Visualizing Marine Soundscapes for Marine Resource Managers and the General Public: Data Visualization Website Developed Using Human-Centered Design Principles and Interdisciplinary Collaboration

Yueyi Che[1], Anmol Parande[2], Audrey Kuptz[2], Leena Elzeiny[2], Edgar Rojo[2], Sindhu Goli[2], Justin Hogenauer[2], Choyang Ponsar[2], Sara Kopunova[2], and Anne Simonis[3]

[1]University of California, Berkeley
[2]University of California Berkeley
[3]NOAA Southwest Fisheries Science Center

November 26, 2022

Abstract

Understanding marine soundscapes, including the biological, anthropogenic, and geological sounds, is essential to conserving protected species and their habitats. However, the marine resource managers often do not have a strong science background to interpret complicated soundscape data to facilitate them making decisions. The biological components of soundscapes can be useful to characterize biodiversity and monitor the distribution and behavior of individual species. Anthropogenic sound in the ocean is increasing and has been recognized as a threat to marine mammals for decades. To help the marine resource managers and the general public understand the impacts of ocean noise, we as nine undergraduate students from different majors of study at UC Berkeley's Fung Fellowship Program utilized Human-Centered Design and created an interactive marine soundscape map (https://calsound.herokuapp.com), focusing on the California Current Ecosystem. Based on 14 interviews we conducted with researchers, policymakers, and environmental lobbyists, we decided to portray spectral soundscape metrics alongside the context of animal and human activities in a map format. We then created a digital hub to easily visualize, analyze, and synthesize marine-sourced soundscape data. Our website displays soundscape data over a range of spatial and temporal scales, acoustic detections of marine mammals, species habitat models, and anthropogenic sound source distributions as heat map layers and graphs. The platform not only displays ocean soundscape data, but also provides an overview of marine soundscape technology, as well as related articles and websites. The website is designed so that users who are not familiar with marine soundscape data, such as coastal managers and the public, can guide themselves through a tutorial and explore on their own to gain a better understanding of oceanographic sound. In the future, we will add more features to the website, such as allowing users to upload their own data to the website to visualize them online. The website will be self-sustainable and continue to serve more people. Our website will facilitate people to visualize and understand marine soundscapes, their impacts and our solutions.

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Background

SOUNDSCAPE
combination of sounds that arises from an immersive environment

- **Biophony:** sounds created by organisms
- **Anthrophony:** sounds created by humans
- **Geophony:** nonbiological ambient sounds of wind, rain, thunder, etc

GOALS
- Establish Baseline Conditions
- Understand Impact on Animals & Their Behavior
- Quantify How Sounds are Changing Over Time

Drifting Buoy

- 3' mast and flag
- 12" orange surface float
- 10-m 3/8" polypropylene line
- 4" ABS-plastic spar buoy (w/ 2 Spot geolocators inside)
- 150 m ¼" nylon line
- 11" sub-surface trawl float 18lb buoyancy
- 15" dampener plate
- upper hydrophone
- Autonomous high-frequency recorder (ST4300)
- 8-m 3/8" nylon line
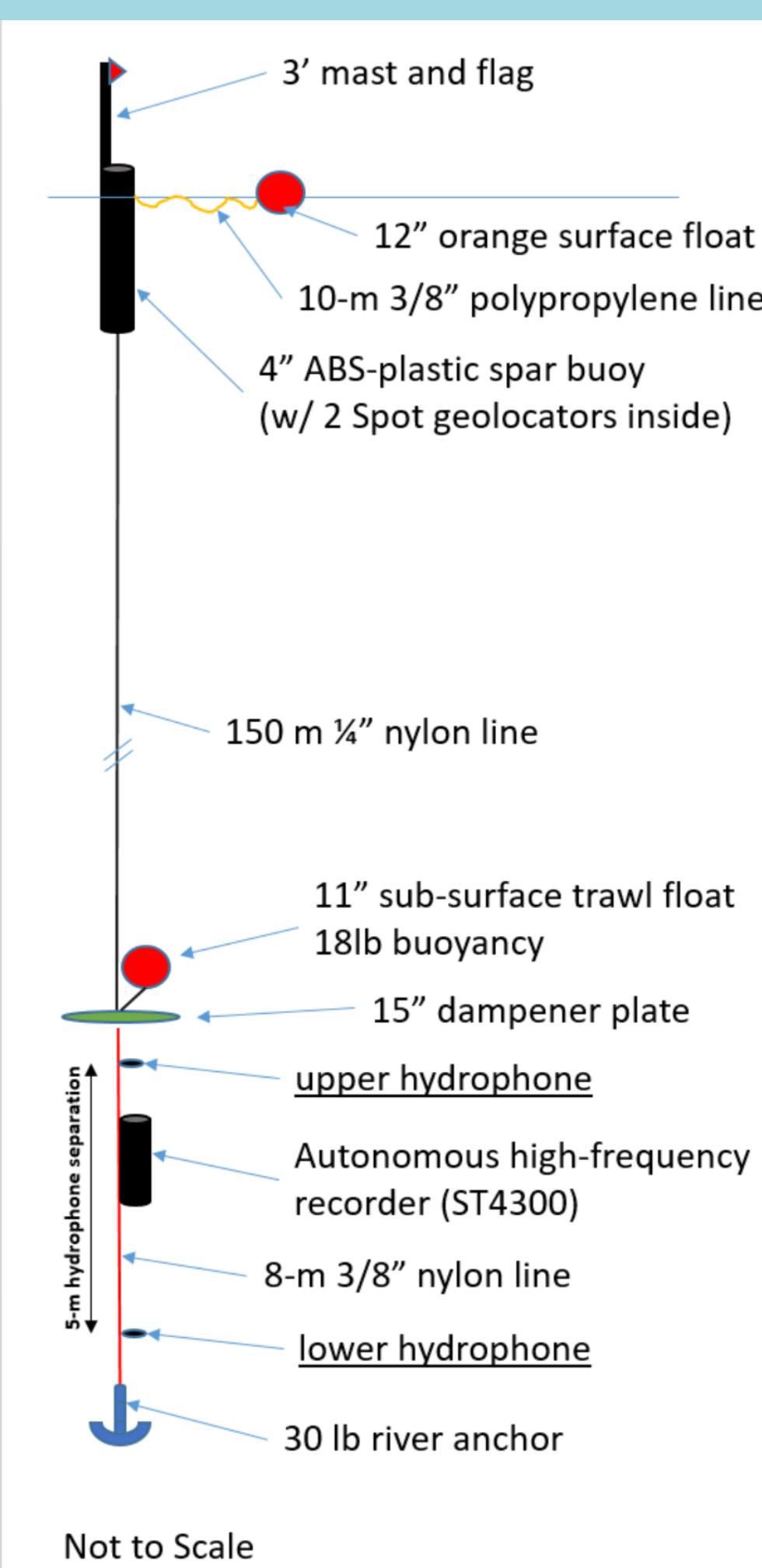- lower hydrophone
- 30 lb river anchor

Not to Scale

Figure Above: Pilot whale swimming near drifting buoy (with acoustic recorder attached underneath). Photo: NOAA Fisheries/Jay Barlow

Figure Left: Diagram of the Drifting Acoustic Spar Buoy Recorders (DASBRs) used in acoustic data collection. (Credit: NOAA Fisheries/Jay Barlow)
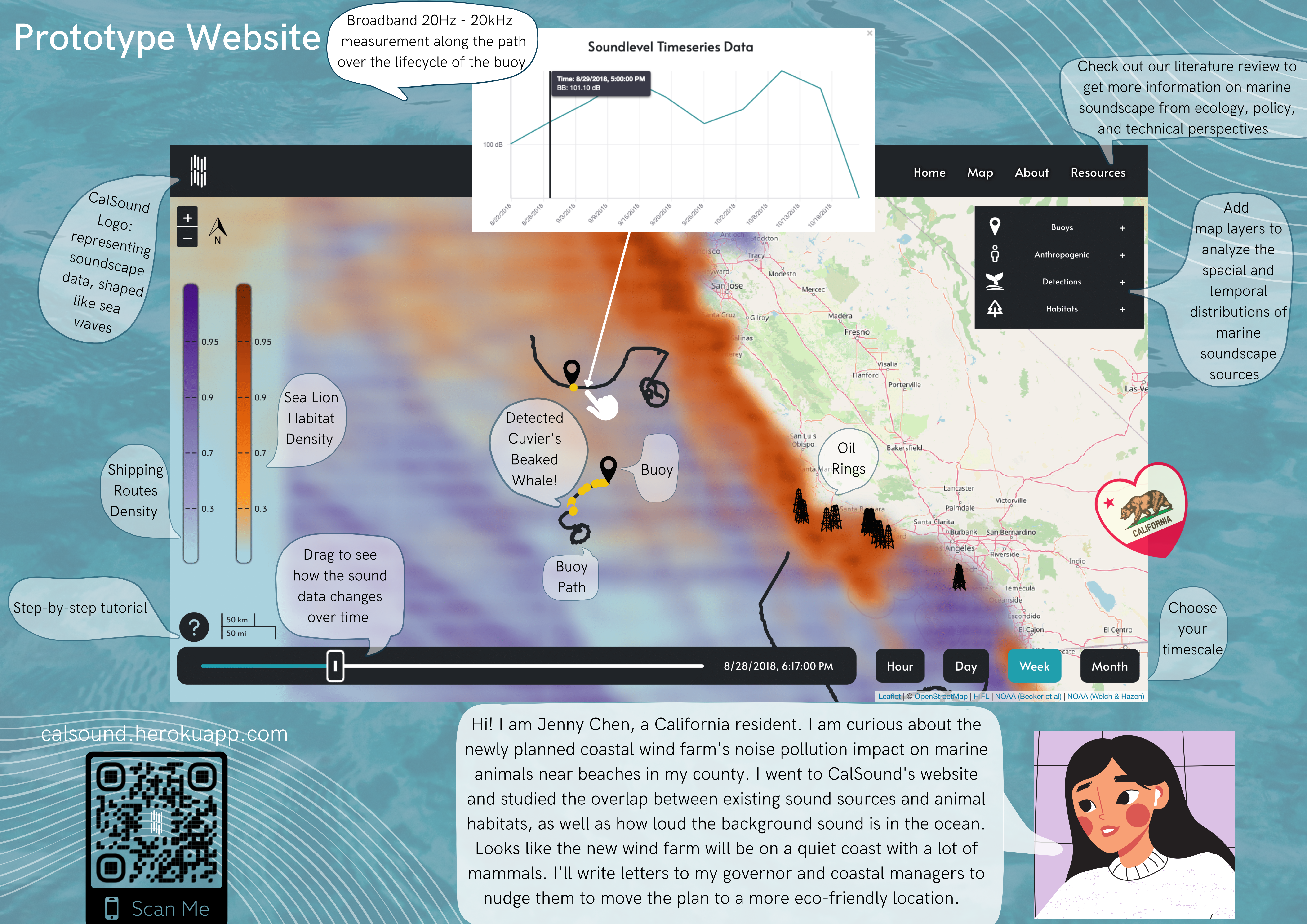
QUICK FACTS
- 12 drifting buoys
- Date range from July 24th to Dec 2nd, 2018
- Data collected as a part of the NOAA 2018 California Current Ecosystem Survey

How Might We...

...help marine resource managers, researchers, policymakers and the general public see the impacts of noise pollution in the ocean and provide a clear, holistic way of synthesizing information and visualizing ocean soundscapes?

Prototype Website

Broadband 20Hz - 20kHz measurement along the path over the lifecycle of the buoy

Soundlevel Timeseries Data
Time: 8/29/2018, 5:00:00 PM
BB: 101.10 dB
100 dB

CalSound Logo: representing soundscape data, shaped like sea waves

Shipping Routes Density

Sea Lion Habitat Density

Step-by-step tutorial

Drag to see how the sound data changes over time

Detected Cuvier's Beaked Whale!

Buoy

Buoy Path

Home | Map | About | Resources

Buoys | Anthropogenic | Detections | Habitats

Oil Rings

CALIFORNIA

Add map layers to analyze the spacial and temporal distributions of marine soundscape sources

Check out our literature review to get more information on marine soundscape from ecology, policy, and technical perspectives

Choose your timescale

8/28/2018, 6:17:00 PM | Hour | Day | Week | Month

Leaflet | © OpenStreetMap | HIFL | NOAA (Becker et al) | NOAA (Welch & Hazen)

50 km / 50 mi

calsound.herokuapp.com

Scan Me

Hi! I am Jenny Chen, a California resident. I am curious about the newly planned coastal wind farm's noise pollution impact on marine animals near beaches in my county. I went to CalSound's website and studied the overlap between existing sound sources and animal habitats, as well as how loud the background sound is in the ocean. Looks like the new wind farm will be on a quiet coast with a lot of mammals. I'll write letters to my governor and coastal managers to nudge them to move the plan to a more eco-friendly location.

Interview Takeaways

1. CENTRALIZE RESEARCH
- Policies are currently geared towards individual species, and we need a platform to showcase the sound impact on the ecosystem as a whole.
- Bridge the divide between ecology and acoustics physics.
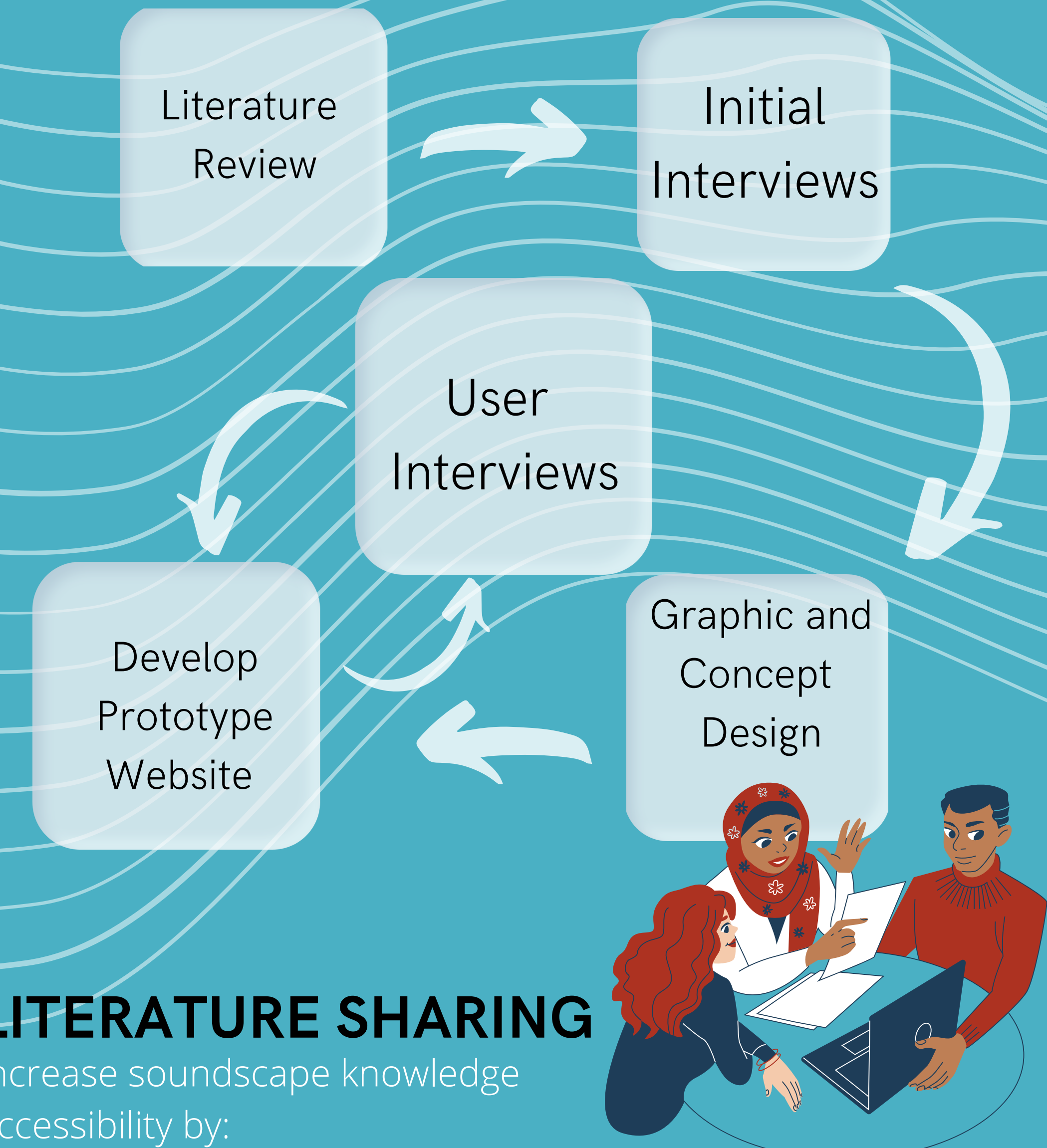
2. REPORT METRICS
- The impact of a sound is judged by its frequency, intensity, temporal frequency, and accumulation in a 24 hour period.
- The contrast of before and after a sound source is introduced is important.
- Soundscape data needs to reflect the current marine environment

3. SHOW LAYERS
- Provide the sound source components and their proportions to the sound data
- Show the intersection of animal and human activities.
- Within anthropogenic sounds, include sources from multiple industries.

Design Process

Literature Review → Initial Interviews → User Interviews → Graphic and Concept Design → Develop Prototype Website

LITERATURE SHARING
Increase soundscape knowledge accessibility by:
- Using non-technological terms
- Easy clicks to sections targeted towards different public interests
- Linking map data sources and featuring marine soundscape projects for further information

INTERVIEWEE PROFILE
12 researchers and marine resource managers from 7 different marine management and research organizations revealed what features they need to improve their fields.

Future Work

INCREASE PUBLIC ACCESSIBILITY
- Build a glossary for soundscape jargon.
- Develop virtual oceanography field trips on the website for K-12 students

RESEARCHER INTERFACE
- Allow researchers to upload and share data themselves so that they can adjust it for their functionality

INCORPORATE FEEDBACK
- Reach out back to interviewees for user feedback to better the website
- Incorporate feedback from conferences

Acknowledgement
We want to acknowledge the Fung Fellowship Program at UC Berkeley for funding this project and NOAA Southwest Fisheries Science Center for providing us the research opportunity. We also want to thank our interviewees Desray Reeb, Michael Jasny, Lindsey Peavey, Anabelle Kok, Megan McKenna, Penny Ruvelas, Brandon Southall, David Stoms, Erica Staaterman, Kate Huckelbridge for contributing knowledge and their feedback to our project. Many thanks to Association for Women Geoscientists (AWG) Takken Student Research Presentation Travel Award and American Geophysical Union (AGU) Student Travel Grant for supporting the travel for presenting at the AGU 2021 annual meeting.