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DATA Nugget

When a species can't stand the heat

Featured scientists: Kristine Grayson from University of Richmond, Nicola Mitchell from University of Western Australia, & Nicola Nelson from Victoria University of Wellington

Research Background:

Tuatara are a unique species of reptile found only in New Zealand. They look like lizards but they are actually in their own reptile group. Tuatara are the only species remaining on the planet from this group, one that dates to the time of the dinosaurs! Tuatara are similar to tortoises in that they are extremely long-lived – some individuals are over 100 years old! Tuatara start reproducing when they are about 15 to 20 years old and they breed infrequently.

An adult male tuatara. Photo by Scott Jarvie.

The sex of tuatara is not determined by sex chromosomes (X or Y) as in humans. Instead, the temperature of the nest during egg development is the only factor that determines the sex of tuatara embryos. If the egg develops with a low temperature in the nest it will be female, and if it develops with a high temperature in the nest it will be male. This process happens in many other species, too, including some turtles, crocodiles, lizards, and fish. However, most species are the opposite of tuatara and produce females at the warmest temperatures.

North Brother Island, one of the small New Zealand islands where tuatara are found today. Photo by Jo Monks.

Today, tuatara face many challenges. Humans introduced new predators to the large North and South Islands of New Zealand. Tuatara used to live on these main islands, but predators drove the island populations to local extinction. Today, tuatara survive only on smaller offshore islands where they can escape predation. Because many of these islands are small, tuatara can have low population numbers that are very vulnerable to a variety of risk factors. One of the current

challenges faced by these populations is climate change. Similar to the rest of the world, New Zealand is experiencing higher and higher temperatures as a result of climate change, and the warm temperatures may impact tuatara reproduction.

Kristine collecting data on a tuatara in the field. Photo by Sue Keall.

North Brother Island has a small population of tuatara (350–500 individuals) that has been studied for decades. Every single tuatara has been marked with a microchip (like the ones used on pet dogs and cats), which allows scientists to identify and measure the same individuals repeatedly across several years. In the 1990s, a group of scientists studying tuatara on this island noticed that there were more males than females (60% of the population was male). The scientists started collecting data on the number of males and females so they could track whether the **sex ratio**, or the ratio of males and females in the population, became more balanced or became even more male-biased over time. The sex ratio is important because when there are fewer females in a population there are fewer individuals that lay eggs and produce future offspring. Generally, a population that is highly male-biased will have lower reproduction rates than a population that is more balanced or female-biased.

The fact that tuatara are long-lived and breed infrequently meant that the scientists needed to follow the sex ratio for many years to be sure they were capturing a true shift in the sexes over time, not just a short-term variation. In 2012, Kristine and her colleagues decided to use these long-term data to see if increasing temperatures due to climate change were associated with the changing sex ratio. They predicted that there would be a greater proportion of males in the population over time. This would be reflected in an unbalanced sex ratio that is moving further and further away from 50% males and 50% females and toward a male-biased population.

Scientific Question: Is there evidence that the tuatara population on North Brother Island has become more male-biased over time due to warming of the island's climate?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

The following graph shows average annual temperatures for New Zealand. Data were collected by the National Institute of Water and Atmospheric Research. The x-axis shows the year the data was collected. The y-axis shows the composite of temperature data from 7 weather stations across New Zealand. The black line shows the trend.

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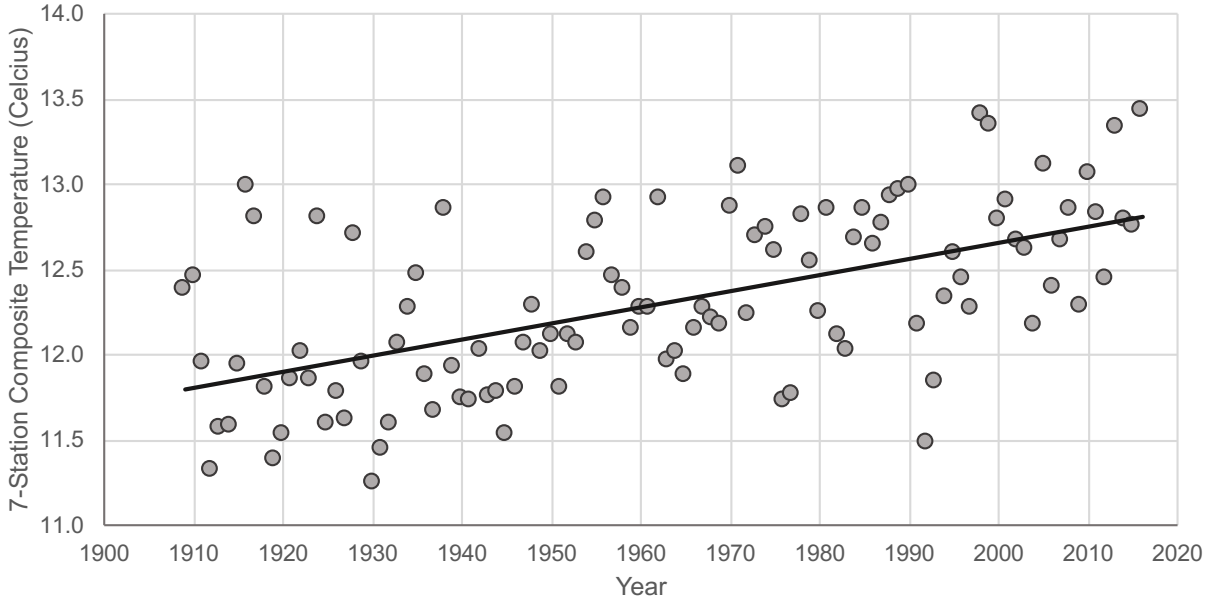
Identify any changes, trends, or differences you see in the graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow. How has the temperature in New Zealand changed over the past century?



Scientific Data:

Use the table below, and the data in the graph of New Zealand temperature, to answer the scientific question:

Year	Number of males	Number of females	Total tuatara	% male tuatara in population	Sex ratio (M:F)
1988	18	12			
1989	20	16			
1990	60	37			
1991	53	39			
1993	123	44			
1994	126	61			
1996	151	68			
1997	154	72			
1998	34	17			
2000	227	132			
2001	164	102			
2005	120	43			
2008	110	39			
2010	101	33			
2011	117	57			
2012	98	40			

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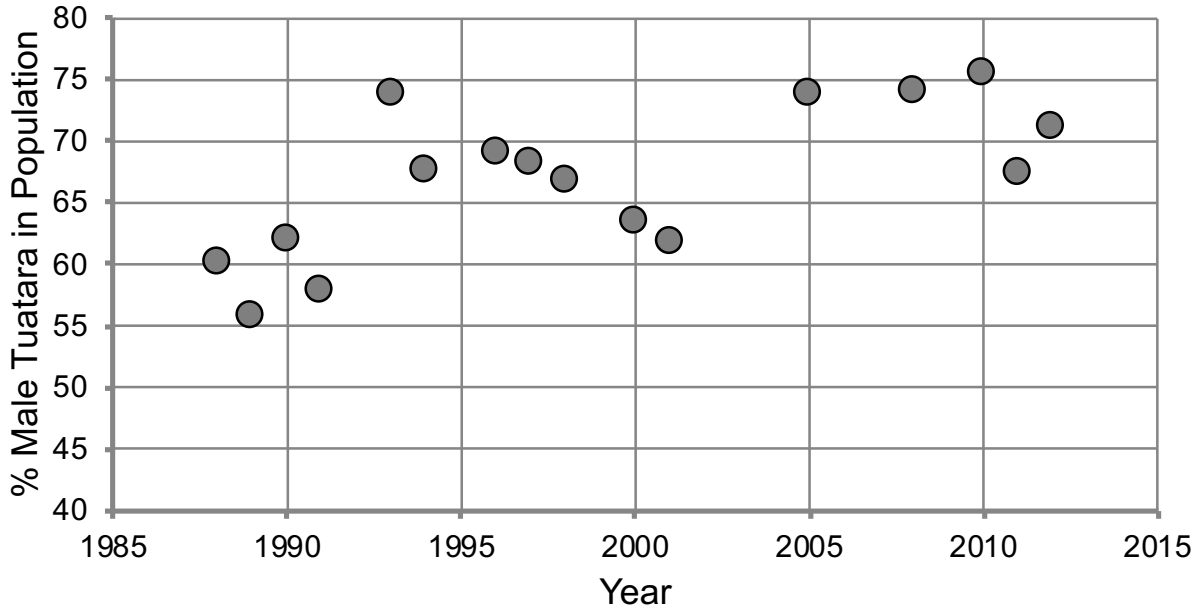
What data will you graph to answer the question?

Independent variable: _____

Dependent variable: _____

Below is a graph of the data: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.



Interpret the data:

Make a claim that answers the scientific question.

What evidence was used to write your claim? Reference specific parts of the table or graphs.

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Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how temperature affects egg development in tuatara.

Did the data support Kristine's hypothesis? Use evidence to explain why or why not. If you feel the data were inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question?