

Project Description

Through interacting with this Notebook, we hope to underscore the importance of recording marine mammal acoustic data by (1) sharing it directly with you, thanks to the National Oceanic and Atmospheric Administration (NOAA) Fisheries New England/Mid-Atlantic Sounds in the Ocean database, (2) engaging you in a guessing game called, *Guess Who? Marine Mammal Edition*, and (3) providing a feedback plot to help you visualize how difficult it might be to analyze audio data without bioinformatics (the bar plot will display how many times a player correctly guesses each marine mammal). Acoustic researchers use the same type of data provided in the database to conduct new studies and maintain records for status updates on endangered or threatened marine mammals.

What's the big deal anyway?

Policy implementations from various nations regarding the protection of ocean ecosystems, the most familiar being Marine Protected Areas in the United States, require active watch of marine ecosystems within certain boundaries to ensure “lasting protection for part or all of the natural and cultural resources” (National). Most of us would think this primarily affects fish and fisheries, but because marine mammals are mass consumers of lower trophic levels, they are impacted, too. Additionally, all marine mammals are under protection in the United States by the Marine Mammal Protection Act (MMPA). One way to manage marine mammal conservation, in addition to MPAs, is to use acoustic data monitoring coupled with marine mammal tracking data (see *Figure 1*). We do not intend to make this process sound trivial; this task is very difficult and there is on-going research to investigate best practices. It is a good start, though.

We hope you enjoy.

Team Member Names and Contributions

- [REDACTED] I helped contribute to background research, markdown cells, and the function combining sounds (`play_sound()` function).
- [REDACTED] I help contribute to the background research, markdown cells, and guessing game challenge, `play_game()`.
- [REDACTED] I created the panda dateframe, `update_plot()` function and help create the guessing game challenge, `play_game()`. I also helped contribute to the background research, markdown cells, coding style, docstrings, in line comments, and the `play_sound()` function.

What are cetaceans and pinnipeds?

Cetaceans and pinnipeds are two of the four marine mammal taxonomic groups. Cetaceans include whales, dolphins, and porpoise, and pinnipeds include seals, sea lions, and walruses.

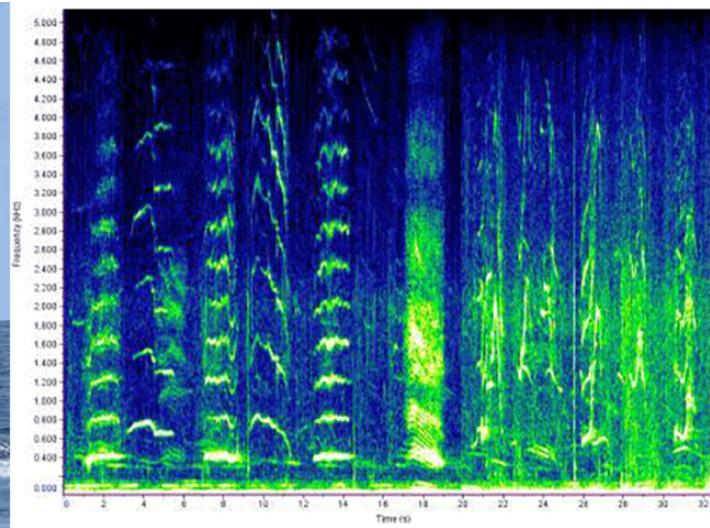
In this Notebook, we will be looking at acoustic data from 8 species of marine mammals within the Cetacean and Pinniped groups: **humpback whale** (*Megaptera novaeangliae*), **beluga whale** (*Delphinapterus leucas*), **killer whale** (*Orcinus orca*), **common bottlenose dolphin** (*Tursiops truncatus*), **leopard seal** (*Hydrurga leptonyx*), **crabeater seal** (*Lobodon carcinophagus*), **harp seal** (*Pagophilus groenlandicus*), and **striped dolphin** (*Stenella coeruleoalba*) (Marine Mammals | NOAA).

Why acoustic data?

Most marine mammals are what marine scientists would often consider *charismatic megafauna*—the important part of that phrase being “**megafauna**.” Whales, dolphins, and seals are (relatively) large and swim long distances, and sometimes in groups. It is difficult and extremely laborious to perform only visual tracking. A more efficient, and possibly more effective, mode of tracking these migratory creatures is through the assistance of autonomous recording devices with programmable technology that capture their acoustic data (i.e. clicks, grunts, and songs).

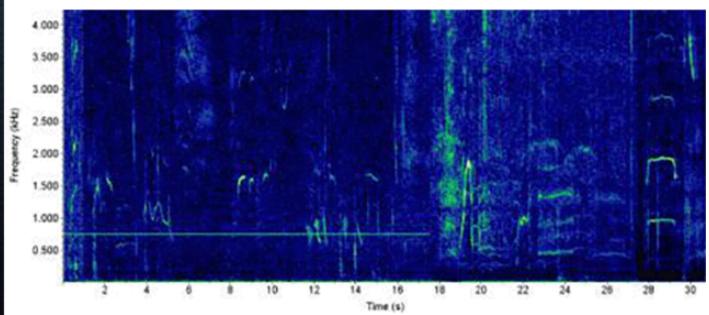
Here are short descriptions about each marine mammals to help you with the game!

Humpback Whale:



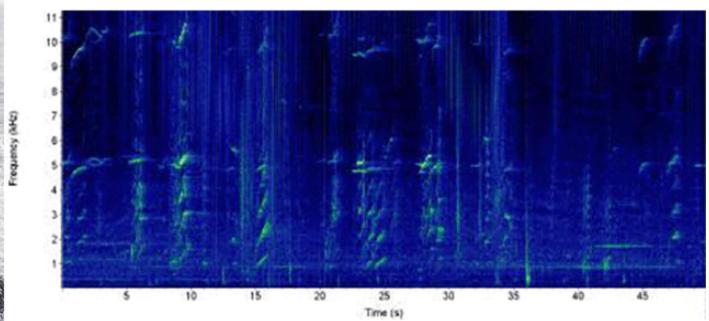
Humpback whales are found all over the world and typically spend the winter season for breeding and other seasons at higher latitudes for hunting prey. This type of whale is identified by their lengthy pectoral flippers with a dorsal black appearance. They are most notable for their song vocalizations as they produce a **low frequency** sound. Male humpback whales tend to make a series of moaning sounds often known as humpback whale songs. These "songs" are often performed for mating purposes.

Beluga Whale:



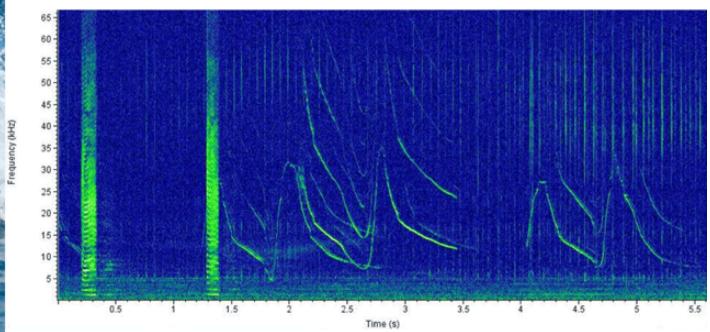
Beluga whales are found in the northern hemisphere's arctic or subarctic oceans. Their appearance is quite noticeable with their protruding forehead and white, stocky body. They are also known for the variety of vocalizations being named the "sea canaries" for the purpose of echolocation and mammalian communication, typically produce a **high frequency** sound. These vocalizations can be heard as **whistles, squeals, chirps and clicks**.

Killer Whale:



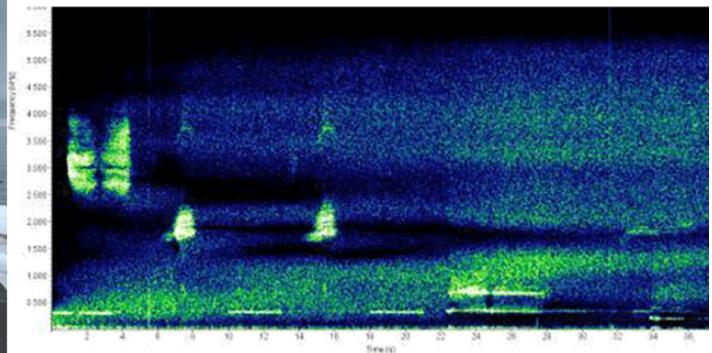
Killer whales are commonly located throughout the arctic and antarctic oceans. Their stunning appearance is always recognizable with their prominent dorsal fin and black and white color coordination. The "killer" name notifies their apex predator status and skilled hunting abilities. Killer whales utilize their vocalizations for echolocation and communication between their pods for hunting. They typically produce a **high frequency** sound such as a wailing sound that starts lower in pitch and gets higher at the end. These vocalizations can sound like "**screams or a harsh metallic sound**" that are accompanied by **clicking sounds**.

Bottlenose Dolphin:



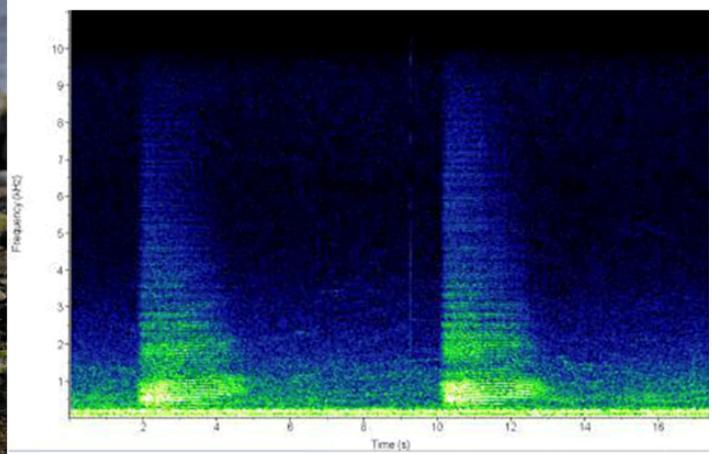
Bottlenose dolphins are commonly spotted offshore and coastal waters, especially near harbors, bays, gulfs, and tropical water estuaries. This type of dolphin's name originates from their snout being short and thick. Bottlenose dolphins may appear with a light to dark gray color, typically with darker color near their dorsal fin and lighter color near their bellies. They are known to be extremely intelligent marine mammals and are able to demonstrate it through their communication and behavior. Through vocal communication, the array of sounds they can produce can be heard as squeaks, grunts, grinds, and whines. These types of sounds can be identified in these categories either **whistles, echolocation clicks, or pulse sounds**. With utilizing passive listening and **high frequency** echolocation, a pod of bottlenose dolphins are capable of herding and hunting their prey in a more efficient manner.

Leopard Seal:



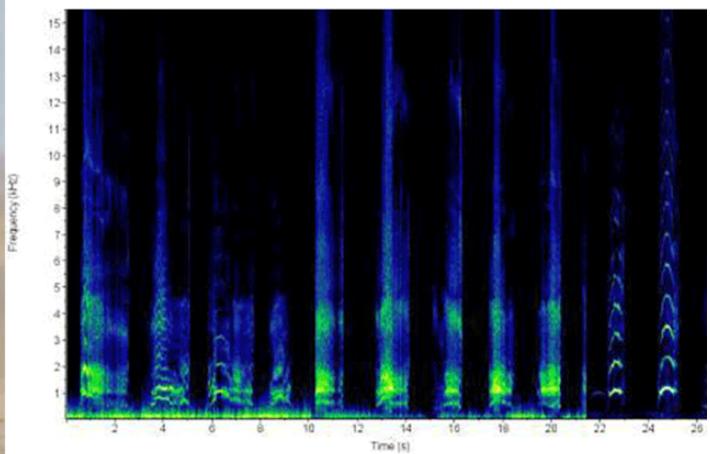
Leopard seals are commonly distributed through open waters of Antarctica. They appear with dark and light gray gradients with dark blotches sporadically found on their body. They are known for being Antarctica's apex predators, being equipped with a long muscular body and a large head and mouth, ideal for hunting their prey. They are most vocal during the months of austral summer, November to January, for mating purposes. These types of sounds can be identified as trills or hoots either being local calls that are short-distance or broadcast calls that are long-distance. Typically their vocalizations have **low-frequency** tonal calls and high frequency pulses. Leopard seals also produce sounds when they elicit aggressive behavior as they hunt their prey; these sounds may be identified as **growls, explosive blasts, or roars**.

Crabeater Seal:



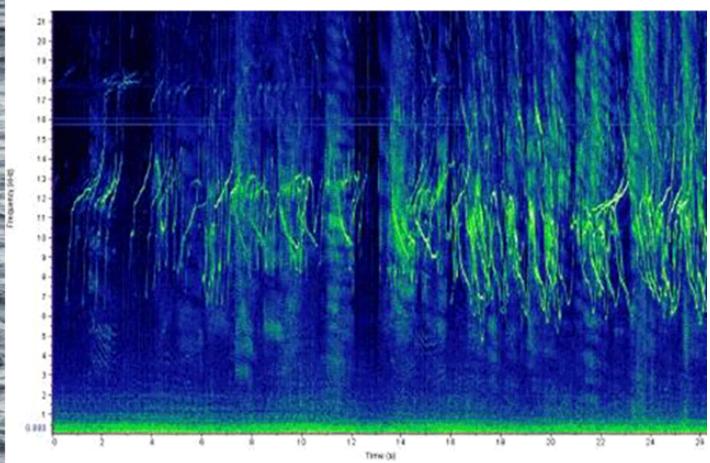
Crabeater seals are the most abundant seal species and are commonly found upon pack ices surrounding Antarctica. Their fur appearance can range from a variety of dark brown to silver gradients. Misleading as their name can be, crabeater seals primarily consume on krill. Male crabeater seals are found to be most vocal during breeding season, producing groan-like vocalizations as low or high moans. The **low moans last for about two seconds** with a constant frequency whereas the **high moans last for about two seconds with altering frequencies and short pulses**. These types of seals have also been noted to make sounds aside from breeding purposes such as **whistles, screeches, and grunts**. However the purpose of these sounds remained unidentified.

Harp Seal:



Harp seals get their name from the black patch on their backs that looks like a harp. They live in the Arctic Ocean and north Atlantic, thus they have adaptations to keep them warm in frigid waters. There are three main populations that are recognized by behavioral differences, among other things; each group can contain up to several thousand individuals. Their calls—at least 19 different types, according to one source, are used during courtship, mating, play, and agonistic tactics (in older animals). Their vocalizations sound as either **loud cries for hunger, mumbles for interacting with others, growls or warbles for hunting and eliciting aggressive behaviors.**

Striped Dolphin:



Striped dolphins are the most abundant and widespread dolphins throughout global waters. Their name originates from their appearance with bold, thin stripes starting from their eye that extend to the end of their flippers and anal region. These types of dolphins produce **high frequency** sounds that resemble **whistles and clicks**. They utilize their vocalizations for the purpose of echolocation and communication.

"Guess Who?" Marine Mammal Edition

In this "Guess Who?" game, you will be listening to 8 different marine mammal audios. Given the additional information above regarding the marine mammals and their expected sounds, the challenge at hand is to match the marine mammal to their vocalization.

When the game starts, a random marine mammal sound will play. Your job as the player is to correctly identify the marine mammal. If you guess wrong, the correct marine mammal will be given. Make sure to remember the vocalization to the correct mammal! The marine mammal sounds are randomized, so some sounds may be repeated. This is to test if you truly learned what the marine mammals sounds like.

This game is not case sensitive. Answers may be typed in any case, but remember to type the correct answer!

Type *****quit***** when you want to stop playing!

When you "quit" playing, a bar graph will be generated showing your results of how many times you guess each marine mammal correctly.

****Happy playing!****

Project Code

Please see the script we wrote

The game is not played on this notebook. Please use this notebook for instructions and hints. The guessing game is played through Python 3.

Work Cited

- [Sounds in the Ocean | NOAA Fisheries](https://www.fisheries.noaa.gov/national/science-data/sounds-ocean) (<https://www.fisheries.noaa.gov/national/science-data/sounds-ocean>)
- [Blue whale acoustic behavior off southern California](https://escholarship.org/uc/item/58b0n7q9) (<https://escholarship.org/uc/item/58b0n7q9>)
- [Performance metrics for marine mammal signal detection and classification](https://www.cetus.ucsd.edu/docs/publications/HildebrandJASA2022.pdf) (<https://www.cetus.ucsd.edu/docs/publications/HildebrandJASA2022.pdf>)
- [Marine Mammals Classification using Acoustic Binary Patterns](https://www.proquest.com/docview/2650295009?pq-origsite=primo&parentSessionId=SCLIZ7xbeHWn1axGBxYXGxFg%2Bp6ZzEQNa%2BFw8hFl9U0%3D) (<https://www.proquest.com/docview/2650295009?pq-origsite=primo&parentSessionId=SCLIZ7xbeHWn1axGBxYXGxFg%2Bp6ZzEQNa%2BFw8hFl9U0%3D>)
- [National Marine Protected Areas Center: Frequently Asked Questions](https://marineprotectedareas.noaa.gov/helpful_resources/faqs.html#MPAs) (https://marineprotectedareas.noaa.gov/helpful_resources/faqs.html#MPAs)
- [Translating Marine Animal Tracking Data into Conservation Policy and Management - ScienceDirect](https://www.sciencedirect.com/science/article/pii/S0169534719300242) (<https://www.sciencedirect.com/science/article/pii/S0169534719300242>)
- [Bottlenose Dolphin Introduction](https://www.marinemammalcenter.org/animal-care/learn-about-marine-mammals/cetaceans/common-bottlenose-dolphin#:~:text=In%20the%20water%2C%20common%20bottlenose,echolocation%20clicks%20and%20p) (<https://www.marinemammalcenter.org/animal-care/learn-about-marine-mammals/cetaceans/common-bottlenose-dolphin#:~:text=In%20the%20water%2C%20common%20bottlenose,echolocation%20clicks%20and%20p>)
- [Leopard Seal Introduction](https://dosits.org/galleries/audio-gallery/marine-mammals/pinnipeds/leopard-seal/#:~:text=Their%20vocalizations%20are%20often%20described,breeding%20season%20may%20be%3A) (<https://dosits.org/galleries/audio-gallery/marine-mammals/pinnipeds/leopard-seal/#:~:text=Their%20vocalizations%20are%20often%20described,breeding%20season%20may%20be%3A>)
- [Crabeater Seal Introduction](https://dosits.org/galleries/audio-gallery/marine-mammals/pinnipeds/crabeater-seal/#:~:text=Crabeater%20seals%20have%20been%20found,of%20these%20sounds%20remains%20unk) (<https://dosits.org/galleries/audio-gallery/marine-mammals/pinnipeds/crabeater-seal/#:~:text=Crabeater%20seals%20have%20been%20found,of%20these%20sounds%20remains%20unk>)
- [Harp Seal - an overview | ScienceDirect Topics](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/harp-seal) (<https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/harp-seal>)
- [Audio Gallery – Discovery of Sound in the Sea](https://dosits.org/galleries/audio-gallery/) (<https://dosits.org/galleries/audio-gallery/>)

Reflection



My knowledge of Python before this class was very minuscule, I only knew of Python as being a coding program for data analysis and felt it was an essential skill to learn before leaving college. I have learned a lot through this course by the interactive collaboration between myself and my classmates during discussion sections, in-class assignments, and the final project. Learning python was a challenge, however, it was a fulfilling experience to overcome and solve each homework problem. Throughout the final project, I challenged myself by writing a function I thought I would solely rely on my notes for, but I was able to write the segment of code without my notes.



I did not know anything about Python coming into this course. I have never coded before. All I really knew was that Python is a coding language that some of my friends use in their computer science classes. Python has proved to be a challenge, especially when you have no coding experience prior to this course. I struggled in this course and spent countless hours on each homework assignment in order to fully understand the content being taught. Through the final project, I learned that there are many ways to make a function that would produce the same outcome. This project challenged me to find alternative ways to code the same function to make it more concise and efficient. This project challenged me to draw from the content taught in class to create new functions that I am not familiar with, such as making Python play audio. I spent a lot of time on this project and things did not always go as planned. I had to become familiar with writing scripts and working with Terminal. This final project really taught me to be patient with myself as this is a learning process. Overall, I think that the final project has allowed me to see how much I grown since the beginning of this class. I now have basic coding skills and feel comfortable enough to code simple functions on my own.



Before this class, I knew little about Python. I'd only just learned an introduction to R in Winter quarter for my Statistical Methods in Marine Biology class. In middle school (and a little before that), I was introduced to javascript and java through Khan Academy and I had a short experience using Arduino. I learned how to animate on a platform whose name does not come to mind. In high school, I also had some Matlab experience, but not enough to say I'd be confident to use it or teach it myself. All this to say, this was a much needed refresher course and introduction to a new language I hope to learn more about. In this final project, I really challenged myself to learn from other coders on the internet about functions I still, while writing this reflection, haven't completely mastered (you won't see it, but I spent hours working with AudioSegment, .wav files, trying to graph frequency data from audio data, and manipulating audio files using Python—these efforts will be stored only on my laptop). I learned that audio is a lot more complicated than it sounds (pun intended). Besides that, I challenged myself to learn how to use Python Idle and Python Launcher, as well as working with scripts imported to the Terminal. I never guessed in a million years that I would learn so much about Python in just 7 days, but that's what happens when you come across problem after problem after problem—which is how we learn and comprises much of the coding challenge kick! I'm excited to continue learning how to use Python for biology and data analysis, and this project gave me a good jump start.