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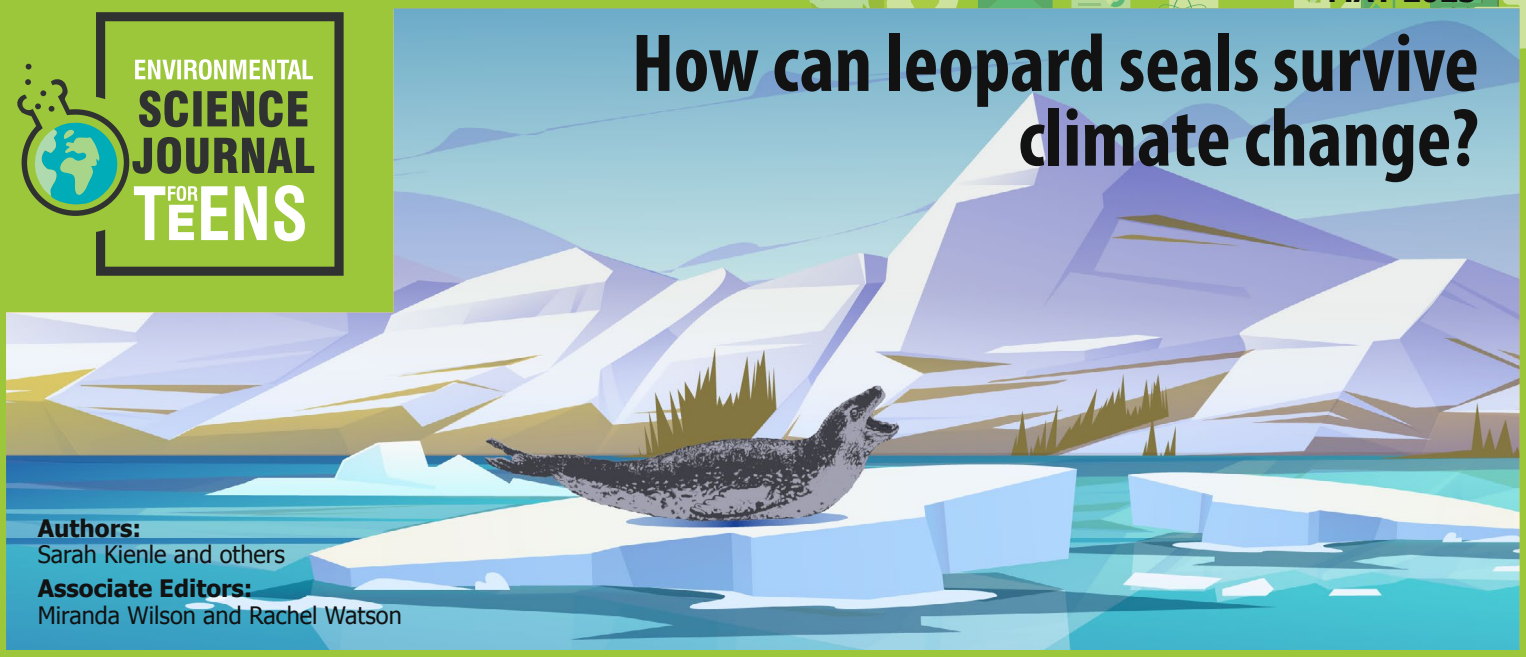
How can leopard seals survive climate change?



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Abstract

Have you ever been by yourself and needed to get something off a high shelf, but couldn't reach? Now imagine you had your whole class with you. It's likely that someone in your class could reach the high shelf.

Variability in traits (and behaviors) is a good thing. It means that groups of organisms can adjust and survive when environments change. We know that animals living at the North and South Poles, especially large predators, are in danger because of the changing climate. We wanted to look at variability in the traits and behaviors of polar predators to assess how they will adapt to climate change.

We tagged and studied a population of leopard seals in Antarctica. We looked at their morphology, movement patterns, and diving behavior. We found lots of variability in these traits in the leopard seal population, especially between males and females. We think this high variability may help leopard seals survive better in the changing Antarctic environment.

Introduction

Many polar predators use ice to hunt, have babies, and to rest. They are also at the top of the **food chain**. This means they can have strong effects on the rest of the organisms living in polar ecosystems. We don't know how different species will survive and adapt as the climate continues to warm and ice continues to melt. We don't know how well polar ecosystems will do either. If we can learn more about polar predators, it can help us manage these ecosystems better as the climate and environment change.

We can learn about how polar predators live by studying how traits and behaviors vary between and within individuals. What does that mean? When we compare different individuals in a species, we call differences in traits or behaviors **variability**. When we look at one individual at different points in time and find differences in traits or behavior, we call it **plasticity**.

Traits we measure include differences in **morphology**, such as body mass or body length. We can compare these between individuals. But morphology can also differ between males and females of the same species. This is called **sexual dimorphism**. Behaviors, like how far polar predators travel or how deep they dive, provide important information on where and how these animals feed, mate, and rest. These behaviors are also linked to their survival. Species are more likely to survive in changing ecosystems if they have more variation in their traits and behaviors.

Leopard seals are top predators in the Southern Ocean around Antarctica. As a species, they are **generalist** predators. Because they eat a variety of prey, leopard seals have a large impact on Southern Ocean **food webs**. Unfortunately, besides diet, there is not much information on other leopard seal traits and behaviors.

We wanted to know more about variability and plasticity in the traits and behaviors of leopard seals. This will help us better understand how climate change is impacting polar predators and ecosystems.

Methods

We studied leopard seals at a research station off the Western Antarctic Peninsula (Fig. 1). We captured, humanely immobilized, and released 22 leopard seals during the local summer and fall of 2018 and 2019. We recorded the size of each seal. We also determined whether each seal was male or female.

We attached GPS and satellite transmitters to each seal to look at their movements. We also attached a time-depth recorder that measures dive behavior. This collection of sensors (or tags) can tell us the location of the seal and whether it was in the water or not. They can also tell us how deep and how long dives were. We also recorded the characteristics of each dive (like how long they spent at different depths).

We used computers to help us look at and filter our data. Then we used statistics to look at patterns of morphology and behavior in our leopard seal population. We also looked specifically at differences between males and females.

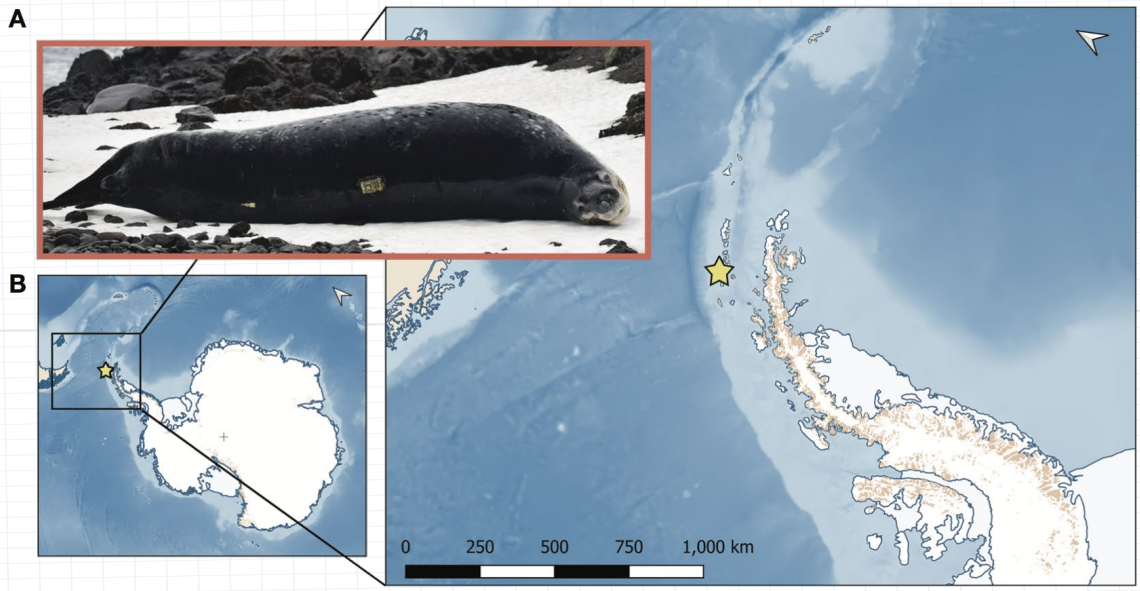


Figure 1:
A leopard seal (**A**) at our study site at Cape Shirreff on the Western Antarctic Peninsula (**B**). The leopard seal has a satellite/GPS tracker attached to its back.

Results

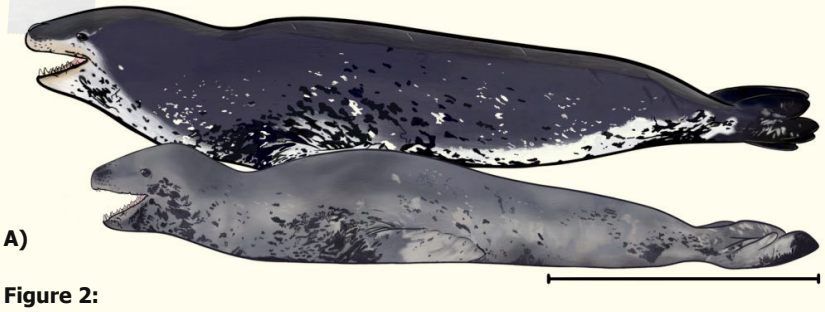
Morphology

- We found that the body mass of leopard seals was between 147 and 540 kg (324 and 1,190 lb). Females were much larger than males. In fact, they were about 50% larger! (See Figure 2.)
- We also noticed that female leopard seals had more injuries and scars than males.

Behavior

- We saw that leopard seals traveled an average of 556 km (345 mi) during our sampling time. The maximum distance an individual traveled was 1,669 km (1,037 mi)!
- Our data showed that female leopard seals spent more time out of the water and resting on ice than males. This is likely when females were giving birth and nursing pups (baby seals).
- We noticed that the diving behavior of leopard seals was highly variable. We didn't see many differences between males and females either. Most dives we recorded were shallow and short, but some were deep and long. In fact, one seal dove to 1.25 km (0.78 mi) and spent 25 minutes underwater!

Please see Figure 2 Page 3



A)

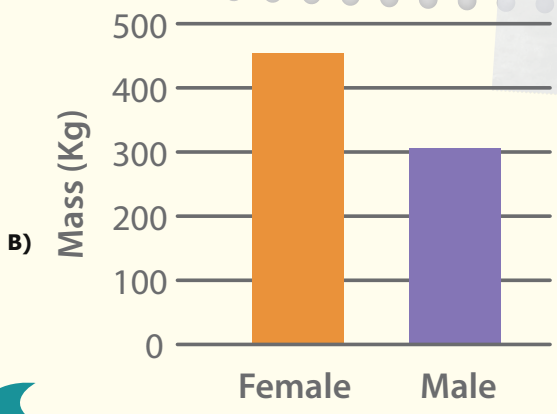


Figure 2:
A) Difference in size between female (top) and male (bottom) leopard seals. The scale bar represents 1 m.
B) The average mass of female and male leopard seals.

How much larger are female leopard seals than males?

Discussion

Female-based sexual dimorphism (where females are larger) is rare in mammals. We found that leopard seals are an extreme example. Females can be up to 1.5 times larger than males. We don't know why females are larger. Being larger means females are more successful at competing for food. If females compete for food more often, that could also explain why females have more injuries than males. We need a larger sample size of leopard seals and more direct observations of their feeding and reproductive behaviors to figure out why females are larger.

It is likely that climate change will impact the amount and types of prey available for leopard seals to eat. Luckily, we saw high plasticity and variability in the movement patterns and diving behavior of our leopard seals. This means they can change behavior quickly. It also allows them to hunt a lot of different types of prey. This behavioral plasticity could help leopard seals survive in a changing climate. Learning more will also help us predict any changes that might happen to polar food chains and food webs.

In the future, we need to conduct larger and broader studies to understand the impact these polar predators have on different ecosystems.

Conclusion

We know climate change is impacting environments all over the world. Organisms that live in polar regions are at risk because of rising temperatures and melting ice. Knowing more about the predators in these ecosystems can help us understand the impacts that climate change will have on food webs and entire ecosystems.

You can also help by doing your part to reduce climate change. You can carpool or take public transportation. You can also use less energy in your home by turning off lights or taking shorter showers. And remember to reduce, reuse, and recycle!

REFERENCES

Sarah S. Kienle, Michael E. Goebel, Erin LaBrecque, Renato Borras-Chavez, Stephen J. Trumble, Shane B. Kanatous, Daniel E. Crocker, and Daniel P. Costa (2022) *Plasticity in the Morphometrics and Movements of an Antarctic Apex Predator, the Leopard Seal*. Frontiers in Marine Science.
https://www.frontiersin.org/articles/10.3389/fmars.2022.976019/full

Nature World News: Scientists Observe Solitary Habits of Leopard Seals Amid Climate Change
https://www.natureworldnews.com/articles/52801/20220829/scientists-gathered-data-solitary-habits-leopard-seals-climate-change.htm

Natural History Museum: Are Leopard Seals Dangerous?
https://www.nhm.ac.uk/discover/are-leopard-seals-dangerous.html

Glossary of Key Terms

Food chain – a linear relationship between organisms based on the foods they eat. The bottom level of a food chain contains producers. Consumers eat the producers. There can be several levels of consumers. At the top of the food chain are the predators who eat other consumers.

Food web – a collection of food chains organized to visualize relationships within the entire ecosystem.

Generalist – an organism that eats a variety of foods. Humans are considered generalists. In contrast, monarch butterfly larvae only eat milkweed plants. They would be considered specialists.

Morphology – the size, structure, or shape of an organism.

Plasticity – the ability of an organism to change its morphology or behavior in response to the environment. For example, plant leaves that have been grown in sunlight are thicker and smaller than leaves grown in the shade. These traits help the leaves collect sunlight without losing too much water in both the sun and the shade.

Sexual dimorphism – a difference in the size or shape of males and females of the same species. For example, male peacocks have a wide, colorful tail fan and females do not.

Variability – Difference in traits and behaviors between individuals of the same species. For example, different types of dog (*Canis lupis familiaris*) look and act very differently to one another. You can probably notice a lot of differences among your classmates, too!

Check your understanding

1. What is sexual dimorphism? Give two reasons why you think sexual dimorphism might have evolved in organisms.

2. Describe the feeding behavior of leopard seals. Why might this mean they have a larger impact on the ecosystem than other predators?

3. Brainstorm with a partner – what are the causes of climate change and how can we prevent them?

4. You are writing a grant proposal to do more research on leopard seals in Antarctica. Justify why you think this work is important and deserves research funds. (Hint: Think about what ecosystems and organisms can do for humans.)

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