



## ICE - Slope Fields

*In the last lesson, you may have studied the impact of the 1998 ICCAT regulations on the Atlantic bluefin tuna. In this ICE, you will also study the impact of these regulations on bluefin tuna numbers, but from a graphical point of view.*

- *Table 1 (below) gives the instantaneous rate at which tuna were caught during 1998. (The units of instantaneous rate are thousands of tuna per month.) Enter these numbers into your calculator and display them. What sort of polynomial function would do a reasonable job of representing the instantaneous rate?*

Month	Rate at which bluefin tuna caught during 1998 (thousands of tuna per month)
January	0.105
February	0.050
March	0.023
April	0.013
May	0.013
June	0.229
July	4.371
August	6.633
September	2.209
October	0.809
November	0.088
December	0.080

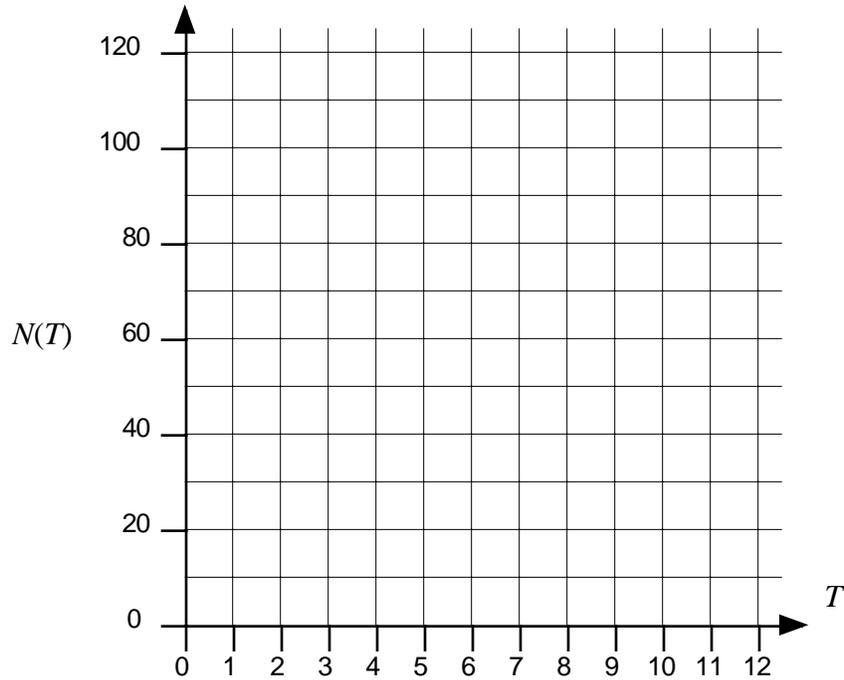
Table 1.

- *Find an equation for the instantaneous rate at which tuna were caught as a function of  $T$ , the number of months since January 1998. Write your equation below.*
- *Let  $N(T)$  represent the number of bluefin tuna (in units of thousands of tuna). If left alone, the tuna will reproduce and start to restore their numbers. Although there is very little data available on bluefin reproductive rates, some preliminary work by the New England Aquarium and the National Academy of Sciences suggest that the growth of tuna numbers might be approximated by the equation:*

$$N'(T) = 0.0875 \cdot N(T)$$

*Combine this information with the equation that you found for the rate at which tuna are caught to create an equation for the net rate of change of the bluefin tuna population.*

- The axes given below have  $N(T)$  on the vertical axis and  $T$  on the horizontal axis. Use the equation that you have just found for the net rate of change for the tuna population to sketch a slope field.



- The best available estimate of the bluefin tuna population at the beginning of 1998 was 40,000 tuna. Use the slope field drawn above to sketch a graph showing the size of the tuna population as a function of time.

- Imagine that you are a researcher at the National Marine Fisheries Service who has been given the task of assessing the impact of the 1998 ICCAT regulations on the Atlantic bluefin tuna. You have just finished drawing a graph showing the size of the bluefin tuna population versus time when your intern comes rushing in, yelling:

“Hold everything! The initial value was wrong! We should have used 20,000 tuna instead of 40,000 tuna!”

**How can you estimate the tuna numbers based on this latest revelation?**