

SCIENCE·3D

TIGER QUEEN

In this packet, sample student answers are provided in **red** and notes to teachers are in **blue**.

In this **STEM Project**, students will use what they have learned to design a new nature preserve for tigers. They will calculate whether the proposed area has enough prey to support a population of tigers, design a monitoring plan for tigers and their prey, and create designs to reduce tiger-human conflict.

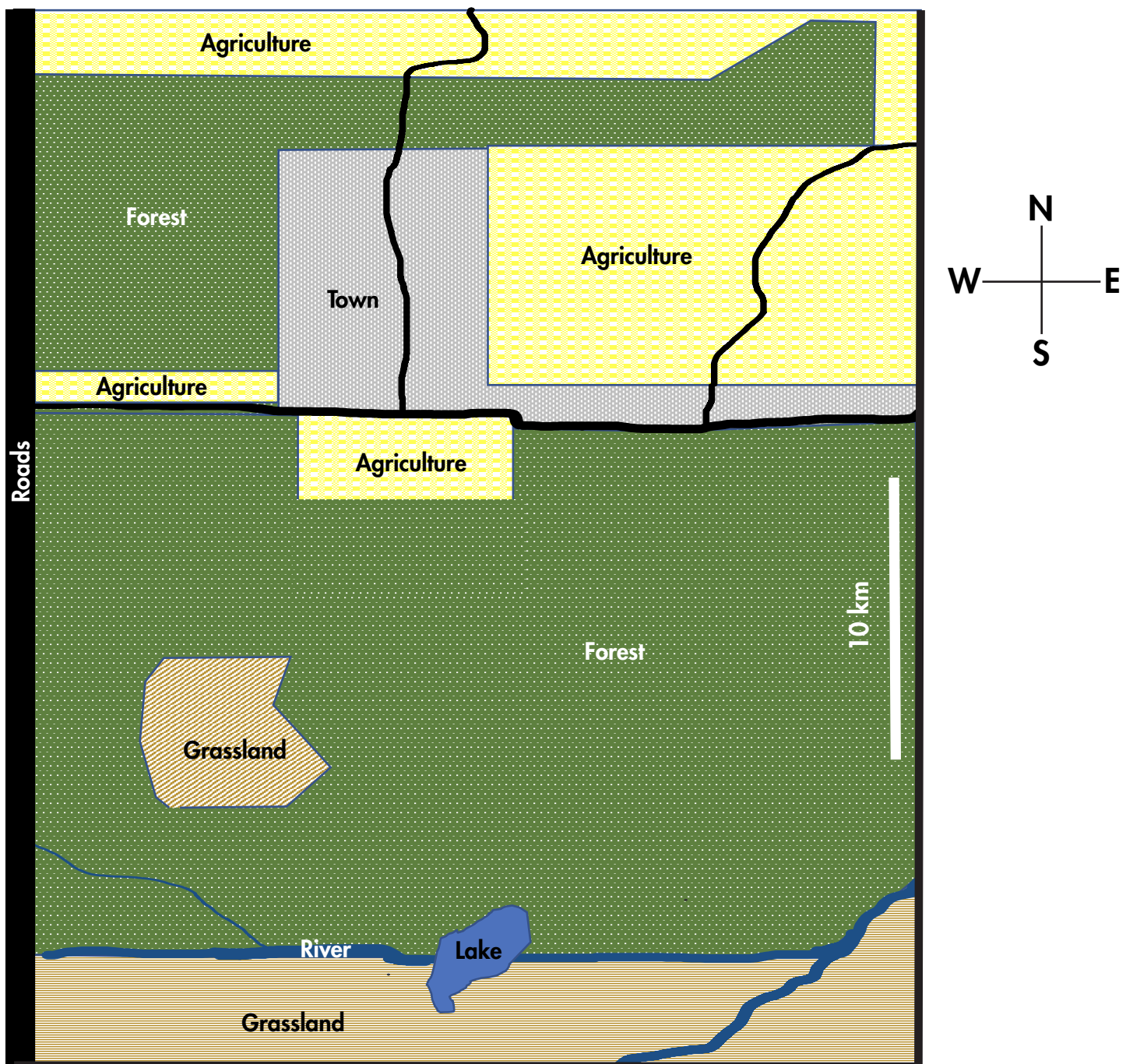
Note: Although not required, it would be helpful for students to have access to rulers.



You have been asked to develop a survey to determine how many tigers are in a forest that may be used to create a protected area. In order to determine whether the forest is big enough, the government wants you to help them. Here are the things they want to know:

- 1) How many tigers are in the area now?
- 2) Is there enough prey in different areas of the park to support 50 tigers?
- 3) Do tigers leave the park?
- 4) Can you design a way for tigers to safely cross between the different forest areas?
- 5) Can you design ways for the livestock in the agricultural areas to be protected from tigers?

Here is a map of the habitat. Use this map to complete the exercise.



Activity 1: Just How Big Could the Park Be?

1. **Estimate** the size of the park that could be created by the natural habitat south of the road that runs along town but inside the roads that form the boundary of the map. Be sure to subtract the size of the agricultural area and the lake and rivers. The agriculture department has already provided the dimensions of the agriculture area that is south of the road (5 km x 2 km). And, the parks department has provided the area of the lake and rivers (5 km²). Show your work. *Hint: Use the scale bar!*
Note: Students could use rulers to be relatively precise or they can estimate. The main idea is to have students try to figure out how to make these calculations.
 - 1a. Total area south of the road = $22 \text{ km} \times 20 \text{ km} = 440 \text{ km}^2$
 (Accept answers around 400 km².)
 - 1b. Agricultural area south of road = $5 \text{ km} \times 2 \text{ km} = 10 \text{ km}^2$
 Total area of lake and rivers = 5 km²
 - 1c. Size of park that could be created by natural habitat south of town:
 $440 \text{ km}^2 - 10 \text{ km}^2 - 5 \text{ km}^2 = 425 \text{ km}^2$ (Answer should be total area estimate minus 15 km².)
2. **Estimate** how large the park could be if the area of forest north of the road that runs along town is included in the park. Show your work. *Hint: Break down the area into two basic shapes. The key is that students are close and show their work.*
 - 2a. Calculate the area of the forest north of the road.
 Upper (northern) rectangle of the strip: $10 \text{ km}^2 \times 6 \text{ km}^2 = 60 \text{ km}^2$
 Section south of upper rectangle (west of town): $14 \text{ km}^2 \times 2 \text{ km}^2 = 28 \text{ km}^2$
 Total forest area north of road: $60 \text{ km}^2 + 28 \text{ km}^2 = 88 \text{ km}^2$
 - 2b. Calculate the total area of the park if north and south sections are added together.
 $425 \text{ km}^2 + 88 \text{ km}^2 = 513 \text{ km}^2$
3. **Round** your estimate of the total possible park size to the nearest 100 km².
 500 km^2

Activity 2: Is There Enough Space for Tigers?

The government hopes to create a park that can sustain at least 100 tigers.

1. **Describe** some information you would want to have in order to know if there is enough space for 50 tigers.

Answers may vary. Accept any logical answers. Some examples include: The size of tiger

territories, how much prey each tiger needs, how much shelter each tiger needs, how far

tigers move, whether poaching is a concern.

2. **Complete** the table below. To calculate the total number of possible tiger prey in the park, multiply the density of individuals by the total park size. Use your estimate of park size from Activity 1 rounded to the nearest 100 km². To calculate the total mass in the park, multiply the total number possible in the park by the mass per individual.

Tiger Prey	Density (individuals/km ²)	Total number possible in park	Mass per individual (kg)	Total mass in park
Gaur	0.5	250	700	175,000
Boar	40	20,000	100	2,000,000
Chital deer	50	25,000	45	1,125,000

3. **Calculate** the total mass of potential prey in the area being considered as a park by adding the masses of all the prey. Show your work.

$$175,000 + 2,000,000 + 1,125,000 = 3,300,000 \text{ kg}$$

4. If 10% of the total mass of prey is available for tigers every year, **calculate** how much food there is for tigers in the park.

$$\frac{3,300,000 \text{ kg}}{10} = 330,000 \text{ kg food available for tigers}$$

5. If each tiger needs 2,500 kg of food per year, calculate the maximum number of tigers that could be supported by the prey in the park. **Describe** whether the park is big enough to meet the design criteria of supporting 50 tigers based on food.

$$\frac{330,000 \text{ kg available for tigers}}{2,500 \text{ kg per tiger}} = 132 \text{ tigers}$$

Yes, the park is big enough to meet the design criteria based on food.

Extend the Lesson: To challenge students, have them calculate how many tigers could be supported on the two pieces of forest separately.

Studies in other forests have shown that tigers will use areas of 15 km² to 100 km². But, tigers defend parts of their range from other tigers. Usually that means that there can only be about 12 tigers per 100 km² of space.

6. **Describe** whether the park is big enough to meet the design criteria of supporting 50 tigers based on the size of the park. Show your calculations to support your answer.

$$\frac{500 \text{ km}^2 \text{ park}}{100 \text{ km}^2} = 5 \times 12 \text{ tigers per } 100 \text{ km}^2 = 60 \text{ tigers}$$

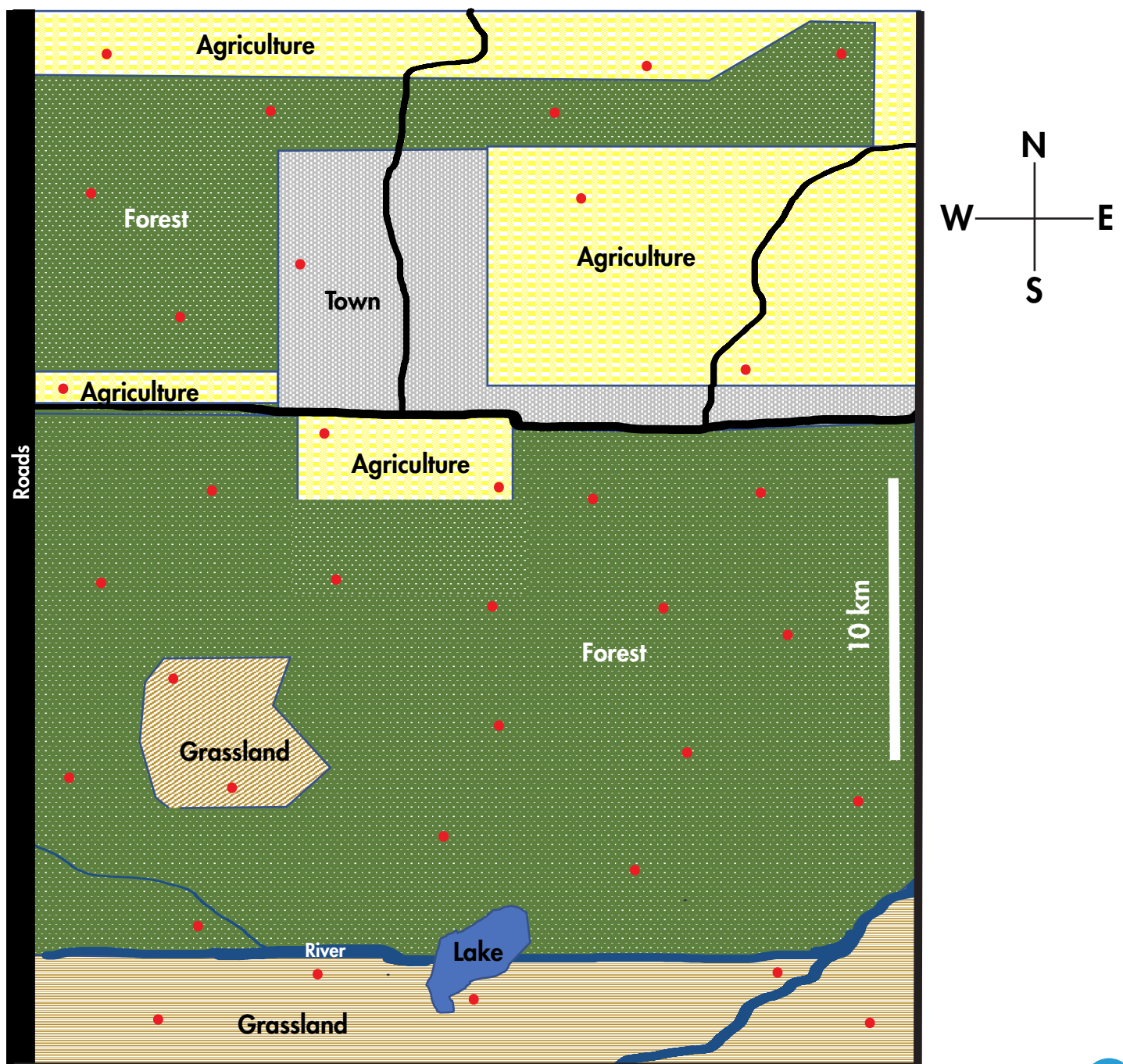
Yes, the park is big enough based on its size to meet the design criteria of supporting at least 50 tigers.

Activity 3: Monitoring the Park and Reducing Human-Tiger Conflict

If the park is created, it is important to know how many tigers live in it. It is important to know the size of prey populations. Once the park is created, it will be important to monitor areas that tigers use and how populations change.

1. On the map below, put dots in locations where you would want to place camera traps to determine 1) how many prey and tigers are in the potential park area and 2) if tigers use places where there are humans and livestock. You have 35 camera traps.

The specific locations are not as important as students placing monitoring stations in the different blocks of forest and habitats. They should also have some in areas with humans in order to see if tigers go there.



2. **Describe** why you chose particular areas for your camera traps.

Complete answers will discuss wanting to cover a large area and the different types of areas tigers and prey might be found. Students should also suggest they want to see if tigers are near people or livestock.

3. **Describe** how you might help protect people and livestock from tigers if the park is established. **Draw** your solution. Label how it works.

Answers will vary. The specifics are less important than coming up with creative solutions. Example solutions include: Fencing (or densely packed vegetation) around town and agricultural areas, monitoring flocks at all times, using domestic dogs to alert people to the presence of tigers.



4. **Describe** how you might help protect tigers crossing between the different forest parts of the park if it is established. **Draw** your solution. Label how it works. *Hint: Use the map to understand the challenges for tigers moving from one forest area to the next.*

Answers will vary. The practice of brainstorming is more important than getting the correct answer! Example solutions include: Creating overpasses or underpasses for roads and creating strips of forest through agricultural areas (corridors) so tigers can easily move between separated forest areas.



Extend the Lesson: Have students present their ideas for protecting people, livestock, and tigers. Then, have students discuss the best solutions. Reinforce that brainstorming many ideas and then selecting the best designs is an important part of the engineering design process. You can further reinforce the engineering design process by having students make a rubric for the most and least desirable aspects of a solution before the presentations begin. Then, have them score each solution with the rubric.