

# WhaleMap: a tool to collate and display whale survey results in near real-time

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## Software

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## Statement of Need

Baleen whales of the Northwest Atlantic live in a highly urbanized ocean. Their recovery from commercial whaling is impeded by anthropogenic risks from ocean industry, pollution, and climate change. Effective research, conservation and risk-reduction action requires near real-time knowledge of whale distribution measured using various methods including visual surveys from vessels or planes or acoustic surveys from autonomous platforms. The rapid collation and dissemination of whale detections and survey effort is critical but challenging given the number and variety of survey organizations and methodologies at work along the east coast of the US and Canada. There are long term databases for whale survey data, such as that maintained by the North Atlantic Right Whale Consortium ([narwc.org](#)), and crowd-source reporting tools (e.g., [Whale Alert](#)) but WhaleMap is the only dedicated system specifically designed to collate and display all available near real-time whale detections and survey effort. Use cases vary widely. For example, WhaleMap is currently used by: government managers to design and implement risk-mitigation strategies, members of military or industry to plan safe operations, researchers to coordinate survey efforts and explore patterns in whale distribution, and members of the general public to learn about and follow along with whale conservation activities.

WhaleMap was designed with several specific goals:

- Incorporate whale detection and survey effort from all survey methods in near real-time
- Allow survey teams to easily contribute and retain complete control over their data
- Provide the latest data in an accurate, user-friendly, and publicly accessible format
- Operate transparently using open-source tools and with limited supervision

Critically, WhaleMap does **not**:

- Perform any quality-control, or take responsibility for the veracity of information contributed
- Provide a long-term database for survey results
- Allow access to raw or processed data without approval from the data originator

## System

The WhaleMap system workflow can be separated into data processing and visualization components (Figure 1). The following provides a brief overview of each. Additional details as well as specific references to all software used is available in the source code documentation.

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## Data processing

Survey teams provide WhaleMap access to a remote repository of their choice (e.g., Google Drive, Dropbox) where they upload their survey data. The WhaleMap curator writes a custom script to extract the detection and effort data from each survey team and convert it to a common WhaleMap format. This method eases the burden on the survey teams by allowing any team to submit data in nearly any format, provided the format is consistent and well-documented. This is essential for rapid data collection, as survey teams in the field typically lack the time and resources to reformat their data.

A scheduled job regularly clones the data from the remote repositories onto the WhaleMap server and uses a makefile to dynamically and efficiently process the data from each platform and coerce it into a common format. Formatting errors in a remote data repository are automatically flagged and the contributor is notified. This ensures that any changes to the raw survey data quickly propagate through the entire system, which allows survey teams to retain complete control of their data and perform quality control as needed. It also guarantees that the WhaleMap always contains the latest available information.

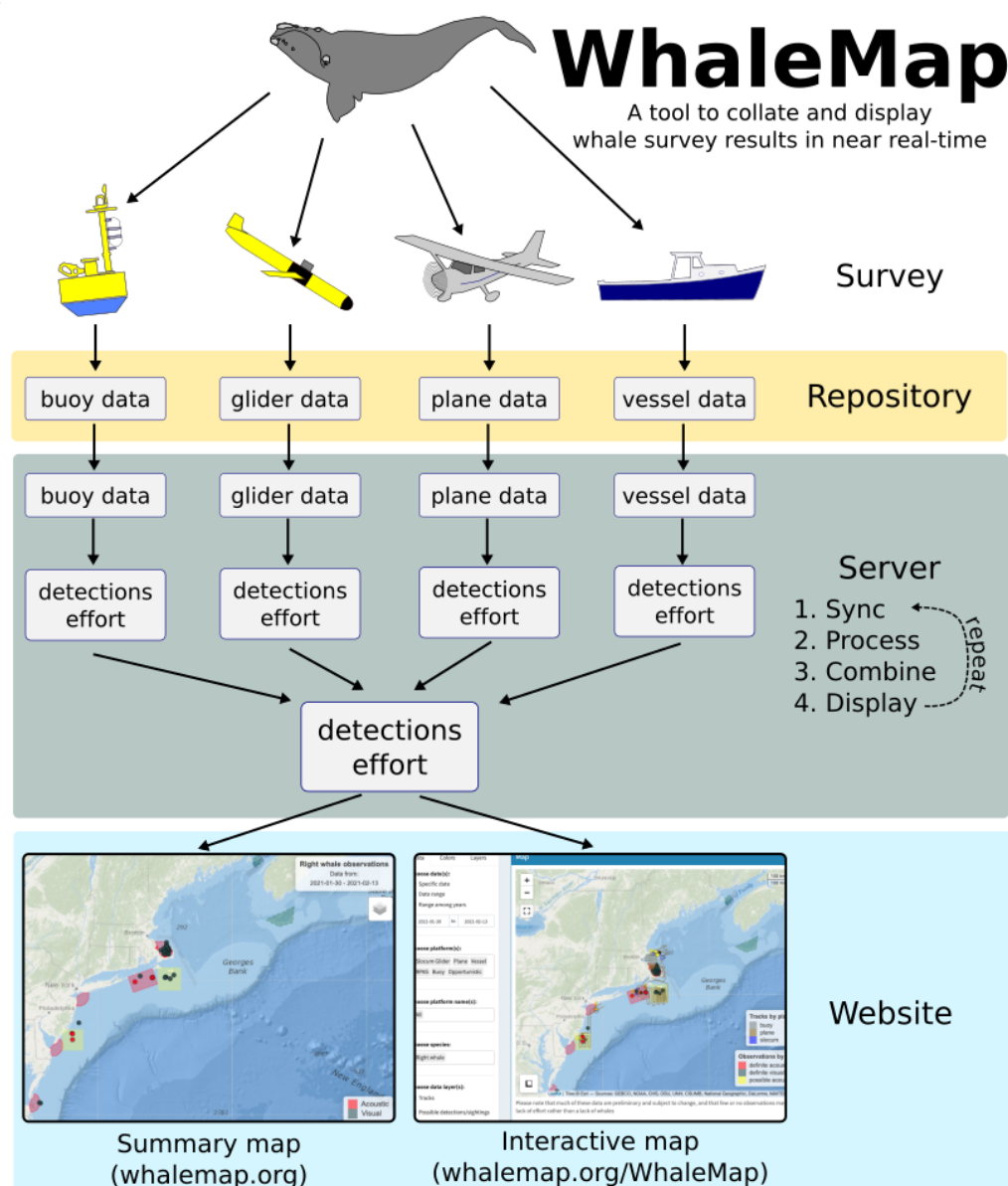
## Visualization

Once the survey data are processed, they are visualized using two different methods. The first is the construction of self-contained HTML summary maps containing sufficient information to satisfy most casual viewers (typically the last 14-days of survey results). These can be conveniently embedded in various webpages (e.g., [whalemap.org](https://whalemap.org)) and browsed without requiring server-side processing. These maps are dynamically regenerated as the final step in the data processing workflow, so they always contain the latest available information. The second visualization method is an interactive online application ([whalemap.org/WhaleMap](https://whalemap.org/WhaleMap)). This provides users with numerous tools with which to filter the latest processed data. The selected data are displayed in several formats including an interactive map, interactive timeseries plot, and table of summary statistics.

## Conclusions

Since its launch in 2018, WhaleMap has been constantly refined and optimized to better serve the overall goal of providing a common source for all near real-time whale survey data in the Northwest Atlantic. It has demonstrably improved conservation outcomes for endangered whales in this region by optimizing research activities, facilitating dynamic risk-mitigation measures, and engaging with the ocean industry and the public. WhaleMap has also already been cited in several scientific publications ([Baumgartner et al., 2020](#); [Gervaise et al., 2021](#); [Johnson et al., 2020](#); [Koubrak et al., 2021](#); [Kowarski et al., 2020](#)). We are not aware of any equivalent software in existence. It is our hope that WhaleMap continues to serve the conservation community in perpetuity, and that this system can be readily adapted to benefit other regions facing similar conservation challenges.

## Figures



**Figure 1:** Conceptual overview of WhaleMap data processing and display

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These are referenced in detail in the system documentation. Finally, we give our most sincere thanks to the many survey teams and numerous agencies that continue to place their trust in this system and praise their tireless efforts to protect these vulnerable species. Supporting funds generously provided by Fisheries and Oceans Canada and the Natural Sciences and Engineering Research Council of Canada.

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