ScienceNews

IN HIGH SCHOOLS | EDUCATOR GUIDE

PIGGYBACKING TADPOLES
are epic food beggars

KILLER PRAIRIE DOGS
make good moms

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SN
EDUCATOR GUIDE

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About the Guide

The *Science News* articles "Piggybacking tadpoles are epic food beggars" (*SN: 4/16/16, p. 4*) and "Killer prairie dogs make good moms" (*SN: 4/16/16, p. 14*) highlight unexpected animal behaviors and the lifestyles that might explain those behaviors.

These articles can be used across a wide range of curricula with a focus on **biology**, particularly **animal behavior** and **ecology**. The activities, questions and discussions in this educator guide can be used to support the following education standards:

Next Generation Science	Common Core
Ecosystems: Interactions, Energy and Dynamics: HS-LS2-1, HS-LS2-2, HS-LS2-4, HS-LS2-6	ELA Standards: Reading Informational Text (RI): 1, 2, 4, 5, 6
Engineering Design: HS-ETS1-4	ELA Standards: Writing (W): 2, 3, 4, 7, 8, 9
	ELA Standards: Speaking and Listening (SL): 1, 3, 4
	ELA Standards: Language (L): 1, 2, 3, 5
	ELA Standards: Reading for Literacy in History/Social Studies (RH): 6
Reinforcement for Middle School: Ecosystems: Interactions, Energy and Dynamics: MS-LS2-1, MS-LS2-4, MS-LS2-5	ELA Standards: Reading for Literacy in Science and Technical Subjects (RST): 1, 2, 5, 6, 9
	ELA Standards: Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 1, 2, 4, 7, 9

Prior to reading

Guide student reading by pointing out connections between these articles and what students are learning in class. Here, find ideas for standard-aligned paths to follow while reading:

- Both "Piggybacking tadpoles are epic food beggars" and "Killer prairie dogs make good moms" describe how far some animals may go to care for their young. Ask students to brainstorm beneficial parenting behaviors that might improve the survival rates of children. Sort the ideas into categories to further foster brainstorming and serve as a reference later. Students can start with things their own parents do and then expand to other families and societies. Once they have made a list for human behaviors, ask them to consider how these behaviors parallel behaviors among nonhuman animals. Do other animals behave in the same way toward their offspring? Encourage students to think of specific examples.
- Ask students to consider whether it is better to have fewer or more children. Once students take a side, have them create a persuasive argument, with evidence to support their thinking. Students might want to consider social, cultural, economic and historical factors, as well as how those factors have impacted human reproductive rates over time. (*Some areas to consider: the human cost of war, the impact of advancing medicine on infant mortality, urban versus rural environments, China's one child policy.*) Ask students to consider whether the same answers and arguments hold for nonhuman animals. This should spark conversation about time and resource investment, competition, survival rates and a habitat's carrying capacity. How might parental investment change as environmental conditions change?

After reading: Comprehend

You can adapt and print these questions (Blackline Master 1) to check for comprehension and analysis before or after discussion:

"PIGGYBACKING TADPOLES":

1. **What is the main topic of the article?** *(Mimic poison frog tadpoles beg for their food, a behavior that appears to be an honest call for help.)*
2. **Name some unusual characteristics of the mimic poison frogs?** *(They are the only known monogamous frogs, parent frogs take care of the young, they produce litters of only two to three eggs, the tadpoles beg their parents for food, female frogs will lay an unfertilized egg as a food source for the young.)*
3. **What explains the adult frogs' different colors?** *(They have evolved colors similar to other local poisonous frogs.)*
4. **Why do the researchers think tadpole begging is an honest call for help?** *(Because, in lab studies, tadpoles that were given less food begged more than tadpoles with more food. Also, parents fed hungrier tadpoles more reliably.)*

"KILLER PRAIRIE DOGS":

1. **What is the main topic of the article?** *(Researchers have observed female prairie dogs killing small ground squirrels, but not eating them. Females that engage in this behavior raise more offspring during their lives.)*

2. **Why is the prairie dog behavior described in the article surprising to researchers?** *(Prairie dogs are herbivores, so it is surprising that they would kill another animal that isn't attacking them directly. No other systematic study has documented routine fatal attacks by one herbivore species on another. This behavior had gone unnoticed.)*
3. **What might explain the female prairie dogs' behavior, according to the researchers?** *(Perhaps the prairie dogs are killing the small squirrels because the two compete for the same plants. Keeping the population of a competing species lower might leave more food for prairie dogs.)*

After reading: Analyze

"PIGGYBACKING TADPOLES":

1. **Why might the tadpoles have to put on an extreme display to get food from their parents?** *(Producing an unfertilized egg for the tadpole requires a lot of energy from female frogs, so these frog mothers might need strong signs that their eggs are truly needed — that the tadpole is actually hungry. Alternatively, mothers might want to know if a tadpole is strong enough to survive.)*
2. **Suggest a factor that might help explain why mimic poison frogs invest so much time in raising their young when most frogs simply mate and leave eggs to develop and grow on their own?** *(Answers will vary, but students might say that tadpoles wouldn't survive without getting food from their parents in a resource-poor environment. Or, if parents are strictly monogamous and mate only with each other, it might be easier for parental care to evolve because both parents benefit equally if they care for their mutual offspring.)*

"KILLER PRAIRIE DOGS":

1. **Why are female prairie dogs described as "good mothers," but also "serial killers"?** *(Good mothers, in this case, raise a lot of offspring. Serial killers kill multiple individuals, often with no clear motive. The fact that these females kill ground squirrels without eating them could be seen as perverse, but it might be that they are protecting a food supply for their offspring. The use of both words conveys the true nature of survival. Animals can have a cute and cuddly side — how we often think of prairie dogs — but also a violent side when it comes to survival.)*
2. **What further evidence might scientists gather to test the idea that killing baby squirrels leaves more food for prairie dogs?** *(Answers will vary, but students might suggest observational studies that monitor in detail how much both species eat throughout the breeding season and nutritional studies that determine whether the species are getting enough food. Scientists might also do more detailed population studies to determine what percentage of the squirrel population the prairie dog kills represent.)*

Discuss and Assess

After students read the articles independently, return as a group to the concepts outlined prior to reading. Invite students to share their answers and observations from the articles and lead a class discussion that further underscores your current curriculum. The discussion can serve as an informal assessment. Ideas for further reading discussion or writing prompts include:

- Ask your students to think about the challenges faced by biologists trying to understand animal behavior. They cannot simply interview their animal subjects to find out why they did something. What types of data can biologists gather? *(Encourage students to think about various lines of evidence: Population dynamics, genotype and phenotype, year-to-year variations in environment, brain scans, physiological data, observational data including offspring numbers, dietary details from gut dissections or fecal samples, analyses of food composition itself.)* In the article "Piggybacking tadpoles are epic food beggars," Susan Milius says that scientists want to know whether the begging is an honest call for help or a histrionic scam. What other signals in the animal world might be dishonest? (*Consider courtship and threats directed at a predator, opponent or intruder.*) How does dishonesty further complicate the study of animal behavior?
- Parental investment is just one area where animals exhibit different behavioral patterns. Ask students to brainstorm others. *(Maturing and reproducing fast versus slow. Producing poison or relying on camouflage. Monogamous relationships versus more open mating. Hibernation or not. Nocturnal or not.)* Consider patterns related to avoiding predators, feeding, reproducing, surviving severe weather and so on. To what extent does a behavioral pattern depend on the degree of competition? What about the environment? What patterns might become risky if environmental conditions change? Ask students to think of specific examples.
- Both articles presented in this guide were written by the same author. Writers often talk about having a distinct voice. Can students notice similarities in the style, tone and language used in each story? What about differences? For the differences, why do students think the writer chose to use the approach she did? Which article did they like better? Why? How did the style and approach affect the students as readers? Students can use Blackline Master 2 to aid their thinking. After analyzing the writing, encourage students to write their own short pieces on a bizarre animal behavior. They should use a different approach, style or tone from the articles presented. They can find an animal of their own, or you can assign them to write about harvester ants, octopus dances, walking fish, flirtatious birds or how shrimpfish roll. In each case, students should do additional research to find relevant details to include in their articles.

Extend

Offer students other ways to explore the content of the articles as they relate to your curriculum, such as:

YOUNG BIOLOGISTS

Students can become young biologists. Have them select an outdoor area to study. This could be a part of campus, an area near their homes or a location in the greater community. Have students select an animal in this location to observe. They should create an organized scientific notebook to record and describe the behaviors they see. They should observe and make notes on: what an animal eats, whether it appears to be advertising for a mate or feeding young, how closely it allows a human or other animal to approach, if and how often it appears to check its surroundings for danger, how much and in what patterns it moves around while foraging, if and how often it makes sounds, whom it competes with, what kind of shelter it creates, how it cares for its young and any other behaviors students can observe. Are there any bizarre or unexpected behaviors? Have students generate a hypothesis to explain a behavior or pattern that they have observed. How do they think this behavior or pattern might relate to survival or reproduction? This activity can be combined with online research on the organism to learn more about its life cycle and life processes.

CHANCE OF SURVIVAL

Purpose: Students will explore factors that influence survival rates and population size.

Notes to the teacher: Complex interactions within an ecosystem determine population size and stability. When the conditions change, the stability of a population might be at risk. This simulation focuses on factors that affect prairie dog survival and population size, including litter size, natural death rates, habitat carrying capacity, human impacts and prairie dog behavior. As students roll the dice (with each sum of the dice corresponding to a prairie dog–related event), they will see how a variety of factors influence survival. They will also see the role of chance in a population. In the second and third rounds of the simulations, students will explore how animal adaptations or environmental changes can alter survival outcomes. The events captured in this simulation are an amalgamation of events experienced by one or more species of prairie dogs in North America. This exercise was inspired by another game based on Holt, Rinehart and Winston's "A Game Called Life."

Materials:

- chips, dried beans or other counters for tracking population size
- a pair of dice per team
- Blackline Master 3 (instructions) and Blackline Master 4 (worksheet, two to three copies per team)

Directions:

1. Set up the scenario for the game: A family of prairie dogs (called a "coterie") has been discovered in a short-grass prairie in South Dakota. In most places, prairie dogs have been considered "pests" with eradication allowed or even encouraged. This attitude, along with habitat loss and fragmentation, has affected survival rates. Prairie dog populations in the United States have declined by 95 percent based on available records. The U.S. Fish and Wildlife Service has asked you to study this particular coterie to better understand the threats to the species and the population dynamics.
2. Students form teams of two. Hand out the rules for the game and review them together. You might want to show students how to play by rolling the dice and modeling how to fill in the handout for one year.
3. Give teams time to play Rounds 1 and 2. They should record their data along the way.
4. Return together as a class and discuss whether any of the prairie dog families died out in the first game. If so, why? What events were a threat to their long-term survival? What events often served as final straws? What could be done to improve the potential survival of these prairie dog families? If the prairie dogs did not die out, what helped them survive? Is there any possibility the prairie dogs could overpopulate their habitat?
5. Which team's population was most stable? If necessary, teams can graph their population over the 10-year period to find the answer.
6. Ask students to compare and contrast Round 1 of the game with Round 2. Did their final populations differ? If so, why? Were there any trends seen from Round 1 to Round 2 across the classroom? What are the implications of the results?
7. Discuss how this game models population size and stability over time. How might the size and stability change in different scenarios? What are the limits of the model?

Optional Extension:

In an optional Round 3, each team can select up to four events to change on the table. Students should change the "action" accordingly. You can encourage them to come up with behavioral adaptations (*prairie dogs hibernate or prairie dogs expand diet to include more drought-resistant plants, for example*) or changing environmental conditions (*moose move in and eat tall vegetation, flash floods fill burrows, new construction separates infected coterie, for example*) depending on your classroom needs.

After Round 3, discuss what changes were selected and how they affected survival and population stability.

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Comprehend

After reading the article "Piggybacking tadpoles are epic food beggars," answer these questions:

1. **What is the main topic of the article?**

2. **Name some unusual characteristics of the mimic poison frogs?**

3. **What explains the adult frogs' different colors?**

4. **Why do the researchers think the begging is an honest call for help?**

Analyze

1. **Why might the tadpoles have to put on an extreme display to get food from their parents?**

2. **Suggest a factor that might help explain why mimic poison frogs invest so much time in raising their young when most frogs simply mate and leave eggs to develop and grow on their own?**

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Comprehend

After reading the article, "Killer prairie dogs make good moms," answer these questions:

1. **What is the main topic of the article?**

2. **Why is the prairie dog behavior described in the article surprising to researchers?**

3. **What might explain this behavior, according to the researchers?**

Analyze

1. **Why are female prairie dogs described as "good mothers," but also "serial killers"?**

2. **What further evidence might scientists gather to test the idea that killing baby squirrels leaves more food for prairie dogs?**

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Style and tone

Style is the unique way a writer arranges words and phrases to convey ideas and purpose in writing.
Tone is how an author expresses his or her attitude about a subject. At its most basic, tone can be positive, negative or neutral, but it can also be serious or flippant, conversational or formal, genuine or sarcastic, argumentative or exploratory.

Directions: Use the following table to track differences in the elements of style and tone found in the articles presented.

Element	Piggybacking tadpoles	Killer prairie dogs
Describe the organization or structure of the article. (Consider the order in which ideas are presented and the specific details the author chose to include.)		
Compare and contrast the sentences. (Does the author use long or short sentences? Are they simple or complex? Does the author repeat sounds, words or sentence types for effect?)		
List examples of language choice that influence the reader's interpretation of the text. (Consider levels of formality, metaphors and personification.)		
What do you think the author thinks about this topic? (Consider language that conveys emotion, types of imagery and point of view.)		

After analyzing these articles, write your own article about a different animal behavior using a different style or tone.

Chance of survival

In this exercise, you will simulate how a prairie dog population changes over time. Each roll of the dice will represent six months of time. The team with the most stable coterie (close-knit family group) after a simulated 10 years wins.

Directions:

ROUND 1

1. Place 10 counters on the table. Two of the counters represent adult prairie dogs. The remaining eight counters represent offspring.
2. Roll the dice and match the sum of the dice to your Round 1 table. For example, if you roll a 4 and a 1, your sum is 5. Two prairie dogs die from poison.
3. Record your results on the worksheet provided and perform the necessary actions — adding or subtracting counters. If your sum is 5, for example, subtract 2 from your population. The first row of the worksheet provides an example as a guide.
4. Repeat Step 2 through 3 and record your results on the same row of the worksheet. Each row of the worksheet represents one year.
5. In addition to the dice roll, there are two additional actions outlined in the worksheet:

   Maturation: At the end of the year, if your coterie gets too large, mature offspring will leave. A typical coterie can have up to 26 members, but the average is 6. If your coterie has more than 6 prairie dogs at the end of any year, subtract 4 from your total. Adjust your number of counters accordingly.

   Reproduction: At the beginning of the next year, add 3 offspring for every 2 prairie dogs remaining. Adjust your number of counters accordingly.
6. Repeat steps 2 through 5 until 10 years have passed or your coterie dies out, whichever comes first.

Round 1 Table

Roll:	Action:	Explanation:
Double 2s, 3s, 4s or 5s	Subtract 3	High mortality rate leads to offspring death.
2	Divide by 2	A new suburb is built which fragments the grassy area where the prairie dogs live. Half the prairie dogs are now in a different coterie.
3	Subtract 1	Young prairie dog dies from an unknown disease.
4 (no double)	Subtract 1	Prairie dog dies of natural causes.
5	Subtract 2	Rancher poisons 2 prairie dogs.
6 (no double) or 7	No change	Coterie lives for 6 months.
8 (no double)	Subtract 3	Food shortage occurs.
9	Subtract 1	Farmer shoots 1 prairie dog.
10 (no double)	Subtract 1	1 prairie dog killed by sylvatic plague, transmitted by fleas.
11	Subtract 1	Grassland converted to cropland. Reduce the size of your coterie by 1.
12	Add 1	Coterie moves onto Rosebud Sioux Tribe lands where limits on the hunting of prairie dogs have been increased. Add 1 prairie dog to your coterie.

ROUND 2

8. Play the game again. Replace the action for doubles with "Add 3" Explanation: "Female prairie dog kills off 2 or more ground squirrels." Use another copy of the game worksheet to keep track of your coterie population.

Round 2 Table

Roll:	Action:	Explanation:
Double 2s, 3s, 4s or 5s	Add 3	Female prairie dog kills off 2 or more ground squirrels.
2 (no double)	Divide by 2	A new suburb is built which fragments the grassy area where the prairie dogs live. Half the prairie are now in a different coterie.
3	Subtract 1	Young prairie dog dies from an unknown disease.
4 (no double)	Subtract 1	Prairie dog dies of natural causes.
5	Subtract 2	Rancher poisons 2 prairie dogs.
6 (no double) or 7	No change	Coterie lives for 6 months.
8 (no double)	Subtract 3	Food shortage occurs.
9	Subtract 1	Farmer shoots 1 prairie dog.
10 (no double)	Subtract 1	1 prairie dog killed by sylvatic plague transmitted by fleas.
11	Subtract 1	Grassland converted to cropland. Reduce the size of your coterie by 1.
12	Add 1	Coterie moves onto Rosebud Sioux Tribe lands where limits on the hunting of prairie dogs have been increased. Add 1 prairie dog to your coterie.

ROUND 3 (OPTIONAL)

9. Play the game again. Replace the action for the missing rows with something else that could affect the prairie dog population. Your teacher might instruct you to focus on behavioral or evolutionary adaptations or a changing environment. Your teacher might provide the new actions or encourage you to come up with your own ideas.

Round 3 Table

Roll:	Action:	Explanation:
Double 2s, 3s, 4s or 5s	Subtract 3	High mortality rate leads to offspring death.
2 (no double)		
3		
4 (no double)	Subtract 1	Prairie dog dies of natural causes.
5		
6 (no double) or 7	No change	Coterie lives for 6 months.
8 (no double)	Subtract 3	Food shortage occurs.
9		
10 (no double)	Subtract 1	1 prairie dog killed by sylvatic plague transmitted by fleas.
11	Subtract 1	Grassland converted to cropland. Reduce the size of your coterie by 1.
12	Add 1	Coterie moves onto Rosebud Sioux Tribe lands where limits on the hunting of prairie dogs have been increased. Add 1 prairie dog to your coterie.

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Chance of Survival Worksheet

ROUND_____

Year	Starting population	Add a litter (+3 for every two prairie dogs)	Sum from dice roll (Doubles? y/n)	1st six months			Sum from dice roll (Doubles? y/n)	2nd six months			If coterie > 6, subtract 4 from total population
				Effect on coterie	Reason	Coterie subtotal		Effect on coterie	Reason	Coterie subtotal	
EXAMPLE	10		5 (n)	–2	Poison	10–2=8	8 (n)	–3	Food shortage	8–3=5	5
1	10										
2											
3											
4											
5											
6											
7											
8											
9											
10											