

WhaleMap

A tool to collate and display whale survey results in
near real-time

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North Atlantic right whales

- *Eubalaena glacialis*
- Up to 55ft (17 m) long
- Up to 70 US tons (~60 mt)
- East coast US / Canada
 - Southern calving (winter)
 - Northern feeding grounds

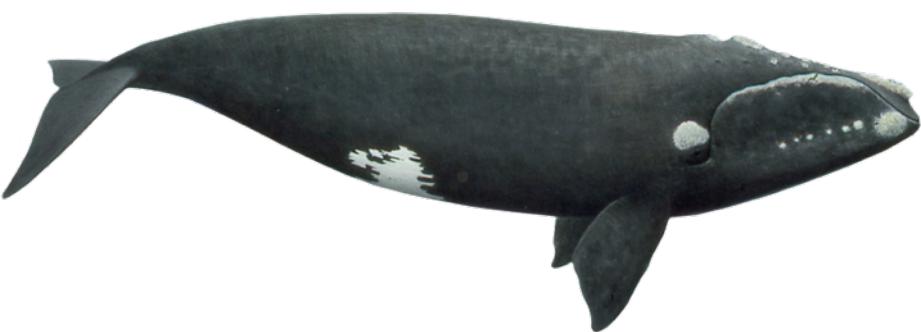
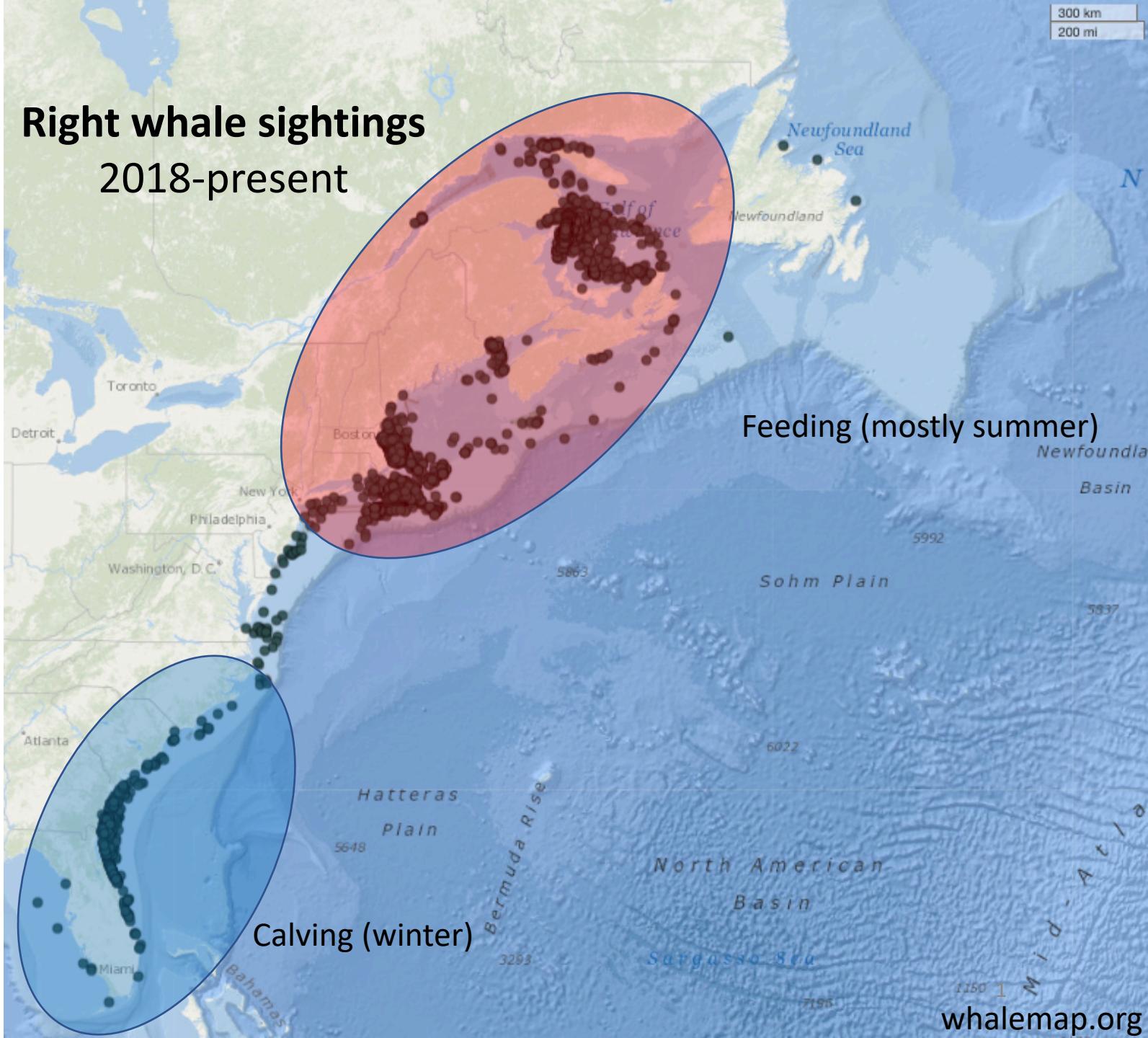
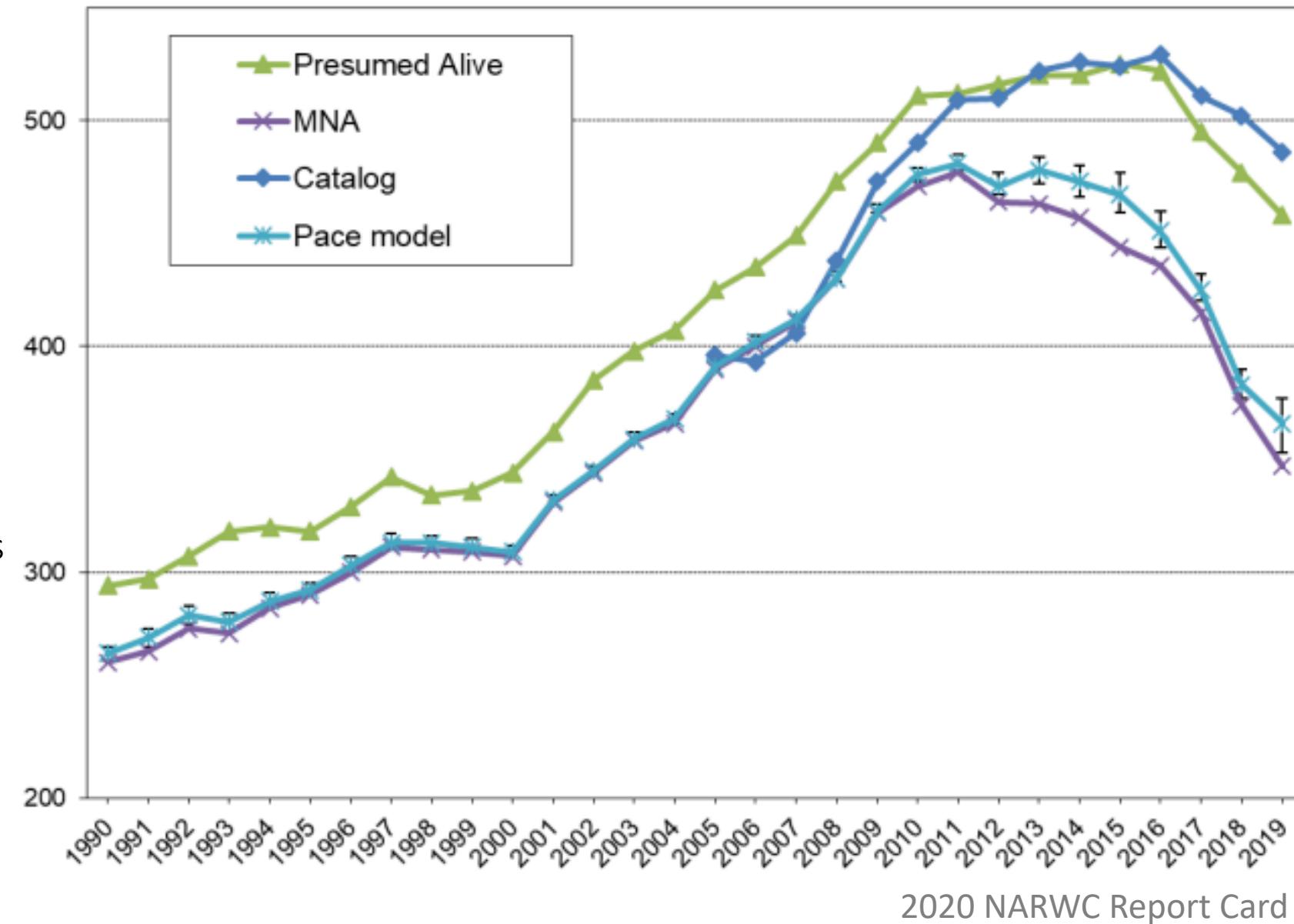


Image credit: whaleopedia.org



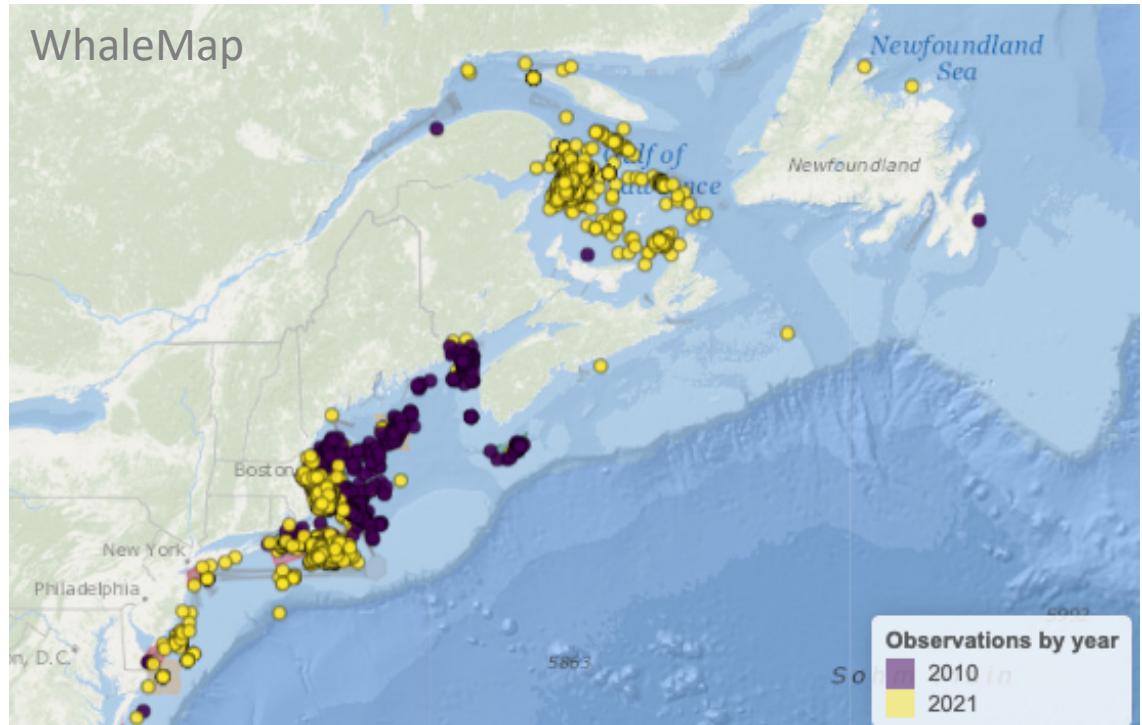
North Atlantic right whales

- The ‘right’ whale to hunt
- Endangered (IUCN)
 - Latest population estimate: **336** (NARWC 2021)
 - Under 100 breeding females



Barriers to recovery

- Climate-induced shifts in prey
- Human-caused stress and mortality
 - Entanglement
 - Vessel strikes
 - Unusual Mortality Event: 34 dead since 2017



Entanglement



Nick Hawkins

Vessel strike

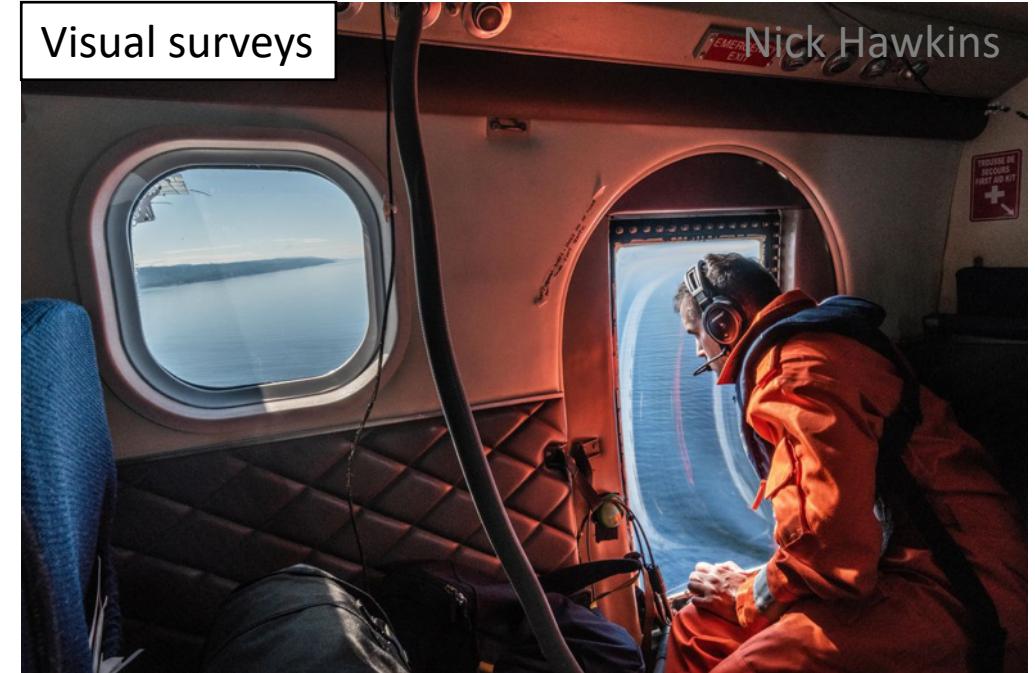


NOAA

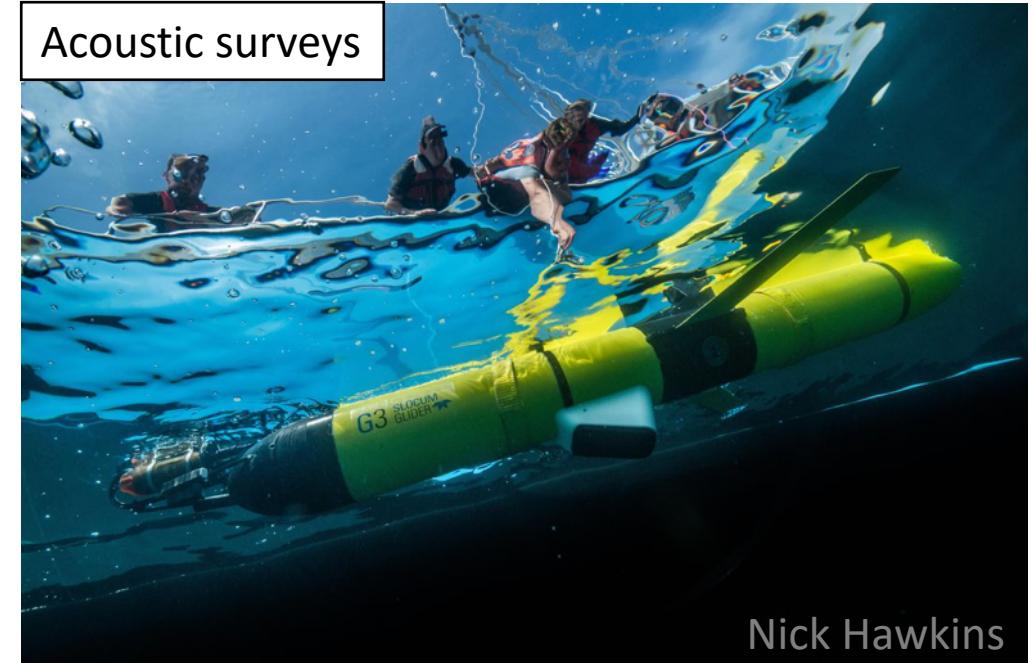
Risk mitigation

- Entanglement: ropeless gear, closures
- Vessel strike: speed restrictions, closures
- Static or **dynamic**
- Rely heavily on near knowledge of whale distribution
 - Visual surveys
 - Acoustic surveys

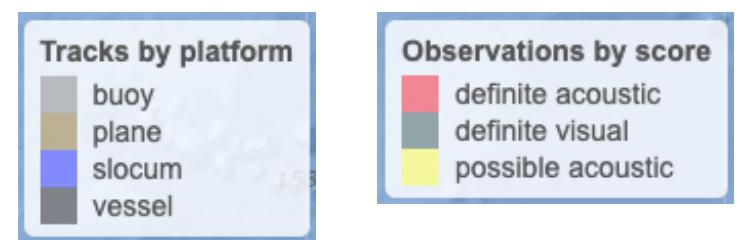
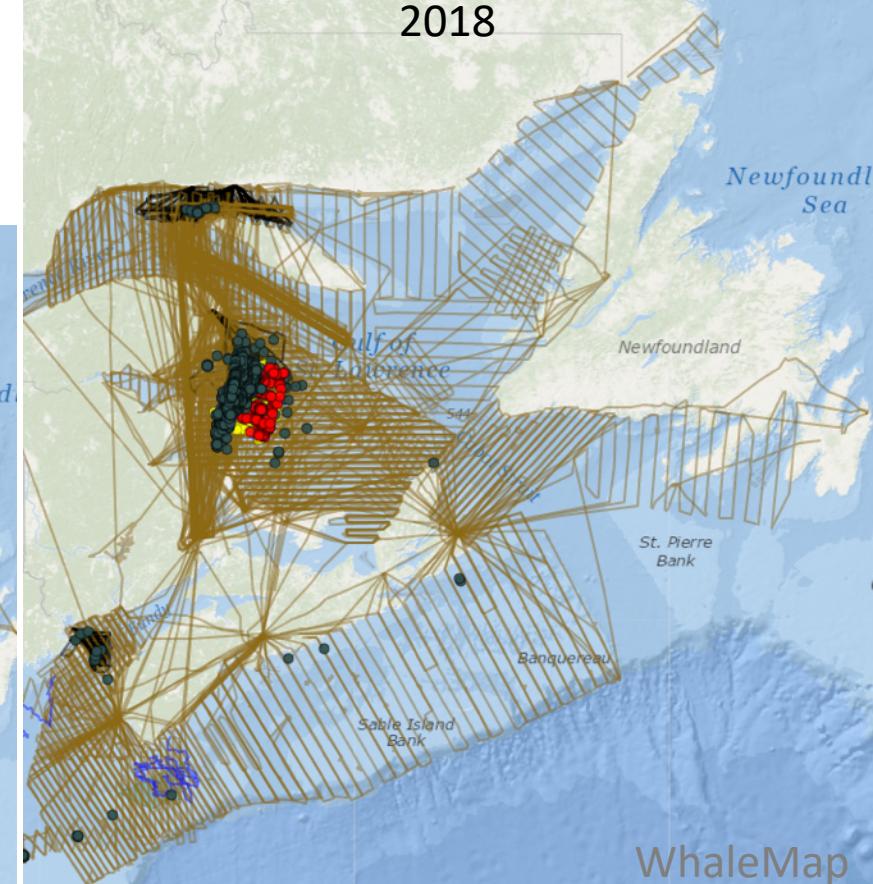
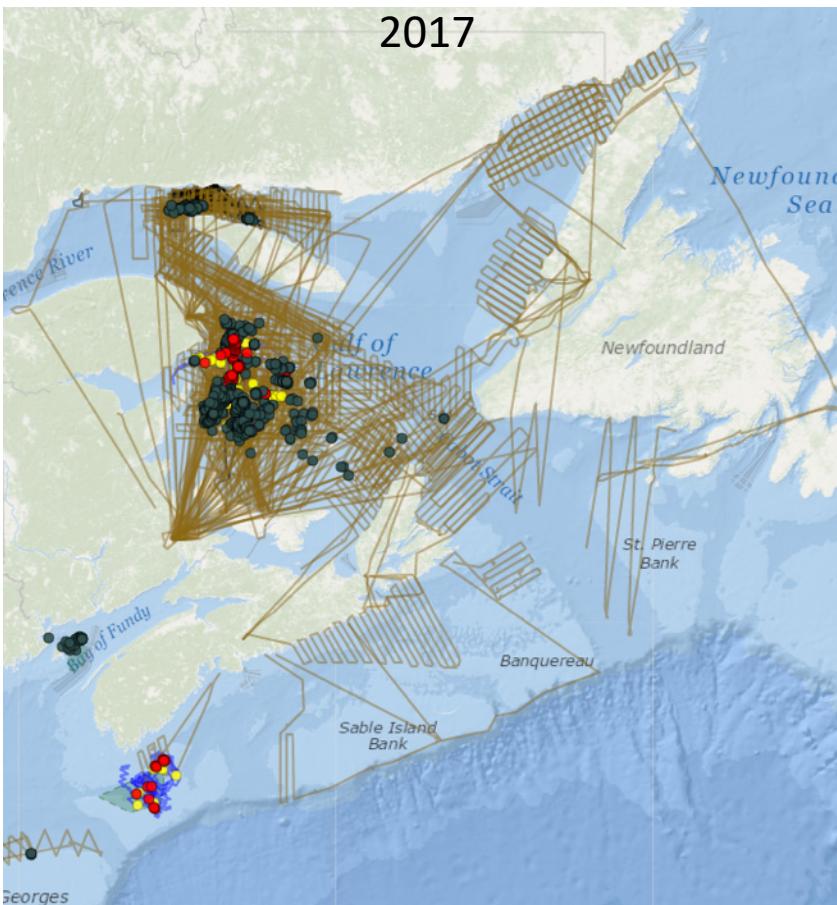
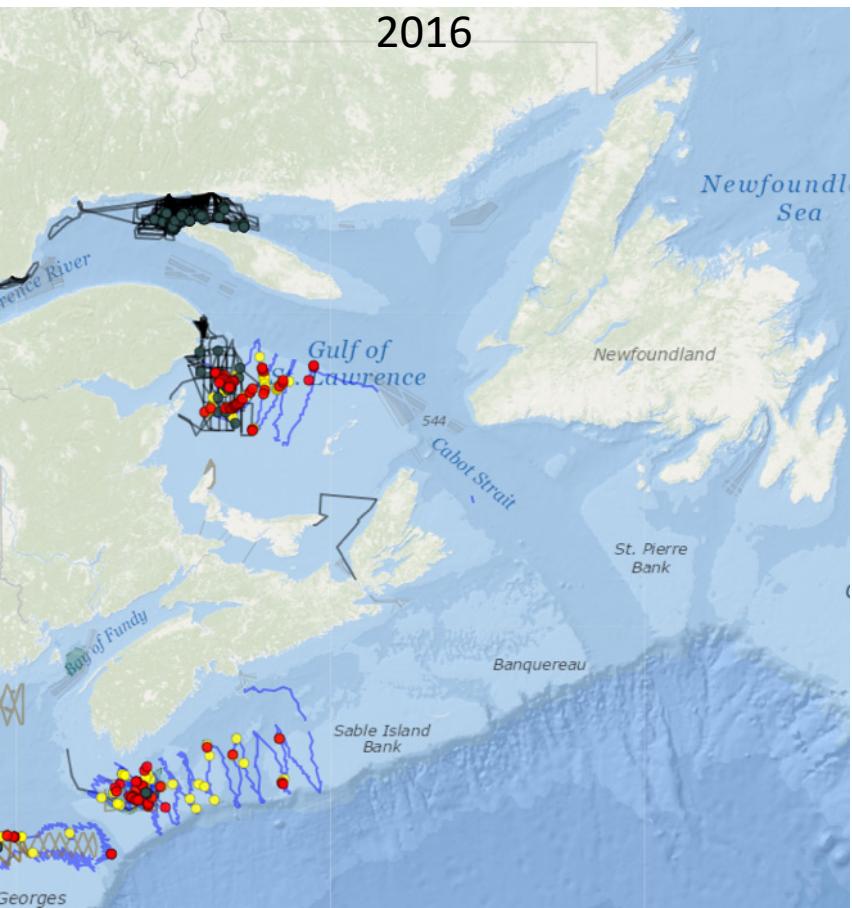
Visual surveys



Acoustic surveys



Survey effort in Canada



Need an efficient way to combine survey results to inform management

Introducing WhaleMap

WhaleMap was designed to:

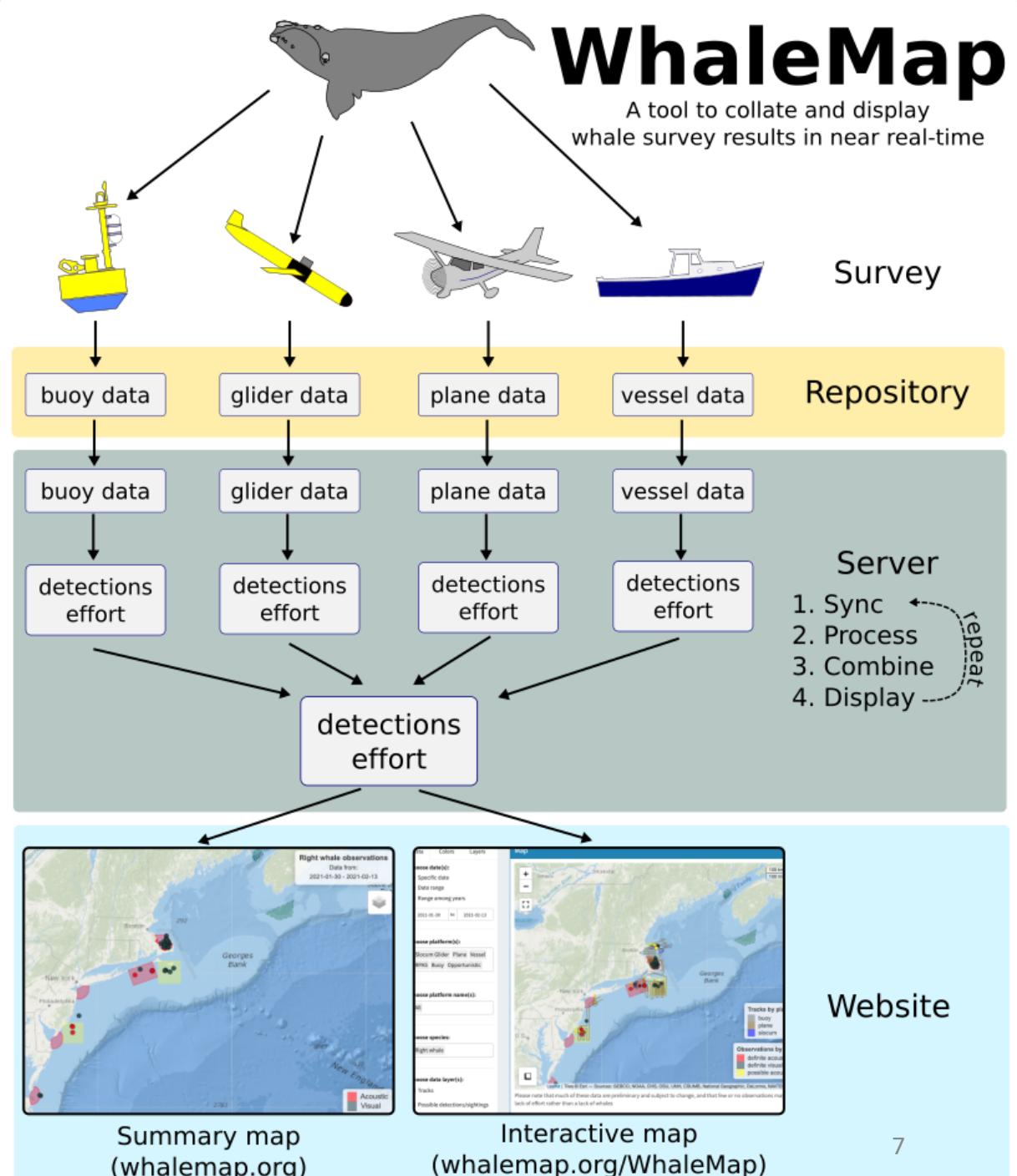
- Incorporate whale detection and survey effort from all survey methods
- Allow teams to easily contribute and retain complete control over their data
- Provide the latest data in an accurate and publicly accessible format
- Operate transparently using open-source tools and with limited supervision

WhaleMap

A tool to collate and display whale survey results in near real-time

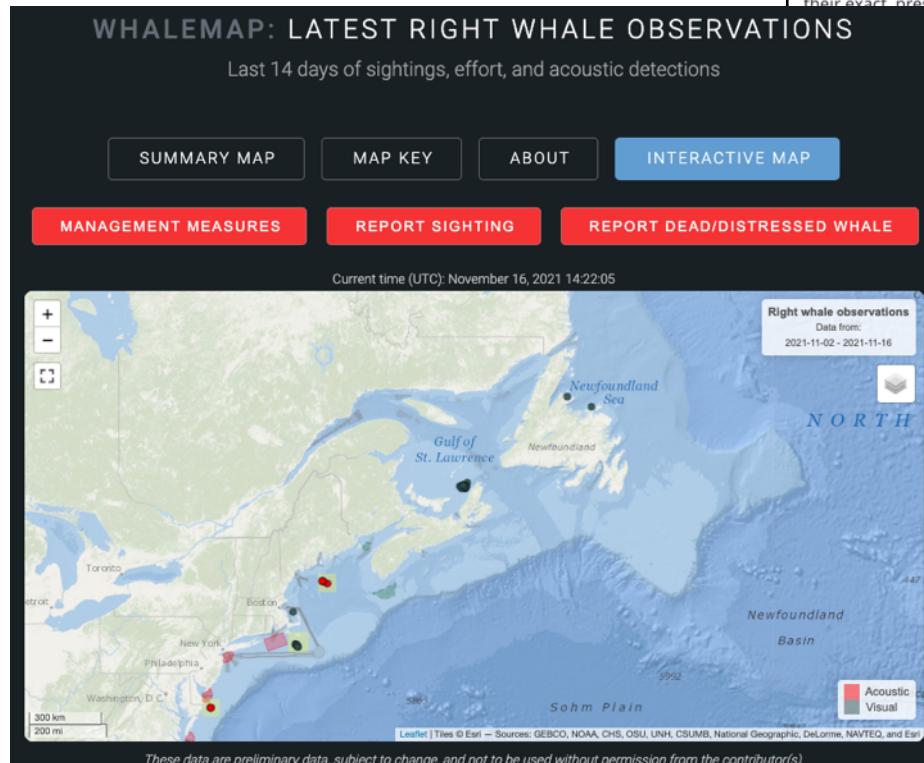
How it works

1. Raw survey data are uploaded to a remote repository (e.g., Google Drive) shared with WhaleMap
2. Data are copied to the WhaleMap server
3. Custom code extracts detections and effort from each survey
4. Data are combined and displayed on summary and interactive maps



Displays: summary map

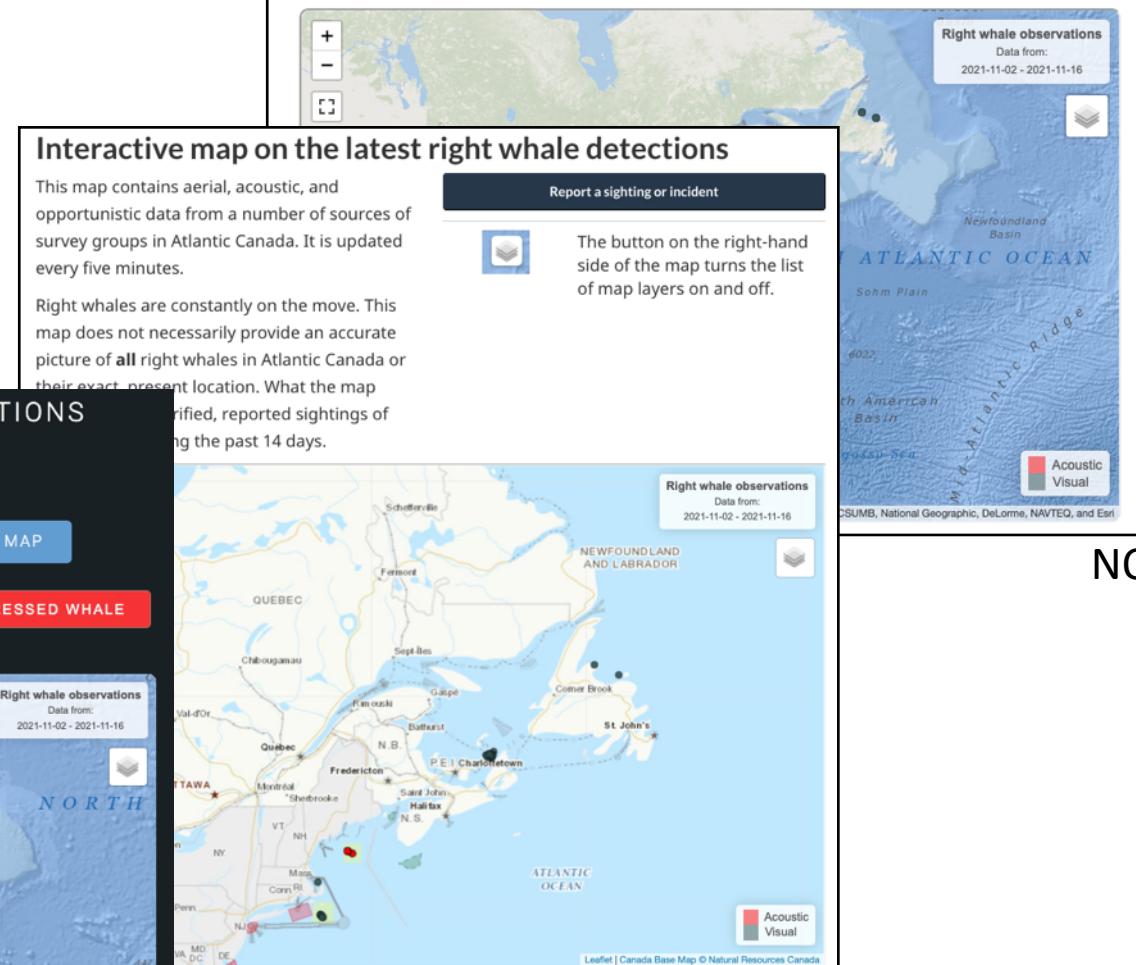
- Provides a snapshot of last 14-days of right whale detections
- Available at the whalemap.org homepage and embedded on several other websites
- Easy to interpret, but limited functionality



whalemap.org

NOAA RIGHT WHALE SIGHTING ADVISORY SYSTEM

This map should not be used for management purposes as detections are not effort corrected. [Please report all right whale sightings](#) from Virginia to Maine to 866-755-6622, and from Florida to North Carolina to 877-WHALE-HELP. Right whale sightings in any location may also be reported to the U.S. Coast Guard via channel 16 or through the WhaleAlert app available through the [Apple Store](#) and [Google Play](#). For more information about right whale protection zones and ship strike regulations, please visit the [National Marine Fisheries Service shipstrike webpage](#).



Displays: dashboard

WhaleMap

Data Colors Layers

Choose date(s):
 Specific date
 Date range
 Range among years
2021-11-02 to 2021-11-16

Choose platform(s):
Slocum Glider Plane Vessel RPAS Buoy Opportunistic

Choose platform name(s):
All

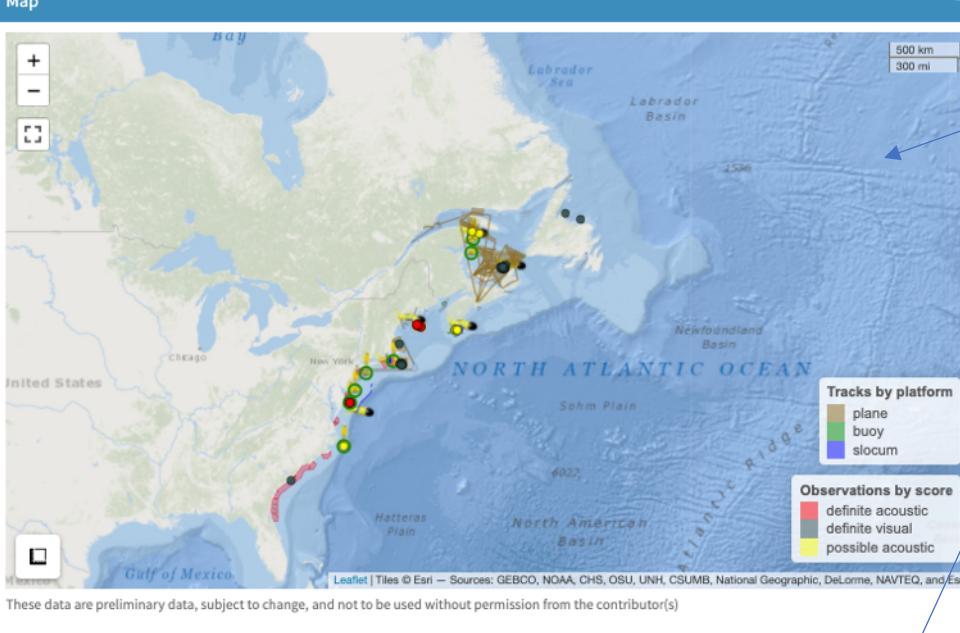
Choose species:
Right whale

Choose data layer(s):
 Tracks
 Possible detections/sightings
 Definite detections/sightings

Show unverified data:
Enter password

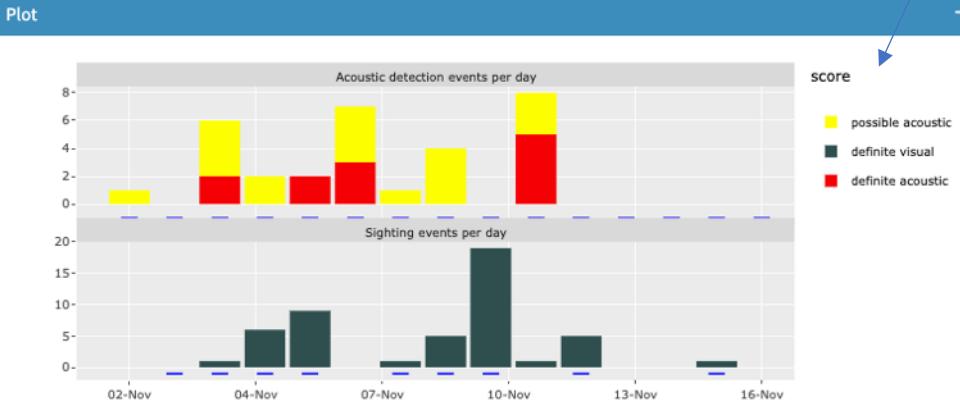
Go!

Map



These data are preliminary data, subject to change, and not to be used without permission from the contributor(s)

Plot



- Available at whalemap.org/WhaleMap
- Several data displays

- Map
- Timeseries
- Summary
- Status

Currently viewing:

Species:	right
Number of definite sighting events:	48
Number of whales sighted (includes duplicates):	81
Number of possible sighting events:	0
Number of whales possibly sighted:	0
Number of definite detections:	12
Number of possible detections:	19
Earliest observation:	2021-11-02
Most recent observation:	2021-11-15
Most recent position:	46.9098, -61.3659

Status:

Platform	Last processed [UTC]
Dal/WHOI acoustic detections	2021-11-16 13:30:51
NOAA NEFSC aerial survey sightings/tracks	2021-11-15 18:03:14
DFO Cessna aerial survey sightings (YOB)	2021-11-15 13:34:25
DFO Cessna aerial survey tracks (YOB)	2021-11-15 13:33:25
DFO opportunistic sightings reports	2021-11-11 20:02:43
TC Dash 7 aerial survey sightings	2021-11-11 00:06:30

Displays: dashboard

The dashboard has three main filter panels:

- Data:** Choose date(s) (Specific date, Date range, Range among years), choose platform(s) (Slocum Glider, Plane, Vessel, RPAS, Buoy, Opportunistic), choose platform name(s) (All), choose species (Right whale), choose data layer(s) (Tracks, Possible detections/sightings, Definite detections/sightings), and show unverified data (Enter password).
- Colors:** Choose basemap (ESRI Ocean), color observations by (Score), choose color palette (Default), and color tracks by (Platform).
- Layers:** Map layers (Graticules, NOAA charts, Latest robot positions, Shipping lanes, Legends), Canadian management areas (2021) (Critical habitat areas, Management Grid, Fishing management areas, Fishing depth contours, Shipping management areas, Transport Canada restricted area), US management areas (Lobster management areas, US fishery seasonal restricted areas, Seasonal management areas, Slow Zones, Wind development areas).

- Available at whalemap.org/WhaleMap
- Several data filters and layers
 - Time range, platform type/name, species
 - Basemap, plot colors
 - Management layers

Examples

Last two weeks of survey effort and observations of all baleen whale species

WhaleMap

Data **Colors** **Layers**

Choose date(s):
 Specific date
 Date range
 Range among years

2021-11-02 to 2021-11-16

Choose platform(s):
 Slocum Glider Plane Vessel RPAS Buoy
 Opportunistic

Choose platform name(s):
 All

Choose species:
 Right whale Fin whale Blue whale
 Sei whale Humpback whale

Choose data layer(s):
 Tracks
 Possible detections/sightings
 Definite detections/sightings

Show unverified data:
 Enter password

Go!

Map

Leaflet | Tiles © Esri — Sources: GEBCO, NOAA, CHS, OSU, UNH, CSUMB, National Geographic, DeLorme, NAVTEQ, and Esri

Tracks by platform

Observations by species

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Plot

Date	Acoustic detection events (blue)	Sighting events (blue)	Sighting events (green)	Sighting events (red)	Sighting events (yellow)
02-Nov	~120	~10	~5	~2	~1
03-Nov	~70	~5	~2	~1	~1
04-Nov	~85	~10	~5	~2	~1
05-Nov	~75	~5	~2	~1	~1
06-Nov	~70	~5	~2	~1	~1
07-Nov	~60	~5	~2	~1	~1
08-Nov	~55	~5	~2	~1	~1
09-Nov	~45	~5	~2	~1	~1
10-Nov	~35	~20	~15	~5	~2
11-Nov	~30	~5	~2	~1	~1
12-Nov	~25	~5	~2	~1	~1
13-Nov	~20	~5	~2	~1	~1
14-Nov	~15	~5	~2	~1	~1
15-Nov	~10	~5	~2	~1	~1
16-Nov	~5	~5	~2	~1	~1

species

- blue
- fin
- humpback
- right
- sei

Examples

Annual variation in right whale distribution in the southern Gulf of St Lawrence during the snow crab fishery from 2017-2021

WhaleMap

Data **Colors** **Layers**

Choose date(s):

- Specific date
- Date range
- Range among years

Jan-01 **Apr-01** Jul-01 Dec-31

Jan-01 Mar-16 May-29 Aug-11 Oct-24 Dec-31

2017 2018 2019 2020 2021

Choose platform(s):

Slocum Glider Plane Vessel RPAS Buoy
Opportunistic

Choose platform name(s):

All

Choose species:

Right whale

Choose data layer(s):

Tracks

Possible detections/sightings

Definite detections/sightings

Show unverified data:

Enter password

Go!

Map

30 km
20 mi

Chaleur Bay

Gulf of St. Lawrence

Observations by year

2017
2018
2019
2020
2021

Leaflet | Tiles © Esri — Sources: GEBCO, NOAA, CHS, OSU, UNH, CSUMB, National Geographic, DeLorme, NAVTEQ, and Esri

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Plot

Acoustic detection events per day

Sighting events per day

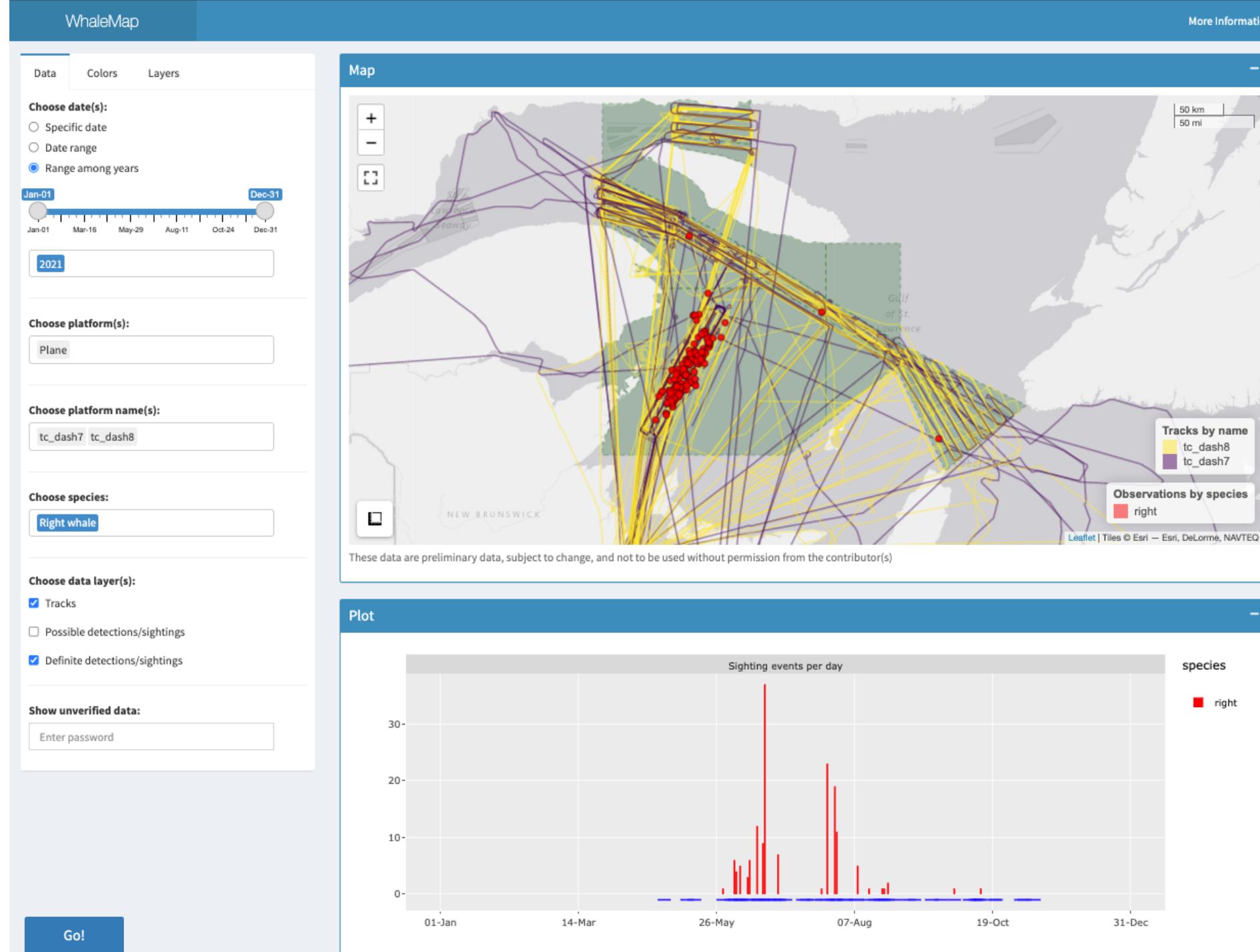
year

2017
2018
2019
2020
2021

01-Apr 19-Apr 07-May 25-May 12-Jun 01-Jul

Examples

Distribution of aerial survey effort and right whale detections by Transport Canada planes in 2021



Available data

- Species: right, fin, sei, humpback, and blue whales
- Region: East coast of US and Canada
- Years: 2010 – present
 - Limited effort data before 2017
- Sources:
 - Direct contributions from >20 organizations
 - NOAA Right Whale Sightings Advisory System (RWSAS)
 - North Atlantic Right Whale Consortium (NARWC)

Data on WhaleMap are subject to numerous caveats. They are often not quality controlled or comprehensive and should be interpreted with care.

Summary reports

- Data and summary reports sent to DFO and TC every day
- Used directly to inform dynamic management
 - Vessel slowdowns
 - Fisheries closures

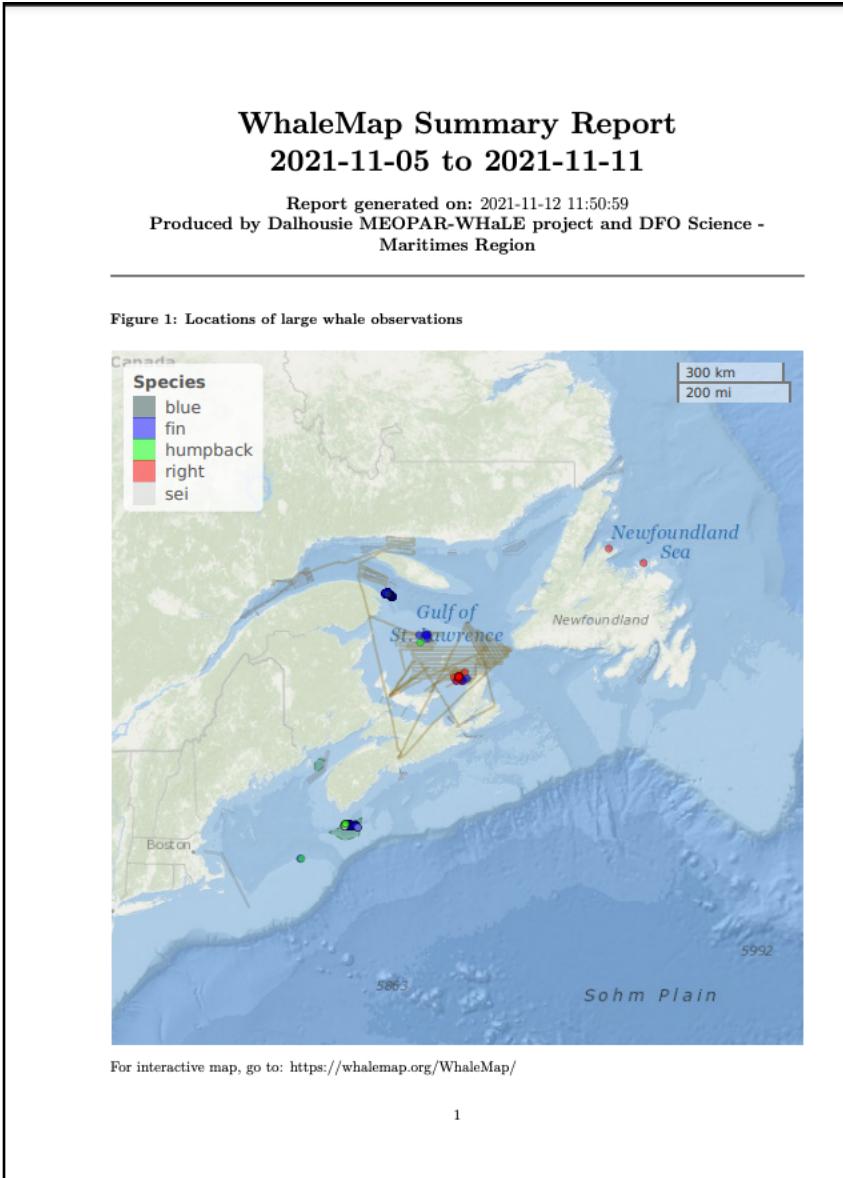


Table 1: Number of large whale observations

species	visual_counts	acoustic_detections
blue	0	1
fin	14	269
humpback	2	2
right	43	0
sei	0	4

Visual counts only include sightings where numbers of whales were recorded, and may include duplicates

Table 2. Platforms with recorded survey effort

name	platform
tc_dash7	plane
noaa_twin_otter	plane
dfo_viking_PMZA-VAS	buoy
dfo_cessna_yob	plane
cabot	slocum
qala1	slocum

Table 3: North Atlantic right whale sightings

date	time	lat	lon	number	calves	platform	name
2021-11-05				1	NA	plane	noaa_twin_otter
2021-11-05				1	NA	plane	noaa_twin_otter
2021-11-05				1	NA	plane	noaa_twin_otter
2021-11-05				2	NA	plane	noaa_twin_otter
2021-11-05				2	1	plane	noaa_twin_otter
2021-11-05				1	NA	plane	noaa_twin_otter
2021-11-08				2	0	opportunistic	Opportunistic
2021-11-09				1	NA	plane	noaa_twin_otter
2021-11-09				4	NA	plane	noaa_twin_otter
2021-11-09				3	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				2	NA	plane	noaa_twin_otter
2021-11-10				2	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				2	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter
2021-11-10				2	1	plane	noaa_twin_otter
2021-11-10				1	NA	plane	noaa_twin_otter

Conclusions

- WhaleMap has improved conservation outcomes for endangered whales
- Currently taking steps to ensure it is maintained in perpetuity
- Open source development allows it to be adapted to others facing similar data or conservation challenges

For more information

- Visit the WhaleMap homepage at <https://whalemap.org>
- Read the (short) manuscript at
<https://joss.theoj.org/papers/10.21105/joss.03094>
- Review the WhaleMap source code at
<https://github.com/hansenjohnson/WhaleMap>
- Email me (hansen.johnson@dal.ca)

Thank you!

Acknowledgements

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Nick Hawkins