

DATA *Nugget*

Gone fishin' for survival

Featured scientist: Ivan Arismendi from Oregon State University, H.J. Andrews Experimental Forest Long Term Ecological Research Site.

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Research Background:

Climate change is affecting our world in many ways. Globally, we are experiencing more droughts and wildfires, shifting seasons, and rising sea levels. Species are responding as well. Some can shift their ranges to follow cooler temperatures. But what about organisms, like fish, that cannot easily move to a new location?

A group of scientists is studying fish in streams in central Oregon to learn more. The H.J. Andrews Experimental Forest, also called the Andrews, is a long-term research site in the Cascade Mountains of central Oregon. Scientists have been collecting data there for decades! The Andrews is an old-growth temperate rainforest with a dense canopy of trees. These trees block the sun's heat, keeping the understory and streams below cool.

Ivan is a biologist on this team who studies fish in these streams. Originally from southern Chile, he has spent decades studying ecology in both marine and freshwater environments. Ivan first came to Oregon to study how logging affects stream ecosystems. While working at the Andrews, he noticed that air temperatures in the forest were getting warmer over time. He wondered if the stream temperatures were warming too and whether this change might be affecting the fish that live there. He focused on coastal cutthroat trout living in Mack Creek, a stream within the Andrews.

Ivan started his exploration with data from historical surveys. For many years, scientists, staff, and students at the Andrews have been sampling coastal cutthroat trout in the streams. They collect data on their body size and other health measures. Ivan and his team found data on **trout fork lengths**, or the distance in millimeters (mm) from the tip of the fish's snout to the center of its tail, dating back to the 1980s. Ivan used these data to calculate the **median fork length** of trout measured each year. The median is the middle value when all the trout are ordered from smallest to largest.



Ivan also found data on Mack Creek water temperature for the same years as the fish length data. Ivan focused on summer water temperatures because these would be the warmest experienced by the trout each year. He found the highest water temperature recorded each summer day, called daily maximum temperature. He then averaged all the daily maximums for each summer, which gave him one temperature value for each year. This value is the **average daily maximum water temperature** for the summer.

Ivan predicted that he would see stream temperatures go up over time due to climate change impacting the Andrews. He also predicted that trout median fork lengths would be getting shorter over time. He based this idea on the **temperature-size rule**, a common pattern seen in fish. In warmer temperatures, fish metabolism speeds up, and animals with faster metabolisms often mature at a smaller body size. This would support the idea that climate change was leading to smaller fish in the Andrews.



Left: Ivan and his team electrofishing the creek to collect fish. Right: The fish are then quickly measured before they are returned to the creek.

Scientific Questions: How have water temperatures in Mack Creek changed since the 1980s? What changes, if any, have occurred in the size of cutthroat trout living in Mack Creek during that same time period?

Scientific Data:

Use the data below to answer the scientific questions:

	Mack Creek average daily maximum during summer months		
Year	Air temperature (°C)	Water temperature (°C)	Trout median fork length (mm)
1987	22.3	8.8	98
1988	24	7.5	111
1989	21.9	6.7	105
1990	24.2	7.9	98
1991	19.8	5.8	102
1992	24.8	9	95
1993	22.6	7	106
1994	23.4	7.8	91
1995	22.3	7.7	104
1996	23	7.5	111
1997	22	7.8	100
1998	23.6	7.7	103
1999	21.5	6.8	103
2000	22.6	7.5	111
2001	22.3	7.5	98
2002	24.2	7.1	106
2003	26	7.8	105
2004	22.9	7.5	95
2005	22.6	7.4	105
2006	23.3	7.3	110
2007	22.4	7.4	104
2008	22.4	6.4	100
2009	23.9	7.1	109
2010	21.4	5.9	100
2011	23.4	8.7	109
2012	22.3	7.1	103
2013	23.4	7.7	98
2014	23.6	8.5	94
2015	25.6	9.1	97
2016	23.7	8.2	106
2017	24.8	7.6	97
2018	24.8	7.9	100
2019	23.5	8.2	98
2020			
2021			97
2022			93

Name_____

What data will you graph to answer the questions?

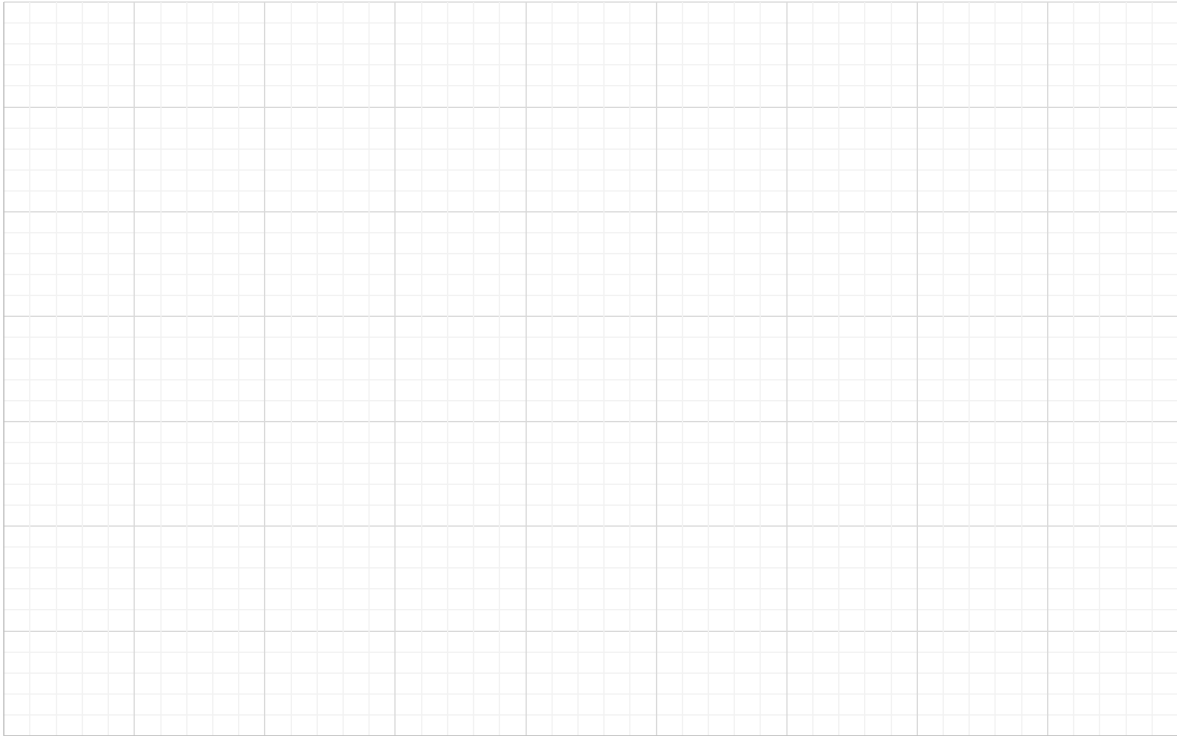
Independent variable(s): _____

Dependent variable(s): _____

Draw your graphs below: 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.



Name_____



Interpret the data:

Make a claim that answers the scientific questions – 1) How have water temperatures in Mack Creek changed since the 1980s? 2) What changes, if any, have occurred in the size of cutthroat trout living in Mack Creek during that same time period?

Name_____

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

Explain your reasoning and why the evidence supports your claims. Connect the data back to what you learned about the size-temperature rule and how it relates to trout growing in Mack Creek.

Your next steps as a scientist:

Science is an ongoing process. What new question(s) should be investigated to build on Ivan's research? How do your questions build on the research that has already been done?

Name_____

What future data should be collected to answer your question?

Independent variable(s): _____

Dependent variable(s): _____

For each variable, explain why you included it and how it could be measured.

What hypothesis are you testing in your experiment? A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.