Science Assessment Grounded in Equity: Unit B.1 Lesson 6 Mid-Unit Assessment

Task Table of Contents

About This Task

Task Name	Reintroducing Wild Dogs	**Grade Level or Course**	Biology
Phenomenon or Phenomenon Based Problem	Conservationists need to identify key features of environments to support the successful reintroduction of endangered wild dogs into new habitats	**Type of Phenomenon** Everyday, Societally Relevant, Culturally Significant, Contemporary Scientific	Societally Relevant
Task Description **(from the learner perspective)**	Learners figure out the factors that affect the reintroduction of wild dogs.	**Time Required & Materials**	90 minutes
Profile of Identified Learner Population(s)	This task was written with Washington state teachers for a general population of high school learners across Washington experiencing OpenSciEd instructional materials.	**Special Considerations** Characteristics of the culturally and linguistically diverse groups that may introduce differential performance	Learners may have experience with and knowledge of different types of endangered animals. learners may have varying levels of proficiency with math concepts in the task.

How is this task meant to be used? Mid-Unit, instructionally embedded, End of Unit	Mid-Unit	**What instruction or experiences should learners have before completing this task?**	Experiences identifying and analyzing data to understand the key relationships and features of ecosystems that support populations like those in the OpenSciEd Biology unit B.1 lessons 1-5.

Note(s)	This version of a task is an adaptation of the assessment included in lesson 6 in the OSE B.1 unit.
Adaptation Suggestion(s)	Collaboration structures in this task can be adapted to fit the needs of the class and students. Consider options for learners to review feedback together since this is the first time in the unit learners are experiencing an assessment including transfer.

Standards Emphasis

Assessment is a balancing act involving multiple tradeoffs. No one task can do everything, and often good design carefully considers what *not* to assess. The targeted NGSS Performance Expectation and supporting dimensions are shown below. The parts of the standard not addressed in the task are ~~struck through~~. Each item in the task may target one or more of the dimensions - not every item has to assess every dimension. What matters is that the task as a whole addresses all three dimensions.

NGSS PE(s)

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.] (HS-LS2-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using mathematics and computational thinking. Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	**Interdependent Relationships in Ecosystems.** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This	**Scale, proportion and quantity.** The significance of a phenomenon is dependent on the scale, ~~proportion~~, and quantity at which it occurs.

	fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.	

Key Equity Feature(s)

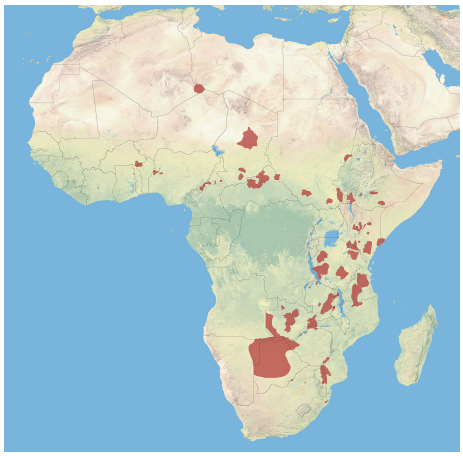
Support Learning: Opportunity to Learn **Accessible:** Producing Responses

Task Worksheet

Reintroducing Wild Dogs

African Wild Dogs are the most endangered carnivore in South Africa and only about 6,600 remain in the world. Wildlife conservationists are working to grow the wild dog population.

One approach to growing the population of wild dogs is reintroducing groups of wild dogs back into areas wild dogs previously lived in.



By Nrg800 - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15819049

"African Wild Dog" by Andy Morffew is licensed under CC BY 2.0

Reintroduction programs are one way **wildlife conservationists** support endangered species like African Wild Dogs. Wild dogs are taken from one area and transferred to a new area that could be in a new country, far away.

> **Reintroduction programs** are initiatives where animals are either raised or rehabilitated in protected areas, like zoos, and then released back into their natural habitats.
>
> **Wildlife conservationists** are people who work to preserve natural lands, habitats, and wildlife.

Wild Dogs can't be reintroduced just anywhere with success. In this task, you will figure out, **What factors do wildlife conservationists need to consider when planning for the reintroduction of wild dogs?**

PART 1 – Analyze Data in Groups

In 2021, conservationists planned to relocate African wild dogs to Liwonde National Park and Majete Wildlife Reserve in Malawi. How did they decide that this relocation effort could be successful?

In your groups, you will use the data from other wild dog populations collected by scientists to make recommendations for what is needed to ensure a successful wild dog reintroduction in Liwonde National Park and Majete Reserve in Malawi.

The data focused primarily on land area and prey requirements. Lindsay et. al. gathered data from studies of wild dogs in South Africa.

In your group, have two people work on land requirements and two people work on prey requirements.

LAND REQUIREMENTS

One of the first considerations is the amount of land needed to support wild dogs. Wild dogs are social animals that gather and hunt in packs. Wild dogs tend to hunt within a specific territory. A team of scientists (Mills & Gorman, 1997) studied 8 different packs of African wild dogs in a nature preserve and monitored where the packs traveled to identify each pack's territory.

A pack of wild dogs in South Africa.

Some data from their study are shown below in Table 1.

Table 1.

Wild Dogs in 1997		
Pack Number	**Pack Size (number of dogs)**	**Territory Size (km^2)**
1	11.4	930
2	7.5	499
3	9.8	425
4	6.6	378
5	7.5	428
6	8.4	357
7	10.2	471
8	9	807

Organizing Space

Note: In the table, pack sizes are not whole numbers because new dogs are born, and old dogs die each year. The pack size is an average over three years.

QL1. Based upon this data, how would you describe the relationship between pack size and territory size? *Hint: You might try ordering the data by pack size or by territory size to look for any patterns in the space provided above. You can also use CODAP to make a graph if that is helpful.*

QL2. What do the data in Table 1 suggest about how much land might be needed to maintain a pack of 14 reintroduced wild dogs? *State your answer in mathematical terms, supported by data from Table 1 above. Support your answer with your calculations.*

PREY REQUIREMENTS

Determining if there is enough available prey to support wild dogs is another consideration for reintroduction programs. All of the prey animals the wild dogs eat are herbivores that eat plants. These animals have their own requirements for land.

Impala

Kudu

Waterbuck

Wild dogs eat a variety of prey animals in South Africa. The table below shows data collected from teams of scientists about the variety of prey eaten by wild dogs in four regions of South Africa. For each region, the scientists determined how much prey *biomass* (or the total mass of organisms in a given area) was eaten by wild dogs in the region.

Table 2. Percent Biomass of Prey Species in the Diet of Wild Dogs in Four Regions of South Africa

Prey	Eastern South Africa	Northeastern South Africa	Northern South Africa	Pilanesberg National Park
Bushbuck	0	2	1.2	0.2
Cattle	0	0	1	0
Grey duiker	0.1	4.4	0.4	0
Eland	0	0	0.2	2.5
Impala	16.3	81	61	10.6
Kudu	0.8	8.1	36	67.6
Mountain reedbuck	0	0	0	0.6
Nyala	76.1	0	0.2	0
Red duiker	0.3	0	0	0
Reedbuck	0.9	2.0	0	0
Steenbok	0	2.5	0	0
Waterbuck	2.0	0	0	18.4
Wildebeest	3.5	0	0	0
TOTAL	**100**	**100**	**100**	**100**

a Adjusted from Kruger et al. (1999); b Mills & Gorman (1997); c Pole (1999); d van Dyk & Slotow (2003)

Analyze the data above.

QP1. Which prey animals do you think are most important to consider when planning to protect wild dogs in each region? Why? *Complete the table for **2 of the four** regions*.

Region	Prey Consideration(s)
Eastern South Africa	
Northeastern South Africa	
Northern South Africa	
Pilanesberg National Park	

QP2. What do you expect the relationship between prey biomass and successful reintroduction would be? *Give a reason for your answer based on what you know about ecosystems.*

PART 2. IDENTIFY THE NEEDS FOR REINTRODUCTION

Q3. What did you figure out about land and prey needed for wild dogs? *Share your findings from Part 1 as a group and write your main findings in bullet points below.*

Collaboration Reflection: In the next part, you will work in your groups both mathematically and creatively. Before you begin, take a few minutes for everyone to write an answer to the next 2 questions.

Q4. How do you like to work when you work in groups?

Q5. How can you work together with someone who likes to do things differently?

One way scientists and conservationists use data is to make mathematical models that consider many factors and help make predictions about what will happen in an ecosystem.

Below is a list of factors that could be included in a mathematical model to predict the requirements for reintroducing a population of wild dogs into a new area.

Possible Factors - Ecosystem Model - Wild Dogs **Wild dog packs range between 5 and 30 individuals.**	
• Area to support a pack of wild dogs of X size • Number of prey killed per year by a pack of dogs • Growth rate of the prey population • Prey Density–the number of prey per km^2 of land • Wild Dog Pack Size at re-introduction • Likely increase in wild dog numbers in a year	• Average number of pups born to a pack in a year • Survival rates for adult wild dogs and pups • kg of food wild dogs eat per day • The amount of prey biomass that is flesh • Total amount of prey biomass in an area

Collaborate with your team to create a mathematical model that helps to answer the question - **What is the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements?** *There is not a correct answer for this question - work as a team to figure out how to best represent the factors in a mathematical model.*

You have **two options** for approaching this task. Review the options below and decide as a team which you will complete.

OPTION 1 - Use Graphical Representations

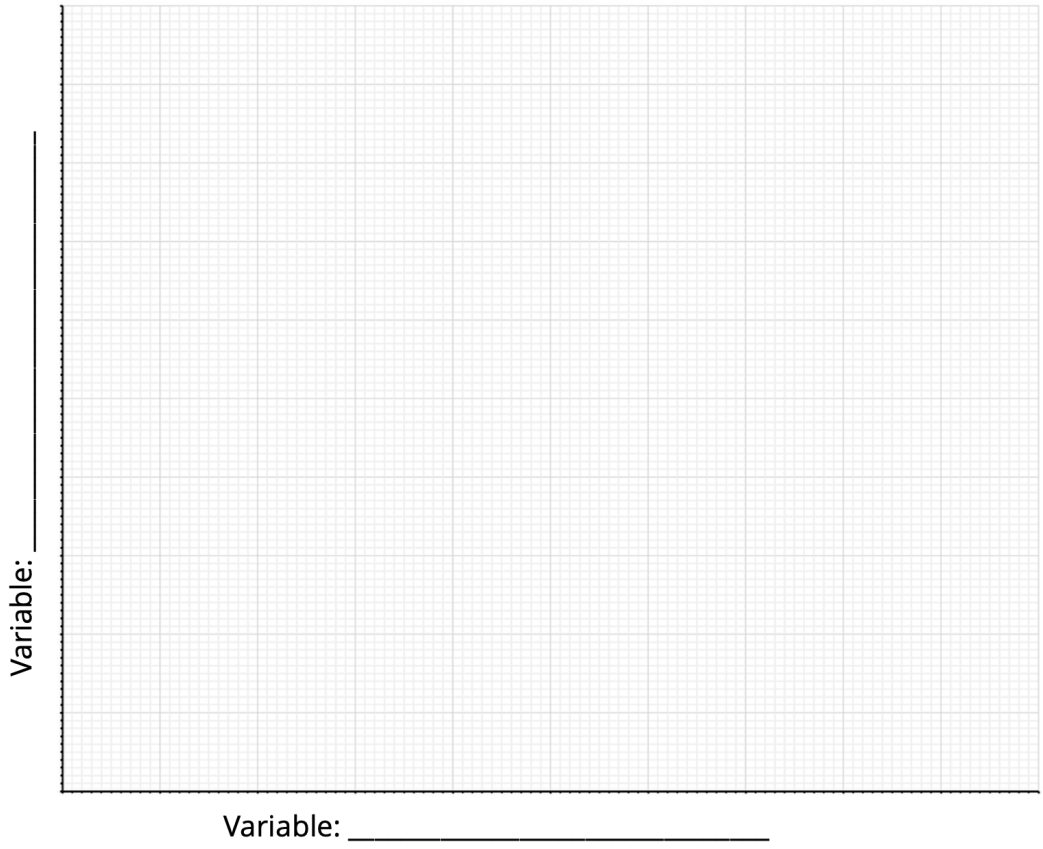
Q6. What is the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements?

A. Identify the variables that represent the essential features that help you answer the question.

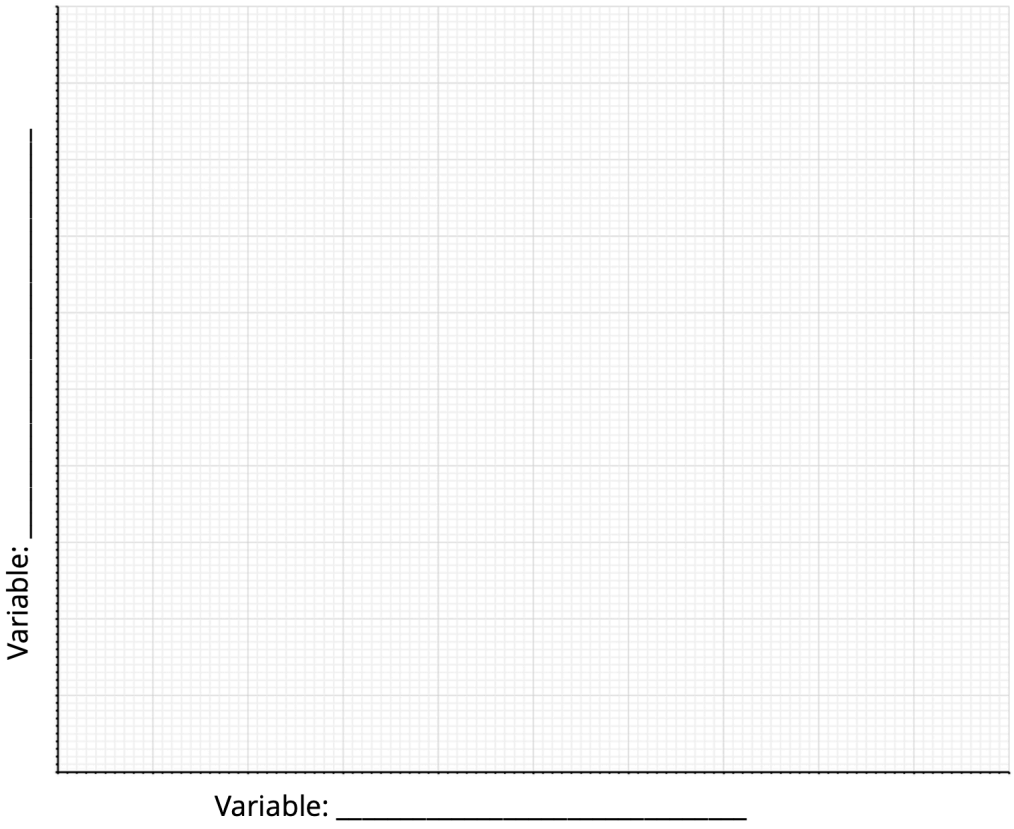
B. Create a set of graphs that demonstrate the relationships between variables.

C. Be ready to explain why these variables and relationships help you determine the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements.

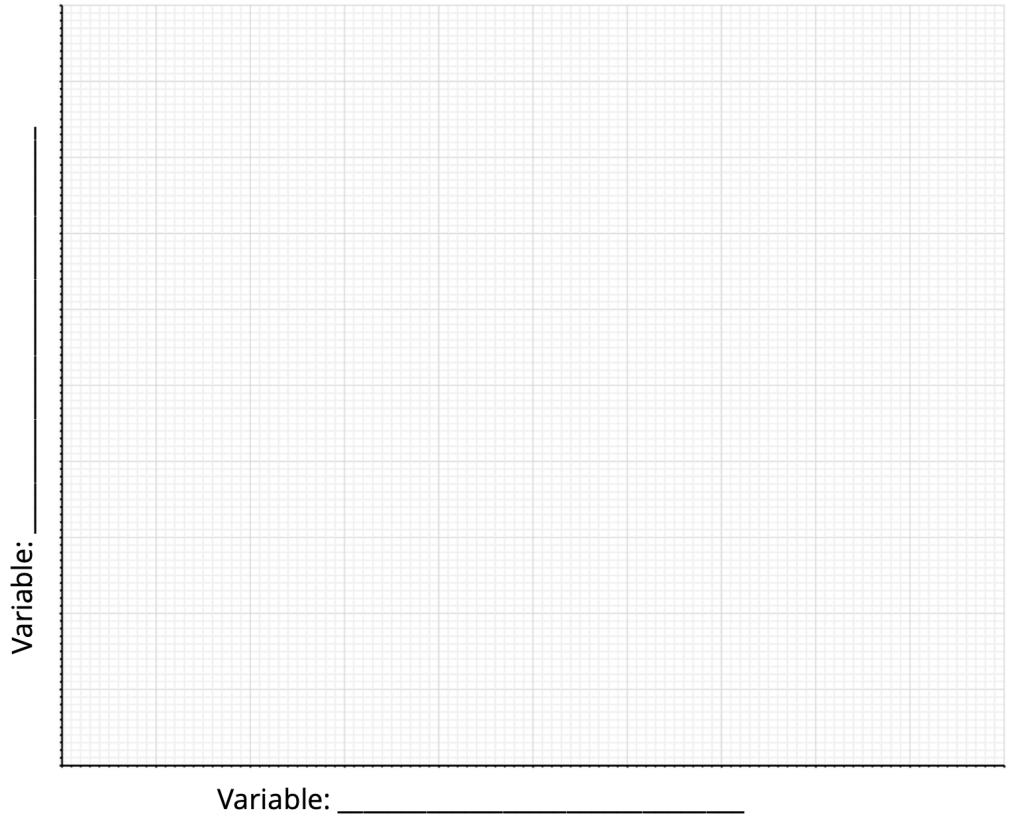
Relationship 1: _____



Relationship 2: _____



Relationship 3: _____



OPTION 2 - Open Ended

Q6. What is the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements?

A. Identify the variables that represent the essential features that help you answer the question.

B. Formulate a model using geometric shapes, graphs, tables, algebra, of statistics - the model must show what you think the relationships between the variables are.

C. Be ready to explain why these variables and relationships help you determine the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements.

Tools to Consider Using	
• Geometry tools • Calculators • Scratch paper • Graph paper	• Dry erase markers • Post-its • Digital tools like graphing technology, spreadsheets, or statistics support

Questions to Consider When Making a Mathematical Model (From IM)

- What quantities are important? Which ones change and which ones stay the same? (identify variables)
- What information do you know? What information would it be nice to know? How could you get that information? What reasonable assumption could you make? (identify variables)
- What pictures, diagrams, graphs, or equations might help people understand the relationships between the quantities? (formulate)
- Under what conditions does your model work? When might it not work? (interpret)
- How could you make your model better? How could you make your model more useful under more conditions? (validate)

Your note/work space

Collaboration Reflection: After you finish your mathematical model. Reflect on your own and then discuss with your group.

Q7. What group or personal strengths and challenges did you notice around communication in your group?

Part 3: Individually Share your Model

Q8. How does your model explain the factors wildlife conservationists need to consider when planning for the reintroduction of wild dogs?

Use flipgrid or another video recording tool, make a **1 minute video** of you explaining the model your group created. In the video make sure to highlight:

- ☐ A quick overview of the model
- ☐ A description of the mathematical relationship in your model that you think is important for predicting the success of wild dog introduction

In addition to your video, submit a **written copy or photo** of your group's mathematical model.

Teacher Instructions

The introduction to this task is designed to be done as a whole group. There are a set of introduction slides for you to use. After the introduction discussion, learners will work in small groups and then individually record an explanation. You may want to plan for small groups of four before getting started.

1. Introduce the African Wild Dogs reintroduce efforts.
    - **Display Slide A.** Tell learners that in this assessment task, they will be working in small groups to dive into the retroduction efforts to help restore the African Wild Dog population.
    - **Display Slide B.** Ask learners to consider the ideas of reintroduction programs and wildlife conservationists and then ask them to begin to think about the question - What factors do wildlife conservationists need to consider when planning for the reintroduction of wild dogs?
2. Connect back to what the class has been working on so far in this unit. In order to support transfer, ask learners to think about what they have figured out so far in this unit and how it might support us.
    - **Display Slide C.** Read the slide and then ask learners:
        - *What do we already have in the classroom?*
        - *What have we already done that helps us figure this out?*
        - *What factors have we investigated when we looked at other populations?*
3. As a class, using ideas generated from experiences with the unit so far, complete the table on **Slide D.** One example is given for you. Listen for learner responses and ask follow up questions as the class develops a table that might look like this:

Factor	Relationship to wild dogs survival
Amount of land available	***Wild dogs need space to hunt, find shelter, and provide the resources they need to survive***
Predators in the area	If there are too many predators, then too many wild dogs might be eaten and they won't survive. If there are not enough predators, there may be too many dogs in packs for the amount of prey.
Prey availability	If there is not enough prey, then the wild dogs won't have enough to eat. If there is too much prey, then there might not be enough land for the wild dogs to make their den, or home.
Diseases	Diseases can harm the wild dogs and possibly kill them off.
Human interactions	If there are too many human interactions, the dogs might get diseases from humans or even their dogs. If humans are building or living in the areas where wild dogs are, then their habitats might be affected and they won't have enough land to roam. They might be hunted or trapped.
Climate	If the climate is too hot or too cold for the wild dogs, they may not survive.
Wild dog characteristics (e.g. behavior, reproduction details)	Knowing how they behave might be related to where they choose to live, how they hunt, and how they reproduce. The number of new babies born and when they are born might be needed to know how fast the population can grow and when new babies will be seen so they can be supported if needed.

4. Introduce the Assessment Task
    - **Display Slide E.** Explain that in the assessment task, learners will use their understanding to evaluate the American Prairie Reserve: Will the conservation plan meet the goals of the 30x30 initiative and increase biodiversity and meet the needs of varied interest holders?

Mathematical Modeling. This task asks learners to be creative and mathematical to consider how they might design a mathematical model to predict success of a reintroduction effort. Some information related to mathematical modeling can be found in this resource from Illustrative Math: https://curriculum.illustrativemathematics.org/HS/teachers/mathematical_modeling_prompts.html

Video recordings. learners share their individual thinking in this task using a video recording. We recommend Flip: https://info.flip.com/en-us.html or another video recording tool of your choice.

Feedback and Scoring Guidance

PART 1 – Analyze Data in Groups

LAND REQUIREMENTS

QL1. Based upon this data, how would you describe the relationship between pack size and territory size? Hint: You might try ordering the data by pack size or by territory size to look for any patterns in the space provided above. You can also use CODAP to make a graph if that is helpful.

There isn't a clear connection between pack size and territory. Some of the larger packs have a larger territory, like pack 1, but the second largest pack (pack 7) had about half the territory as the largest pack. Yet pack 2 which is smaller than pack 7 has a larger territory.

QL2. What do the data in Table 1 suggest about how much land might be needed to maintain a pack of 14 reintroduced wild dogs? *State your answer in mathematical terms, supported by data from Table 1 above. Support your answer with your calculations.*

Below are multiple different ways learners could respond to this question and answers could range from about 800-about 1200 km^2 .

Using average pack size and territory size: A good estimate is that at least 854 km^2 for would be needed, because that is the average territory size per wild dog based upon the data shown in the table.
Calculation: average of the 8 territory sizes divided by the average of the 8 pack sizes x 14
61 km^2/dog 8 x 14 = 854 km^2

Using minimum territory size: A good estimate is that at a minimum, 608 km^2 would be needed because the minimum territory size is 42.5 km^2 per wild dog based upon data shown in the table.
Calculation: (in table above) Average territory size/wild dog. Identify the minimum territory size and multiply by 14.

Using maximum territory size: A good estimate is that 1,256 km^2 would be needed because the maximum territory size is 89.7 km^2 per wild dog based upon data shown in the table.
Calculation: (in table above) Average territory size/wild dog. Identify the maximum territory size and multiply by 14.

Using the average of the minimum and maximum territory size: A good estimate is 932 km^2 because that is the average of the minimum and maximum territory sizes per wild dog based upon data shown in the table.
Calculation: (in table above) Average territory size/wild dog. Identify the minimum territory size and multiply by 14. Identify the maximum territory size and multiply by 14. Add minimum and maximum territory size and divide by 2 to find the average.

Using pack sizes as an estimate: A good estimate is 806 km^2 because that is the territory size of packs 4 & 5 which include 14.1 wild dogs.
Calculation: 378 + 428

PREY REQUIREMENTS

QP1. Analyze the data above. Identify the prey animals that you think are most important to consider **and why** when planning to protect wild dogs in each region. **Complete the table for 2 of the four regions.**

Region	Prey Consideration(s)
Eastern South Africa	Impala and Nyala would be most important to consider for the wild dogs since these two make up the highest amount of prey for the wild dogs in this region.
Northeastern South Africa	Impala and Kudu would be most important to consider for the wild dogs since these two make up the highest amount of prey for the wild dogs in this region.
Northern South Africa	Impala and Kudu would be most important to consider for the wild dogs since these two make up the highest amount of prey for the wild dogs in this region.
Pilanesberg National Park	Waterbuck and Kudu would be most important to consider for the wild dogs since these two make up the highest amount of prey for the wild dogs in this region.

QP2. What do you expect the relationship between prey biomass and successful reintroduction would be? *Give a reason for your answer based on what you know about ecosystems.*

I think that the more prey biomass there is the more likely the reintroduction of wild dogs will be successful because this means there will be enough food available for the dogs.

PART 2. IDENTIFY THE NEEDS FOR REINTRODUCTION

Q3. Share your findings from Part 1 as a group and write your main findings in bullet points below.

Learner responses should be consistent with their findings from Part 1 above.

Collaboration Reflection: In the next part, you will work in your groups both mathematically and creatively. Before you begin, take a few minutes for everyone to write an answer to the next 2 questions.

Q4. How do you like to work when you work in groups?

Look for learners to do an honest reflection on their collaboration practices.

Q5. How can you work together with someone who likes to do things differently?

Look for learners to propose a feasible, generous idea for collaboration with others.

One way scientists and conservationists use data is to make a mathematical model that considers many factors and helps make predictions of what will happen in an ecosystem.

Below is a list of factors that could be included in a mathematical model to predict the requirements for reintroducing a population of wild dogs into a new area.

Possible Factors - Ecosystem Model - Wild Dogs
Wild dog packs range between 5 and 30 individuals.

- Area to support a pack of wild dogs of X size
- Number of prey killed per year by a pack of dogs
- Growth rate of the prey population
- Prey Density–the number of prey per km^2 of land
- Wild Dog Pack Size at re-introduction
- Likely increase in wild dog numbers in a year
- Average number of pups born to a pack in a year
- Survival rates for adult wild dogs and pups
- kg of food wild dogs eat per day
- The amount of prey biomass that is flesh
- Total amount of prey biomass in an area

Collaborate with your team to create a mathematical model that helps to answer the question - **What is the minimum area of land required for a pack of dogs given the prey availability and the prey's survival requirements?** There is not a correct answer for this question - work as a team to figure out how to best represent the factors in a mathematical model.

You have **two options** for approaching this task. Review them below and decide as a team which option you will take.

OPTION 1 - Use Graphical Representations

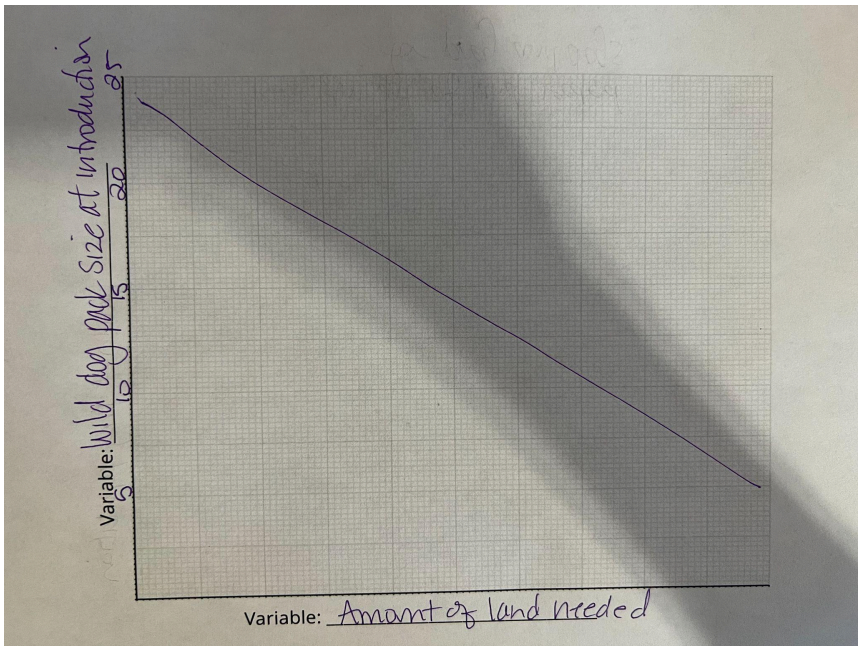
Q6. What is the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements?

A. Identify the variables that represent the essential features that help you answer the question.

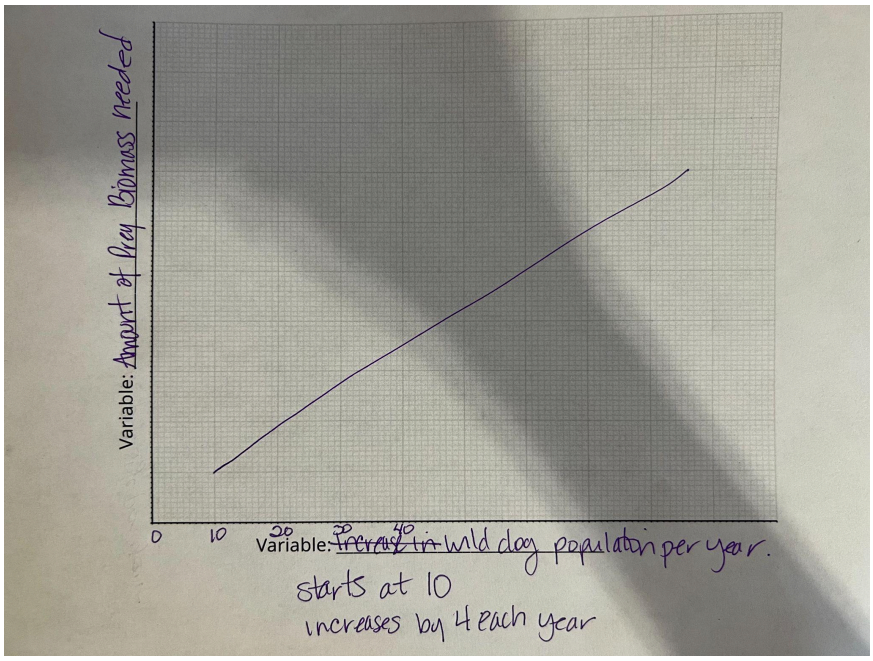
learner responses will vary and should come from the list above or the initial class list or be clearly relevant to the task.

B. Create a set of graphs that demonstrate the relationships between variables.
C. Be ready to explain why these variables and relationships help you determine - What is the minimum area of land required for a pack of dogs given the prey availability and the prey's survival requirements?

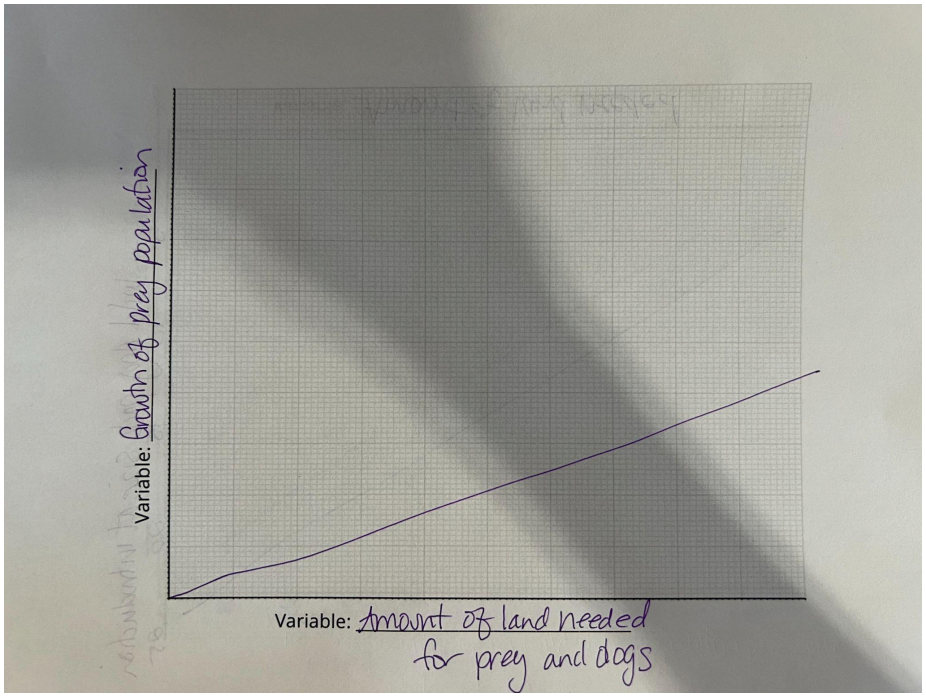
Relationship Model Example 1. Relationship between the size of the pack at introduction and the amount of land needed. This graph only shows thinking about the initial introduction. You would expect learners to consider what happens when the pack grows.



Relationship Model Example 2. Relationship between the amount of pre biomass needed and the size of a wild dog population growing each year. learners would make sense of this by saying that because the need for pre biomass increases each year, the amount of land to start would need to be larger than expected for a 10 dog pack to make space for increasing prey needs as the pack grows.



Relationship Model Example 3. Relationship between the amount growth of the prey population and the amount of land needed for prey and dogs. We can assume that the prey population will also increase year after year given enough land and food resources in the area.



For other factors, look for evidence of plausible relationships and learners thinking about the importance of the factor. The table below gives some additional information about important factors to help see learner sense making in their responses.

Factor	Why is this factor important
Number of prey killed per year by a pack of dogs	There needs to be a balance of the number of prey killed and the number of prey born so that the wild dogs will have enough to eat.
Growth rate of the prey population	There needs to be enough prey born each year to replace the prey the wild dogs eat.
Prey Density–the number of prey per km^2 of land	There needs to be enough prey within the territory or area that the dogs live so they don't have to expend so much energy they can't catch the prey when they find them.
Wild Dog Pack Size at re-introduction	*There needs to be just enough wild dogs re-introduced. If there are too many for the territory, then there might not be enough prey or land for them to survive. If there are not enough, then they might not reproduce enough to replace any wild dogs that had died.*
Likely increase in wild dog numbers in a year	This would be important to consider to make sure there are enough to reproduce to replace any that might die.
Average number of pups born to a pack in a year	This is important to consider because if too many are born each year, then there might not be enough land and/or food for the new pups. If there are not enough born each year, or enough that survive from being born each year, then the pack size will decrease in size over time.
Survival rates for adult wild dogs and pups	If adults or pups don't survive very long, the pack size will decrease and may not survive over time.
kg of food wild dogs eat per day	This is important to consider in terms of prey available within their territory.
The amount of prey biomass that is flesh	This is where the wild dogs get their nutrients from the prey.

OPTION 2 - Open Ended

learner models should be open-ended and creative yet show a plausible and ecologically important set of relationships between the variables.

Q6. What is the minimum area of land required for a pack of wild dogs given the prey availability and the prey's survival requirements?

A. Identify the variables that represent the essential features that help you answer the question.

B. Formulate a model using geometric shapes, graphs, tables, algebra, of statistics - the model must show what you think the relationships between the variables are.

C. Be ready to explain why these variables and relationships help you determine - What is the minimum area of land required for a pack of dogs given the prey availability and the prey's survival requirements?

Tools to Consider Using
• Geometry tools • Calculators • Scratch paper • Graph paper • Dry erase markers • Post-its • Digital tools like graphing technology, spreadsheets, or statistics support

Questions to Consider When Making a Mathematical Model (From IM)
What quantities are important? Which ones change and which ones stay the same? (identify variables) What information do you know? What information would it be nice to know? How could you get that information? What reasonable assumption could you make? (identify variables) What pictures, diagrams, graphs, or equations might help people understand the relationships between the quantities? (formulate) Under what conditions does your model work? When might it not work? (interpret) How could you make your model better? How could you make your model more useful under more conditions? (validate)

Collaboration Reflection: After you finish your mathematical model. Reflect on your own and then discuss with your group.

Q7. What group or personal strengths and challenges did you notice around communication in your group?

Look for learners to make an honest reflection on the strengths and challenges of collaborating on this task.

Part 3: Individually Share your Model

Q8. How does your model explain the factors wildlife conservationists need to consider when planning for the reintroduction of wild dogs?

Using flipgrid or another video recording tool, make a 1 minute video of you explaining the model your group created. In the video make sure to highlight:

- ☐ A quick overview of the model
- ☐ A description of the mathematical relationship in your model that you think is important for predicting the success of wild dog introduction

In addition to your video, submit a written copy of your group's mathematical model or a photo.

In the videos, look for learners to explain their models using a specific example that makes sense and has an important relationship to understanding the success of wild dog reintroduction. Ask follow up questions one-on-one where necessary to get to the depths of learner understanding.