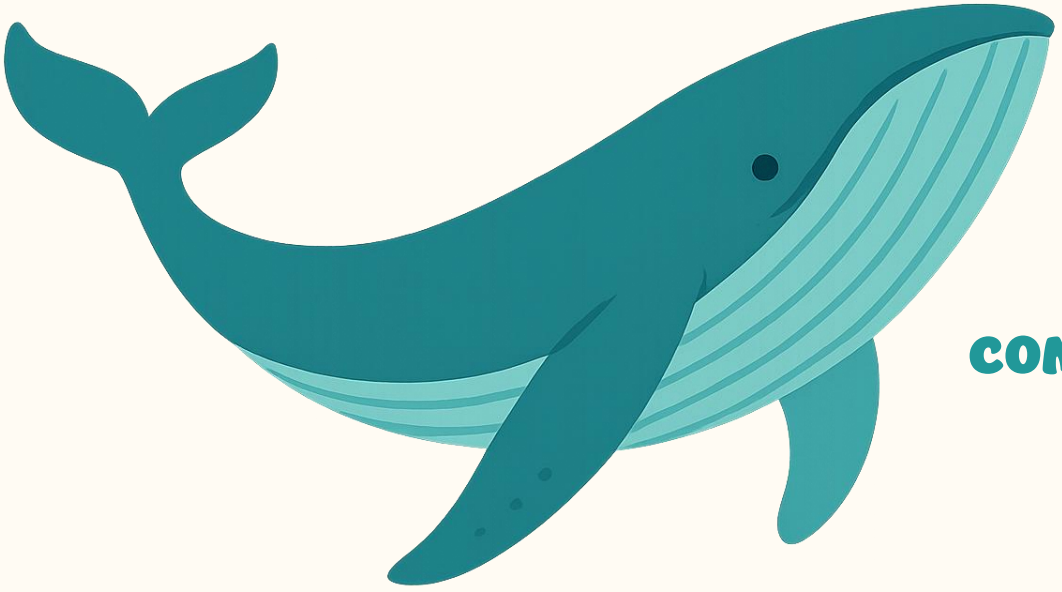
CETACEA

Vanishing Giants – Mapping the Past, Present, and Future of Cetacea

Where Were Whales

Camille Challier
Cyrill Strassburg
Eglantine Vialaneix



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Introduction

Motivation:

The idea for this project emerged from our shared interest in marine life and concern for ocean health. We were especially drawn to cetaceans, whales, dolphins, and porpoises, not only for their beauty and intelligence, but for what they reveal about our planet's wellbeing. While data on these animals exists, it's often fragmented and hard to understand. To change that, we created *Where Were Whales*, a platform that makes cetacean information accessible, engaging, and visually appealing, aiming to raise awareness about their evolution, current conservation status, and the threats they face today.

Goal:

Our primary goal is to foster awareness and appreciation for cetaceans through interactive, data-driven storytelling. By visualizing key aspects such as global species distribution, extinction status, evolutionary relationships, sighting patterns, and cumulative threats, we aim to make complex information from different sources approachable, while retaining its holistic nature. The project is designed for a wide audience, from marine biology enthusiasts to educators, conservationists, and curious minds, inviting users to explore and understand the delicate balance these marine mammals rely on. Through this engaging platform, we hope to spark interest, encourage informed dialogue, and ultimately contribute to stronger conservation efforts for cetaceans worldwide.

II. Design and Development Process

After setting our goals, we focused on brainstorming effective ways to visualize and communicate the data, with the aim of raising awareness about cetacean protection. In this section, we retrace the steps taken to reach the final result, reusing sketches and plans from earlier milestones while explaining how they evolved throughout the development process.

A) Website layout

Our color palette, green to dark blue, was chosen to reflect the colors of the ocean, reinforcing our theme of marine life and cetacean protection. The green evokes shallow, vibrant waters and a sense of vitality, while the dark blue conveys depth, calm, and reliability. Paired with neutral backgrounds and black text for readability, this palette ensures a clean, engaging, and consistent visual experience throughout the site.

To support the visual narrative, we incorporated ocean-themed illustrations and icons sourced from Freepik, creating a cohesive design. Additionally, both the introduction and conclusion feature black and white images to highlight the urgency and danger faced by marine life. These monochrome visuals provide stark contrast, evoking a more serious, reflective tone that underscores the environmental threats at the heart of the project.

B) Storytelling

The website is structured to offer a clear, intuitive, and user-friendly experience, allowing visitors to navigate seamlessly through different sections. A top navigation bar provides direct access to the main parts of the site, while the overall layout follows a logical narrative that guides users step by step.

The journey begins with an introductory section that sets the stage: although more than a century has passed since the peak of commercial whaling, many cetacean species are still struggling to recover. This section highlights the urgency of their situation while offering a playful and engaging entry point into the topic.

After the introduction, users are invited to explore three interactive visualizations: sightings data, the cetacean phylogenetic tree, and individual species profiles. The main content then unfolds into a section that highlights the major threats cetaceans face today.

Finally, a concluding section wraps up the journey, summarizing the key insights and reinforcing the importance of cetacean conservation.

C) Visualizations: Sightings Map

Cetacean sightings data were sourced from OBIS Seamap, with original records provided by HappyWhale. We developed a dynamic map-based visualization that allows users to explore **cetacean sightings** in **marine protected areas**.

Key interactive features include:

- Species selection (e.g., filter by specific cetaceans)
- Conservation status filters (e.g., endangered species)
- Seasonal filters to analyze migration patterns
- Time range selectors to track changes over time
- 2D/3D toggle switch for flexible spatial perspectives

Since Milestone 2, we have made several design improvements. Protected areas are now represented with hatching instead of solid colors to reduce visual clutter and create clearer contrast with the colors used for species sightings. Additionally, we introduced a new functionality: users can now double-click on a species to isolate it on the map, allowing for more focused analysis. Instead of simply highlighting endangered species, we expanded the conservation status filter to allow users to select species based on IUCN Red List categories, specifically Endangered (EN&CR), and Vulnerable (VU).

The main goal is to reveal critical overlaps (or gaps) between high-sighting regions and protected zones, while offering preliminary insights into species migration patterns.

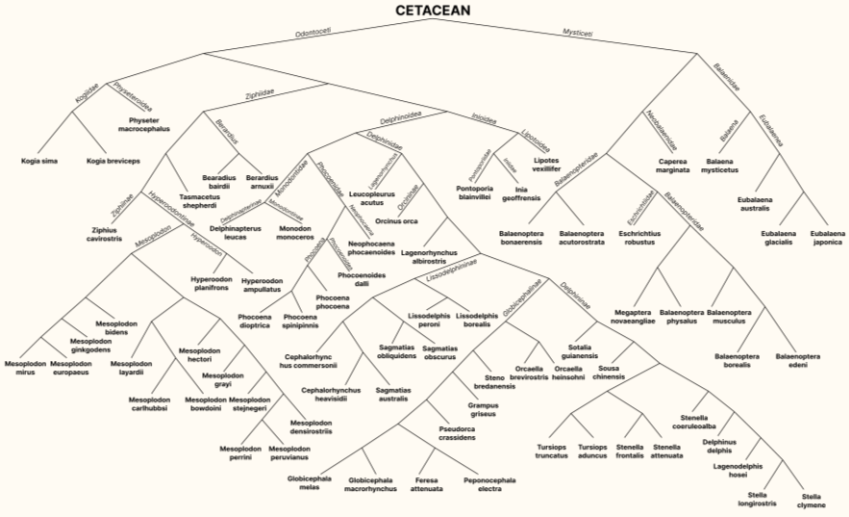
What can we observe by playing with the map?

- From May to November, sightings are more frequent in the northern regions; from November to May, they shift toward the south.
- Sightings have increased over the years.
- Some endangered species have very few recorded sightings, highlighting their rarity or detection challenges.

Tree of life of Cetaceans

To create an interactive exploration of the evolution of cetaceans, we were inspired by OneZoom, which had the great idea of revisiting the typical tree-like structure of phylogenetic trees. Since phylogenetics is a constantly evolving field, to construct our tree, we took the most recent genomics analysis of cetaceans from a May 2020 Systematic Biology paper, which would also allow us to see the new family classifications this paper proposes compared to the current one, taken from Wikipedia.

Our goal was to turn static data into an interactive, zoomable tree where users can explore evolutionary relationships, view taxonomic ranks, and click species names to access detailed profiles. To make our traditional tree-like representation more appealing, we opted for a force-directed graph (adapted from D3.js), whose root would be the center of an ellipse shape. This layout better reflected the actual distance between the several species and looked more fun according to the users we tested our product on.



Key challenges for this visualization included:

- Manually translating complex phylogenetic data from the paper into a digital format (hierarchical JSON).
- Adapting D3.js force-directed graph to our desired user interactions.
- Adding proper images to the leaf nodes: a lot of images from Wikipedia depicted violence and hunting of cetaceans, which we had to manually take care of. We did not remove these scenes, which are part of the reality cetaceans face, but prevented them from appearing before the user may be advised about this risk.
- Precomputing the initial positioning of the leaf nodes for the dynamic beginning of the visualization: prevent links from crossing each other as much as possible.

This visualization helps users understand the evolutionary relationships among cetacean species, offering an intuitive way to explore their diversity, taxonomy, and shared history.

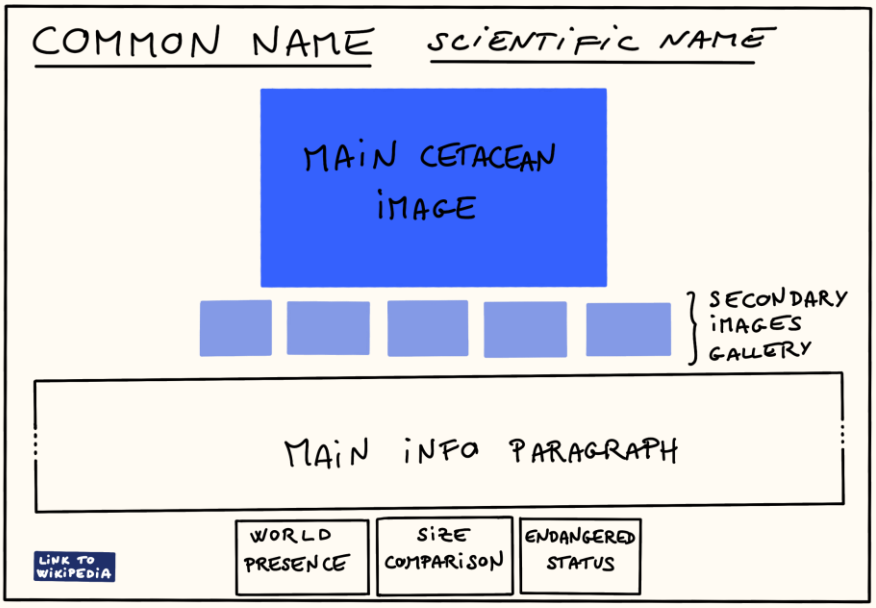
Species Profile Pages

The tree of life and sightings map provide interesting information about different cetacean species, but general information about cetaceans is not available. This motivated the creation of a profile page for each cetacean, providing a brief overview of the species, inspired from traditional Wikipedia articles.

We started by gathering basic information on all known cetacean species from the Wikipedia list of cetaceans , which includes names, taxonomic data, and conservation status. We then used the Wikipedia API to access the Wikipedia articles of each cetacean, adding habitat, size visuals, images, and the summary paragraph to the pool of information. Based on these elements, an interactive profile page that displays information dynamically depending on a selected species was developed. The biggest improvements compared to milestone 2 is the implementation of robust search input handling and page loading, as well as visual adjustments.

There are multiple ways to access the profile page of a species:

- When browsing the map or tree of life, the user is redirected to the profile page displaying the species the user clicked on the previous page.
- When directly accessing the profiles from the main page, the user is redirected to a page with a search bar and a gallery.
- The search bar can be used to directly search for a cetacean species and the gallery provides suggestions if the user enters an ambiguous species name.



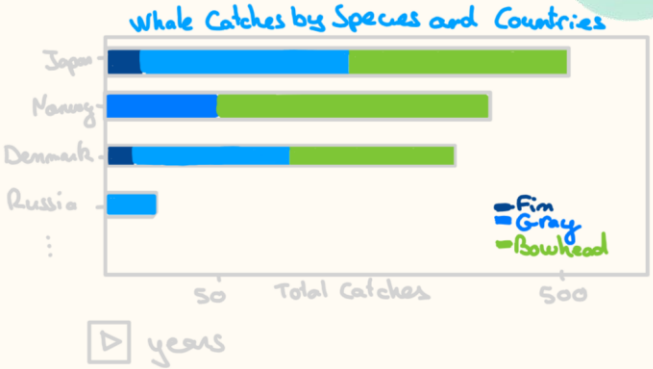
Profile pages help users to dive deeper into individual cetacean species, enriching their understanding through accessible, up-to-date information in a centralized and interactive format.

Multiple Threats to Cetaceans

To fully understand the urgency of cetacean conservation, it is essential to explore the multiple threats these marine species currently face. This section presents three visualizations that shed light on the human-driven and environmental pressures impacting cetacean populations worldwide.

Whaling Activities – Dynamic Stacked Bar Chart

The visualization is a dynamic stacked bar chart, designed as a race bar chart, which visualizes the top countries involved in whaling over time. Each bar is segmented by whale species, allowing users to see both the scale and species-specific impact of whaling activities across decades, as reported by the International Whaling Commission.



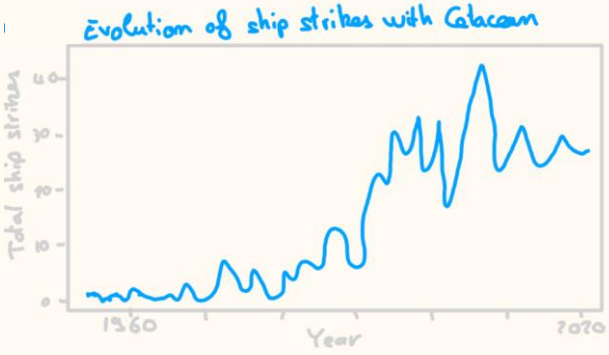
This animation provides an engaging way to observe:

- Shifting patterns in global whaling practices.
- The rise and fall of whaling activities by nation.
- Changes in targeted species over time.

The motion-driven format effectively emphasizes temporal trends, making the historical evolution of whaling efforts more intuitive and impactful.

Maritime Traffic – Ship Strike Line Chart

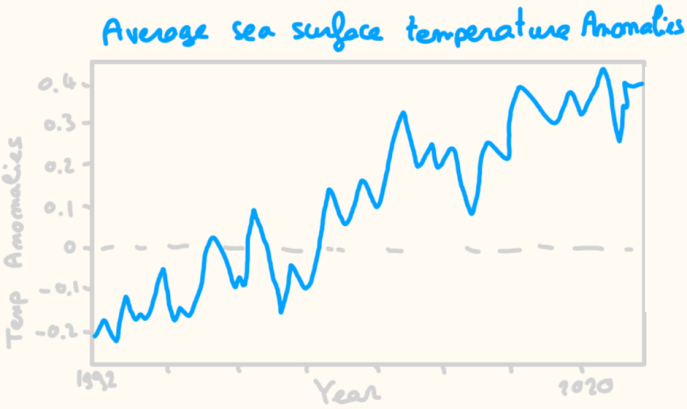
The second visualization focuses on the impact of maritime traffic, specifically tracking the number of reported ship strikes involving cetaceans per year. The data come from the IWC Ship Strike Database. This line chart highlights a lesser-known but serious threat: collisions with vessels, which often lead to injury or death for large marine mammals.



This visualization shows how increasing global maritime traffic might be affecting whales. It aims to raise awareness about the consequences of expanding global trade and shipping routes on marine life.

Climate Change – Sea Temperature Line Plot

The final chart presents the average sea surface temperature over the years in a line plot, offering a perspective on climate change as a growing threat to marine ecosystems. Climate disruption data is sourced from Copernicus, which offers global monthly average sea surface temperature anomalies from 1993 to 2021. When interpreted alongside our cetacean sightings map, this chart enables exploration of a critical question: *Are changes in ocean temperature influencing cetacean migration routes?*



By encouraging this cross-analysis, users can begin to draw connections between environmental trends and behavioral shifts in marine species, reinforcing the complex and interlinked nature of the threats faced by cetaceans today.

III. Challenges

- Many sighting datasets lacked precise coordinates, often listing only the country of observation. To create an accurate and informative map, we manually cleaned and merged multiple datasets, one for each species, to address the missing location details.
- Another challenge was implementing the complex 3D map. Building the 3D map with D3.js was challenging due to its low-level nature. For example, filtering out sightings on the opposite side of the globe and dynamically updating the display while the globe moves had to be custom-coded. In hindsight, using a higher-level library like Three.js or Kepler.gl would have saved considerable time and effort.
- One challenge we faced was handling sensitive images for the species profiles. Images were extracted from Wikipedia, but the first image shown was sometimes distressing (e.g., stranded or injured whales). To address this, we manually selected and reordered images to ensure the first one displayed was appropriate and aligned with the project's tone.
- Data wrangling: An essential part of creating connections from the sightings map and tree of life to profile pages of selected species was ensuring consistency of information for each species across the different data sources and implementing workarounds for special cases.

IV. Conclusion and Future Improvements

Throughout this project, our team was able to gather and combine diverse information about cetaceans and combine them, creating a complete and interactive website, showcasing cetacean life. We learned that gathering information from different sources and making it easily accessible is challenging, but the potential benefits are highly valuable.

Potential Improvements:

- Implementation of dynamic data retrieval pipelines: This would involve developing a reliable system to automatically update information about the threats cetaceans face by extracting data from various websites, enabling continuous updates of recent cetacean sightings, and ensuring the website always reflects the latest data. Building these pipelines would require robust workflows for data extraction, cleaning, and validation to maintain consistency and accuracy in the visualizations.
- Additional data sources for profiles: Including other sources (in addition to Wikipedia) to retrieve information about cetaceans for the profile page could enrich the range of insights gained and ensure information for species with a limited Wikipedia article.
- Common Ancestors: Including information about common ancestors in the tree of life could enhance the understanding of threats endangering cetaceans that are closely related.

V. Peer Assessment

Eglantine Vialaneix

- Tree of life
- Wikipedia scrapping of all cetacean URLs (pages and images)
- Screencast

Camille Challier

- Main page of the website (style and structure)
- Map of sightings
- Multiple Threat Visualizations
- Process Book

Cyrill Strassburg

- Cetacean profiles
- Dynamic retrieval of info with Wikipedia API into profile cards
- Automation