LESSON 3
Now You See Me, Now You Don't:
Investigating Bobcat Activity Patterns Using Camera Trap Data

GRADES: 6-8

KEY QUESTIONS:

- How can camera traps inform us about animal activity patterns?
- What determines a predator's activity pattern?

LEARNING GOALS:

After completing this activity, students will be able to:

- Explain what animal activity patterns are and why scientists study them.
- Use eMammal to assess activity patterns using camera trap data.
- Interpret activity pattern graphs.
- Infer potential causes of predator activity patterns from camera trap data.
- Develop methods for testing activity pattern hypotheses.

TIME: One 50-minute class period.

MATERIALS:

- Student worksheet: *Bobcat Activity Patterns*
- Bobcat Activity Patterns instructional PowerPoint. This can either be projected or given in digital or hard copy form to students. (AnalyzingActivityPatterns-eMammal.ppt or .pdf)
- Access to eMammal website: http://emammal.si.edu*
- Optional: rulers

Throughout this lesson, items in **bold blue font** indicate that students should answer a question on their worksheets.

*Technology-Free Option: If you don't have technology access for your students or the eMammal website is undergoing maintenance or errors (this is unlikely, but may occur), we have provided a technology-free option at the end of this teacher guide.

STANDARDS:
Virginia State Science Standards Addressed:

(From "Science Standards of Learning for Virginia Public Schools – January 2010")

LS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which

h) data are organized, communicated through graphical representation, interpreted, and used to make predictions;
i) patterns are identified in data and are interpreted and evaluated; and
j) current applications are used to reinforce life science concepts.

LS.8 The student will investigate and understand interactions among populations in a biological community. Key concepts include

a) the relationships among producers, consumers, and decomposers in food webs;
b) the relationship between predators and prey;
e) niches.

BIO.8 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include

e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.

THE LESSON:

PART 1: Introduce Activity Patterns

1. Start this lesson with a discussion of what is meant by the term "activity pattern" as it relates to wildlife. An activity pattern can be defined as the times in a 24 hour period when an animal is most active in its daily habits (i.e. not sleeping or resting). It might be useful to start here with the human animal – using input from the class, you could create a chart for peak activity for a typical student in your class, for example.

   Once students appear to understand the concept of an activity pattern, have them answer **Question 1 on their worksheet.**

2. Now that you have established what an activity pattern is, have the class brainstorm what factors might affect an animal's activity pattern. They should record these on **Question 2 on their worksheet** To help facilitate this discussion, some additional helpful questions might be:
   - What do animals need to survive and be successful? They need to acquire food, water, mates, and shelter, while also avoiding predation and staying warm or cool.
   - How do these factors vary throughout a day? Some of these don't vary at all in a day, but an animal's ability to find resources or avoid risks might depend on their ability to perceive their environment at different times of day. Animals that perceive mostly through hearing may not be as affected by changes in light levels as animals that rely on sight. In addition, animals often change their activity patterns to help maintain their internal temperature and reduce the costs of heating or cooling their bodies. This is called **behavioral thermoregulation**.

3. Why do scientists study animal activity patterns? There are many reasons this can be of interest. Animals face many challenges in their daily lives, including finding food, shelter, mates, and avoiding predation or human harassment. Most decisions animals make in their daily lives involve maximizing energy inputs (feeding) and minimizing risks from other animals, such as predation or competition. Community ecologists often study activity patterns to better understand how species with similar niches might partition a resource throughout a day (e.g. Lynam et al. 2013). Activity patterns are particularly of interest to scientists that study human-wildlife interaction, as animals often avoid humans or their pets, sometimes changing their activity patterns to do so (e.g. Wang et al. 2015).

   Discuss this topic as a class, then ask students to answer **Question 3 on their worksheet.**

PART 2: Bobcat Activity Patterns

1. Some key information students may want to know about bobcats for **Question 1** include:
   - Bobcats are predators. They eat many mammals, birds, and reptiles, but rabbits and squirrels make up a large proportion of their diet.
   - Bobcats are ambush predators, meaning they often catch their prey by carefully stalking and then pouncing on prey.
   - Like all felids, bobcats have very good hearing and night vision.

2. Of all the potential factors that might affect bobcat activity, we selected predation-related hypotheses for this activity for a two main reasons: (1) capturing prey has an obvious effect on bobcat survival and (2) these two hypotheses are easy for students to understand and test using eMammal data.

   When thinking about these two hypotheses, it is important for students to consider what kinds of changes in a 24-hour period might impact bobcat hunting success. These two hypotheses focus on:
   - H1 - STEALTH: bobcats' ability to successfully hunt will be determined by their ability to sneak up on prey. One would think this is easier in the dark for an animal with good night vision and hearing.
   - H2 – PREY AVAILABILITY: bobcats' ability to successfully hunt will be determined by how active their prey are. One would think this would lead to an alignment of bobcat activity with their prey's activity pattern.

   For **Question 2** on their worksheet, students should shade in the chart on Page 3, with the prediction that if Hypothesis 1 (Stealth) is true, then bobcats will be most active at night (see key to this chart below).

	1 a.m.	3 a.m.	5 a.m.	7 a.m.	9 a.m.	11 a.m.	1 p.m.	3 p.m.	5 p.m.	7 p.m.	9 p.m.	11 p.m.
Prediction 1 (Stealth)												
Prediction 2 (Prey Availability)*		R	R	R/S	S	S			S	R	R	
Actual Bobcat Activity												

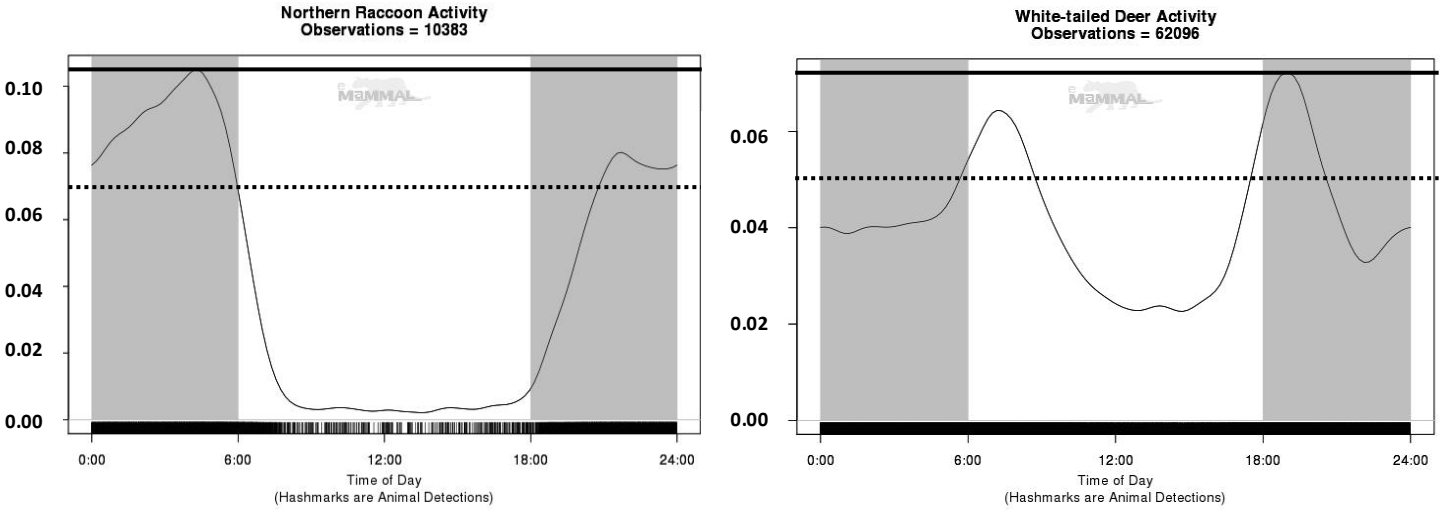
* Letters in the cells indicate which prey species (rabbit or squirrel) is active at each time of day.

Bobcat Activity

For **Question 3** on their worksheet, students will need to do a bit more work; they need to figure out when bobcat prey are active. To do this, students should follow the directions in the PowerPoint associated with this lesson (AnalyzingActivityPatterns-eMammal.ppt or .pdf). This can be projected on a screen to walk students through the process as a class, or it can be provided individually to students in digital or printed form.

Students should download activity patterns for gray squirrels (*Sciurus carolinensis*) and eastern cottontail rabbits (*Sylvilagus floridanus*) and combine both species' activity patterns in the Prediction 2 row of their chart.

It is important to note that **species are not equal in their maximum activity levels**, as indicated by the different scales on the y-axis of the activity pattern graphs[1]. For example, the graphs below represent activity patterns for raccoons and white-tailed deer. In both graphs, there are clear times of day when each species is most active, but if you look carefully at the y-axis, each species' peak activity does not correspond to the same activity level on the y-axis. For raccoons, the peak is an activity level of 0.11, while for deer it is 0.07 (peak values are indicated by a solid line across the top of the graph).



In addition, the peak value alone may not adequately represent when a species is active. Scientists usually select a threshold above which the animal is considered "active." For these two species, we might select 0.07 for raccoons and 0.05 for deer. These values are indicated by a dotted line across the graph.

For the reasons explained above, we recommend using different threshold values for determining peak activity for each species. You can either let students select these thresholds themselves, or provide the thresholds. If you choose the latter, we recommend considering >0.07 as "active" for gray squirrels, >0.06 for eastern

[1] The y-axis of activity level graphs in eMammal is the probability of getting a photo of the target species at a given time of day, based on the detections in the eMammal data set. The graphs on pages 7 and 8 are summaries of the data found in eMammal for each species.

cottontails, and >0.05 for bobcats. These are simply guidelines to make interpretation easier for students. You may want to provide rulers to help students visualize a line across their screens at each of these thresholds, as well as to better estimate the location of each time on the graph. See chart on page 4 for correct answers. Activity graphs for gray squirrels, rabbits, and bobcats can be found at the end of this guide.

Suggested answers to **the remaining questions on the student worksheet** are listed below.

4. You now have two predictions in your table on Page 3. How will you know which hypothesis is better supported by bobcat activity data obtained from eMammal?

   I will know which hypothesis is better supported by counting the number of times each prediction overlaps with the bobcat activity pattern. The bobcat activity pattern will have more times in common with the prediction that matches the better supported hypothesis.

5. Using the same methods you used to obtain prey activity data, use eMammal to find out bobcat activity patterns for Maryland, Virginia, and the Carolinas. Plot this activity in the final row of the table on Page 3. (Use an activity level cutoff of 0.04 for determining peak bobcat activity.)

   See chart on previous page for correct answer.

6. How many shaded cells does Actual Bobcat Activity have in common with Prediction 1? __3___

7. How many shaded cells does Actual Bobcat Activity have in common with Prediction 2? __5___

8. Which of your alternative hypotheses is better supported by the actual bobcat data?

   Hypothesis 2 is better supported by the real bobcat data.

9. Why might the better supported hypothesis make sense, given that a bobcat needs to successfully hunt to survive?

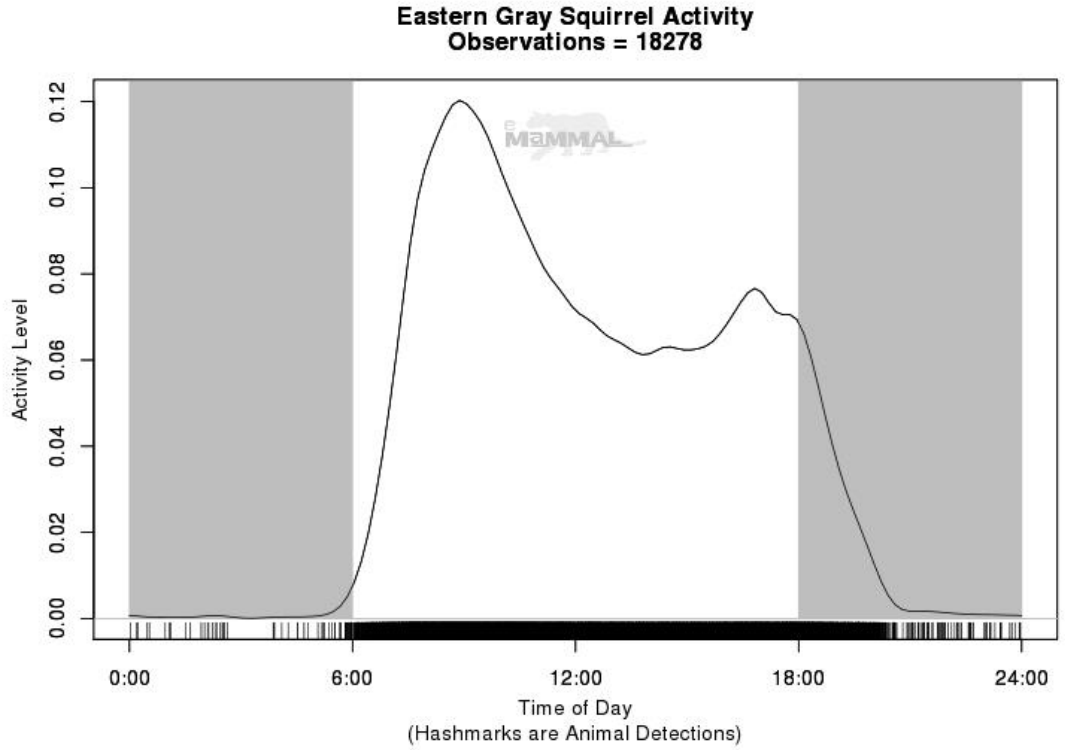
   Being stealthy doesn't do much good when there is nothing to catch! Bobcats can maximize their energy gained through hunting while minimizing energy lost while hunting when prey are easiest to find (most active).

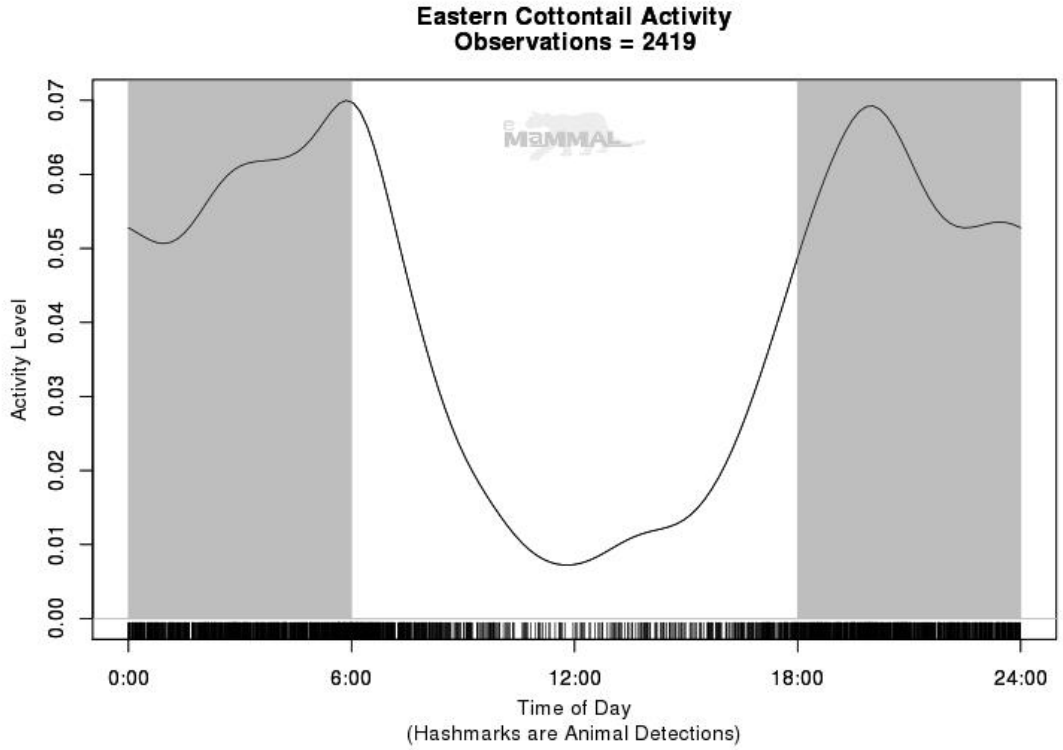
10. We were able to look at the relationship between time of day, prey availability, and bobcat activity patterns with eMammal data today, but these results don't tell us for sure that prey are causing bobcats to be active when they are. How would you design a study to determine if prey availability is what is really causing bobcat activity patterns?

    There are many ways this could be tested. Students should be encouraged to use their creativity on this question. The best way (and one of the more challenging ways) to determine causation, rather than correlation between prey availability and bobcat activity would be to experimentally manipulate prey availability at different times of day and track bobcat activity in response.

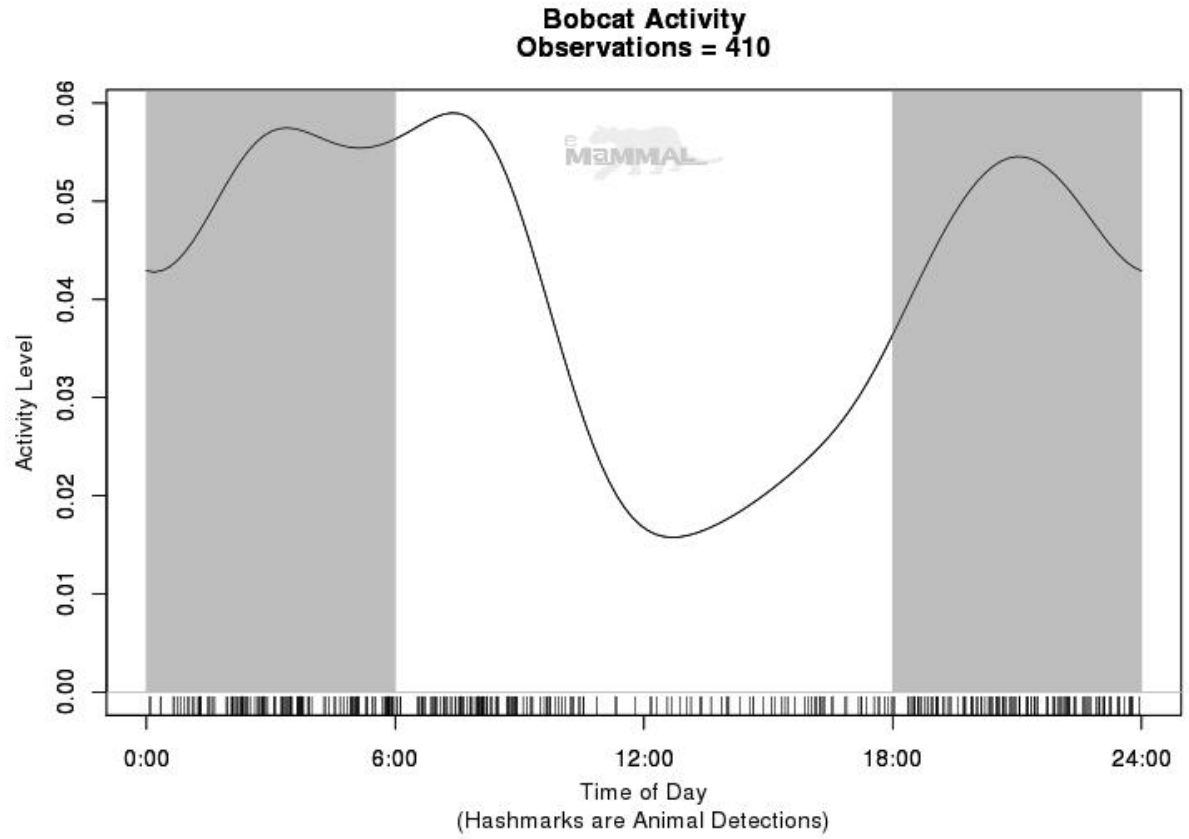
Technology-Free Option:

If your class is unable to connect to the eMammal website or encounters errors while using the site (this is unlikely, but could happen), the graphs below can be provided in hard copy to students for completion of Part 2.

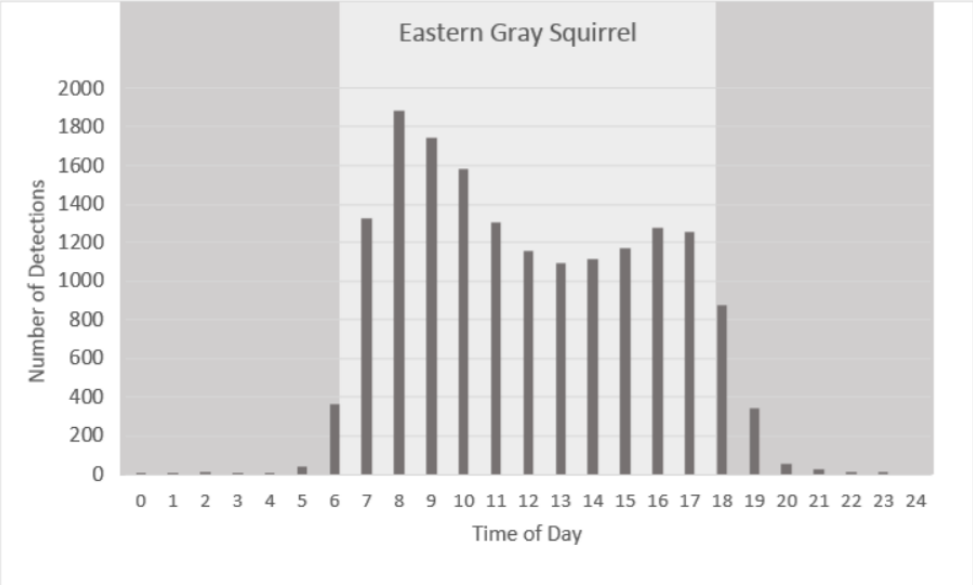




Bobcat Activity



Curious about how these graphs are made? The probability of capturing a photo of the target species at a given time of day is calculated using total captures per hour, summed across all cameras in all 19 projects included in this lesson. Examples of these captures per hour graphs are provided below.



Bobcat Activity