

## LESSON 6: COMPLEX URBAN ECOSYSTEMS

### OVERVIEW:

*Students will focus on the interactions among biophysical and social forces by completing a four corners activity in which they brainstorm different factors (biological, chemical, physical and social) that interact with each other and impact cities. Then students will develop their understanding of good research questions and expand on the idea that scientific inquiry is an iterative and social process. Students will also go out to their field site and use their observational and questioning skills to come up with a variety of research questions by looking at their field site through a variety of lenses. Finally, the class discusses the different questions that the students develop focusing specifically on what type of data would need to be collected and how it could be done. During this lesson, students do not answer the research questions, but over the year the students will be studying their field sites from these different lenses which will allow them to address a number of the questions they generate in this first module.*

### SUB-QUESTION:

How do biological, chemical, physical and social forces influence cities?

### WAYS OF KNOWING URBAN ECOLOGY:



*Students will...*

#### Understand

- Understand how humans are impacting the urban ecosystem. (*human impact*)
- Understand that there are biological, chemical, physical and social factors that influence cities. (*forces and drivers*)
- Understand the elements of good research questions.
- Understand that ecosystems can be studied through different perspectives.

#### Talk

*No specific goals connected with talking about urban ecology in this lesson.*

#### Do

- Develop research questions about their field site.

#### Act

*No specific goals connected with acting on urban ecology in this lesson.*

### SAFETY GUIDELINES

Safety precautions associated with field visits.

### PREPARATION:

**Time:** 2 class periods

- Class 1: Activity 6.1  
Activity 6.2
- Class 2: Activity 6.3  
Activity 6.4

**MATERIALS:****Activity 6.1:**

Copies of the Ecological Systems Model Handout

**Activity 6.2:**

Four large sheets of paper

Four different colors of markers

Optional Student Worksheet

**Concluding:**

Student notebooks

**Activity 6.3:**

Student notebooks

**Activity 6.4:**

- One “lens” card per student
- Copies of Student investigation sheet 6.4

**Concluding****INSTRUCTIONAL SEQUENCE:****Activity 6.1: Reviewing Terms– Drivers and Forces, Presses and Pulses**

1. Review the following main concepts with students.
  - *Urban ecology is the study of cities as the interactions among biological, chemical, physical and human social forces. The human impact on the environment is a key dimension that must be considered when studying urban ecology.*
  - *Urban ecologists recognize two main types of drivers that change the ecology of cities. The first category of drivers is biophysical. These are what we might call “natural” forces such as sunlight energy, climate, biodiversity, the movement of chemicals and the fluctuations in animal and plant populations.*
  - *Urban ecologists consider an additional category of drivers called socioeconomic. These are the forces that are exerted by humans through their cultural beliefs, political ideologies and behavior practices.*
  - *Biological, chemical and physical forces = biophysical drivers*
  - *Social forces = Social drivers*
  - *Press = a driver or force that occurs over a long period of time*
    - *Ex. Climate Change, Sea Level Rise, Increased Human Resource Use, Continuous/Repeated nutrient loading*
  - *Pulse = a driver or force that has a short duration.*
    - *An Earthquake, Storm, Drought, Fertilization*
2. Distribute a copy of the Ecological Systems Model Handout to each student.
3. Review the terms in each lens and explain to students that although all of the lenses are interacting with each other to influence our understanding of ecosystems, the questions scientists ask usually highlight specific lenses and specific elements of each lens.

- Example – “How does building houses on a wetland influence the ecosystem?” This question can be considered through each lens, although it initially seems to focus on specific drivers: residential development and ecosystem change. But using the different lenses of the model, many more specific questions can be asked which help to better define the methods which will be used to investigate the question. The following are some short examples.
  - Ecosystems change – How does it impact the biodiversity of a specific species? How does it influence the food webs in that area? How does it influence the populations of different species?
  - Scale – How does it influence the neighbors on the street? How does it influence the ability for a certain species population to exist in that region of the country?
  - Ecosystems Services – How does it influence the ability for that area to provide water run-off sinks for the neighborhood?
- The specific questions that are asked will have different importance to different people in the community.

### **Activity 6.2: Four Corners – Different Drivers and Forces in Cities**

The purpose of the four corners activity is to brainstorm which biological, chemical, physical and social drivers can impact an ecosystem?

1. Using large pieces of paper write one of the four questions below at the top of each piece of paper. The remainder of the paper is divided into 4 equally sized boxes. The four questions relevant to this section could be:
  - What biological drivers or forces in cities are impacted by the presence of humans? (Simpler language: What living things in cities are changed because of humans?)
  - What physical drivers or forces in cities are impacted by the presence of humans? (Simpler language: What aspect of a city’s layout or physical characteristics is impacted by humans?)
  - What social drivers or forces in cities are impacted by the presence (or absence) of humans? (Simpler language: What types of human interactions are impacted by the presence (or absence) of humans?)
  - What chemical drivers or forces in cities are impacted by the presence of humans? (Simpler language: What types of chemical balances are impacted by the presence of humans?)

#### ***Teaching Alternative***

You can also have the students work in small groups at their desks and have them explore all four of the questions together and then have them share their ideas with the class. If you decide on the later option, there is an optional student handout that you can use. The idea of the puzzle is to help students begin to realize that all the four types of drivers are connected to one another. This also means that some student groups may place some impacts in one category while another group may place the exact same idea in another category. You can use this to reinforce the idea that urban ecosystems are complex

systems with each factor strongly impacting one another.

2. Have the students go around the room and fill in their ideas for each of the questions.
  - Below is a potential example of what one of the large pieces of paper may look like.

What physical drivers or forces in cities are impacted by the presence of humans?	
<b>Group 1</b> <i>Heat: cities are hot because of all the buildings and asphalt.</i>	<b>Group 2</b> <i>There are lots of cars and roads in cities.</i>
<b>Group 3</b> <i>The air is sometimes dirty in cities because of cars and industries.</i>	<b>Group 4</b> <i>Litter on streets (Coke cans and candy wrappers, not leaves from trees) are from people.</i>

3. Groups discuss their own question, and write an answer to the question with their marker in a given amount of time.
  - At the end of the allotted time (2 to 5 minutes), groups rotate to the next sheet, taking their marker with them.
  - Rotations continue until all of the questions have been answered by all of the groups.
  - Groups rotate one more time to see all answers written by the other groups.

**Potential Student Ideas**

It is important to note that the four factors are not isolated from one another and in fact there is significant overlap. So you may have one group with pollution in biological factors while another group may place pollution in the chemical factors category. This would be a good time to point out that these four variables/factors interact and impact one another, that humans impact each factor, and that each factor then impacts humans.

<b>Physical</b> Shape of the land (Topography) How many buildings there are Quality and number of roads Parking lots	<b>Biological</b> Diversity of species (biodiversity) Urban Tree Health Diseases (such as West Nile) Population (how many people live in the
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Open space How hot does the city get (heat islands) Vegetation in the city (are there trees?)	city and how fast is it growing) Wildlife populations (i.e. birds) Vegetation (flowers, shrubs, other, plants)
<b>Social</b> How healthy is the population? Does the government support a health ecosystem? Is green/open space valued? Economic development (shopping centers which need parking vs. open space) Is public transportation available?	<b>Chemical</b> air quality water quality (is the water safe to drink) soil quality (will plants grow) Pollution (sewage, factories, etc..)

4. Have the students note what they found to be surprising or interesting to them.
5. At this point it also may be a good time to review for students that cities are really ecosystems but just very complex ones, depending on the nature of the student discussion (it may come up naturally during the discussion). The interactions that occur in a city are greatly affected not only by the structures that people have built and the energy they import, but also by people’s cultures, behaviors, social organization and economy. So cities are just a somewhat more complicated kind of ecosystem, and new interactions among researchers will be required to understand cities as ecosystems. Ecologists, social scientists, economists, and engineers are all involved, along with city, county, state and national agencies.

**Concluding the Lesson**

1. Review for the students what they have learned today. In this review be sure to emphasize the interconnectedness of the four forces (biological, physical, chemical and social).
2. For the reflection today, ask students to write about one aspect of cities as biological, chemical, physical or social systems, and talk about what surprised you or most interests you about the conversation, and why. Today’s reflection should be at least 5 sentences in length.

**Activity 6.3: Research Questions**

**Discussion of Researchable Questions**

1. For the *Do Now*, have students select one of the questions they created with regard to their study site in previous lessons. Then ask them to answer the following questions.
  - Do you think this is a good research question? Why or why not?
  - What are the characteristics of a good research question? Provide one example of a good research question and one example of a question that would be difficult to answer through research.
2. Students can both record their responses in their notebooks and then discuss their responses or you can just have a full class discussion. Ask students to share their

- ideas about the characteristics of a good research question. As students share their ideas, you may want to write them on the board.
- After students have responded with their ideas about good research questions, stress the following three characteristics of research questions trying to connect back to the student responses whenever possible:
    - Testable – You should be able to answer the question by conducting an investigation.
    - Include an outcome (dependent) variable – There should be a specific outcome that students can measure.
    - Be specific – The question should explicitly state the variables that will be studied and any relationships between those variables.
3. You may also want to talk to your students about how there are different types of research questions in science. When people think about science research questions they often think of cause and effect research questions. For example: How are dissolved oxygen levels affected by changes in water temperature? In this lesson (and over the course of the year), students will be developing a variety of types of research questions. Some of the questions will be cause and effect, but other questions will be more observation or descriptive types of research questions.
- For example: What is the bird biodiversity of my field site? Scientists ask a variety of different questions depending on the particular problem they are addressing.
4. To get some feedback on how well the students understand how to refine questions to make them better for research, you could give them a question and ask them to critique it and make changes to it in order to improve it.
- Example question – Does noise pollution matter?

***Teaching Strategy***

- If students have difficulty coming up with a list of characteristics to define a good research question, you may want to list on the board their examples of “good” and “bad” research questions. You can then discuss what the characteristics are of the good research questions.

***Teacher Content Knowledge***

- Variable- a piece of the experiment that is changing. There are two types of variables:
  - Independent Variable- The part of the experiment that is changed by the scientist
  - Dependent Variable- The changes that the scientist observes when actively changing the independent variable.
- Constant- the parts of the experiment that remain the same.
- Bias- when the experiment lacks the proper amount of controls which can cause some outcomes to be favored over others.

- Control- A standard of comparison for checking the results of an experiment. In the control trial you do not apply the independent variable.

### **Activity 6.4**

1. Remind students that yesterday they learned that urban ecology is the study of cities as the interactions among biological, chemical, and physical forces. Over the course of the school year, there will be learning about cities through these different lenses and specifically investigating their field study through these different lenses. For example, in one module they will focus on biological aspects of the field site, such as biodiversity, while in another module they will focus on chemical aspects, such as the quality of their water.
2. Tell students that in order to start thinking about all of the different forces that effect their field site, they are going to create research questions from different lenses.
3. Hand out one card to each student describing a different lens with which you could view an ecosystem. Tell students that they should work individually to each develop their own unique research questions.
4. Once every student has a card which represents the lens which they will be looking through, head out to the study site. At the site students should be sure to spend time walking around the site, trying to come up with at least three questions. Some sites lend themselves more readily to some types of questions than others. Students should record their questions on the first page of the student worksheet. After they record all three questions, they should select the research question they believe is the strongest and provide a rationale for their choice.
5. After students have finished recording their research questions, head back into the classroom to discuss their findings.

### **Discussion of Activity 6.4**

6. Have students sit in groups with the other students who had the same lens as they had (e.g. political lens). Have students share their research questions with the other members of the group. Remind students of the three characteristics of good research questions (testable, include an outcome variable and be specific) and tell them to keep these in mind as they listen to and provide feedback on each others' research questions. Each group should select one question to share with the whole class.
7. Have each of the eight groups share one research question with the whole class. They should also provide their rationale for why they selected that research question. As each group presents, you should record their questions on piece of butcher paper or an overhead transparency.
8. Tell students that a number of these questions will be answered over the course of the year as they study cities and their field site from these various perspectives.
  - a. *The main point of this activity is to get students to start thinking about cities from the various perspectives. Students are not expected to answer these questions at this time. You may want to post the list on your wall*

*and refer back to it over the course of the year as students are studying their site from these different lenses.*

**Concluding the Lesson:**

1. Ask students - How do you think we will go about answering some of the questions you have developed over the course of this school year? How do scientists answer their research question? How would you describe the process of science to someone who is not familiar with it?
  - *The purpose of this question is to illicit students' ideas. Some keys elements of responses should focus on measurements or observations that will adequately suit the question being discussed.*
2. Tell students that over the course of the school year they are going to engage in a number of investigations in their field site using the various lenses that they discussed in this lesson. As they investigate these questions, they will be constantly engaging in all of these different practices to help them make sense of their urban environment and recommend future solutions and action

**Homework:**

Have students read the lab instructions and review the data collection sheets for tomorrow's field site investigation.