnews.html#low

Implementing the Lesson

INSTRUCTIONS:

1. Hand out copies of the student instructions and *EHP Student Edition*, March 2005, and refer your students to the news articles "Roe, Interrupted" and "POPs in Polar Bears" or hand out article copies.
2. Split the class in half, assigning each half one article.
3. Review the student instructions and matrix, noting what information students need to look for in the article.
4. Have the groups read the articles and highlight and/or take notes as needed.
5. Have the groups complete the matrix in the student instructions.
6. Pair students such that each article is represented in the team (i.e., one student read "Roe, Interrupted" and the other read "POPs in Polar Bears"). Have the students summarize their articles to each other and finish filling in the matrix and answering the questions.
7. Lead a discussion summarizing the results of the matrix on the worksheet for each study.

NOTES & HELPFUL HINTS:

- Splitting the class into two groups speeds the reading process. Students then share their information with each other as they complete the matrix and present to the rest of the class. Alternatively, students can do this exercise individually or as a homework assignment.

Aligning with Standards

SKILLS USED OR DEVELOPED:

Communication (oral)
Comprehension (reading)
Experimentation (design)

SPECIFIC CONTENT ADDRESSED:

experimental study design, organochlorines, persistent organic pollutants, wildlife

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Content Standards:

Unifying Concepts and Processes Standard

- Systems, order, and organization
- Evidence, models, and explanation

- Change, constancy, and measurement
- Evolution and equilibrium
- Form and function

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Science in Personal and Social Perspectives Standards
- Personal and community health
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

History and Nature of Science Standards
- Science as a human endeavor
- Nature of scientific knowledge

Teaching Standards:

Plan an inquiry-based science program
- Develop student understanding and nurture community of science learners
- Work within and across disciplines and grade levels

Guide and facilitate learning
- Support inquiries when interacting with students
- Orchestrate discourse among students about scientific ideas

Create learning environments that provide time, space and resources for learning science
- Use resources outside of the school

Develop communities of science learners that reflect the intellectual rigor of scientific inquiry and attitudes and social values conducive to scientific learning
- Nurture collaboration among students
- Facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse

Assessing the Lesson

Students complete the matrix and provide written responses to the four questions on the student worksheet. The responses must include justification using data from the matrix or from other information discussed in the journal article.

The matrix should be completed as follows:

Answers to the questions on the student worksheet should include some of the issues raised below:

1. What might be some limitations of a study done in a laboratory?
   A lab might not replicate some important environmental factors that play a role in fish fertility.
2. What might be some limitations of a study done on biological samples collected over a long time period?
   The sampling method might have varied over time or the samples might represent some subset of bears that differed from bears in general (i.e., sicker bears.) Data or samples as old as these can be of poor quality due to inconsistent handling, loss, etc.
3. Why were zebrafish and polar bears chosen as subjects for the two studies?
   Zebrafish were chosen for their short maturation time and East Greenland polar bears for their higher body burdens of organochlorines than other Arctic bears.
4. What implications might these studies' findings have for human health?
   Environmental exposure to endocrine disruptors and organochlorines may have detrimental effects on human fertility and bone density over a long period. More research is needed though to determine if human health is endangered by these levels of exposure.

	Roe, Interrupted	POPs in Polar Bears
Time period studied	Approximately 630 days	1892–2002
Subjects studied	720 zebrafish	139 East Greenland polar bears
Samples taken	Eggs, testes, whole fish	Skulls
Environment studied	Aquaria replicating natural environment	Nature
Chemicals of interest	Estrogens	Organochlorines
Describe experimental design	four different levels of exposure plus a control group in a controlled laboratory design	Natural exposure to pollution by time period (yes/no classification)
Hypothesis	Exposure to estrogens have a negative effect on zebrafish fertility	Increasing pollution has had a negative effect on bears' bone density
Conclusions	Zebrafish fertility is negatively impacted after one generation of exposure, although reproductive behavior is not	Bears exposed to higher levels of environmental organochlorines have significantly lower bone density than pre-pollution bears

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Student Instructions: Wildlife Study Comparison

Step 1: Read the article "Roe, Interrupted" and/or "POPs in Polar Bears," *EHP Student Edition*, March 2005, as assigned.

Step 2: Complete the following matrix with information from each article:

	Roe, Interrupted	POPs in Polar Bears
Time period studied		
Subjects studied		
Samples taken		
Environment studied		
Chemicals of interest		
Describe experimental design		
Hypothesis		
Conclusions		

Step 3: If you did not read both articles, pair up with a student in your class who read the article you did not read, and finish filling in the matrix.

Step 4: Answer the following questions:

1. What might be a limitation of a study done in a laboratory?

2. What might be a limitation of a study done on biological samples collected over a long time period?

3. Why were zebrafish and polar bears chosen as subjects for the two studies?

4. What implications might these studies' findings have for human health?

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