A Little Devil In Need of Help

I. UNIT OVERVIEW & PURPOSE:

In this unit students will investigate several fictitious populations of the endangered Tasmanian Devil population. Through the investigation students will focus on relating the solutions to the population equations they develop to the graphs of the equation, the x-intercepts of the graph, the zeros of the equation as well as the factors of polynomial equations as they relate to the Devil population.

II. UNIT AUTHOR:

Kelly Robinson

III. COURSE:

Mathematical Modeling: Capstone Course

IV. CONTENT STRAND:

Algebra

V. OBJECTIVES:

- ❖ Students will be able to find linear and quadratic equations given a data set.
- ❖ Students will be able to graph linear and quadratic equations.
- ❖ Students will be able to use the equations and the graphs to analyze to a population model.
- ❖ Students will be able to identify x-intercepts of a graph and relate this to the zeros of the equations as well as the factors when appropriate and use this information as it relates to the population model.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):

- ❖ MPE.12 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.

- ❖ **MPE.13 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression.**

- ❖ MPE.14 The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions.

- ❖ MPE.16 The student will investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically. Key concepts include:
- ❖ b) local and absolute maxima and minima;
- ❖ d) zeros;
- ❖ e) x- and y-intercepts;
- ❖ f) intervals in which a function is increasing or decreasing;

- k) finding the values of a function for elements in its domain; and
- l) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.
- MPE.18 The student, given rational, radical, or polynomial expressions, will
- d) factor polynomials completely.

VII. CONTENT:

During this unit students will have the opportunity to research different populations of endangered species either animal or plant, whichever peaks the individual's interest.

REFERENCE/RESOURCE MATERIALS:

- Graphing calculator for each student
- computer with internet access and media player
- Projector
- graph paper
- "Little Zoo Devils" worksheet
- "Little Wild Devils" worksheet
- "A Mouse for A Devil" worksheet
- "A Devil for A Dingo" worksheet
- "Devils, Mice & Dingoes" assessment
- Teacher answer sheets
- Rubric for final population model and presentation

VIII. PRIMARY ASSESSMENT STRATEGIES:

Students will complete and present a very brief summary of a population model that follows the format of the lesson presented to students for an endangered population of animals or plants of their choosing.

IX. EVALUATION CRITERIA:

Students will complete a formal assessment – "Devils, Mice & Dingoes"
Students will complete research and develop their own population model and present it to the class.

X. INSTRUCTIONAL TIME:

Eight to ten 50 minute class meetings or four to five 90 minute class meetings.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Little Devils in a Zoo

Strand
Algebra

Mathematical Objective(s)

- Students will be able to find a linear model equation given a data set.
- Students will be able to graph a linear model equation.
- Students will be able to use the model equation and the graph to analyze the population.
- Students will be able to identify x-intercepts of the graph and use this develop a basic understanding of the concept of finding the zero of a function.
- Students will be able to connect solutions of the model equation with coordinates from the graph using a graphing calculator.
- Students will be able to relate the slope of the model equation to the rate of change in the model population.

Mathematics Performance Expectation(s)

- MPE.12 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.
- **MPE.13 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression.**
- MPE.16 The student will investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically. Key concepts include:

    d) zeros;
    e) x- and y-intercepts;
    f) intervals in which a function is increasing or decreasing;
    k) finding the values of a function for elements in its domain; and
    l) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.

Additional Objectives for Student Learning:
Students will become familiar with the ability for a contained and monitored zoo population to quickly increase in population size and discuss the advantages and disadvantages of this occurrence to the wild population.

Materials/Resources

- ❖ Graphing calculator for each student
- ❖ computer with internet connection and media player and projector for short video
- ❖ "Little Zoo Devils" question sheet
- ❖ graph paper

Assumption of Prior Knowledge

Students who have completed Algebra 1 and Algebra 2 will build on their prior knowledge of graphing and solving linear equations. In order to be highly successful students should be familiar with the concept of finding a linear equation given a set of data either by hand or by using the graphing calculator. They should also be able to easily graph this equation on a coordinate plane and identify the intercepts of the function as well as the slope both from the equation and from the graph.

Students should begin to develop a fluent use of the terms x-intercept and zero.

Introduction: Setting Up the Mathematical Task

As an intro play the following video – stop at 2:15 if desired as the rest of the information is not pertinent to the lesson: http://video.nationalgeographic.com/video/player/nat-geo-wild/wild-all-videos/ngc-tasmanian-devils-bite-force.html

In this lesson you we will learn a little about the Tasmanian Devil. In 2008 the Tasmanian Devil was put on the endangered species list for the first time in its long and normally healthy existence. We will watch a short video from National Geographic on the Tasmanian Devil.

Play: http://kids.nationalgeographic.com/kids/animals/creaturefeature/tasmanian-devil/

Short Class Discussion (3-5 minutes)

Use this time to briefly review the information from the video and build interest in the endangered species world wide. During the discussion be sure to draw out the following information needed for the activities to follow:

1. If they all survive, Tasmanian Devils will raise only four offspring each year.
2. Captive (or zoo) populations are being raised to hopefully help wild populations regenerate back to strong population numbers of the past.

Suggestions:

Open full class discussion with teacher prompting

Small group discussion leading to providing the class with 3 things learned in the video (be sure key points are included in the class list of information)

Present students with the population information of a captive Devil population given in the "Little Zoo Devils" worksheet. In small groups, grouped by similar ability levels to promote appropriate discussion through the problem, allow students to begin working through the worksheet.

Student Exploration 1:

Students can work in small groups to work through the guided questions on the "Little Zoo Devils" question sheet. Students should discuss the information given and arrive at answers to each question using prior knowledge. Some questions are more open ended and require only logical discussion as it relates to the information they have collected through completing the questions provided.

Monitoring Student Responses

Additional leading questions may be needed for some groups to work through some questions in the activity. In some cases students may need to be reminded of the concept of rate of change as it relates to the activity. Relating values of the domain (see #9) to a range value on the graph may pose some issue for students as well. Likewise, establishing a meaning for to the term zeros of a function may stretch students' prior knowledge of zeros by requiring a real world meaning to the concept. In both cases, discussions with the groups about their prior knowledge in these concepts will concrete what they already know. From this questioning groups should be able to continue working together to establish their own understanding.

Assessment

- Each student should prepare a short summary of their group's findings as well as any information they found interesting or observations that were made during class discussions. There are questions provided to students to get the summary started however they should be encouraged to conclude the summary with their own explanation of the meaning of what they found while working with their group.
- This can be assigned either as homework or as an additional class assignment.

Little Devils in the Wild

Strand

Algebra

Mathematical Objective(s)

- ❖ Students will be able to find a quadratic model equation given a data set.
- ❖ Students will be able to graph a quadratic model equation.
- ❖ Students will be able to use the model equation and the graph to analyze a population.
- ❖ Students will be able to identify x-intercepts of the graph and relate this to the zeros of the equation.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

- Students will be able to factor the quadratic function.
- Students will be able to relate the factors of the quadratic function to the graph of the function.
- Students will be able to interpret when the population is decreasing or increasing by relating the slope of an interval of the graph of the function.
- Students will be able to connect solutions of the model equation with coordinates from the graph using a graphing calculator.

Mathematics Performance Expectation(s)

- MPE.12 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.
- **MPE.13 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression.**
- MPE.14 The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions.
- MPE.16 The student will investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically. Key concepts include:
- b) local and absolute maxima and minima;
- d) zeros;
- e) x- and y-intercepts;
- f) intervals in which a function is increasing or decreasing;
- k) finding the values of a function for elements in its domain; and
- l) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.
- MPE.18 The student, given rational, radical, or polynomial expressions, will
- d) factor polynomials completely.

Additional Objectives for Student Learning (include if relevant; may not be math-related):
Students will become familiar with the ability for a contained and monitored zoo population to quickly increase in population size and will discuss the advantages and disadvantages of this occurrence to the wild population.

Materials/Resources

- Graphing calculator for each student

- ❖ “Wild Little Devils” question sheet
- ❖ graph paper

Assumption of Prior Knowledge

Students who have completed Algebra 1 and Algebra 2 will build on their prior knowledge of graphing and solving quadratic equations. In order to be highly successful students should be familiar with the concept of finding a quadratic equation given either a graph or a set of data. This can be accomplished either by hand or by using the graphing calculator. They should also be able to follow the graph of a quadratic equation; finding the maximum or minimum point, x-intercepts, and y-intercept.

As students begin to work through this lesson use of the terms x-intercept and zero should become more fluent and interchangeable.

Introduction: Setting Up the Mathematical Task

As an opener for this lesson watch the following videos to briefly review factoring trinomials.

- ✓ Video #1: no leading coefficient
  http://algebrafree.com/74Factoring%20Trinomials%20x2%20+%20Bx%20+%20C.html
- ✓ Video #2: leading coefficient
  http://algebrafree.com/75Factoring%20Trinomials%20Ax2%20+%20Bx%20+%20C.html

- ✓ If more review is desired a factoring review game can be found here using the Smartboard:
  http://exchange.smarttech.com/details.html?id=52d8a88e-9f83-45f9-8c3d-4f952b13e668

- ✓ This link will take you to a website that provides flashcards to review factoring trinomials (with leading coefficient in this case.) These flashcards can be used online or printed out and used in class.
  http://www.proprofs.com/flashcards/cardshow.php?title=factoring-trinomials--1&quesnum=1

During the last class we developed a better understanding of how a captive Tasmanian Devil population can grow rather quickly. We also talked about why this situation was less than realistic. Now we are going to look at a very small wild model population. You will see in just a moment that there is a good bit of difference in how the wild population changes compared to the zoo’s population of Devils. Keep this comparison in mind as you work. Collecting yours thoughts will help you prepare your summary.

Present students with the “Wild Little Devils” worksheet. In small groups, grouped by similar ability levels to promote appropriate discussion through the problem, allow students to begin working through the activity sheet.

Student Exploration 1:

Again working in small groups this activity becomes slightly more challenging with the same context in mind. Students will work together to answer questions both computational and open ended to arrive at an understanding of the relationship of the zeros to the model population and the values of a given domain as they relate to the range values on the graph. Students will find the factored form of the quadratic equation they found for the given graph.

Monitoring Student Responses

Factoring may be an area of difficultly for some students.

Assessment

- Each student should prepare a short summary of their group's findings as well as any information they found interesting or observations that were made during discussions. There are questions provided to students to get the summary started however they should be encouraged to conclude the summary with their own explanation of the meaning of what they found while working with their group.
- This can be assigned either as homework or as an additional class assignment.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

A Mouse for a Devil or A Devil for a Dingo

Strand
Algebra

Mathematical Objective(s)

- Students will be able to find a quadratic model equation given a data set.
- Students will be able to graph a quadratic model equation.
- Students will be able to use the model equation and the graph to analyze a population.
- Students will be able to identify x-intercepts of the graph and relate this to the zeros of the equation.
- Students will be able to factor the quadratic function.
- Students will be able to relate the factors of the quadratic function to the graph of the function.
- Students will be able to interpret when the population is declining or increasing by relating the slope of an interval of the graph of the function.
- Students will be able to connect solutions of the model equation with coordinates from the graph using a graphing calculator.

Mathematics Performance Expectation(s)

- MPE.12 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.
- **MPE.13 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression.**
- MPE.14 The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions.
- MPE.16 The student will investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically. Key concepts include:

- b) local and absolute maxima and minima;
- d) zeros;
- e) x- and y-intercepts;
- f) intervals in which a function is increasing or decreasing;

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

- k) finding the values of a function for elements in its domain; and
- l) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.
- MPE.18 The student, given rational, radical, or polynomial expressions, will
- d) factor polynomials completely.

Additional Objectives for Student Learning (include if relevant; may not be math-related):
Students will become familiar with the ability for a contained and monitored zoo population to quickly increase in population size and will discuss the advantages and disadvantages of this occurrence to the wild population.

Materials/Resources
- Graphing calculator for each student
- "A Mouse For A Devil" or "A Devil For A Dingo" question sheet
- graph paper

Assumption of Prior Knowledge
Students who have completed Algebra 1 and Algebra 2 will build on their prior knowledge of graphing and solving quadratic equations. In order to be highly successful students should be familiar with the concept of finding a quadratic equation given either a graph or a set of data. This can be accomplished either by hand or by using the graphing calculator. They should also be able to follow the graph of a quadratic equation; finding the maximum or minimum point, x-intercepts, and y-intercept.
As students begin to work through this lesson use of the terms x-intercept and zero should become more fluent and interchangeable.

Introduction: Setting Up the Mathematical Task

So far we have investigated how a zoo population of Tasmanian Devils could grow very quickly and how a wild population could increase or decrease for various reasons. Today you will look at how mouse populations and dingo populations may affect or be affected by the wild Tasmanian devil population.

Student Exploration 1:

Before handing out the activity sheets, separate students into two categories for differentiation purposes. Students who manage developing curves of best fit should be given "A Mouse for A Devil" worksheet. Others can be given "A Devil for A Dingo" worksheet. Students should work independently at first to work through the worksheet questions. For the final thoughts section of the worksheet students will work with a partner to discuss their independent work and take notes of their discussion.

Monitoring Student Responses

Reinforcing the correct use of the term “zero” and making sure the correlation between the zeros and the factored form of the equation are made should be a focus while monitoring student work for this activity. Refer individuals and groups back to the techniques they used in the previous activities to overcome their challenges in this activity.

Assessment

As pairs finish their discussions, lead a class discussion keeping in mind the questions in the “Devils, Mice & Dingoes” assessment.

Have students draw the three graphs (wild devils, mice and dingo) on the same coordinate plane on the board for reference through the class discussion.

Students should now complete the “Devils, Mice & Dingoes” assessment.

Devils Aren't the Only Animals In Need of Help

Strand
Algebra

Mathematical Objective(s)

- Students will be able to find linear, quadratic and third degree equations given a data set.
- Students will be able to graph linear, quadratic and third degree equations.
- Students will be able to use the equations and the graphs to analyze to a population model.
- Students will be able to identify x-intercepts of a graph and relate this to the zeros of the equations as well as the factors when appropriate and use this information as it relates to the population model.

Mathematics Performance Expectation(s)

- MPE.12 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.
- **MPE.13 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression.**
- MPE.14 The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions.
- MPE.16 The student will investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically. Key concepts include:

- b) local and absolute maxima and minima;
- d) zeros;
- e) x- and y-intercepts;
- f) intervals in which a function is increasing or decreasing;
- g) asymptotes;
- k) finding the values of a function for elements in its domain; and
- l) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.
- MPE.18 The student, given rational, radical, or polynomial expressions, will
- d) factor polynomials completely.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Additional Objectives for Student Learning (include if relevant; may not be math-related):
Students will become familiar with the ability for a contained and monitored zoo population to quickly increase in population size and will discuss the advantages and disadvantages of this occurrence to the wild population.

Materials/Resources

- computer lab for student use
- graphing calculator
- graph paper

Assumption of Prior Knowledge

Students who have completed the previous three lessons in this unit should have established an understanding of the above listed objectives and should be successful in completing this final assessment for the unit.

Introduction: Setting Up the Mathematical Task

This will be a final assessment for the unit.

Assessment

Students will work individually. They should do some light research on the internet or other resource as they see fit to find an endangered animal or plant species that interests them. They should collect some population information about the species they choose such as what is the current population, the life expectancy of an individual, the reproduction rate at its best and what is believed to be threatening the species into extinction. They should then develop two models for their species population using the Tasmanian Devil activities as a template. They should establish their own initial population values that are somewhat realistic to the situation they give and establish an equation for the model as well as a graph to represent it. They should explain the meaning of the zeros for each model, any peaks in the graphs and establish population predictions for at least three years within the domain of the models.

Once the models are established, students should again write a brief summary to relay the information they collected and explain the models they developed.

This assessment will likely require two 50 minute class periods or about two 90 minute class periods.

Little Zoo Devils

Below is six years of data on how a group of orphaned and or injured Tasmanian Devils has flourished in an Australian zoo.

Year	1	2	3	4	5	6
Population	217	221	225	229	233	237

1. Determine the equation that would best represent this Devils population.

2. What is the rate of change for this population model? What does this mean to the Devils population?

3. Predict how large the population would be 22 years from now if no Devils died. How did you arrive at your prediction?

4. Do you believe this increase may help the Tasmanian Devil get off the endangered species list? Why or why not?

5. Graph the model for this Devil population.

6. Does the graph show an increasing, decreasing or stable (not changing) population? Explain how you arrived at your conclusion.

7. What was the Devils population for this zoo when the study started?

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

This value is called the y-intercept. Why would it have such a name? Will the y-intercept always be at the same place?

8. In what year would the Devil population have been zero? Does this value make sense here? Why or why not?

This value is called the x-intercept. Why would it have such a name? Will the x-intercept always be at the same place?

The x-intercepts are sometimes called “zeros” of the function as well. Why do you think they are called zeros?

9. Previously you found the predicted population for this model Devil population 22 years from now. Confirm your calculations with the graph? How did you do this? Were your calculations correct? Why or why not?

10. Using the graph, find the population for each of the following years:

year	population
31	
14	
55	

11. Using the graph, find the year that the following populations will be achieved:

population	413	265	621
year			

12. In your opinion, does this model seem to represent what would really happen in a zoo kept Tasmanian Devil population? What makes it a good model? What makes it a bad model? Support your opinion logically and in complete sentences.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Final Thoughts on Little Zoo Devils

Write a summary (one page typed) to explain your findings about this Devil population. Include anything that you found interesting or connections you noticed while working with your group through the questions above.

Suggestions to get you started:

What does the “line” mean in terms of the population?

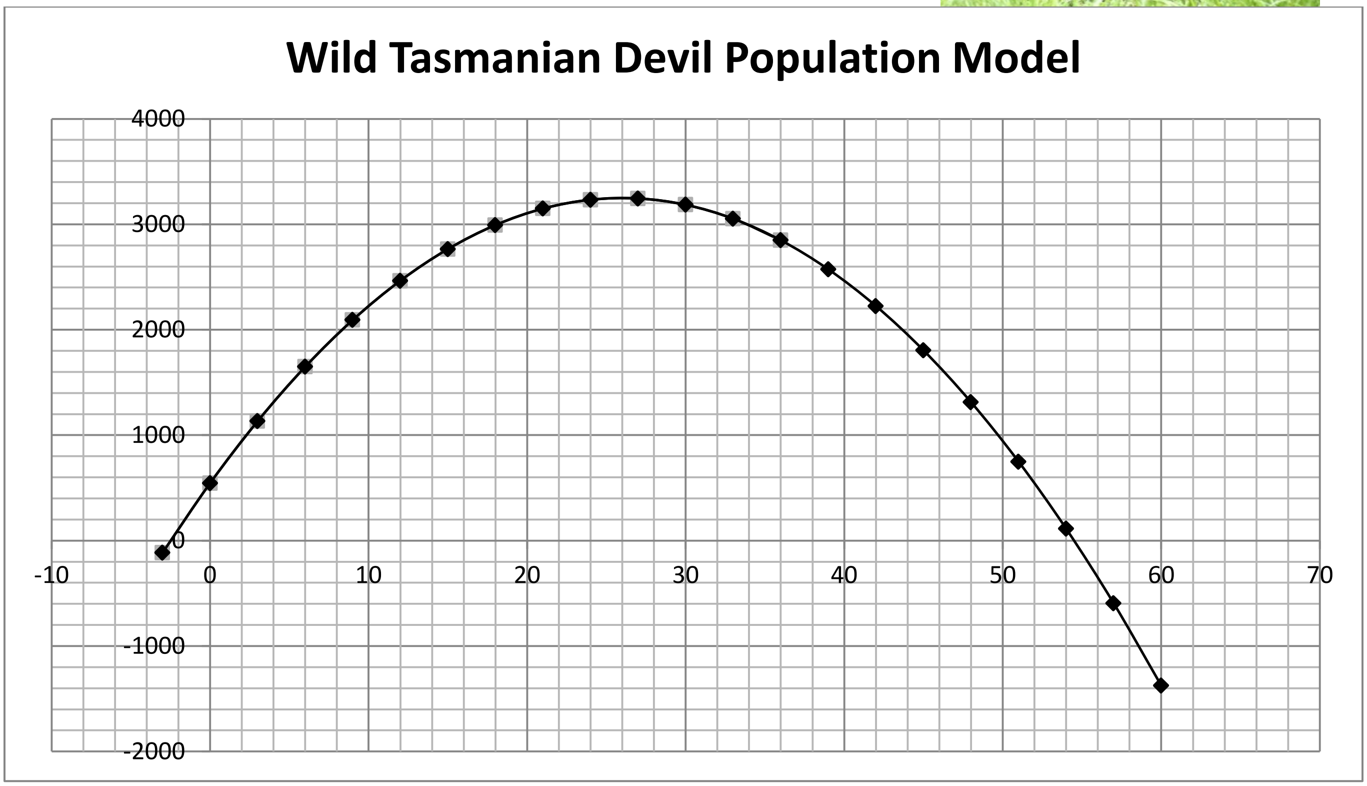
Is there a peak or a low point in the population? What does this tell you about the how the Devil population will grow or decline?

Will the population flourish or go extinct? Make your own prediction as to why this would happen.

What does the zero represent in terms of the population?

Does there seem to be a connection between the zeros on the graph and the model equation?

Wild Little Devils



1. Given the graph of a very small isolated wild Devil population what observations can you make about the future of this population? Explain.

2. Make a table to show how large the population will be in 10, 15, 20, 25, 30 and 35 years. Explain how you make your predications.

3. What are the zeros of this function? How did you find these without knowing the equation for the graph?

4. What do the zeros tell you about the Devil population?

5. What do the values of the zeros tell you about the equation of the graph?

6. Unlike the zoo population that constantly grew, does it seem that this population has a maximum and/or minimum? How do you know? Try to use algebraic terminology to describe how you arrived at your discussion.

7. Find the equation of the graph of this Devil population. (There are several ways to do this so show your work and explain how you got your model equation.)

8. What is the factored form of the model equation? (There are several ways to get this so show your work.)

9. Do you notice anything correlation between the factored form of the equation and the graph?

10. Use your equation to confirm your previous predictions of the Devil population.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

11. Confirm the zeros from the graph with the model equation.

12. Do these calculated values match the values you found earlier using the graph? Why or why not?

13. In your opinion, does this model seem to represent what would really happen in a wild Tasmanian Devil population? What makes it a good model? What makes it a bad model? Support your opinion logically and in complete sentences.

Final Thoughts on the wild little Devils

Write a summary (one page typed) to explain your findings about this Devil population. Include anything that you found interesting or connections you noticed while working with your group through the questions above.

Suggestions to get you started:

What does the “curve” mean in terms of the population?

Is there a peak or a low point in the population? What do these values mean to the Devil population?

Will the population flourish or go extinct? Make your own prediction as to why this would happen.

What do the zeros represent in terms of the population?

Does there seem to be a connection between the zeros on the graph and the model equation?

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

A Mouse for a Devil

Tasmanian Devils are they world's smallest carnivorous mammals. As the Devil population decreases, changes can be noted in the population of their prey species as well. Mice are just one of the many delicacies for the Tasmanian Devil. In the previous investigation of Wild Devils we saw how the model population would grow and decline over time. As a result of the Devil population changing, the mouse population would fluctuate as well. In this model at year 11, the mouse population was 2,025. By year 26, the population had disappeared all together, however recovered slightly to a population of 144 by year 30.

1. Using this information, graph the points and find the model equation for the mouse population.

2. Find the factored form of the model equation.

3. Determine the zero(s) and explain what they represent in terms of the mouse population.

4. Compare the graph of the mouse population with the graph of the Wild Devi population from earlier. What do you notice?

   a. Is there an intersection point for the graphs? What would the intersection point(s) mean for the populations?

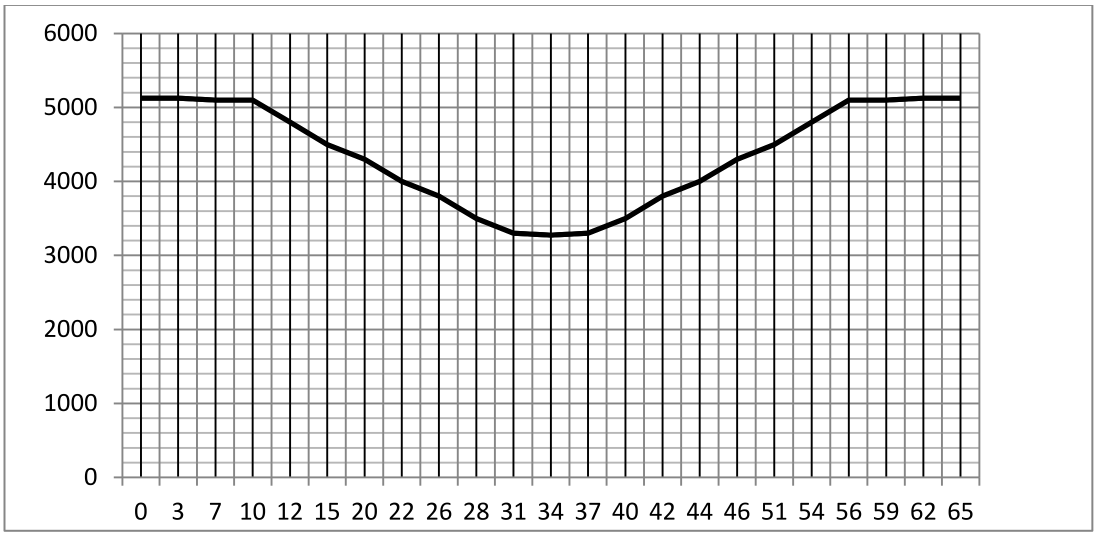
   b. Is there a maximum or minimum? How are these related between the two populations?

Final Thoughts on a mouse for a devil

With a partner, discuss what you observed about the Mouse population. Take down a few notes on what you discuss. Be sure to compare the Mouse graph with the Wild Devil graph from earlier and take notes on what you observed and anything you found interesting.

A Devil for A Dingo

Dingoes, or wild Australian dogs, have been known to prey on Tasmanian Devils. Below is a graph modeling a Dingo population.



1. Determine the zero(s) and explain what they represent in terms of the Dingo population.

2. Compare the graph of the Dingo population with the graph of the Wild Devil population from earlier. What do you notice?

a. Is there an intersection point for the graphs? What would the intersection point(s) mean for the populations?

b. Is there a maximum or minimum? How are these related between the two populations?

3. What do you expect will happen with the Dingo population?

Final Thoughts on a Devil for A Dingo

With a partner, discuss what you observed about the Dingo population. Take down a few notes on what you discuss. Be sure to compare the Dingo graph with the Wild Devil graph from earlier and take notes on what you observed and anything you found interesting.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Devils, Mice & Dingoes

Answer each of the following questions in complete sentences. Refer to the class discussion and your notes from the lesson.

1. When does the Dingo population reach zero?

2. When does the Mouse population reach zero?

3. When does the Devil and Mouse population balance out?

4. When does the Devil and Dingo population balance out?

5. When does the Dingo and Mouse population balance out?

6. What is the relationship between the Devil and Mouse population?

7. What is the relationship between the Devil and Dingo population?

8. What is the relationship between the Dingo and Mouse population?

9. How can we tell so much about the Dingo population without knowing the model equation?

10. Find the equation for the Mouse population?

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

11. What is the factored form of the Mouse population?

12. Is there a correlation between the factored form and the graph for the Mouse population? If so, describe the correlation.

13. Using the graph, find the following solutions for each population:

a. At year 25, the Dingo population is ________________.

b. At year 25, the Mouse population is _______________.

c. At year 40, the Dingo population is ________________.

d. At year 40, the Devil population is ________________.

e. At year 26, the Mouse population is _______________.

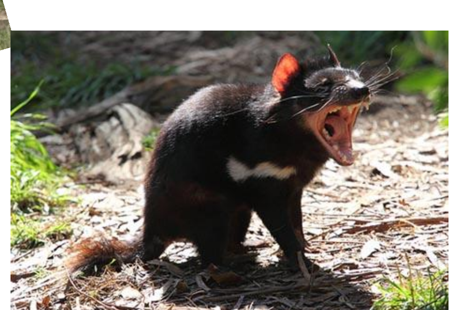
f. At year 26, the Devil population is _________________.

14. Determine the zeros for each population equation:

a. Wild Devils: ________________________

b. Mice: _____________________________

c. Dingoes: ___________________________



Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Answer Sheets & Rubrics

Little Zoo Devils

Below is six years of data on how a group of orphaned and or injured Tasmanian Devils has flourished in an Australian zoo.

Year	1	2	3	4	5	6
Population	217	221	225	229	233	237

1. Determine the equation that would best represent this Devil's population.

y = 4x + 213

2. What is the rate of change for this population model? What does this mean to the Devil's population?

The rate of change is 4. This refers to the rate that the Devil population grows. In this case it means that population grows by 4 each year. (Think of this as a slope ratio $\frac{4}{1}$ referring to $\frac{\Delta population}{\Delta years}$)

3. Predict how large the population would be 22 years from now if no Devils died. How did you arrive at your prediction?

using the equation y = 4x + 213.

4 * 22 + 213 = 301

The Devil population would be 301 in 22 years.

4. Would this increase help the Tasmanian Devil get off the endangered species list? Why or why not?

Answers may vary here.

5. Graph the model for this Devil population.

This is a linear function with y –intercept at 213 and x-intercept between -53 and -54

6. Does the graph show an increasing, decreasing or stable (not changing) population? Explain how you arrived at your conclusion.

The graph shows an increasing population because the slope of the line is positive. This means that the incline is from left to right making the population values larger as the years increase as well.

7. What was the Devil's population for this zoo when the study started?

The initial Devil population was 213.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

This value is called the y-intercept. Why would it have such a name? Will the y-intercept always be at the same place?

It would be called the y-intercept because this is the point that the lines crosses or intersects with the y-axis. For this equation the y-intercept will always be at 213 but if the equation changes then the y-intercept may change as well.

8. In what year would the Devil's population have been zero? Does this value make sense here? Why or why not?

The Devil population was zero between -53 and -54 which does not make sense because we cannot use negative numbers for years.

This value is called the x-intercept. Why would it have such a name? Will the x-intercept always be at the same place?

It would be called the x-intercept because this is the point that the lines crosses or intersects with the x-axis. For this equation the x-intercept will always be between -53 and -54 but if the equation changes then the x-intercept may change as well.

The x-intercepts are sometimes called "zeros" of the function as well. Why do you think they are called zeros?

X-intercepts are called zeros because this is where the value of the equation will be zero.

9. Previously you found the predicted population for this model Devil population 22 years from now. Confirm your calculations with the graph? How did you do this? Were your calculations correct? Why or why not?

The calculated value and the value found on the graph should be exactly the same because if you evaluate the equation at a given domain value (22 in this case) then a correlating range value will result. These values together form a coordinate for the graph.

10. Using the graph, find the population for each of the following years:

year	population
31	337
14	269
55	435

11. Using the graph, find the year that the following populations will be achieved:

population	413	265	621
year	50	13	102

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

12. In your opinion, does this model seem to represent what would really happen in a zoo kept Tasmanian Devil population? What makes it a good model? What makes it a bad model? Support your opinion logically and in complete sentences.

Look for a logical explanation to support their opinion and remember it is an opinion so as long as the students can give a valid argument they have achieved the expectation.

Final Thoughts on Little Zoo Devils

Write a summary (one page typed) to explain your findings about this Devil population. Include anything that you found interesting or connections you noticed while working with your group through the questions above.

Suggestions to get you started:

What does the "line" mean in terms of the population?

Is there a peak or a low point in the population? What does this tell you about the how the Devil population will grow or decline?

Will the population flourish or go extinct? Make your own prediction as to why this would happen.

What does the zero represent in terms of the population?

Does there seem to be a connection between the zeros on the graph and the model equation?

Rubric for Little Zoo Devils

Evidence of working in the group effectively should be observed during the in class activity

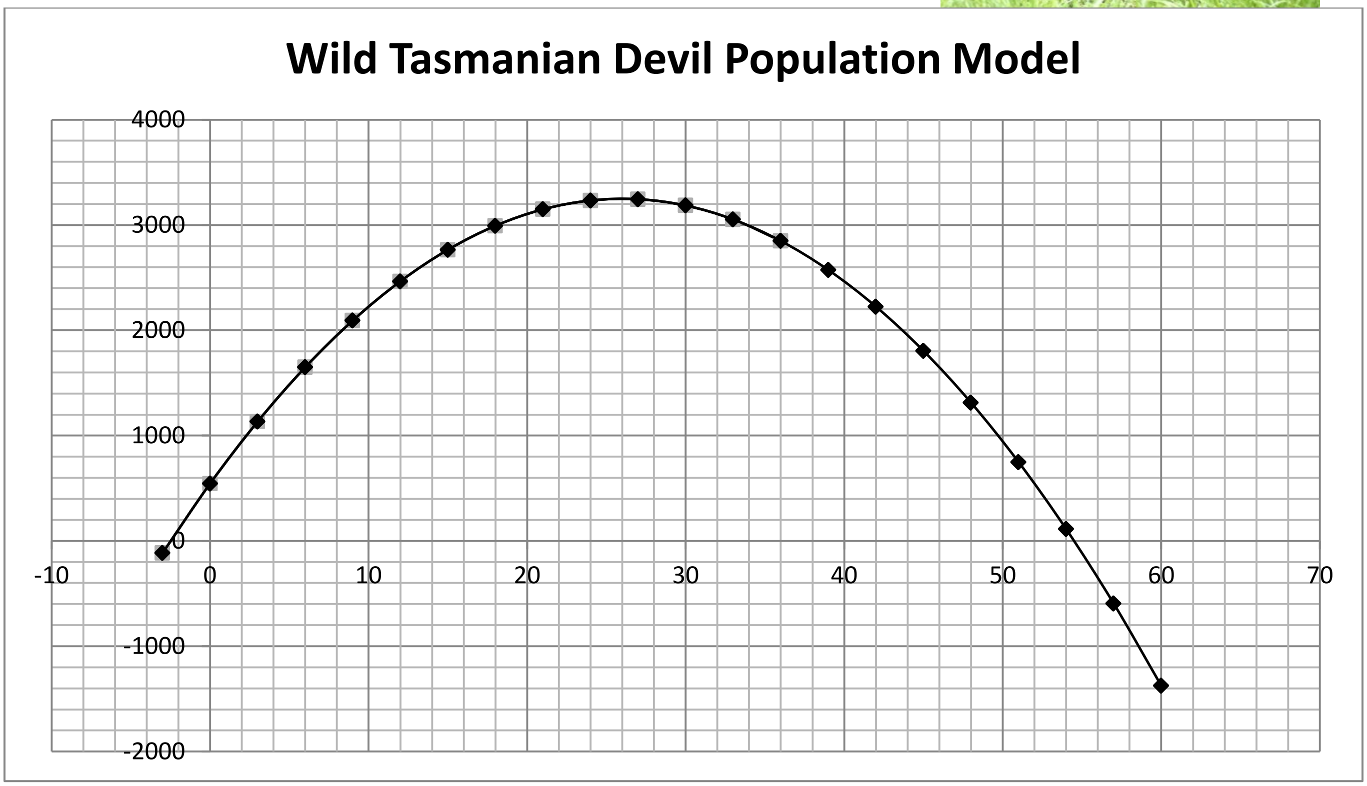
In evaluating this summary look for:

1. correct use of the term zero and emerging understanding of the definition
2. understanding of the relation of the slope to the meaning for the population
3. a connection is made between the value of the zero and the solution of the equation when y = 0

Category	4	3	2	1
terminology: zero				
explanation: slope				
connection: zero → solution				
Working with Others				
Neat and Organized				

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Wild Little Devils



1. Given the graph of a very small isolated wild Devil population what observations can you make about the future of this population? Explain.

It will grow for a while but then it will die out completely.

2. Make a table to show how large the population will be in 10, 15, 20, 25, 30 and 35 years. Explain how you make your predications. (estimated graph values below.)

year	10	15	20	25	30	35
population	2200	2700	3100	3250	3200	2900

3. What are the zeros of this function? How did you find these without knowing the equation for the graph?

Zeros are at -3 and just past 54. The zeros are found at the x-intercepts.

4. What do the zeros tell you about the Devil population?

The Devil population was zero at both year -3 (which doesn't make sense because we can't have a negative year) and just a little after year 54.

5. What do the values of the zeros tell you about the equation of the graph?

They give you the solutions to the graph when y equals 0.

6. Unlike the zoo population that constantly grew, does it seem that this population has a maximum and/or minimum? How do you know? Try to use algebraic terminology to describe how you arrived at your discussion.

The population does a have a maximum value. This would be found at the highest point called the vertex of the parabola. The maximum population would be approximately 3250 Devils.

The zeros are the minimum values for this problem. (Suggestion: This could lead to a discussion with students to determine if zeros would ALWAYS be minimum values or not.)

7. Find the equation of the graph of this Devil population. (There are several ways to do this so show your work and explain how you got your model equation.)

$y = -4x^2 + 208x + 545$

8. What is the factored form of the model equation? (There are several ways to get this so show your work.)

$(-2x – 5)(2x – 109)$

9. Do you notice anything correlation between the factored form of the equation and the graph?

If you solve for x in each of the factors the solutions are the zeros of the graph.

10. Use your equation to confirm your previous predictions of the Devil population.

Confirm calculations.

11. Confirm the zeros from the graph with the model equation.

Confirm calculations.

12. Do these calculated values match the values you found earlier using the graph? Why or why not?

They are very close if not exactly what was found on the graph.

13. In your opinion, does this model seem to represent what would really happen in a wild Tasmanian Devil population? What makes it a good model? What makes it a bad model? Support your opinion logically and in complete sentences.

Answers will vary.

Final Thoughts on the wild little Devils

Write a summary (one page typed) to explain your findings about this Devil population. Include anything that you found interesting or connections you noticed while working with your group through the questions above.

Suggestions to get you started:

What does the “curve” mean in terms of the population?

Is there a peak or a low point in the population? What do these values mean to the Devil population?

Will the population flourish or go extinct? Make your own prediction as to why this would happen.

What do the zeros represent in terms of the population?

Does there seem to be a connection between the zeros on the graph and the model equation?

Rubric for Little Wild Devils

Evidence of working in the group effectively should be observed during the in class activity

In evaluating this summary look for:

1. correct use of the term zero and valid understanding of the definition
2. understanding of the relation parabola on the population including the meaning of the vertex
3. a connection is made between the value of the zero and the factors of the quadratic equation

Category	4	3	2	1
understanding: zero				
explanation: parabola & vertex				
connection: zero → factors				
Working with Others				
Neat and Organized				

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

A Mouse for a Devil

Tasmanian Devils are they world's smallest carnivorous mammals. As the Devil population decreases, changes can be noted in the population of their prey species as well. Mice are just one of the many delicacies for the Tasmanian Devil. In the previous investigation of Wild Devils we saw how the model population would grow and decline over time. As a result of the Devil population changing, the mouse population would fluctuate as well. In this model at year 11, the mouse population was 2,025. By year 26, the population had disappeared all together, however recovered slightly to a population of 144 by year 30.

1. Using this information, graph the points and find the model equation for the mouse population.

$y= 9x^2 – 468x + 6084$

2. Find the factored form of the model equation.

$(x – 26)^2$

3. Determine the zero(s) and explain what they represent in terms of the mouse population.

There is only one zero at 26. The mouse population will be zero at year 26.

4. Compare the graph of the mouse population with the graph of the Wild Devi population from earlier. What do you notice?

a. Is there an intersection point for the graphs? What would the intersection point(s) mean for the populations?

The population of the Devils and the Mice would be equal when they graphs intersect.

b. Is there a maximum or minimum? How are these related between the two populations?

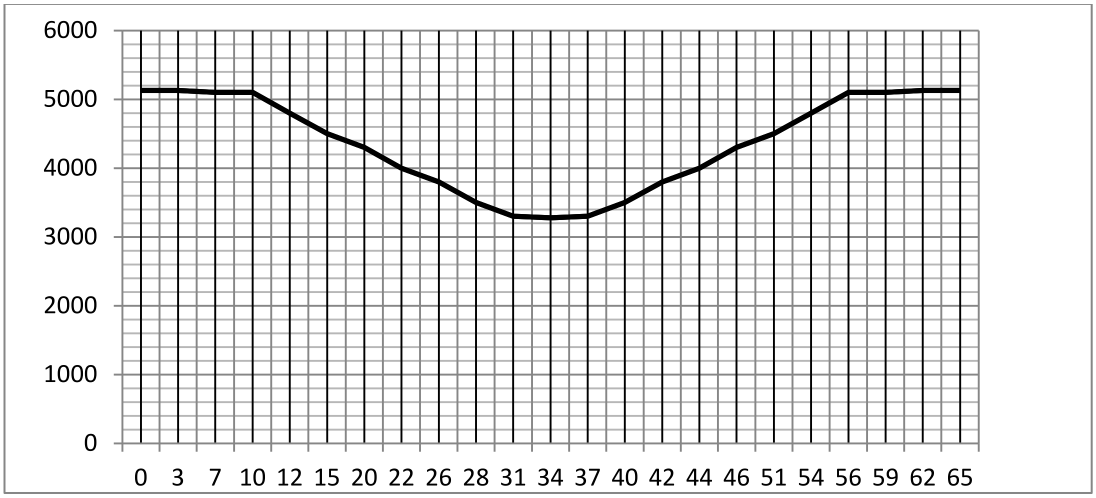
The Mice have a minimum value and the Devils have a maximum value at 26 years. This means that when the Devil population is the highest the mouse population is at its lowest.

Final Thoughts on a mouse for a devil

With a partner, discuss what you observed about the Mouse population. Take down a few notes on what you discuss. Be sure to compare the Mouse graph with the Wild Devil graph from earlier and take notes on what you observed and anything you found interesting.

A Devil for A Dingo

Dingoes, or wild Australian dogs, have been known to prey on Tasmanian Devils. Below is a graph modeling a Dingo population.



1. Determine the zero(s) and explain what they represent in terms of the Dingo population.

There are no zeros for this function

2. Compare the graph of the Dingo population with the graph of the Wild Devil population from earlier. What do you notice?

a. Is there an intersection point for the graphs? What would the intersection point(s) mean for the populations? The population of the Devils and the Mice would be equal when they graphs intersect.

b. Is there a maximum or minimum? How are these related between the two populations?

The Devils have a maximum at 26 years. The Dingos have a minimum at 12 years. There does not seem to be a correlation here.

3. What do you expect will happen with the Dingo population?

It seems they will either level off or the pattern will repeat. They will decrease a bit then regain at about the same rate, level off for a bit then cycle through again.

Final Thoughts on a Devil for A Dingo

With a partner, discuss what you observed about the Dingo population. Take down a few notes on what you discuss. Be sure to compare the Dingo graph with the Wild Devil graph from earlier and take notes on what you observed and anything you found interesting.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Devils, Mice & Dingoes

Answer each of the following questions in complete sentences. Refer to the class discussion and your notes from the lesson.

1. When does the Dingo population reach zero?

There are no zeros for the Dingo population.

2. When does the Mouse population reach zero?

The Mouse population has only one zero at 26 years.

3. When does the Devil and Mouse population balance out?

At 10 years and at 42 years the Devil and Mouse population will be balanced at about 2250.

4. When does the Devil and Dingo population balance out?

Refer to graph drawn for class discussion for consistency.

5. When does the Dingo and Mouse population balance out?

Refer to graph drawn for class discussion for consistency.

6. What is the relationship between the Devil and Mouse population?

The Mice have a minimum value and the Devils have a maximum value at 26 years. This means that when the Devil population is the highest the mouse population is at its lowest.

7. What is the relationship between the Devil and Dingo population?

There does not appear to be a significant relationship between the Devil and Dingo population.

8. What is the relationship between the Dingo and Mouse population?

There does not appear to be a significant relationship between the Dingo and Mouse population.

9. How can we tell so much about the Dingo population without knowing the model equation?

Each coordinate on the graph refers to a year and a population value. By looking at the graph you can tell how the population increases or declines.

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

10. Find the equation for the Mouse population?

$y = 9x^2 - 468x + 6084$

11. What is the factored form of the Mouse population?

$(x - 26)^2$

12. Is there a correlation between the factored form and the graph for the Mouse population? If so, describe the correlation.

When the factored form is solved for x the value is equal to the zero of the graph.

13. Using the graph, find the following solutions for each population:

a. At year 25, the Dingo population is ___3790________.

b. At year 10, the Mouse population is ___2304_______.

c. At year 40, the Dingo population is ___3500________.

d. At year 40, the Devil population is ____2465_______.

e. At year 26, the Mouse population is ____0_________.

f. At year 26, the Devil population is ____3249________.

14. Determine the zeros for each population equation:

a. Wild Devils: __-3 and 54_

b. Mice: __26_______________________

c. Dingoes: _none____________________

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Math - Problem Solving : Endangered Species

Teacher Name:

Student Name: ____

CATEGORY	4	3	2	1
Explanation	Explanation is detailed and clear.	Explanation is clear.	Explanation is a little difficult to understand, but includes critical components.	Explanation is difficult to understand and is missing several components OR was not included.
Mathematical Concepts	Explanation shows complete understanding of the mathematical concepts used to solve the problem(s).	Explanation shows substantial understanding of the mathematical concepts used to solve the problem(s).	Explanation shows some understanding of the mathematical concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Mathematical Terminology and Notation	Correct terminology and notation are always used, making it easy to understand what was done.	Correct terminology and notation are usually used, making it fairly easy to understand what was done.	Correct terminology and notation are used, but it is sometimes not easy to understand what was done.	There is little use, or a lot of inappropriate use, of terminology and notation.
Neatness and Organization	The work is presented in a neat, clear, organized fashion that is easy to read.	The work is presented in a neat and organized fashion that is usually easy to read.	The work is presented in an organized fashion but may be hard to read at times.	The work appears sloppy and unorganized. It is hard to know what information goes together.
Presentation	Presentation showed evidence of preparation and forethought	Presentation showed some evidence of preparation	Presentation showed little evidence of preparation	Presentation showed no evidence of preparation

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education

Grade Sheet

Endangered Species Unit

Student: ____________________________

Little Zoo Devils (total 20 points)	_______________
Wild Little Devils (total 20 points)	_______________
Devils, Mice & Dingoes (total 20 points)	_______________
Endangered Species Presentation (total 20 points * 2 = 40 points)	_______________
Total (100 points)	**________________**

Developed by Dr. Agida Manizade & Dr. Laura Jacobsen, Radford University MSP project
in collaboration with
Mr. Michael Bolling, Virginia Department of Education