**Linear Functions versus Exponential Functions**

The aim of this investigation is to develop students’ ability in recognizing data patterns likely to be modeled well by exponential growth functions. A further goal is to utilize graphing calculator experimentation to find a good regression model. Students should think analytically about the data being modeled as well as to use estimation and calculator-based tools.

**![C:\Documents and Settings\kkelley\Local Settings\Temporary Internet Files\Content.IE5\UQWTZD9I\MP900438769[1].jpg]()Wolf Populations in the Midwest**

Suppose that census counts of Midwest wolves began in 1980 and produced these estimates for several different years:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Time Since 1980 (in years)** | 0 | 2 | 5 | 7 | 10 | 13 |
| **Estimated Wolf Population** | 100 | 300 | 500 | 900 | 1,500 | 3,100 |

1. Plot the wolf population data on paper and decide whether a linear or exponential function seems likely to match the pattern of growth well.
2. Use your graphing calculator to find both linear and exponential regression models for the given data pattern. Make sure you have turned your Diagnostics On (2nd 0).

Linear y = a + bx Exponential y = abx

y = \_\_\_\_\_\_\_\_\_\_\_\_\_ y = \_\_\_\_\_\_\_\_\_\_\_\_\_

r2 = \_\_\_\_\_\_\_\_ r2 = \_\_\_\_\_\_\_\_

1. What do the numbers in the linear and exponential function rules from part 2 suggest about the pattern of change in the wolf population?

Linear Exponential

a = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ b = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Which model do you think best fits the data? Why?
2. Use the model for wolf population growth that you believe to be best to calculate population estimates for the missing years (1981, 1983, 1984, 1986, 1988, 1989, 1991, and 1992).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Time Since 1980 (in years)** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **Estimated Wolf Population** | 100 |  | 300 |  |  | 500 |  | 900 |  |  | 1,500 |  |  | 3,100 |

1. Use your model to give population estimates for the year 2000, 2005, and 2010. When will the population reach an estimated 500,000 wolves?

**![C:\Documents and Settings\kkelley\Local Settings\Temporary Internet Files\Content.IE5\C5OTUJAY\MC900329484[1].wmf]()Alaskan Bowhead Whales**

Suppose that census counts of Alaskan Bowhead Whales began in

1970 and produced these estimates for several different years:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Time Since 1970 (in years)** | 0 | 5 | 15 | 20 | 26 | 31 |
| **Estimated Whale Population** | 4700 | 5,800 | 8,000 | 9,300 | 11,000 | 12,300 |

7. Plot the given whale population data on paper and decide which type of function seems likely to match the pattern of growth well.

8. Use your calculator to find both linear and exponential regression models for the data pattern.

Linear Exponential

y = \_\_\_\_\_\_\_\_\_\_\_\_\_ y = \_\_\_\_\_\_\_\_\_\_\_\_\_

r2 = \_\_\_\_\_\_\_\_ r2 = \_\_\_\_\_\_\_\_

9. Which model do you think best fits the data? Why?

10. What do the numbers in the linear and exponential function rules from problem 8 suggest about patterns of change in the whale population?

Linear Exponential

a = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ b = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11. Use the model for whale population growth that you believe to be the best to calculate population estimates for the years 2002, 2005, and 2010.

12. When will the whale population reach 25,000?

**Summarize the Mathematics**

In the problems of this investigation, you studied ways of finding function models for growth patterns that could only be approximated by one of the familiar types of functions.

13. How do you decide whether a data pattern is modeled best by a linear or exponential function?

14. What do the numbers *a* and *b* in a linear function *y* = *a* + *bx* tell about patterns in the graph of the function?

15. What do the numbers *a* and *b* in a linear function *y* = *a* + *bx* tell about patterns in a table of (*x*, *y*) values for the function?

16. What do the numbers *a* and *b* in a exponential function *y* = *a*(*bx*) tell about patterns in the graph of the function?

17. What do the numbers *a* and *b* in a exponential function *y* = *a*(*bx*) tell about patterns in a table of (*x*, *y*) values for the function?

18. What strategies are available for finding a linear or exponential function that models a linear or exponential data pattern?