

DATA *Nugget*

Crunchy or squishy? How El Niño events change zooplankton

Featured scientist: Laura Lilly from Scripps Institution of Oceanography, UC San Diego

Research Background:

El Niño events happen every 5 to 10 years and take place in the Pacific Ocean. El Niño occurs when the winds that blow west over the equator temporarily weaken, and even switch direction. This allows warm surface waters that typically pile up on the western side of the Pacific Ocean to flow to the east. In South America, El Niño brings heavy rains and floods because the warm water moves toward that continent. On the other hand, the warm water moves away from the continent of Australia, causing drought. In the U.S., warm waters travel up to California during El Niño years, causing the ocean to be much warmer than usual. El Niño's effects are so strong that it even changes the marine animals that live off the California coast in those years!

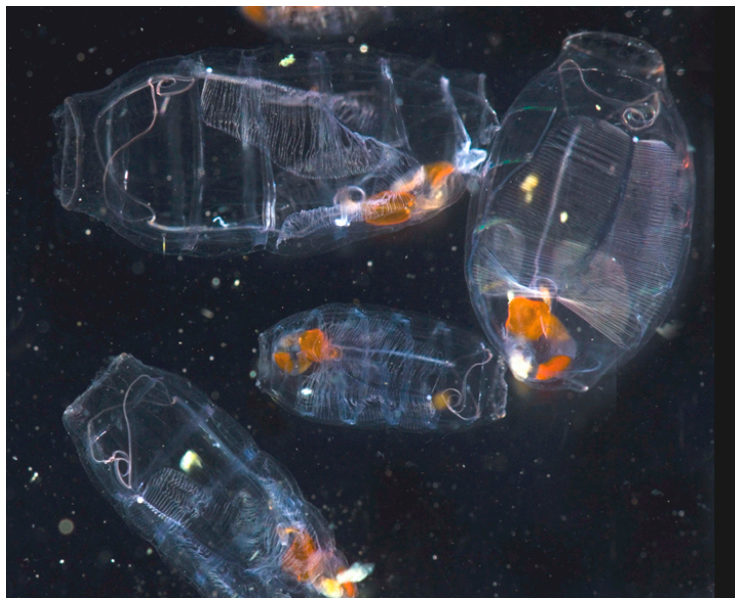
Laura's first experience with El Niño came when she was growing up in California. A strong El Niño event hit in 1997-98, and many cities in California flooded because of heavy rainstorms. The event even made the national news on TV! Laura's second El Niño experience came in 2015, the year she started training to become a scientist. These events had such a big impact on her that she decided to study how zooplankton in the ocean are affected by El Niño. **Zooplankton** are tiny drifting ocean animals ("zoo" = animal + "plankton" = drifter) that eat **phytoplankton** ("plant drifters"). Zooplankton are important for the ocean's food web because they are food for fish, whales, and seabirds.

Zooplankton come in many shapes, sizes, and species. The two main groups are **crustaceans** and **gelatinous animals**. Crustaceans look like small shrimp and crabs, with hard, crunchy shells and segmented legs like insects. In contrast, gelatinous animals are watery and squishy, like jellyfish. Laura wanted to know how El Niño events might affect which group of zooplankton are found off the coast of California.



Laura identifies and counts zooplankton from a net tow using a microscope. Laura conducted these identifications while on a research ship at sea.

Warm ocean waters during El Niño events have lower nutrient levels, so fewer phytoplankton grow leading to less food available for zooplankton. Gelatinous animals can survive in areas of the ocean where there is less food available. They are also able to live in warmer water than crustaceans. For these two reasons, Laura thought that gelatinous animals may be able to live in the warmer water off California during El Niño events. Laura predicted that during the El Niño events of 1992-93, 1997-98, and 2015-16, the balance would shift in favor of gelatinous animals over crustaceans



To test her idea, Laura used a long-term dataset that documents zooplankton collected offshore of southern California since 1951. Every spring, a ship goes out on the ocean and tows plankton nets for 30 minutes at 40 different locations. The ship brings back jars full of zooplankton.

Scientists look at samples from those jars and identify the species and measure the lengths of each individual zooplankton in the sample. They then add up all the lengths of individual plankton to get the total biomass of each group. **Biomass** is similar to weight and shows us how big each animal is and how much space their group takes up. Scientists also measure water temperature and how much phytoplankton is found. The amount of phytoplankton is measured by detecting **chlorophyll** in the water. Chlorophyll from phytoplankton is a measure of how much food is available to zooplankton.

Top image - Doliolids are a type of gelatinous zooplankton, meaning they have soft, watery bodies and not a lot of nutrition for other animals to eat. They can form large groups in the ocean called 'blooms'. *Bottom image* - Krill is a type of crustacean zooplankton, meaning that it is related to shrimp and crabs. It has a hard, segmented shell (exoskeleton). It is the main food source for blue whales and other whales and birds.

Scientific Question: Do the two main groups of zooplankton (crustaceans and gelatinous animals) increase or decrease in response to changes in their phytoplankton food during El Niño events?

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.

Scientific Data:

Use the data below to answer the scientific question:

Year	Zooplankton biomass (mg C m ⁻²)	Crustacean biomass (mg C m ⁻²)	Gelatinous biomass (mg C m ⁻²)	Temperature (Celsius)	Nitrate (uM)	Chlorophyll (ug/L)
1990	766.3	439.7	49.5	11.7	7.1	11.1
1991	1333.4	74.3	882.6	13.4	1.3	0.9
1992	461.1	211.0	19.1	13.2	2.6	2.5
1993	440.0	276.1	40.5	11.4	13.0	2.9
1994	490.0	343.1	19.1	12.5	5.1	2.4
1995	452.4	515.6	42.5	13.9	0.0	0.7
1996	1216.9	758.4	56.0	11.9	8.4	5.2
1997	527.9	242.7	94.4	12.3	8.2	0.6
1998	429.2	274.0	35.0	13.7	0.0	2.1
1999	909.8	379.7	196.1	11.8	9.8	2.7
2000	1359.7	734.1	162.1	13.8	1.6	1.4
2001	1053.3	561.3	53.1	10.8	9.4	13.0
2002	1320.6	719.0	166.1	12.3	3.7	8.8
2003	2829.9	925.3	284.0	12.7	1.3	4.3
2004	633.9	351.1	47.8	11.5	13.5	5.5
2005	1201.1	579.4	143.0	12.5	4.5	3.0
2006	973.3	850.7	138.9	14.2	0.5	0.9
2007	893.9	783.7	68.0	11.4	17.7	0.8
2008	1208.5	1007.2	234.4	10.6	18.0	2.5
2009	439.0	392.7	46.2	12.7	3.1	1.8
2010	943.2	495.7	161.2	10.5	18.2	2.5
2011	1351.3	1267.7	178.7	11.1	13.6	7.5
2012	408.8	694.3	98.3	10.4	19.1	1.8
2013	1616.0	957.0	243.7	12.0	7.9	1.1
2014	956.0	638.5	160.8	12.5	9.7	2.2
2015	478.4	209.0	127.2	13.6	2.1	1.3
2016	1058.0	902.9	125.1	12.4	7.0	2.8

*Units are: 'micrograms carbon per meter²' for crustaceans and gelatinous organisms; degrees C for temperature; micromolar concentration (μM) for nitrate; and micrograms per liter ($\mu\text{g L}^{-1}$) for chlorophyll. All measurements were taken at 10 m depth.

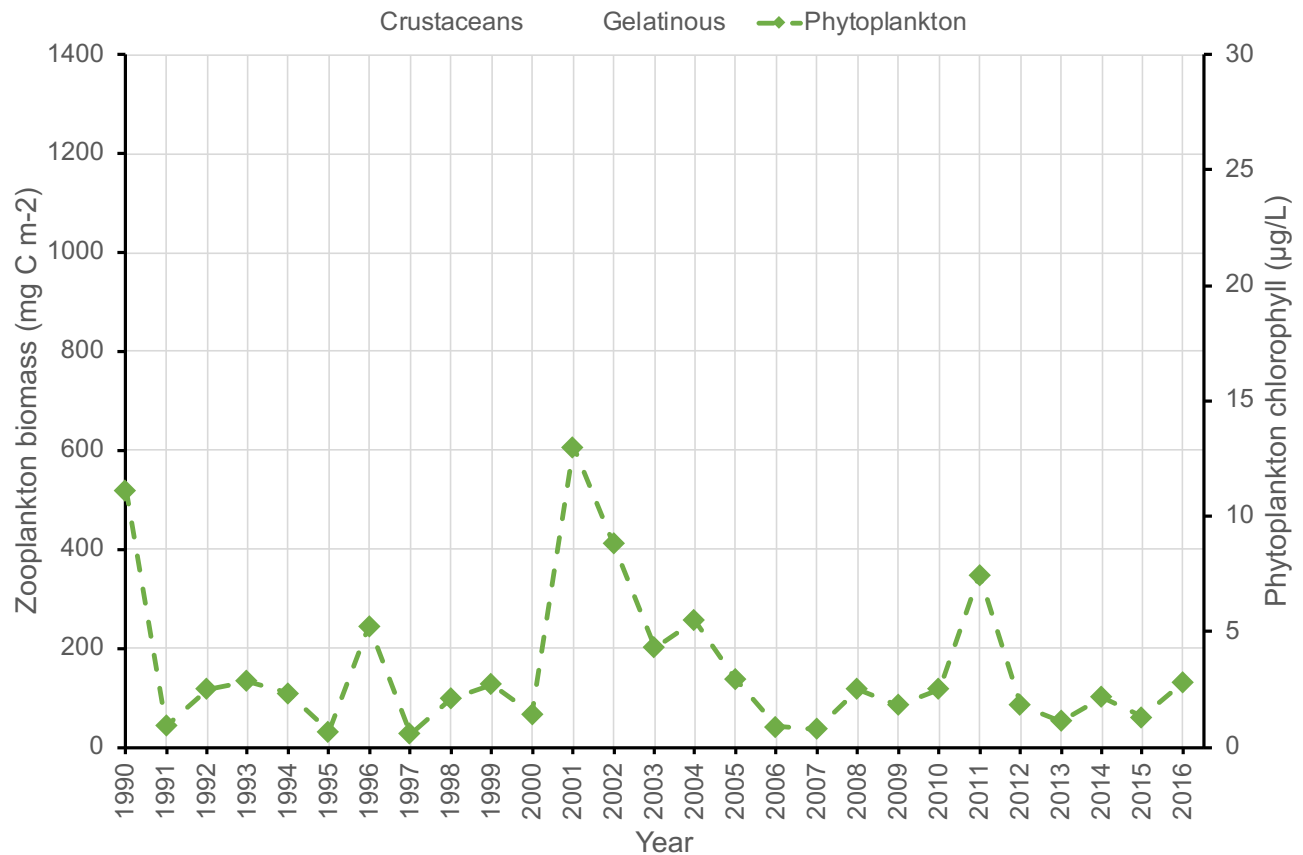
**El Niño years are marked with grey cells in the table.

What data will you graph to answer the question?

Independent variables: _____

Dependent variables: _____

Draw your graph 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 question.

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

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how different groups of zooplankton change during El Niño events.

Name_____

Did the data support Laura's hypothesis? Use evidence to explain why or why not. If you feel the data was 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?