# Whale Song Analysis - Design Project Summary

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Whale Song Analysis is a platform designed to help advance the studies of whale songs and communication by processing a collection of whale song recordings by isolating the whale song and using signal processing and machine learning to then analyze these songs. The system will extract various communication features such as shifts in frequency, intensity, and rhythms to reveal patterns and possible syntax in whale vocalizations. Currently, studies based on whale vocalizations require you to manually examine audio snippets and spectrograms, making for a long and labor intensive process. This platform aims to solve the limitations in this current method. By creating automated processes, Whale Song Analysis will increase the speed, accuracy, and accessibility of whale song research, therefore accelerating the rate in which we make new discoveries. This platform will also serve as an educational platform, allowing students, teachers, and the general public to explore whale songs and gain insight into whale behavior and conservation needs.

Stakeholders for this project include marine biologists, conservationists, data scientists, animal linguists, software developers, and educators, each contributing to the development and usage of the platform. The success of this project will be determined based on the accuracy of its sound classification and the amount of analysis time reduced compared to the existing manual methods. Because there is currently no platform on the market comparable to Whale Song Analysis, this platform will fill that space by offering a space for both research and conservation efforts. The necessary software will typically be run in indoor research environments and will utilize various existing databases, cloud storage, and standard audio formats. This platform will ultimately aim to increase public awareness, accelerate scientific discovery, and aid in whale conservation efforts.

The Whale Song Analysis will support a large variety of use cases that deal with uploading, processing, analyzing, and managing whale song audio recordings. Its main focus includes uploading audio recordings into a library, cleaning and processing these recordings, extracting acoustic features, uncovering vocalization patterns, and linking these patterns to various metadata such as species, behavior, or location. Within the platform, users can visualize their findings with charts and graphs, annotate data, filter recordings, generate reports, export, and import results. Collaboration between researchers will be supported and various administrative tools will also be provided to manage users, permissions, and conduct general system maintenance. A guided tutorial will also be provided for new users, ensuring that these new users can understand how to navigate through the site and make the most of their resources. Users can choose to opt out of this tutorial, close out the window to complete at a later date, or return back to it after completion for any needed guidance.

Performance expectations for this platform include fast processing, high accuracy, and support for large audio files. Additional requirements will ensure reliability and safety with role-based control, malware protection, multilingual support, WCAG accessibility, and cross-platform compatibility. Environmental and operational requirements will be tailored toward browser access, include cloud storage and database integration, have regular patches and long-term product support. Every requirement is validated through an acceptance testing framework that covers usability, performance, inclusivity, and legal compliance, ensuring that the platform remains functional, ethical, and suitable for both the scientific community and general public.

The Whale Song Analysis Platform will put user experience first, valuing a smooth experience, accurate performance, and capabilities for large datasets. The system will adopt an MVC architecture to separate data processing, visualization, and user interaction, while other subsystems such as ingestions services, processing pipelines, and audit logging tools ensure modularity, maintainability, and secure operation. Design patterns such as Builder and Singleton will support the construction of these audio processing and analyzation workflows. The system will also include various considerations for hardware and software mapping, consistent data management, access control, real-time synchronization, and protocols for crash recovery.

Outside of the platform's capabilities, we recognize that there might be potential constraints and risks. The user might come across the issue of not having access to high-quality whale recordings, possible variation in data quality, machine learning bias, and general computational demands for data processing and storage. To help lower these risks, the platform will reuse components, use ready-made software tools to process audio, and existing machine learning frameworks to increase speed and help mitigate development efforts. The platform also anticipates a learning curve and possible environmental limitations, therefore emphasizing the need for an ongoing system fine-tuning to ensure a smooth experience for all. Costs for this platform are at an estimated amount of $500,000 over 9-12 months, with additional requirements for resources and partnerships. More long-term considerations for this project include real-time microphone streaming integration, 3D acoustic visualization, and mobile app extensions.

Overall, the Whale Song Analysis represents the future of marine research and whale conservation efforts. The platform is one step forward toward a wealth of scientific discoveries. Through a combination of machine learning, the audio processing of large databases and various visualization tools to choose from, this platform provides scientists, educators, and conservationists with a platform to study and further the research of whale communication. The platform's detailed requirements and focus on accessibility will allow the platform to remain reliable as the world evolves and new technologies begin to surface.