Whale Disappearance: A Slippery Slope

Subject: Math

Grade Level: Algebra I & II and Pre-calculus

Rational or Purpose: This activity covers the meaning of slope and the method to calculate slope while relating mathematics to real life situations and raising students' awareness of how whaling affects whale populations.

Materials:

- Graph paper
- Ruler

Lesson Duration: 45 minutes

Source of Lesson: *Hot Science – Cool Talks* CD-ROM # 45: "The History and Future of Whales"

TEKS Objectives:

§111.32. Algebra I.
(1A) describe independent and dependent quantities in functional relationships;
(1B) gather and record data and use data sets to determine functional relationships between quantities;
(1C) describe functional relationships for given problem situations and write equations or inequalities to answer questions arising from the situations;
(1D) represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities;
(1E) interpret and make decisions, predictions, and critical judgments from functional relationships.
(5A) determine whether or not given situations can be represented by linear functions;
(5B) determine the domain and range for linear functions in given situations;
(5C) use, translate, and make connections among algebraic, tabular, graphical, or verbal descriptions of linear functions.
(6A) develop the concept of slope as rate of change and determine slopes from graphs, tables, and algebraic representations;
(6B) interpret the meaning of slope and intercepts in situations using data, symbolic representations, or graphs;
(6C) investigate, describe, and predict the effects of changes in m and b on the graph of $y = mx + b$;
(6D) graph and write equations of lines given characteristics such as two points, a point and a slope, or a slope and y-intercept;
(6E) determine the intercepts of the graphs of linear functions and zeros of linear functions from graphs, tables, and algebraic representations;
(6F) interpret and predict the effects of changing slope and y-intercept in applied situations; and
(6G) relate direct variation to linear functions and solve problems involving proportional change.
(8A) analyze situations and formulate systems of linear equations in two unknowns to solve problems;
(8B) solve systems of linear equations using concrete models, graphs, tables, and algebraic methods; and
(8C) interpret and determine the reasonableness of solutions to systems of linear equations.

§111.33. Algebra II.
(1A) identify the mathematical domains and ranges of functions and determine reasonable domain and range values for continuous and discrete situations;
(1B) collect and organize data, make and interpret scatterplots, fit the graph of a function to the data, interpret the results, and proceed to model, predict, and make decisions and critical judgments.

§111.35. Precalculus (One-Half to One Credit).
(1D) recognize and use connections among significant values of a function (zeros, maximum values, minimum values, etc.), points on the graph of a function, and the symbolic representation of a function; and
(3D) use properties of functions to analyze and solve problems and make predictions;

Activity:

Engage the students by watching a microdocumentary on *The Secret Lives of Whales* (www.stanford.edu/group/Palumbi/microdocs.html#secret). Then, provide background information about Fin Whale catch records and how to calculate slope. Next, have students plot the data on a graph paper and answer questions.

Background Information:

The international whaling industry grew rapidly after the creation of factory vessels in 1926[1]. In 1931, the number of catches climbed to an historical high. During 1950s and 1960s, catches of Fin Whale were *constantly* kept at high quantity.

The number of catches is inversely related to the number whales. In other words, as the number of whales caught increases, the population of whales in the oceans decreases. Often, the decrease of population follows a trend. In order to recognize the trend of the population, it is very important to understand the concepts of slope.

Slope is used to measure the steepness of an incline or decline of a straight line. The method to measure a slope of a straight line is to divide the change of *y*-value by the change of *x*-value. (If there are only points on a graph, link two desired points with a straight line and follow the same procedure.) Slope is usually represented by alphabet letter *m*. A positive slope represents an incline of the line, and a negative slope represents a decline.

It is important to know that every point on a *straight line* has the same slope. The absolute value of the slope reflects the line's steepness (the greater of the absolute value of a slope, the greater steepness of a line). Slope is sometimes represented by terms such as rate of change, speed, velocity, or other terms that reflect a change of dependent variable in respect to an independent variable.

[1] Clark, CW and R. Lamberson. 1982. An economic history and analysis of pelagic whaling. *Marine Policy* 6 (2): 103-120.

Procedure:

Presented here is a set of data that describes the number of Fin Whales caught between 1925 and 1979 (Figure 1). Analyze the data and represent it graphically. Name the graph with a suitable title, and set up two axes with proper labels. Plot each point on your graph paper and connect the points with straight lines.

Year	# of Fin Whales	Year	# of Fin Whales
1925	2500	1951	17500
1927	4000	1953	22000
1929	3500	1955	26000
1931	8500	1957	26000
*1932	1000	1959	26000
1933	4500	1961	27500
1935	11500	1963	24000
1937	14500	1965	13000
*1938	26000	1967	3500
1939	19000	1969	3500
1941	7500	1971	3500
1943	500	1973	2500
1945	1000	1975	2000
1947	13000	1977	200
1949	17500	1979	200

Figure 1. The number of Fin Whales caught between 1925 and 1979.
(*) indicates the years with important information that are not included in the regular two-year interval.

Questions: (Show your work for all calculations)

1. What is the equation for slope?

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2. What is the slope between a) 1938 and 1943 b) 1945 and 1949 c) 1961 and 1967

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3. Construct a linear equation by using the data of 1967 and the slope between 1965 and 1967.

4. Predict the number of catch of fin in 1969 by using the linear equation in question 3.

5. Does the prediction provide a reasonable estimation? Why?

6. Construct a linear equation by using the data of 1975 and the slope between 1971 and 1975.

7. Predict the number of catch of Fin Whales in 1977 by using the linear equation in question 6.

8. Does the prediction overestimate or underestimate? By how many Fin Whales?

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9. Does it matter if the data of 1971 (instead of 1975) is used to construct the linear equation? Why?

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10. What historical event caused a significant reduction in the number of Fin Whales caught between 1943 and 1945?

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11. What caused the drop in number of Fin Whales caught between 1961 and 1967?

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Why does the number of Fin Whales caught remain low after 1967?

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12. What do you predict will happen to the Fin Whale population and number caught in the future? Why?

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Additional Facts:

From 1943 to 1945, almost all sailing in open oceans was stopped because of World War II. Countries required whaling industries to provide their fleets for military use, so only few ships could travel and whale. Although World War II caused a significant reduction in the number of whales caught, the whaling industries were able to recover shortly after the end of war.

Starting in 1961, the population of Fin Whale began to decrease dramatically, which made catching Fin Whales more difficult. This is reflected on the table by the significant drop in the number of Fin Whales caught.