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Suggested Procedures (Parts 1-6):

Part 1: What kinds of ticks are present in the ecosystem? (30 minutes)

1. Share Ticks, Biodiversity and Climate Virtual Field Trip website link with each student. https://sites.google.com/view/ticksbiodiversityclimate/home

   Teachers can screen share to show students the website before the students work independently or in groups.

   Teachers should direct students to watch the video on the Home page. Dr. AlcØn-Steiner, from the Life Sciences Learning Center, provides an overview for the field trip in the video.

2. Teachers should explain that the virtual field trip has six parts. Students are about to participate in Part 1: What kinds of ticks are present in the ecosystem?

3. The website will guide students through the identification of ticks that are present in the ecosystem.

   If students are using a mobile device and not a computer, they will need to scroll downward when the directions direct them to use the Tick Identification Key on the right.

   Students using computers will see the Tick Identification Key on their right.

   All students will answer three multiple choice questions in the Tick Identification Key then scroll downward to progress forward with new instructions.

4. Provide the link f]TJ /TT1e1 1 Tf wgfvKevit sde(h)-0.7 (e)]TJ 0 -6.3 (d)-2.9 (o)1.3 T1e1 1 T (i)-3.3 (t)-7J /TT2

Part 2 What pathogens can ticks carry? (30 minutes)

1. Share Ticks, Biodiversity and Climate Virtual Field Trip website link with each student.

   Teachers can screen share to show students the website before the students work independently.

   Students can be encouraged to work with one or more partners to complete Part 2.

   Teachers should explain that the virtual field trip has six parts. Students are about to participate in Part 2: What pathogens can ticks carry?

2. Read the information in the top text box aloud to the class or have students read individually.
3. The website will guide students through a simulated Gel Electrophoresis Tick DNA from the three dogs (Max, Daisy and Lainey).

   All students will record their observations along with answers to the posted questions in their digital lab notebooks.

   Remind students that the data from today will be recorded in their digital lab notebook for Part 2. The lab notebook has the questions and prompts that each student will need to have a complete Read aloud Part 2 (dy)-4.6a ct all t2a.9 (h)2.2 (r h5.7(h)13.2 hy)-4.6a cx al7 ( ) al

Tick Identification Key

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Human Diseases Transmitted by Ticks

Disease	Transmitted by	Symptoms
Anaplasmosis	Blacklegged tick	Fever, chills, severe headache, nausea, vomiting, diarrhea, rash
Babesiosis	Blacklegged tick Brown Dog Tick	Common: Fever, chills, sweats, fatigue, joint pain, headache, nausea Less common: cough, sore throat, depression
Ehrlichiosis	Brown Dog Tick Lone Star Tick	Fever, chills, headache, muscle pain, nausea, vomiting, diarrhea, altered mental status, rash
Lyme disease	Blacklegged tick	Red ring-like expanding rash; classic rash is not present in all cases, flu-like symptoms, headache, fever, joint pain, muscle pain, heart abnormalities, facial paralysis
Rocky Mountain Spotted Fever	Brown Dog Tick Lone Star Tick American Dog Tick	High fever, severe headache, muscle pain, swelling around eyes and on the back of hands, nausea, vomiting, altered mental status, coma, respiratory distress, multi-organ system damage
'Stari' borreliosis	Lone Star Tick	Red, expanding bull-s-eye lesion, fatigue, headache, fever, and muscle pains.
Tularemia	American Dog Tick	Fever, chills, headache, fatigue, muscle pain, chest discomfort, cough, sore throat, vomiting, diarrhea, abdominal pain

Throughout the course of the day, Dr. Louis examined two more dogs, Lainey and Daisy. Both dogs loved the outdoors and took long walks through the woods with their human companion. Dr. Louis removed ticks from each of these dogs as well!

4. Use the Tick Identification Key to identify the tick found on Lainey. What type of tick was found on Lainey?

   Blacklegged Tick

5. Support your identification by checking the characteristics the tick had that helped in identification.

   ____ Festoons
   _X_ Long mouth parts
   ____ Several silvery markings
   ____ One single white spot

6. Use the Human Diseases Transmitted by Ticks reference page to determine what diseases, if any, this kind of tick are likely to be transmitted to humans.

   The blacklegged tick is capable of transmitting several diseases to humans. These diseases include Borrelia burgdorferi (Lyme Disease), Babesiosis, and Anaplasmosis

7. Use Tick Identification Key to identify the tick found on Daisy. What type of tick was found on Daisy?

   Lone Star Tick

8. Support your identification by circling the characteristics the tick had that helped in identification.

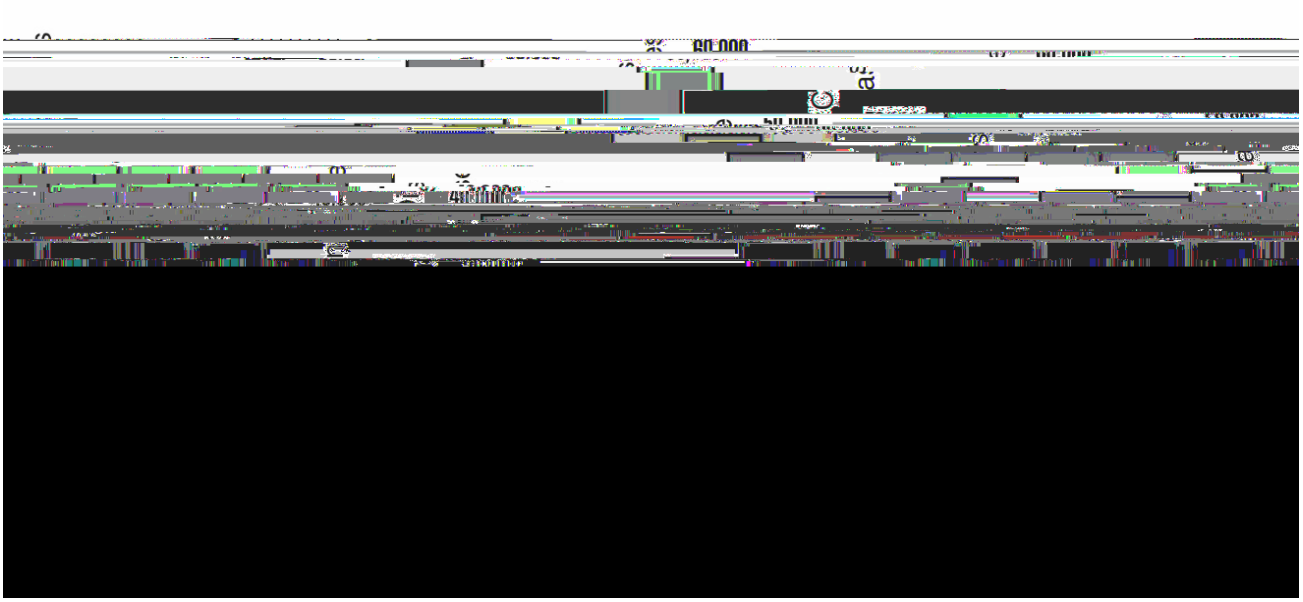
   _X_ Festoons
   ____ Long mouth parts
   ____ Several silvery markings
   _X_ One single white spot

9. Use the Human Diseases Transmitted by Ticks

Part 3: Analyzing patterns in tick-borne diseases

The veterinary lab that Dr. Louis uses participates in a research project that collects data about tick-borne diseases in dogs. The US Centers for Disease Control and Prevention (CDC) collects similar data on tick-borne diseases in humans. Researchers can use this data to recognize patterns in the dog and human tick-borne infections.

Total number of reported tick-borne diseases in humans from 2004-2018



Modified from CDC: https://www.cdc.gov/ticks/datasummary/index.html

1. Use the graph above to describe the overall change in the incidence of tick-borne diseases in the United States.

   Tick-borne diseases have increased in the United States

Researchers decided to focus on the blacklegged tick because this tick can carry several diseases that are transmissible to humans, including the pathogen that causes Lyme disease. In 2018, the CDC developed a map to illustrate the geographic distribution of the blacklegged tick in the United States. This map is shown below.

Map of Blacklegged Tick Distribution

Modified from CDC https://www.cdc.gov/ticks/geographic_distribution.html

2. What part of the United States would you most likely find blacklegged ticks?

The Eastern part of the US.

Red dots on the following maps of the U.S. illustrate the geographic distribution for several blacklegged tick-borne diseases in humans. The data was collected in 2016.

Researchers continued to look at environmental data from this region. This time they focused on changes in annual average precipitation over time.

Change in Average Annual Precipitation

Modified from Climate Science Special report https://science2017.globalchange.gov/chapter/7/

7. What is the trend in annual precipitation in the region you identified as important to the tick-borne disease?

   Rainfall has increased in this region.

8. Can this pattern in precipitation change provide an explanation for the increase in tick-borne diseases in this entire region? Support your answer with information from the Change in Average Annual Precipitation map and .7 (i)86 (c)3.9 mf090.8 (u)-6 (n)-hi4 (n)-0.7 7 (d)-0.8k <</MCID 6 >>BD (c)3.9

Part 4: Do living things influence the pattern of tick-borne diseases?

The researchers involved in the voluntary reporting project studying the patterns in tick-borne diseases realized that this was a very complex problem that may involve even more factors. They decided to enlist the help of an environmental scientist. Environmental scientists use their knowledge of science to protect the environment. They gather data and monitor environmental conditions related to ecosystems, which are an intertwined web of interacting abiotic and biotic factors. The environmental scientist explained that ticks are part of a complex system of interactions. Models are a way to visualize interactions within an ecosystem. Scientists use models to help answer the question, Are biotic factors in the ecosystem involved in the pattern of tick-borne diseases?

1. According to the Complex Interactions Model model, what organisms is eaten by immature ticks?

   Small mammals, like chipmunks.

2. What effect would an increase in acorns have on the number of ticks in the environment? Explain.

   An increase in acorns would increase the number of ticks because acorns are food for the small mammals. An increase in food would increase the population of small mammals. An increase in small mammals would increase the number of ticks by providing a food source for the ticks.

3. What effect would an increase in the number of small mammal predators have on the number of ticks?

   An increase in predators would decrease the number of small mammals which would decrease the number of ticks.

The squiggly arrows shown on the Steps to Infection in the Complex Interactions Model represent the movement of ticks through the ecosystem. If you did not do so yet, Click Here to see if you found where the bacteria that causes Lyme disease is transferred to the tick, then answer questions 4-5.

Students should circle the area around the chipmunk and the immature tick.
This is the link provided to students online when the use the "Click Here

The environmental scientist had been monitoring the number of small mammal hosts, acorns and ticks for eight years. Her data are below:

Figure 1.

Modified from PbS Biology

9. Describe how the pattern of peaks in the chipmunk population compares to the pattern of peaks in the tick population.

The chipmunk population peaks one year prior to the tick population peak.

10. Provide an explanation for this pattern.

Chipmunks are the hosts for ticks. As the chipmunk population increases, there are more hosts for ticks. This leads to an increase in the tick population.

11. In what 2 years would you expect to see an increase in tick-borne diseases? Why?

1996, 2000 would show an increase because there are more ticks.

12. Assume that 2001 is a peak in the acorn population. What year, following this peak would you warn people about a potential increase in tick-borne diseases? Why?

2003. Based on the pattern, ticks peak two years after the peak in acorns.

The environmental scientist explained that increasing the number antody <<ta3 (in)2.3 5.2 (n)-0.8 (g)10..02-1.1