

Name: _____
First Name *Last Name*

Name: _____
First Name *Last Name*

School: _____ Team Number: _____
Full School Name, No Abbreviations

ECOLOGY

C DIVISION

Kansas City Regional Science Olympiad Tournament
February 17, 2018

EXAM BOOKLET

INSTRUCTIONS

- By marking your name(s) on the lines above and on your Answer Sheet, **you are agreeing to the Science Olympiad Code of Ethics Students' Pledge:** "[I/We] will compete with integrity, respect, and sportsmanship towards my fellow competitors. [I/We] will display courtesy towards Event Supervisors and Tournament Personnel." The Ecology Event Supervisor can deduct points from a team's final score at their discretion if the team fails to uphold the Students' Pledge.
- You are only allowed to use a calculator and one 8.5" x 11" sheet of notes during the exam. All other materials are prohibited. **No phones allowed.** You can use either pencil or blue or black pen to complete the exam.
- An illegible response will be an incorrect response. Thus, **write neatly.**
- Be sure you have **sixteen pages in the Exam Booklet** and **three pages in the Answer Sheet.** If you do not have all of the pages in the Exam or Answer Sheet, alert the Event Supervisor immediately.
- Do *not* discuss the content of this exam with anyone until after the tournament is over.

FORMAT

- **The exam is 70 points** and consists of five sections: Fill-in-the-blank (10 points), Quantitative Reasoning (5 points), Diagram Creation (10 points), Multiple Choice (20 points), Scenario Analysis (15 points), and True-False (10 points).
- You will have **50 minutes to complete the entire exam.** You can pace yourself and divide the exam however you choose. (Hint: The questions are *not* arranged by difficulty level.)
- Ties will first be broken by the highest score on the Multiple Choice section, followed by the highest score on the Scenario Analysis section, followed by the highest score on the Fill-in-the-blank section, followed by the highest score on the Quantitative Reasoning section.

Exam by Jeffrey Rubel
Kansas City, Missouri • February 2018

SECTION 1: FILL-IN-THE-BLANK

10 Questions, 10 Points

Directions: Complete each of the following sentences with the appropriate word or phrase, and write the correct answer on the corresponding blank on your Answer Sheet. There is only one correct answer for each blank.

1. While rare, a species can exhibit its ___ when undergoing exponential growth if there are no limiting factors affecting the population.
2. While a polar bear's habitat could be described as "the arctic," a polar bear's ___ could be described as "eating seals and being a top predator."
3. An ecologist notices that the white-tailed jackalope hunts for baby chupacabras on mountaintops, while the black-tailed jackalope hunts for baby chupacabras on beaches. These two jackalope species exhibit ___ in order to prevent competition.
4. Fire and ___ are two dominant controls on grasslands, preventing trees from growing up and maintaining the grassy state of the biome.
5. Soils in grasslands have a deep topsoil layer filled with ___, decaying organic matter, because of the extensive root system of prairie plants.
6. While in most other biomes plants have ___ to allow water to move in and out of cells, desert plants often lack this cellular structure in order to contain water within the plant.
7. Nitrogen fertilizers, if applied in excess, can often run off into water bodies and cause ___, which causes a dense growth of plant life and a subsequent death of animal life due to a lack of oxygen.
8. Rachel Carson's groundbreaking book *Silent Spring* discussed how chemicals used in pesticides and fertilizers would compound and increase in concentration moving up the food web through the process of ___.
9. Sedimentation, particularly from agriculture, is the number one ___ pollutant in the United States. It is a significant threat to aquatic habitats and a very difficult problem to solve.
10. The ___ layer has been gradually thinning since the 1970's because of the introduction of chlorofluorocarbons (CFC's). The chlorine atoms in the CFC react with the molecules in this atmospheric layer, breaking it down.

• CONTINUE TO SECTION 2 •

SECTION 2: QUANTITATIVE REASONING

5 Questions, 5 Points

Directions: For each of the following questions, calculate the correct response and write the answer on your Answer Sheet. Round your answers to the nearest tenth and report as decimals (not fractions). There is no partial credit. Units are optional.

1. Consider the following food chain:

Mandrake → Ahoor → Gunni → Chupacabra → Jackalope

If the mandrake (a plant) has a net primary productivity of 24,000 joules, how much of the energy from the mandrake will be contained within the jackalope? Report your answer in joules.

2. A population of gunni has 125 individuals in it, with an intrinsic rate of increase of 4 yr^{-1} . However, the gunni are experiencing logistic growth; the carrying capacity of the gunni in their environment is 110 individuals. Calculate the population growth (dN/dt , or G) for the gunni. Round your answer, if needed, to the nearest whole number.
3. A population of jackalope is growing at a rate of 30% (increase per month). How long (in months) will it take for the population to double? Report your answer in months.
4. In order to get an estimate of the chupacabra population, you decide to use a capture-recapture method. On the first day, you capture and mark 50 individuals. On the second day, you go back out and capture 70 individuals, 35 of which you had previously marked. What is the size of the chupacabra population?
5. Christopher Robin needs your help calculating the species richness of the Hundred Acre Woods. During your fieldwork, you study 576 individual organisms, representing 15 different species. What is the species richness (Menhinick's index) for the Hundred Acre Woods?

• CONTINUE TO SECTION 3 •

SECTION 3: DIAGRAM CREATION

5 Questions, 10 Points

Directions: For each of the following questions about the porgs on Longhofer Island, create or complete the drawing/diagram on the Answer Sheet. Make sure your drawings are clear and simple, and be sure to include all components noted in the question.

1. On the graph on your Answer Sheet, the dashed line represents the carrying capacity (K) for the porg population on Longhofer Island, and the dotted line represents the population (n) over the past three years. The porg population is expected to hit carrying capacity in Year 6. Complete the graph from Year 3 to Year 10.
2. On Longhofer Island, there are two porg species—the brown porg and the pink porg—that compete for nesting sites. The brown porg is a generalist (nesting at most elevations), while the pink porg is a specialist (only nesting in low elevations). On the axes provided, draw and label (1) one curve representing the brown porg niche and (2) another curve representing the pink porg niche. Label (3) the zone of competition on the graph.
3. A highly simplistic sketch of Longhofer Island is shown in the box on your Answer Sheet, including the ocean, a cloud and a tree. Using this sketch, draw and label arrows representing the following components of the water cycle: (1) evaporation, (2) transpiration, (3) precipitation, (4) runoff.
4. A highly simplistic sketch of Longhofer Island is shown in the box on your Answer Sheet, including a porg and a tree. Using this sketch, draw and label arrows representing the following components of the carbon cycle: (1) respiration, (2) photosynthesis, (3) death/decay, (4) consumption.
5. Life for a porg on Longhofer Island isn't easy. Chewbaccas are one of the only predators of the porgs. The graph on the Answer Sheet shows the chewbacca population over the past ten years. Given the predator-prey relationship between these two species, draw the graph for the porg population over the same time period. Overlay your graph on the same axis.

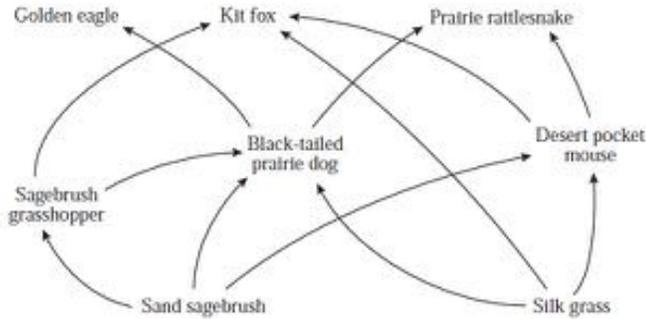
• CONTINUE TO SECTION 4 •



SECTION 4: MULTIPLE CHOICE

20 Questions, 20 Points

Directions: For each of the following questions, select the best response from the choices provided. Mark your selection with the appropriate capital letter (e.g., A not a) on your Answer Sheet.



- Consider the food web above. Which of the following could accurately describe the prairie rattlesnake?
 - Second-order consumer
 - Second-order carnivore
 - Third-order consumer

(A) I only
 (B) II only
 (C) I and II only
 (D) II and III only
 (E) I, II, and III
- Consider the food web above. What trophic level(s) is the kit fox in?
 - First trophic level
 - Second trophic level
 - Third trophic level

(A) II only
 (B) III only
 (C) I and II only
 (D) II and III only
 (E) I, II, and III
- Consider the food web above. Which of the following would lead to an increase in the black-tailed prairie dog population?
 - Decrease in the golden eagle population
 - Increase in the silk grass population
 - Increase in the prairie rattlesnake population

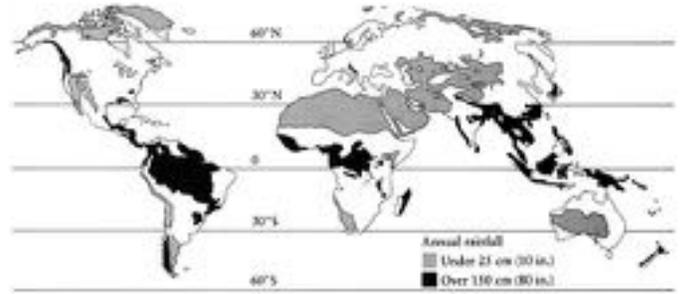
(A) I only
 (B) II only
 (C) III only
 (D) I and II only
 (E) II and III only

- Complete the following paragraph with the correct terms:
 There's a population of 150 white-tailed deer in a local Kansas City nature preserve. For two years, the population stayed around 150 deer, due to [1] limiting factors. However, last year, a drought—i.e., a [2] limiting factor—killed the plants that the deer relied on, causing the population to drop to 30 deer.¹
 (A) [1] density independent ... [2] density dependent
 (B) [1] density dependent ... [2] density independent
 (C) [1 and 2] density independent
 (D) [1 and 2] density dependent
 (E) None of the above

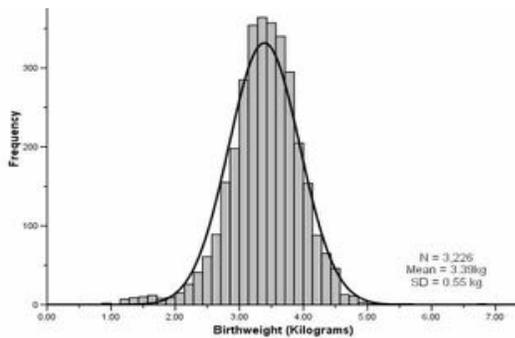


- An ecologist wanted to study the symbiotic relationship between two organisms. So, she conducted a study, and the graph above shows her results. What type of symbiotic relationship is shown between organisms 1 and 2?
 - Mutualism
 - Commensalism
 - Parasitism
 - Amensalism
 - Not enough information to tell.

¹ "Oh dear!" exclaimed an ecologist upon learning about the drought.



6. The black crows and white gulls shown in the cartoon above both eat fish, filling the same niche. This cartoon² best illustrates the concept of:
- Resource partitioning
 - Competitive exclusion
 - Survivorship curves
 - K-selected v. r-selected species
 - If seagulls fly over a bay, are they bagels?



7. The graph above is a histogram of birthweights of human newborns (sample size of 3,226). The mean weight is 3.39 kg, with a standard deviation of 0.55 kg. What type of evolutionary selection is shown?
- Directional selection
 - Stabilizing selection
 - Disruptive selection
 - Balancing selection
 - Not enough information to tell



8. The image above shows the front paw of a badger, an American prairie mammal. Why might the badger have such large front paws?
- To uproot grasses for food
 - To swat away small insects
 - To dig burrows for protection
 - To dissipate body heat
 - To attract mates

9. As seen in the map above, most of the world's deserts are located around 30°N or 30°S latitude. Why are deserts clustered at 30° latitude?
- Low-pressure zones form at 30° N/S because of the rising warm air in the westerlies and trade winds.
 - Because the atmospheric cells are flowing downwards at 30° N/S, there is a high-pressure zone with cool, dry air.
 - Direct airflow in Hadley cells from the equator brings very warm air to 30° N/S, creating ideal desert conditions.
 - Atmospheric cells are flowing upwards at 30° N/S, leading to a zone with very high evaporation rates.
 - The doldrums are located at 30° N/S, and the doldrums are known for limited plant growth due to general stagnation in airflow.



10. The (really cute) animal in the picture above is a Gobi jerboa, a small rodent found in the Gobi desert. Which of the following adaptations to desert life does the Gobi jerboa exhibit?
- Nocturnal, to avoid daytime heat
 - Big ears, to cool blood and dissipate heat
 - Hibernation, to avoid wintertime predators
- I only
 - II only
 - I and II only
 - II and III only
 - I, II, and III

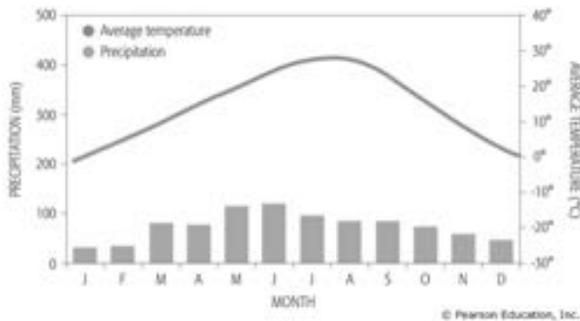
² From: *The Cartoon Guide to the Environment* by Larry Gonick (1996)



11. The image above shows the top of a Missouri prairie grass, big bluestem. What common prairie plant reproductive method does big bluestem utilize?
- (A) Fire pollinated
 - (B) Water pollinated
 - (C) Animal pollinated
 - (D) Wind pollinated
 - (E) All of the above

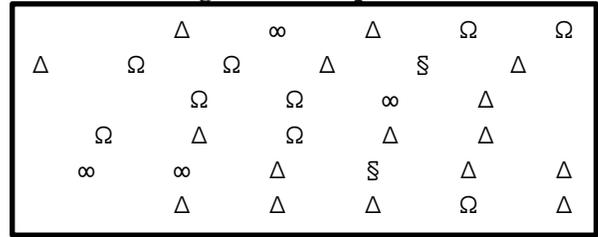


12. The diagram above shows Big Rock Candy Mountain, in a land that's fair and bright.³ Winds blow over Big Rock Candy Mountain from east to west. On which side of the mountain, if any, would you expect a desert to form?
- (A) On the west side of the mountain
 - (B) On the east side of the mountain
 - (C) On both sides of the mountain
 - (D) On neither side of the mountain
 - (E) Only at the summit of the mountain



13. In the graph above (often called a “climograph”), the bars represent precipitation (mm) while the line represents temperature (°C). What biome is depicted in this graph?
- (A) Grassland
 - (B) Desert
 - (C) Tropical rainforest
 - (D) Taiga
 - (E) Tundra

Diagram of Sample Area



Jaw of Specimen



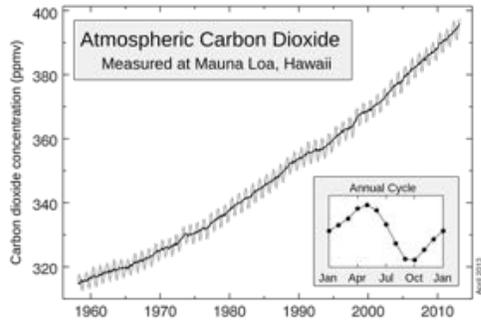
14. An area of a grassland was studied, and the species found were plotted in the “Diagram of Sample Area” above. The four symbols in this diagram each represent a species in the following food chain: Producer → Primary Consumer → Secondary Consumer → Tertiary Consumer. In this same study area, the jaw above (“Jaw of Specimen”) was found. This jaw is from one of the four species plotted in the diagram. What symbol in the diagram represents the species that the jaw is from?
- (A) ∞
 - (B) Δ
 - (C) Ω
 - (D) §
 - (E) Not enough information to tell

	Mt. Berkley	Mt. Sloan	Mt. Wright
<i>Base of mountain</i>	Δ Ω ≈ ∞ § á	ç ∞ §	£
<i>Summit of mountain</i>	∞ Δ ∩ ≈ á §	Ω ≈ Δ	£ ¶

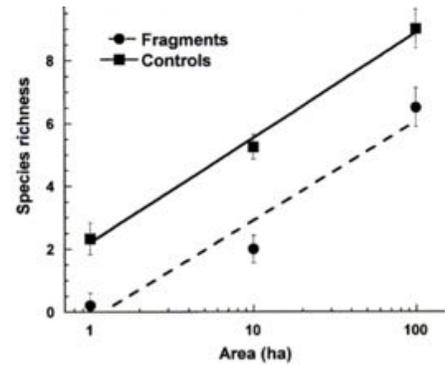
15. The table above shows the species composition of three mountains at the base of the mountain and at the summit of the mountain. Each distinct symbol represents a distinct species found at the base or summit (and the same symbol represents the same species). Which mountain has the highest beta diversity?
- (A) All three mountains have an equal beta diversity
 - (B) Mt. Berkley
 - (C) Mt. Sloan
 - (D) Mt. Wright
 - (E) Mt. Olympus

³ Please excuse my terrible sense of humor. [Lyrics from “Big Rock Candy Mountain” by Harry McClintock.]

16. A fifteen-person Science Olympiad team wants to buy matching silk pajamas (\$100 each) embroidered with goofy science memes to wear at the Missouri State Tournament.⁴ For the production and delivery of each \$100 silk pajama, 0.042 metric tons of carbon dioxide are emitted into the atmosphere.⁵ Considering the $I=P*A*T$ equation, what are the total emissions from the team's purchase?
- (A) 0.0028 metric tons of CO₂
 (B) 0.63 metric tons of CO₂
 (C) 3.57 metric tons of CO₂
 (D) 63 metric tons of CO₂
 (E) 357 metric tons of CO₂



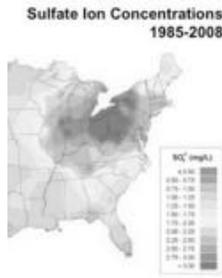
17. In the 1950s, oceanographer Charles David Keeling began taking regular atmospheric carbon dioxide measurements in Mauna Loa, Hawaii. What best explains the annual up-and-down variability seen in the curve?
- (A) Human output of carbon dioxide is highest in the spring and early summer because of increased seasonal production and summer travel (air/car)
 (B) There are more trees in the Northern Hemisphere than the Southern Hemisphere, thus there is more photosynthesis in June through August, removing atmospheric carbon dioxide
 (C) North Atlantic Deepwater formation is the strongest in the late fall (October-November), pulling carbon dioxide out of the atmosphere and into the deep ocean through circulation
 (D) There are, on average, more hibernating animals in the Northern Hemisphere than in the Southern Hemisphere, so there is less carbon dioxide respiration in October through December
 (E) The annual variability in the curve is simply an artifact of how the data is collected. The wet season in Hawaii leads to, on average, higher carbon dioxide readings.



18. In a study from the Biological Dynamics of Forests Project in Brazil (shown in graph above), ecologists compared isolated fragmented pieces of forest ("Fragments") with areas of untouched, non-isolated forest areas ("Controls") and measured the species richness in these sites. Which of the following is/are true of their study?
- I. Species richness increases directly with land area.
 II. Species richness is higher in non-isolated forests than in isolated fragments.
 III. If we were to conduct a follow-up study looking at richness of interior habitat species versus edge-dwelling species, we'd expect to find more edge-dwelling species in the isolated fragments than in the control areas.
- (A) I only
 (B) II only
 (C) I and II only
 (D) I and III only
 (E) I, II, and III

⁴ #squadgoals

⁵ Emissions estimate based on data from UC Berkeley's Renewable and Appropriate Energy Laboratory



19. The two maps above show sulfate ion concentrations in the eastern United States in 1985 (top) and 2008 (bottom). Darker colors represent higher sulfate ion concentrations.⁶ The change in sulfate ions from 1985 to 2008 is because of the U.S. Clean Air Act, which regulated emissions. A pond in western Pennsylvania would have observed which of the following changes—due to shifts in atmospheric sulfate concentrations—between 1985 and 2008?
- (A) The turbidity increased
 - (B) The turbidity decreased
 - (C) The pH increased
 - (D) The pH decreased
 - (E) There should be no change in the pond

20. In the image above, the soil on the left is from tilled farmland while the soil on the right is from a tall-grass prairie. Which of the following is **not** true of the differences between these soils?
- (A) The tilled soil is lighter in color than the prairie soil because it has less organic matter in it.
 - (B) The prairie soil has a more granular texture than the tilled soil because prairie grasses have deeper root systems than farm plants.
 - (C) The A Horizon is shallower in the farmed soil than in the prairie soil because of the annual tilling.
 - (D) There are likely more nitrogen-fixing bacteria in the tilled soil than the prairie soil because of agricultural fertilizers.
 - (E) All of the above are true.

• CONTINUE TO SECTION 5 •

⁶ This isn't fully true as this figure is supposed to be seen in color (oh well), with greens and reds, but for the purposes of this question, let's work from the idea that dark colors are higher sulfate concentrations.

SECTION 5: SCENARIO ANALYSIS

15 Questions, 15 Points

Directions: In this section, there are five scenarios of varying length and context. Answer each question using both your knowledge of ecology and the information provided. Question formats vary. All questions are weighted equally.

SCENARIO 1: “There’s a dead zone the size of New Jersey.” (2 questions)

Where the Mississippi River flows into the Gulf of Mexico, there’s a dead zone. You’ve been hired by the Natural Resources Defense Council (NRDC) to better understand the cause of the dead zone and what we can do about it. Figure 1 below shows a map of the dead zone, as of 2014. Figure 2 provides information about land usage within the Mississippi River watershed.

Figure 1: Dead zone map



Figure 2: Mississippi River watershed land use data⁷

Land Use/Cover	Percent of Mississippi River Watershed
Urban land	0.6%
Agricultural land	58%
Woodland	18%
Range or barren land	21%
Wetlands	2.4%

- Which of the following non-point source pollutants best explains the presence of the dead zone?
 - Road salt runoff from cities
 - Sediment runoff from woodlands, rangelands, and barren lands
 - Nutrient runoff from farms
 - Gasoline and fuel runoff from cities and farms
 - All of the above
- The NRDC wants to suggest some regulations to help decrease the size of the dead zone. A relatively uninformed intern came up with the list below. From this list, select all regulations that would directly help remediate the dead zone. [This is not a multiple choice question. List the numbers of all the correct regulations on your Answer Sheet.]
 - Regulation 1: Set limits on the amount of fertilizer a farmer can apply to his land.
 - Regulation 2: Require pet owners to pick up their pet’s waste and dispose of it properly, or else receive a fine.
 - Regulation 3: Create incentive programs for cities to install green roofs on buildings taller than ten stories.
 - Regulation 4: Require construction sites to install sediment containment walls to hold sediment on site.
 - Regulation 5: Expand monitoring of septic systems to ensure they are well-sealed and will not leak.

⁷ Data from the National Academies Press, 2012

SCENARIO 2: “There are deserts in Missouri!?” (2 questions)

Wanda and Riley are biking in Burr Oak Woods Nature Center (Blue Springs, Missouri). They stop at a clearing and look down. Their jaws drop. They cannot believe what they’re seeing. It’s a prickly pear cactus growing in Kansas City!⁸ (See Figure 1.) Then, they notice an informational sign next to the trail (Figure 2). But, they still have a few questions, so they text you—their smartest, and most ecologically-minded friend—to get some help.

Figure 1: Glade photograph



Figure 2: Glade informational sign⁹

Aren’t you GLADE to be here?

This microenvironment in front of you is a glade. Glades experience near desert conditions and are often home to grasses, drought-adapted forbs, and even cacti. These plants are resistant to droughts and sunlight, especially compared to nearby forest species. While people used to not value glades, they are finally being appreciated for their beauty.

3. Glades often appear in the middle of forests, seemingly out of nowhere. But the presence of a glade is defined by some abiotic factors. You get a text from Riley that asks: “Yo, why’s this glade here?” You respond with:
- I. “The slope of the land at the glade is probably south or west facing.”
 - II. “There’s very little soil development. The plants are basically growing on bedrock.”
 - III. “Glades often fall in isolated watersheds, keeping them very dry.”
- (A) II only
(B) I and II
(C) II and III
(D) I and III
(E) I, II, and III
4. A couple minutes later, you get a text from Wanda: “Why aren’t there more glades in Missouri? I know there used to be more, but why’d they disappear?” Your response is below. Fill in the two blanks with the correct words. *[Note: Each blank has a different correct answer.]*

“Because of [4.1] suppression policies in the United States, many glades were overgrown with forests. Because of these policies, invasive Eastern Red Cedar wasn’t controlled naturally. And when this tree would invade the glades, it would block [4.2] from the shade-intolerant cacti, killing them. Then no more glade. Sad story, for sure.”

⁸ Yes, you actually can go to Burr Oak Woods and see this! It’s very cool. You should do it sometime.

⁹ Information on this sign based on articles by Washington University in St. Louis (“Glades of Missouri”) and the USDA Mark Twain National Forest (“Glade Top Trail National Scenic Byway”).

SCENARIO 3: “The case of the missing chicken.” (5 questions)

The greater prairie chicken (Figures 1 and 2) was once a signature species of United States grasslands. However, its population and range have been rapidly declining (Figures 3 and 4), particularly in Missouri. You, as a prairie ecologist, have been hired by the Missouri Department of Conservation (MDC) to investigate the ecology of this beautiful bird, why the greater prairie chicken is no longer in Missouri, and if there is anything that can be done to bring it back.

Figure 1: Greater prairie chicken



Figure 2: Prairie chicken “dancing”



Figure 3: Prairie chicken population

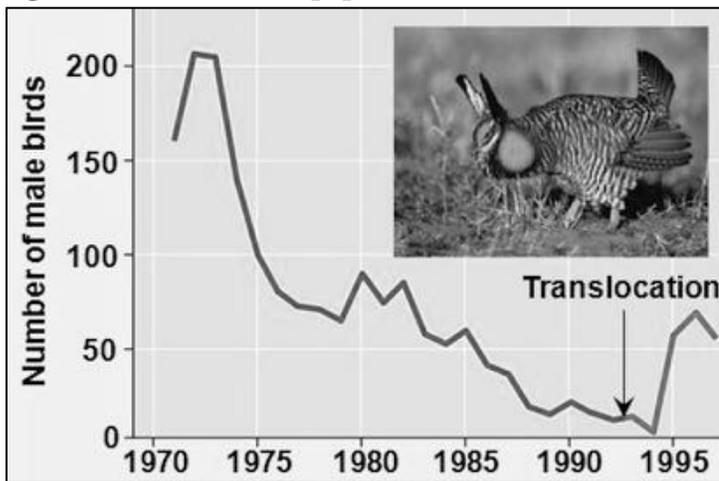


Figure 4: Prairie chicken range



In Figure 4, the dark-colored region is current range, and the light-colored region plus the dark-colored region is pre-settlement range.

- Prairie chickens sometimes do dances,¹⁰ as seen in Figure 2, where they jump up and down while flapping their wings. Why might a prairie chicken do this seemingly silly behavior?
 - Interspecific competition with other bird species for nesting sites
 - Intraspecific competition for mates
 - Response to predators to make the prairie chicken appear bigger and fiercer
 - Method of warning fellow chickens of a potential danger
 - All of the above, depending on the context.
- Winters in greater prairie chicken habitats can be surprisingly harsh, with cold temperatures and significant amounts of snow. What is one way the prairie chicken has adapted to survive grassland winters?

Questions for Scenario 3 continue on the next page.

¹⁰ Might we even call it “the chicken dance”?

7. Figure 4 shows a significant loss in greater prairie chicken habitat since European settlement in North America. Which of the following best explain this decline? *[This is not a multiple choice question. List the numbers of all the correct reasons on your Answer Sheet.]*
- Reason 1: Conversion of grassland to farmland
 - Reason 2: Fire suppression
 - Reason 3: Heat island effect radiating out from urban centers
 - Reason 4: Competition with the introduced ring-necked pheasant
 - Reason 5: Poor disposal of RCRA hazardous waste materials
 - Reason 6: Property owners replacing warm season grasses with cool season grasses
8. Translocation is the capture, transport, and release of species from one location into another. The MDC has found a plot of land where they are hoping to translocate some prairie chickens. However, before they can release the prairie chickens, they need to prepare the new habitat. For the two prairie chicken needs listed below, match the need with the best vegetation option from the given choices. This will help the MDC make sure the right vegetation coverings are cultivated in the new habitat.
- | | | |
|-----------------------|-------------------------------------|---------------------------------|
| <u>Habitat needs:</u> | <u>Vegetation covering options:</u> | |
| 8.1: Nesting cover | (A) Short grass | (D) Forbs and sparse grass |
| 8.2: Food | (B) Tall grass | (E) Barren lands, no vegetation |
| | (C) Tall forbs and sparse grass | (F) Cool season grasses |
9. You and your colleague Phoebe are surveying a plot of land for potential prairie chicken translocation. There are a couple of sporadic trees growing in the plot of land. Phoebe looks at you and asks, “Do you think we need to cut down these trees?” You say:
- (A) “Yes, the trees shade out wildflowers that the chickens rely on for food.”
 - (B) “Yes, the trees provide perches for predatory birds and encourage generalists to invade.”
 - (C) “No, the trees actually provide important roosting areas for the prairie chickens.”
 - (D) “No, the trees provide shelter for the prairie chickens in severe storm events.”
 - (E) “We should leave the deciduous trees as they provide food but remove the conifers.”

SCENARIO 4: “Bye-bye desert birdies.” (3 questions)

The Firestone National Park¹¹ is a desert region in Arizona, maintained by the National Park Service (NPS). Recently, however, things have been going a bit haywire in Firestone: populations and overall environmental conditions are declining. You've been hired by the NPS to explore what's going on in Firestone. So far, you've found population data for some species (Figure 1).

Figure 1: Species population sizes from 2014-2017, as counted in a 100-acre plot of Firestone National Park

	2014	2015	2016	2017
Blue-nosed mouse	57	62	71	85
Green-nosed mouse	54	48	42	39
Deep-rooted cactus	21	19	16	11
Shallow-rooted cactus	24	26	26	30
Little brown bird (<10 g)	46	39	31	28
Big brown bird (10-40 g)	40	42	40	39

10. The blue-nosed and green-nosed mice have different predators and different food sources. Through further research into environmental impacts in Firestone National Park, you were able to pinpoint what caused the change in each of the mouse species. Match the appropriate environmental impact with the species it affected.
- | | |
|-------------------------|--|
| <u>Species:</u> | <u>Environmental Impact:</u> |
| 10.1: Blue-nosed mouse | (A) Introduction of an invasive cacti that outcompeted the native shrubs |
| 10.2: Green-nosed mouse | (B) Overhunting of local coyote and large cat populations |
| | (C) Over-pumping of groundwater from local wells |
| | (D) Nitrate and phosphate runoff from agricultural fertilizers |
11. Next, you look at the populations of the deep-rooted cactus and the shallow-rooted cactus. You know this difference has to do with climate change and the species' different root depths. Which of the following best explains the difference in population changes between these two species?
- (A) The shallow-rooted cactus takes advantage of brief, intense pulses of moisture following summer thunderstorms, which are more common given climate change, while the deep-rooted cactus relies on cool-season precipitation.
- (B) The top soil is warmer given climate change, which facilitates an increase in water absorption, helping the shallow-rooted cactus to proliferate.
- (C) As the climate warms, groundwater infiltration decreases, which limits the amount of water that makes it down to the deep roots of the deep-rooted cactus. The shallow-rooted cactus fills the cactus' niche.
- (D) The change in these two species has nothing to do with climate change, and this question is silly and too long.
- (E) Only (A) and (B) are correct.
12. Climate change, and subsequent heat waves, can kill birds in two ways. First, when it gets really hot, birds die because they cannot evaporate enough water to stay cool, leading to heat stroke. Or, second, the rate of evaporation needed to keep cool depletes their body water pools to lethal levels, leading to dehydration.¹² Based on this context, what is the best explanation for the different population trends seen in the little and big brown birds?
- (A) The big brown bird can evaporate more water, given its larger surface area, than the little brown bird, allowing it to better regulate its body temperature.
- (B) The big brown bird is able to migrate further out of Firestone National Park, avoiding significant heat waves, while the little brown bird is stuck and dies.
- (C) The little brown bird is particularly susceptible to lethal dehydration because it can lose water at a proportionally higher rate.
- (D) All of the above are explanations for this difference.
- (E) It probably has something to do with the 1960 Broadway musical *Bye Bye Birdie*.

¹¹ Don't go looking for Firestone National Park. It doesn't exist. The park, and all the species in this scenario, are fictional.

¹² This question is based on the *Biology Letters* paper "Climate change increases the likelihood of catastrophic avian mortality events during extreme heat waves" by Andrew McKechnie and Blair Wolf (2009).

SCENARIO 5: “Dear Theodosia, what to say to you?” (3 questions)

Ecologist Evan Hansen studies the populations on Theodosia Island,¹³ home to only four species, shown in the food web (Figure 1), and the small town of Burr. A few years ago, Evan discovered the blue buckleberry bush on Theodosia Island. It has spread across the island and wreaked environmental havoc. Evan has taken some notes (Figure 2) recording how populations have changed as a result of the blue buckleberry’s introduction. Right now, Evan is preparing an op-ed for a local newspaper about what’s happening. And he needs your help.

Figure 1: Theodosia food web, native species

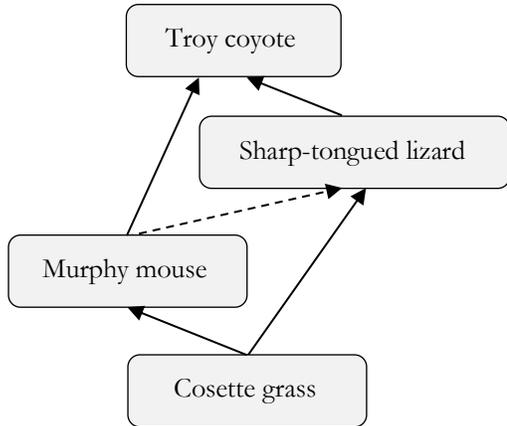


Figure 2: E. Hansen’s notes, after buckleberry introduction

Species	Notes
Cosette grass	Significant declines; population down to ~10% of its original size
Murphy mouse	Not much change in population size; around ~5% drop in population size; herbivorous
Sharp-tongued lizard	Declines; population down to ~50% of its original size; primarily herbivorous
Troy coyote	Declines of ~15% in population size; eats both mouse and lizard interchangeably

13. From the list below, select all of the reasons why the blue buckleberry bush is a successful invasive species on Theodosia Island. *[This is not a multiple choice question. List the numbers of all the correct reasons on your Answer Sheet.]*
- Reason 1: The bush grows taller than the grass, shading it out.
 - Reason 2: The seeds of the bush—within the buckleberry—require birds for distribution.
 - Reason 3: The bush produces a prolific number of seeds per year and has a long reproductive season.
 - Reason 4: The bush’s leaves are poisonous to the sharp-tongued lizard.
 - Reason 5: The bush is suited to only grow on the beaches of Theodosia Island.
 - Reason 6: A fire recently swept through Theodosia Island, disrupting the ecosystem.
14. In his op-ed, Evan plans to include some predictions about what might happen to the ecosystem if nothing is done. From the hypotheses below, select which ones you think are the most likely to occur. *[This is not a multiple choice question. List the numbers of all the correct hypotheses on your Answer Sheet.]*
- Hypothesis 1: The murphy mouse could go extinct.
 - Hypothesis 2: The sharp-tongued lizard could go extinct.
 - Hypothesis 3: The troy coyote could see population increases.
15. When the newspaper’s editor read Evan’s article, she told him he needed to include something positive, like a potential solution to the buckleberry bush invasive problem. Which of the following should Evan include in his article?
- I. Thick black tarps should be placed over the bushes to suffocate them by preventing photosynthesis.
 - II. An herbicide, such as Roundup, should be sprayed on the cut stems of the bush to prevent regrowth.
 - III. Students at the Burr Elementary School should be taught why planting the bush in their gardens is a bad idea.
- (A) II only
 (B) I and II only
 (C) II and III only
 (D) I and III only
 (E) I, II and III

• CONTINUE TO SECTION 6 •

¹³ This island is fictional. But those of you who got the Broadway musical references probably knew that already.

SECTION 6: TRUE-FALSE

10 Questions, 10 Points

Directions: Determine if each of the following statements is true or false. If the statement is true, circle "True" on your Answer Sheet; if the statement is false, circle "False" on your Answer Sheet.

1. The most common population distribution pattern is random.
2. r-selected species show greater fluctuation in population size than K-selected species.
3. Both energy and nutrients cycle through an ecosystem.
4. An ecosystem with high evenness has a couple of species that dominate the area.
5. Desert annual plants are often dormant during the dry season, but they germinate and grow rapidly during the wet season.
6. In a prairie, most of the plant biomass comes from forbs while most of the plant diversity comes from grasses.
7. Ecological health is defined as a biological system's resiliency and ability to maintain itself over time.
8. Cities are often hotter than natural ecosystems because asphalt and buildings absorb heat, increasing surface temperatures.
9. Climate change is a myth because Groundhog Day this year was the coldest on record.
10. Ecology is the study of how organisms interact with each other and their environment... and it's one of the best Science Olympiad events!

. . .

CONGRATULATIONS!

You have completed the Ecology exam at the 2018 Kansas City Science Olympiad tournament!



This test, along with the answer key, will be posted on the SciOly.org Ecology 2018 Test Exchange later this weekend.