NOAA FISHERIES

GAiA

Christin Khan, Kim Goetz, Caleb Robinson, John Wall, Meredith Sackett,
Lauren Connor, Jeffrey Wyman, Eric Krapf, Marcus England, Dani Cholewiak

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www.nature.com/scientificreports

SCIENTIFIC REPORTS
nature research

Check for updates

OPEN

A comparison of baleen whale density estimates derived from overlapping satellite imagery and a shipborne survey

C. C. G. Bamford[1,2✉], N. Kelly[3], L. Dalla Rosa[4], D. E. Cade[5,6], P. T. Fretwell[1], P. N. Trathan[1], H. C. Cubaynes[1], A. F. C. Mesquita[4], L. Gerrish[1], A. S. Friedlaender[6] & J. A. Jackson[1]

Using satellite imagery to estimate abundance of Cumberland Sound beluga whales *(Delphinapterus leucas)* in 2021

Bryanna A. H. Sherbo[1*], Amanda M. Belanger[1,2], Bertrand Charry[3] and Cortney A. Watt[1,2*]

[1]Arctic Aquatic Research Division, Fisheries and Oceans Canada, Winnipeg, MB, of Biological Sciences, University of Manitoba, Winnipeg, MB, Canada, [3]Whale QC, Canada

RESEARCH HIGHLIGHT | 06 November 2018

Thar she blows! Whales seen exhaling from space

Satellite used by intelligence agencies can identify some large whale species down to the flipper.

PLOS ONE

RESEARCH ARTICLE

Aerial-trained deep learning networks for surveying cetaceans from satellite imagery

Alex Borowicz[1,2*], Hieu Le[2,3], Grant Humphries[4], Georg Nehls[5], Caroline Höschle[5], Vladislav Kosarev[5], Heather J. Lynch[1,2]

1 Department of Ecology & Evolution, Stony Brook University, Stony Brook, New York, United States of America, **2** Institute for Advanced Computational Science, Stony Brook University, Stony Brook, New York, United States of America, **3** Department of Computer Science, Stony Brook University, Stony Brook, New York, United States of America, **4** HiDef Aerial Surveying Ltd., Cleator Moor, Cumbria, United Kingdom, **5** BioConsult SH GmbH & Co. KG, Husum, Germany

Estimating beluga whale abundance from space: using drones to ground-validate VHR satellite imagery

Jordan B. Stewart[1,2], Justine M. Hudson[2], Bryanna A. H. Sherbo[2] & Cortney A. Watt[1,2]

[1]Centre for Earth Observation Science, Department of Environment and Geography, University of Manitoba, Winnipeg Manitoba, R3T 2N Canada
[2]Fisheries and Oceans Canada, Winnipeg Manitoba, R3T 2N6, Canada

Marine Mammal Science

MARINE MAMMAL SCIENCE, 00(00): 1–26 (2018)

DOI: 10.1111/mms.12544

Whales from space: Four mysticete species described using new VHR satellite imagery

Hannah C. Cubaynes,[1] British Antarctic Survey, Madingley Road, Cambridge CB3 0ET, United Kingdom and Scott Polar Research Institute, Department of Geography, University of Cambridge, Lensfield Road, Cambridge, CB2 1ER, United Kingdom; **Peter T. Fretwell,** British Antarctic Survey, Madingley Road, Cambridge, CB3 0ET, United Kingdom; **Connor Bamford,** British Antarctic Survey, Madingley Road, Cambridge, CB3 0ET, United Kingdom and University of Southampton, University Road, Southampton, SO17 1BJ, United Kingdom; **Laura Gerrish** and **Jennifer A. Jackson,** British Antarctic Survey, Madingley Road, Cambridge, CB3 0ET, United Kingdom.

ARTICLE

Marine Mammal Science

Individual North Atlantic right whales identified from space

Matus Hodul[1] | Anders Knudby[1] | Brigid McKenna[2] | Amy James[2] | Charles Mayo[2] | Moira Brown[3] | Delphine Durette-Morin[3] | Stephen Bird[4]

PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Mapping Arctic cetaceans from space: A case study for beluga and narwhal

Bertrand Charry, Emily Tissier, John Iacozza, Marianne Marcoux, Cortney A. Watt

Remote Sensing in Ecology and Conservation — Open Access — ZSL

Research Article | Open Access

Walruses from space: walrus counts in simultaneous remotely piloted aircraft system versus very high-resolution satellite imagery

Hannah C. Cubaynes, Jaume Forcada, Kit M. Kovacs, Christian Lydersen, Rod Downie, Peter T. Fretwell

Polar Biol (2011) 34:1727–1737
DOI 10.1007/s00300-011-1023-0

ORIGINAL PAPER

Satellite imagery can be used to detect variation in abundance of Weddell seals (*Leptonychotes weddellii*) in Erebus Bay, Antarctica

Michelle A. LaRue · Jay J. Rotella · Robert A. Garrott · Donald B. Siniff · David G. Ainley · Glenn E. Stauffer · Claire C. Porter · Paul J. Morin

OPEN ACCESS Freely available online

PLOS ONE

Whales from Space: Counting Southern Right Whales by Satellite

Peter T. Fretwell[1]*, Iain J. Staniland[2], Jaume Forcada[2]

1 Mapping and Geographic Information Centre, British Antarctic Survey, Cambridge, United Kingdom, **2** Ecosystems Department, British Antarctic Survey, Cambridge, United Kingdom

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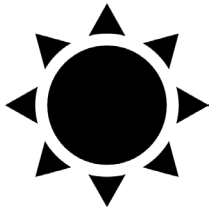
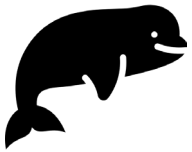
FEW
IMAGES

Only a single image or a handful of images



IDEAL
CONDITIONS

Clear skies, sunny day, and low wind conditions



WHALE
HOTSPOTS

Areas of known spatial and temporal aggregations

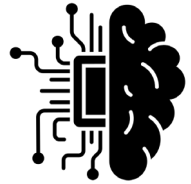
NOAA FISHERIES

SATELLITES

Resolution is detailed enough for species identification

CLOUD

Potential for rapid image processing without downloading



AI

Incredible advances in machine learning

NOAA FISHERIES

GAIA

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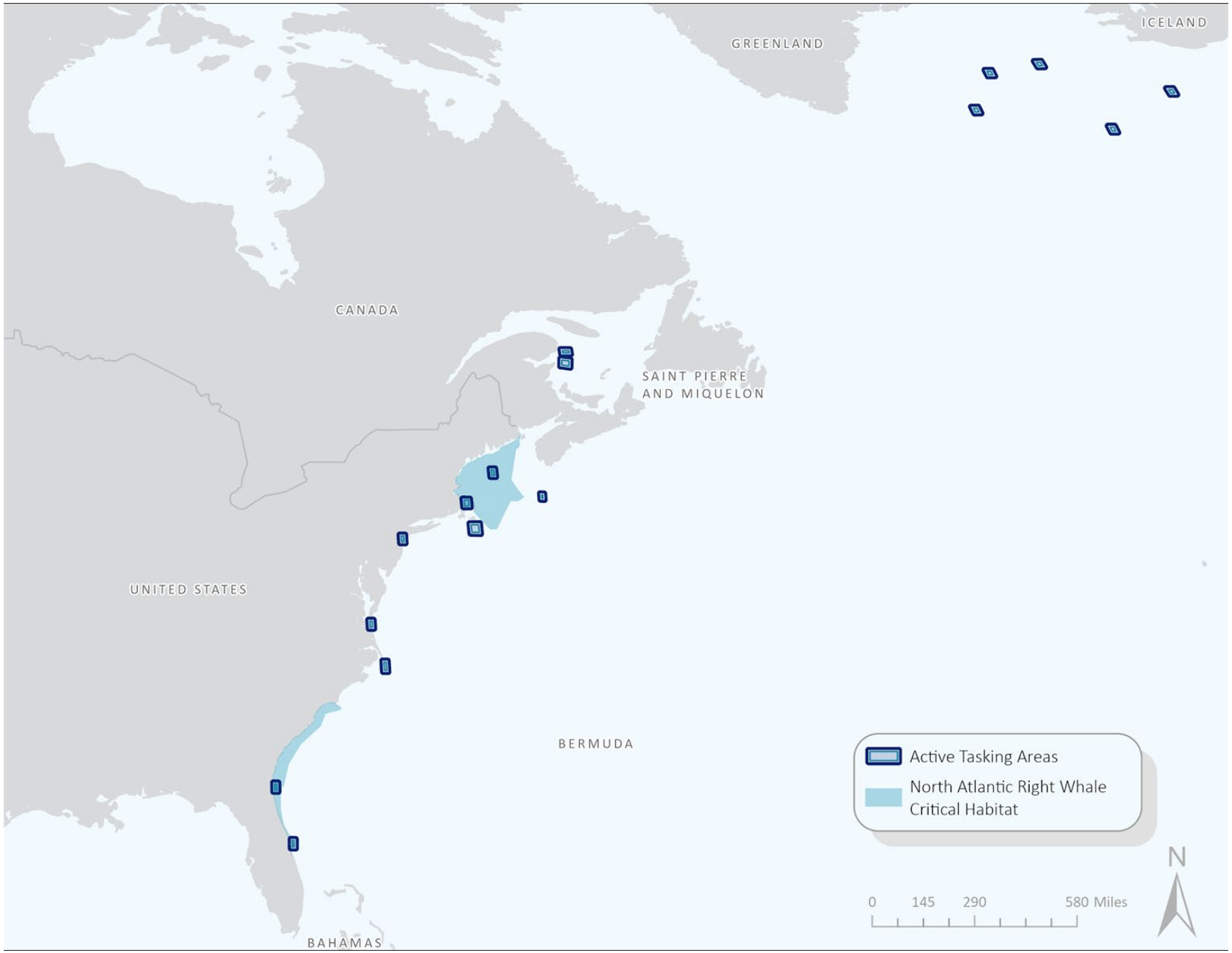
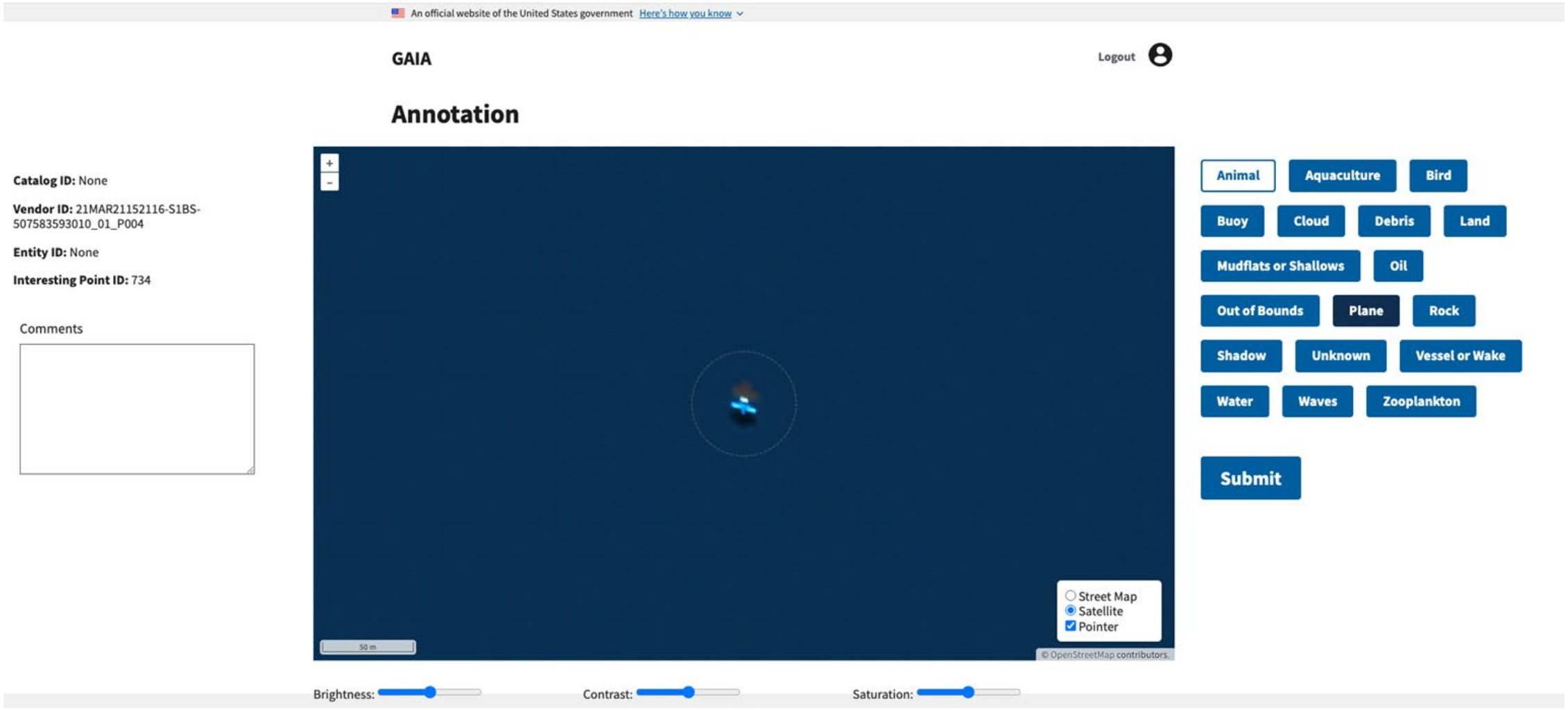
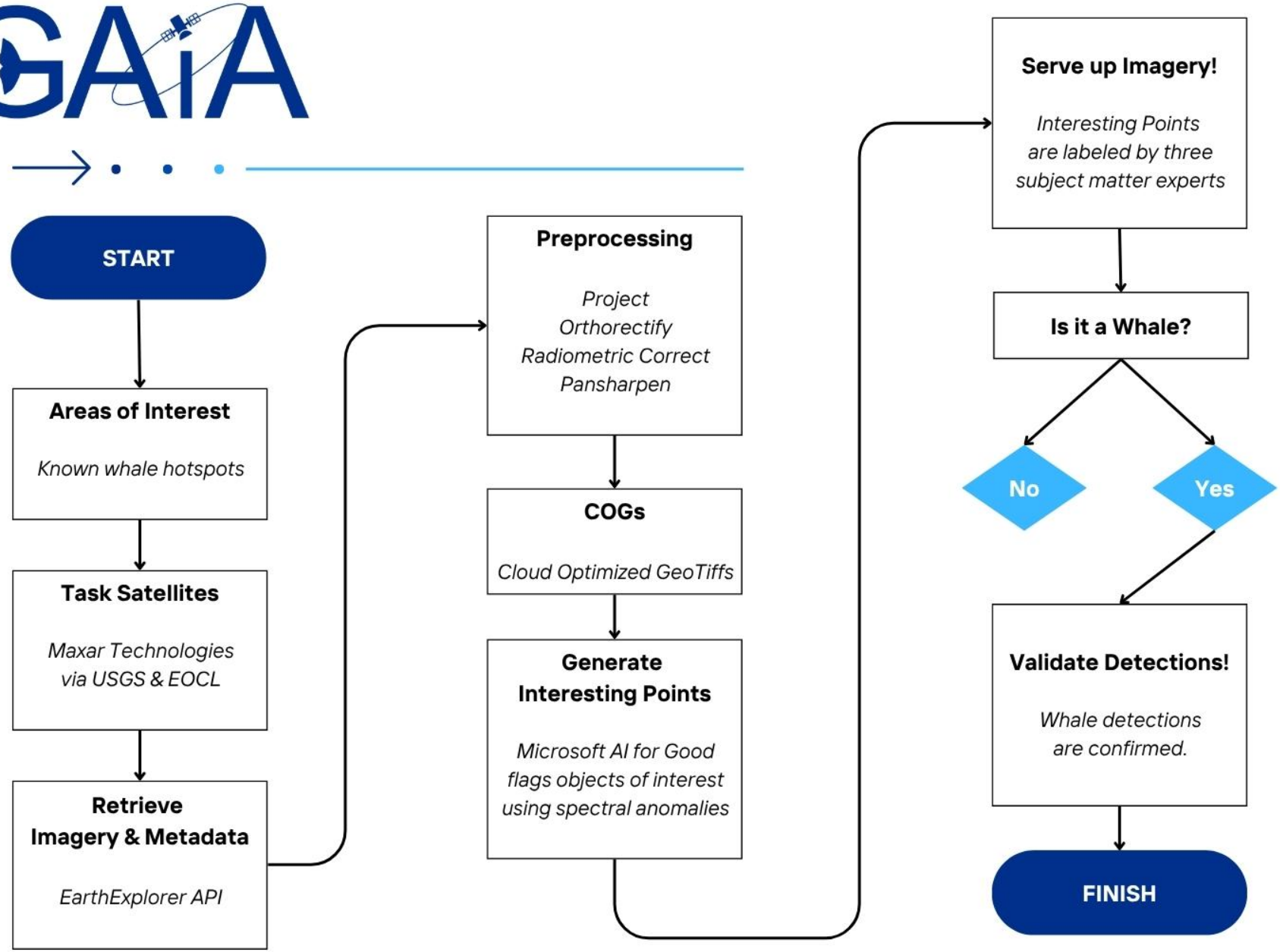
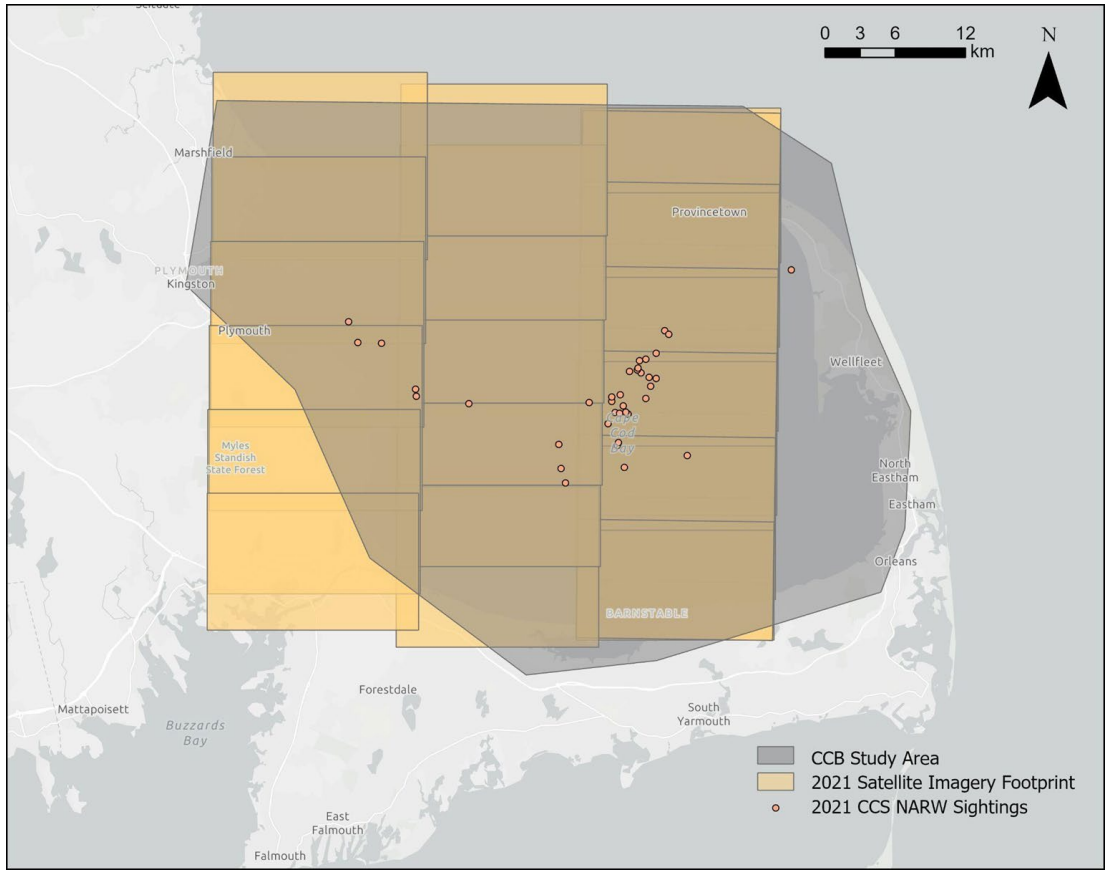
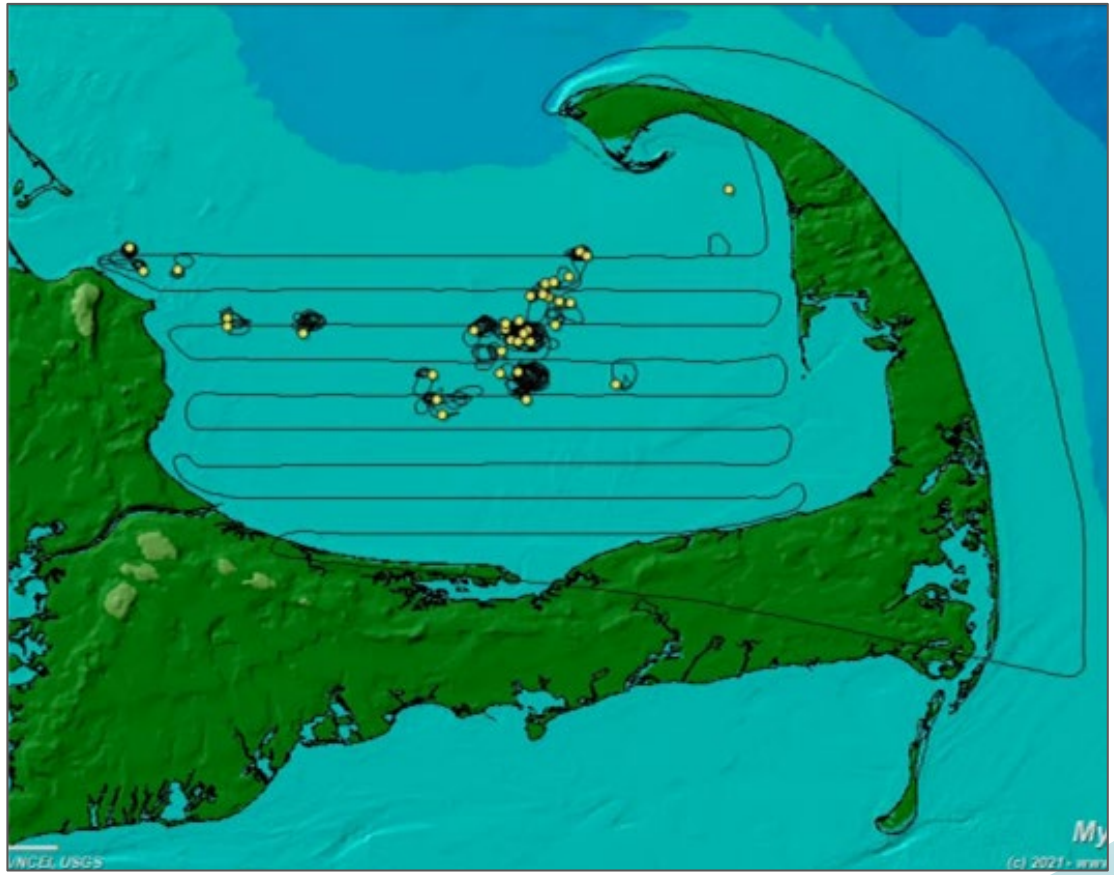


NOAA FISHERIES


An official website of the United States government Here's how you know
GAIA
Logout
Annotation
Catalog ID: None
Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004
Entity ID: None
Interesting Point ID: 734
Comments
Street Map
Satellite
Pointer
50 m
© OpenStreetMap contributors.
Animal
Aquaculture
Bird
Buoy
Cloud
Debris
Land
Mudflats or Shallows
Oil
Out of Bounds
Plane
Rock
Shadow
Unknown
Vessel or Wake
Water
Waves
Zooplankton
Submit
Brightness:
Contrast:
Saturation:


GAiA
START
Areas of Interest
Known whale hotspots
Task Satellites
Maxar Technologies via USGS & EOCL
Retrieve Imagery & Metadata
EarthExplorer API
Preprocessing
Project
Orthorectify
Radiometric Correct
Pansharpen
COGs
Cloud Optimized GeoTiffs
Generate Interesting Points
Microsoft AI for Good flags objects of interest using spectral anomalies
Serve up Imagery!
Interesting Points are labeled by three subject matter experts
Is it a Whale?
No
Yes
Validate Detections!
Whale detections are confirmed.
FINISH


0 3 6 12
km
N
Marshfield
Provincetown
PLYMOUTH
Kingston
Plymouth
Wellfleet
Myles
Standish
State Forest
North
Eastham
Eastham
Orleans
BARNSTABLE
Forestdale
Mattapoisett
Buzzards
Bay
South
Yarmouth
East
Falmouth
Falmouth
CCB Study Area
2021 Satellite Imagery Footprint
2021 CCS NARW Sightings



North Atlantic Right Whales in Cape Cod Bay 2020–2024

Very high-resolution Maxar satellite imagery (WorldView-2 and WorldView-3) will be compared with Center for Coastal Studies aerial surveys on days when North Atlantic right whales were observed in Cape Cod Bay and satellite imagery was collected concurrently (2020–2024). This analysis will assess the strengths and limitations of satellite imagery as a complementary tool for whale detection within this well-studied and ecologically important habitat.

Contact: christin.khan@noaa.gov

Beluga Whales in upper Cook Inlet Alaska 2020–2025

Very high-resolution Maxar satellite imagery (WorldView-2, WorldView-3, GeoEye) will be compared with the biennial June aerial abundance surveys and annual summer-fall Unmanned Aerial Surveys (UAS) to find belugas in Cook Inlet where they commonly aggregate in large groups. The analysis aims to identify potential missed groups in traditional surveys and improve understanding of beluga distribution in periods when surveys are not conducted.

Contact: kim.goetz@noaa.gov

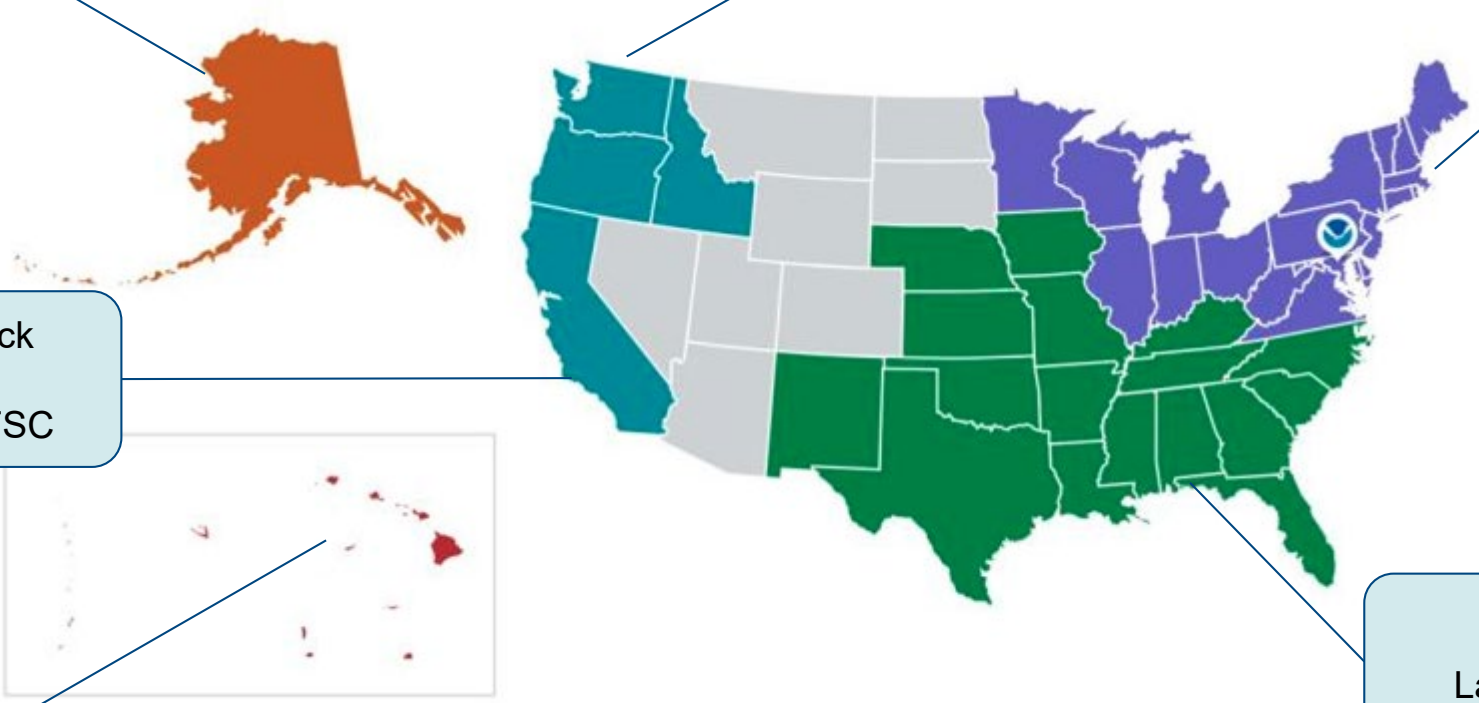
Manage Projects

Add or change projects.

Cook Inlet beluga whale
Kim Goetz, AFSC

Southern Resident killer whale
Candice Emmons, NWFSC

North Atlantic right whale
Christin Khan, NEFSC



Blue and humpback whales
Trevor Joyce, SWFSC

Rice's whale
Laura Dias, SEFSC

Hawaiian Monk Seals & Sea Turtles
Michelle Barbieri, PIFSC

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North Atlantic Right Whales in Cape Cod Bay 2020-2024

Add Points

Scan image grid cells to detect animals and place annotation points.

Annotate Points

Label detections one at a time by looking at each point individually.

Annotate Batch

Label similar detections across an entire scene in a single batch step.

Validate Labels

Confirm species identity and confidence for each annotated detection.

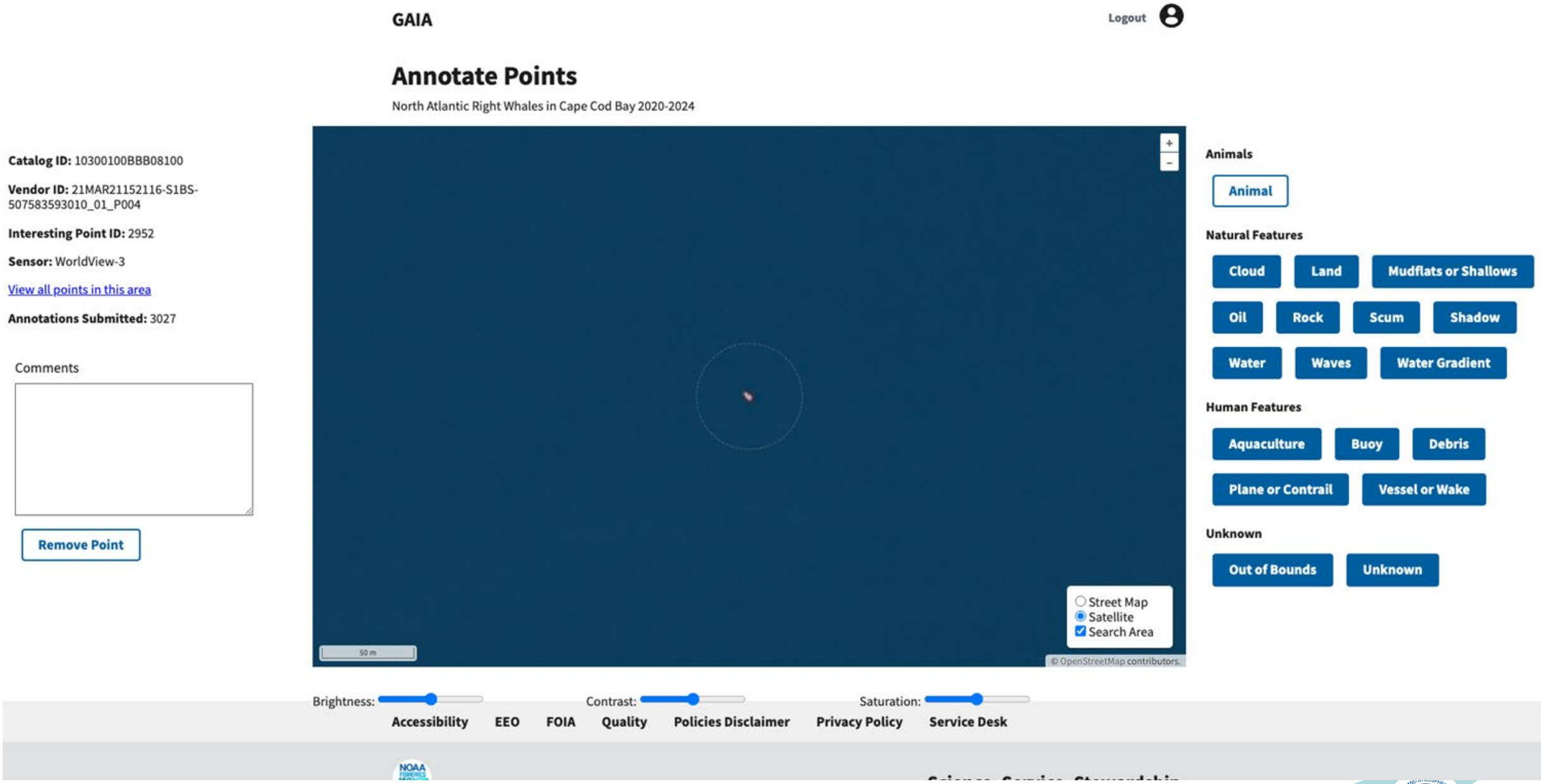
Review Duplicates

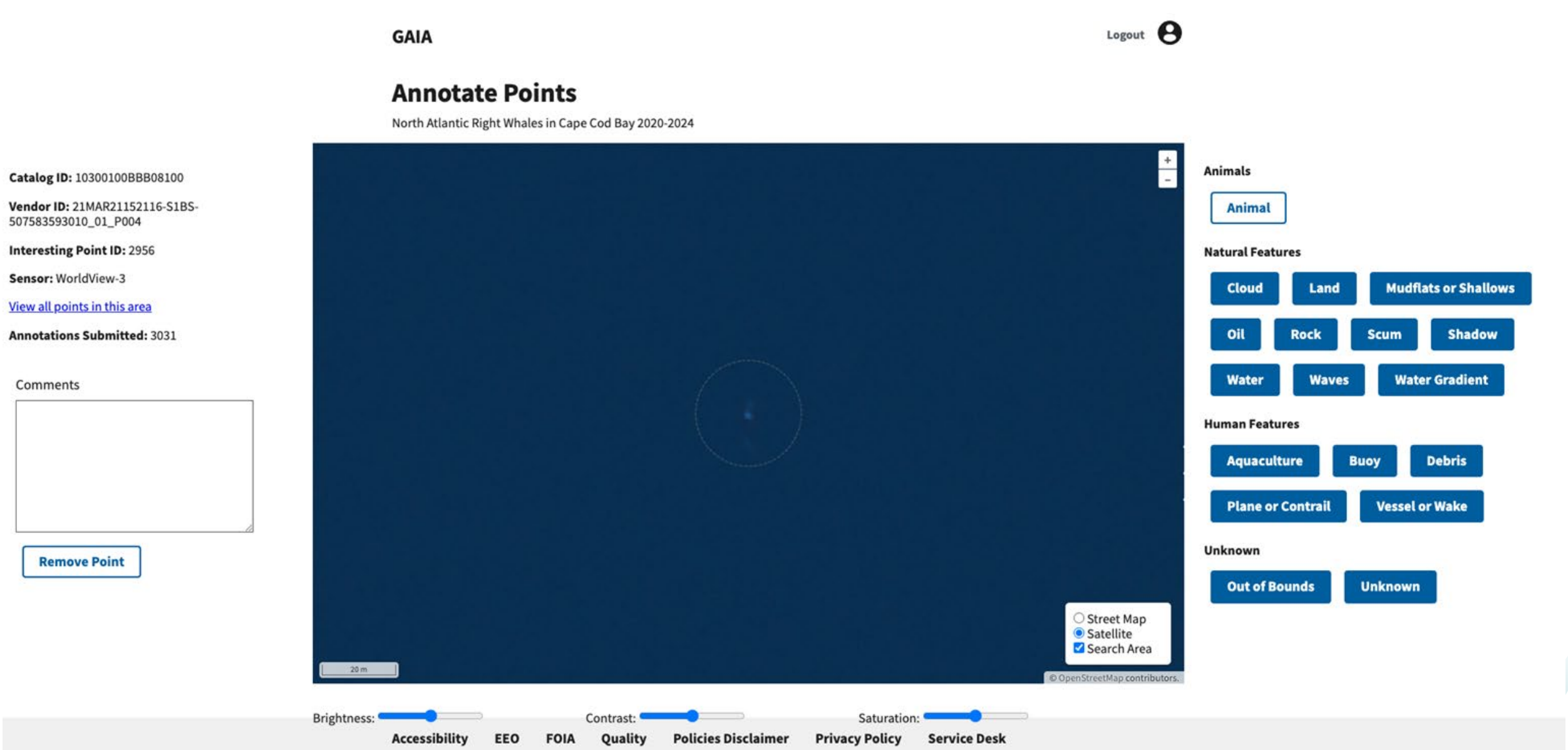
Identify and remove any redundant or overlapping animal detections.

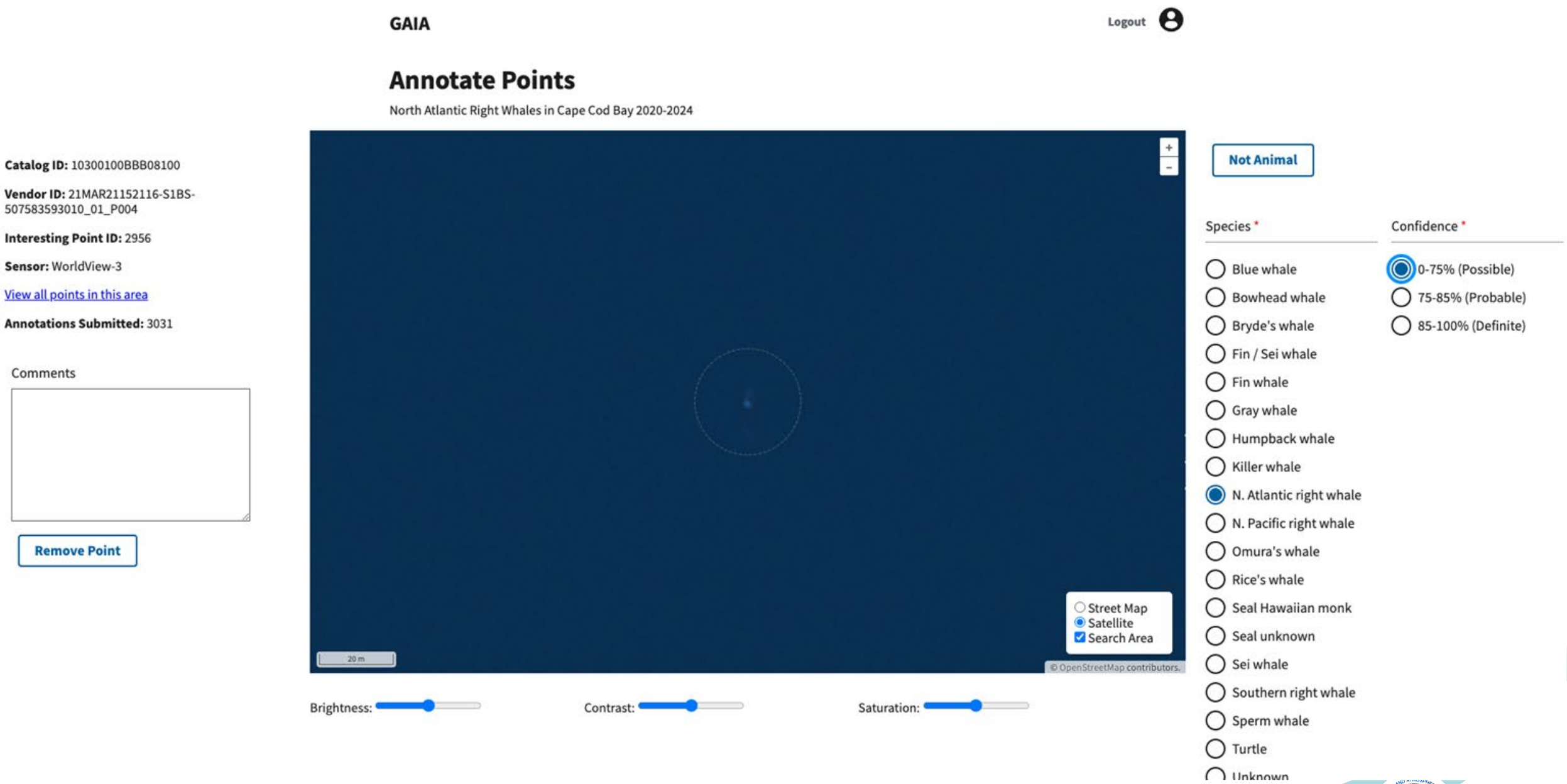
Export Results

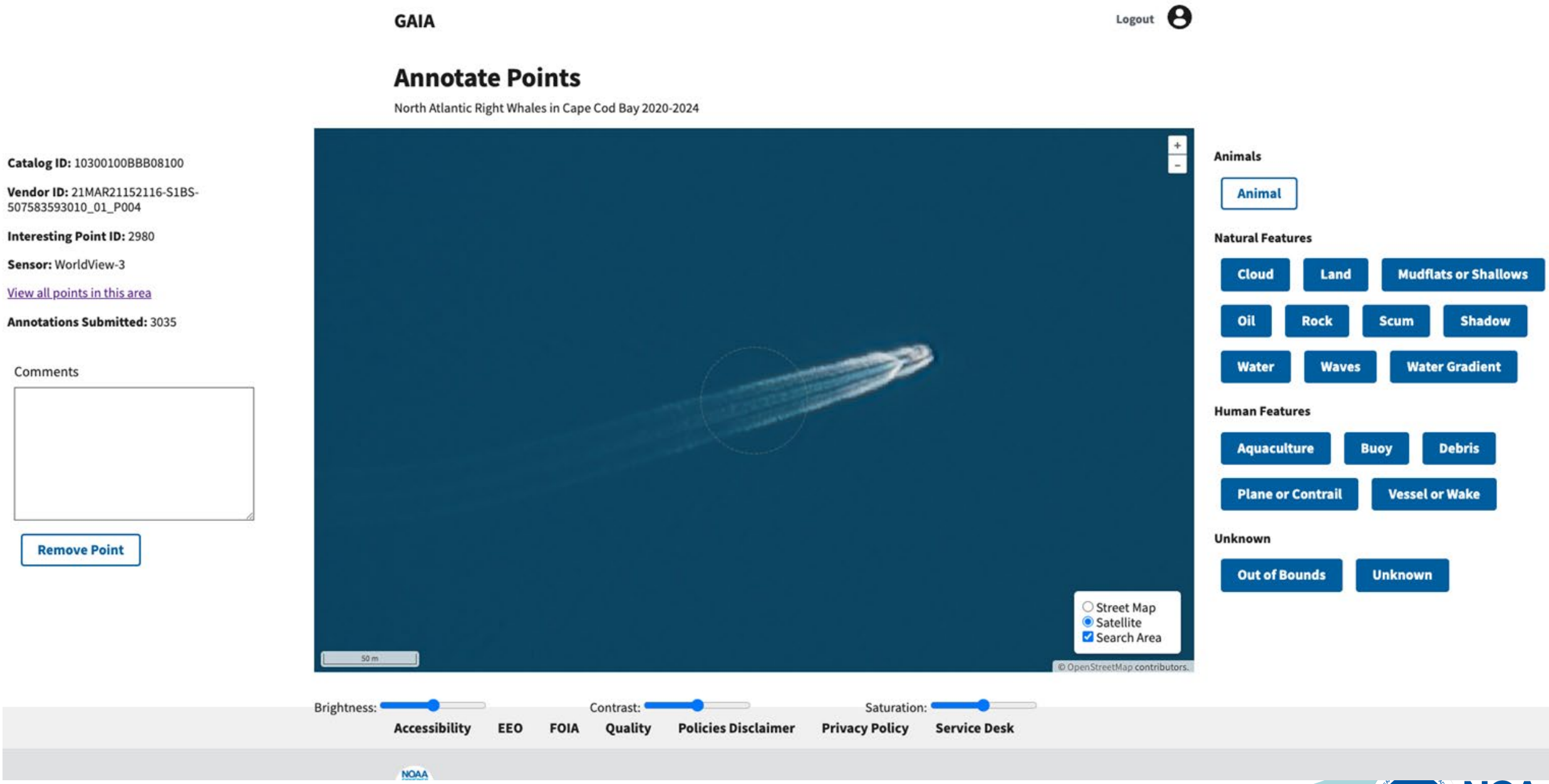
Download all confirmed annotations as a CSV file for further analysis.

NOAA FISHERIES


GAIA
Logout
Annotate Points
North Atlantic Right Whales in Cape Cod Bay 2020-2024
Catalog ID: 10300100BBB08100
Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004
Interesting Point ID: 2952
Sensor: WorldView-3
View all points in this area
Annotations Submitted: 3027
Comments
Remove Point
Street Map
Satellite
Search Area
50 m
© OpenStreetMap contributors.
Animals
Animal
Natural Features
Cloud
Land
Mudflats or Shallows
Oil
Rock
Scum
Shadow
Water
Waves
Water Gradient
Human Features
Aquaculture
Buoy
Debris
Plane or Contrail
Vessel or Wake
Unknown
Out of Bounds
Unknown
Brightness:
Contrast:
Saturation:
Accessibility
EEO
FOIA
Quality
Policies Disclaimer
Privacy Policy
Service Desk


GAIA
Logout
Annotate Points
North Atlantic Right Whales in Cape Cod Bay 2020-2024
Catalog ID: 10300100BBB08100
Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004
Interesting Point ID: 2956
Sensor: WorldView-3
View all points in this area
Annotations Submitted: 3031
Comments
Remove Point
Street Map
Satellite
Search Area
20 m
© OpenStreetMap contributors.
Animals
Animal
Natural Features
Cloud
Land
Mudflats or Shallows
Oil
Rock
Scum
Shadow
Water
Waves
Water Gradient
Human Features
Aquaculture
Buoy
Debris
Plane or Contrail
Vessel or Wake
Unknown
Out of Bounds
Unknown
Brightness:
Contrast:
Saturation:
Accessibility
EEO
FOIA
Quality
Policies Disclaimer
Privacy Policy
Service Desk


GAIA
Logout
Annotate Points
North Atlantic Right Whales in Cape Cod Bay 2020-2024
Catalog ID: 10300100BBB08100
Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004
Interesting Point ID: 2956
Sensor: WorldView-3
View all points in this area
Annotations Submitted: 3031
Comments
Remove Point
Not Animal
Species *
Blue whale
Bowhead whale
Bryde's whale
Fin / Sei whale
Fin whale
Gray whale
Humpback whale
Killer whale
N. Atlantic right whale
N. Pacific right whale
Omura's whale
Rice's whale
Seal Hawaiian monk
Seal unknown
Sei whale
Southern right whale
Sperm whale
Turtle
Unknown
Confidence *
0-75% (Possible)
75-85% (Probable)
85-100% (Definite)
Street Map
Satellite
Search Area
20 m
© OpenStreetMap contributors.
Brightness:
Contrast:
Saturation:


GAIA
Logout
Annotate Points
North Atlantic Right Whales in Cape Cod Bay 2020-2024
Catalog ID: 10300100BBB08100
Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004
Interesting Point ID: 2980
Sensor: WorldView-3
View all points in this area
Annotations Submitted: 3035
Comments
Remove Point
Animals
Animal
Natural Features
Cloud
Land
Mudflats or Shallows
Oil
Rock
Scum
Shadow
Water
Waves
Water Gradient
Human Features
Aquaculture
Buoy
Debris
Plane or Contrail
Vessel or Wake
Unknown
Out of Bounds
Unknown
Street Map
Satellite
Search Area
50 m
© OpenStreetMap contributors.
Brightness:
Contrast:
Saturation:
Accessibility
EEO
FOIA
Quality
Policies Disclaimer
Privacy Policy
Service Desk

GAIA

Logout

Annotate Batch

North Atlantic Right Whales in Cape Cod Bay 2020-2024

Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004

Selection Methods

Individual: Click on points on the map to select/deselect

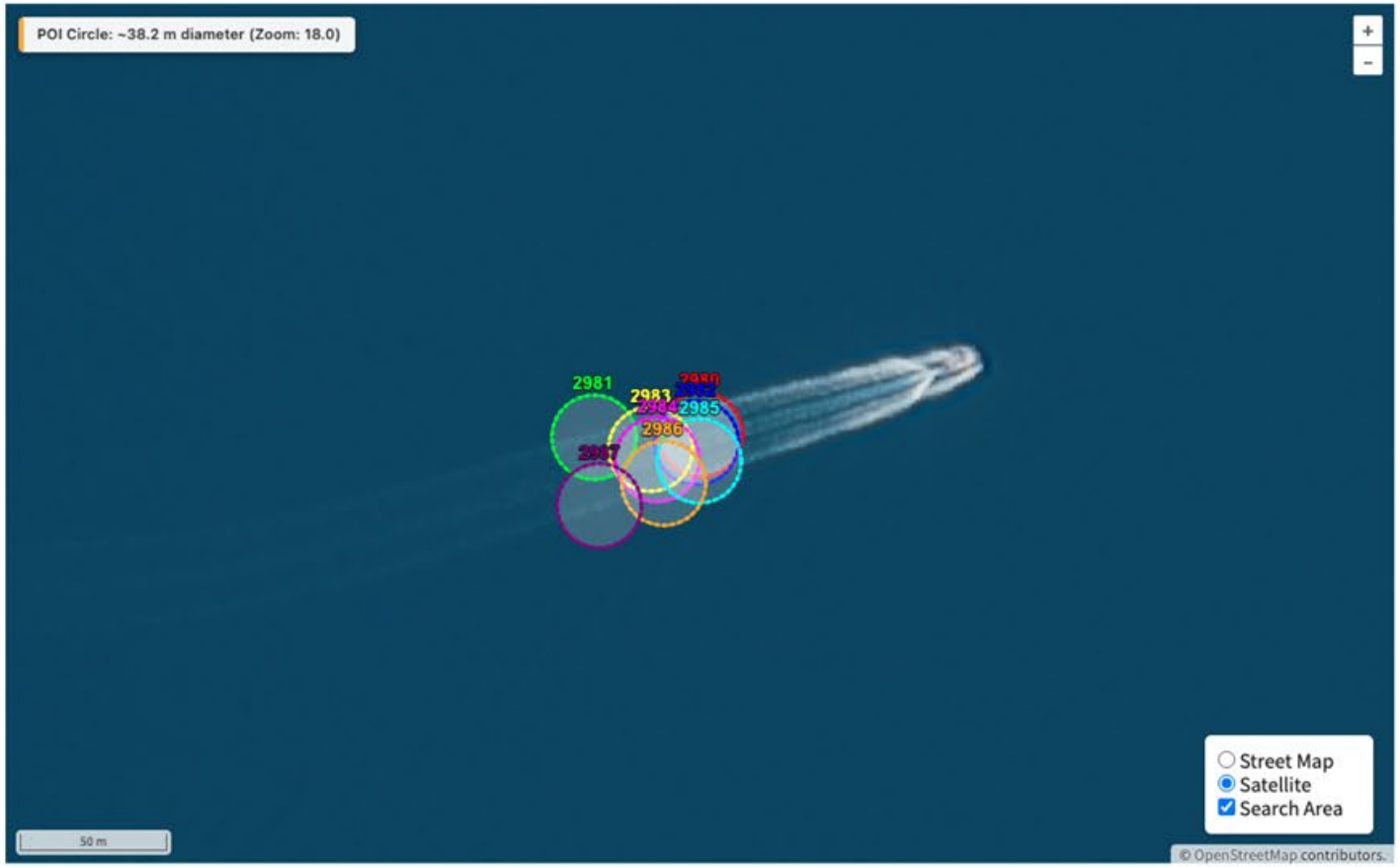
Area Select: Hold `Ctrl` (or `Cmd` on Mac) and drag on the map to select multiple points in an area

Points of Interest

POI ID	Status
Click on POIs on the map to select them	

Total POI's: 10 of 209, **Selected POI's:** 0

Loading more POIs in background... Pause



Brightness: Contrast: Saturation:

Animals

Animal

Natural Features

Cloud | Land | Mudflats or Shallows | Oil | Rock | Scum | Shadow | Water | Waves | Water Gradient

Human Features

Aquaculture | Buoy | Debris | Plane or Contrail | Vessel or Wake

Unknown

Out of Bounds | Unknown

Comments

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GAIA

Logout

Annotate Batch

North Atlantic Right Whales in Cape Cod Bay 2020-2024

Vendor ID: 21MAR21152116-S1BS-507583593010_01_P004

Selection Methods

Individual: Click on points on the map to select/deselect
Area Select: Hold `Ctrl` (or `Cmd` on Mac) and drag on the map to select multiple points in an area

Points of Interest

POI ID	Status
2980	PENDING
2981	PENDING
2982	PENDING
2983	PENDING
2984	PENDING
2985	PENDING

Total POI's: 60 of 209, **Selected POI's:** 8

Loading more POIs in background... Pause

Brightness: Contrast: Saturation:

Animals

Animal

Natural Features

Cloud | Land | Mudflats or Shallows | Oil | Rock | Scum | Shadow | Water | Waves | Water Gradient

Human Features

Aquaculture | Buoy | Debris | Plane or Contrail | Vessel or Wake

Unknown

Out of Bounds | Unknown

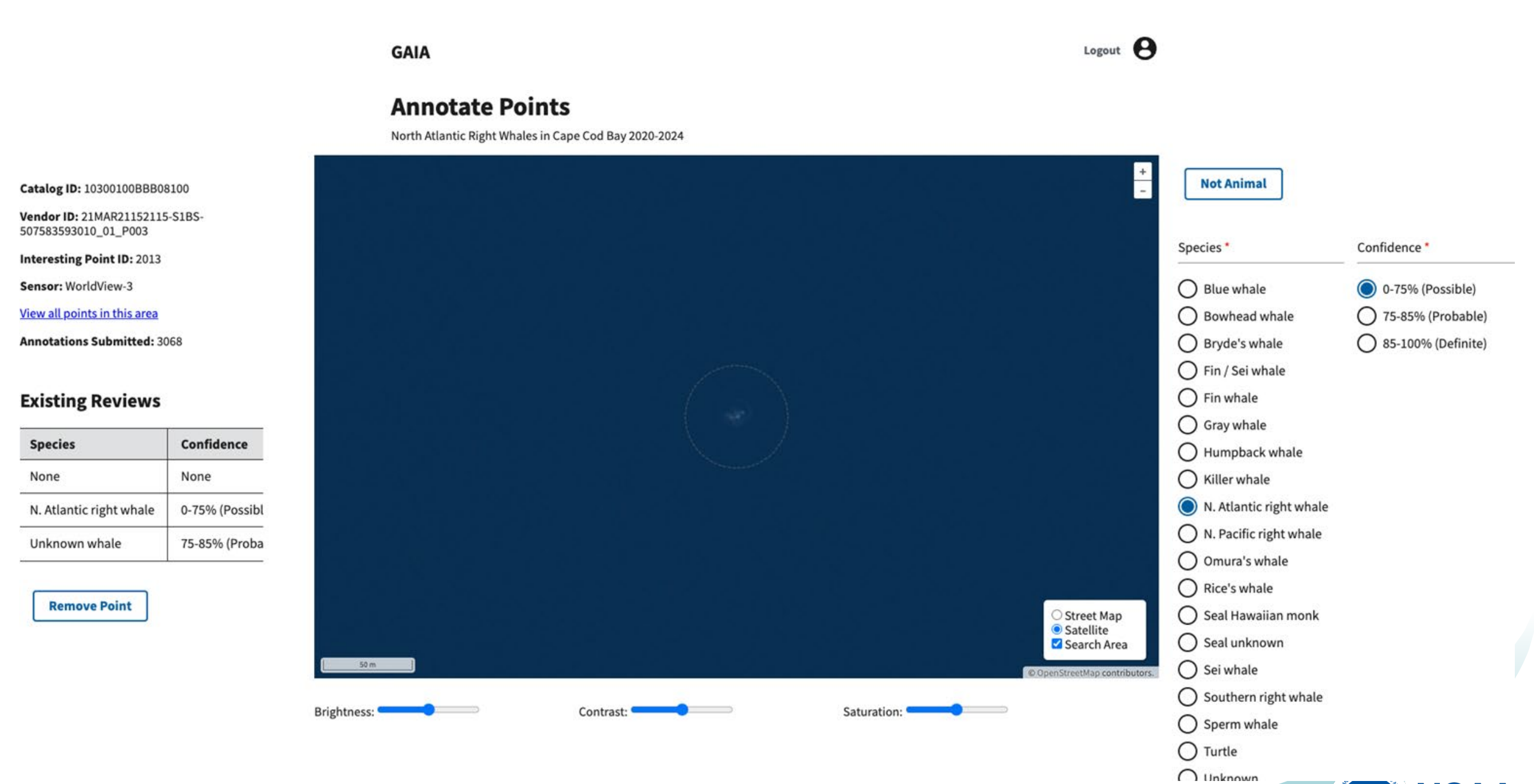
Comments

Validate Annotations

North Atlantic Right Whales in Cape Cod Bay 2020-2024

☐ Show Records with Final Reviews

ID ↑	User 1	User 2	User 3	Final Review	Final Review Date
2013	Unknown	N. Atlantic right whale: 0-75% (Possible)	Unknown whale: 75-85% (Probable)		
2079	Water	Zooplankton: 0-75% (Possible)	Zooplankton: 75-85% (Probable)		
2167	Water	Zooplankton: 0-75% (Possible)	Zooplankton: 75-85% (Probable)		


GAIA
Logout
Annotate Points
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Vendor ID: 21MAR21152115-S1BS-507583593010_01_P003
Interesting Point ID: 2013
Sensor: WorldView-3
View all points in this area
Annotations Submitted: 3068
Existing Reviews
Species
Confidence
None
None
N. Atlantic right whale
0-75% (Possibl
Unknown whale
75-85% (Proba
Remove Point
Not Animal
Species *
Confidence *
Blue whale
Bowhead whale
Bryde's whale
Fin / Sei whale
Fin whale
Gray whale
Humpback whale
Killer whale
N. Atlantic right whale
N. Pacific right whale
Omura's whale
Rice's whale
Seal Hawaiian monk
Seal unknown
Sei whale
Southern right whale
Sperm whale
Turtle
Unknown
0-75% (Possible)
75-85% (Probable)
85-100% (Definite)
Street Map
Satellite
Search Area
50 m
© OpenStreetMap contributors.
Brightness:
Contrast:
Saturation:

Review Duplicates

North Atlantic Right Whales in Cape Cod Bay 2020-2024

This page shows Points of Interest (POIs) with animal classifications that are within 100 meters of each other.

No duplicate POIs found within 100 meters of each other.

Export Results

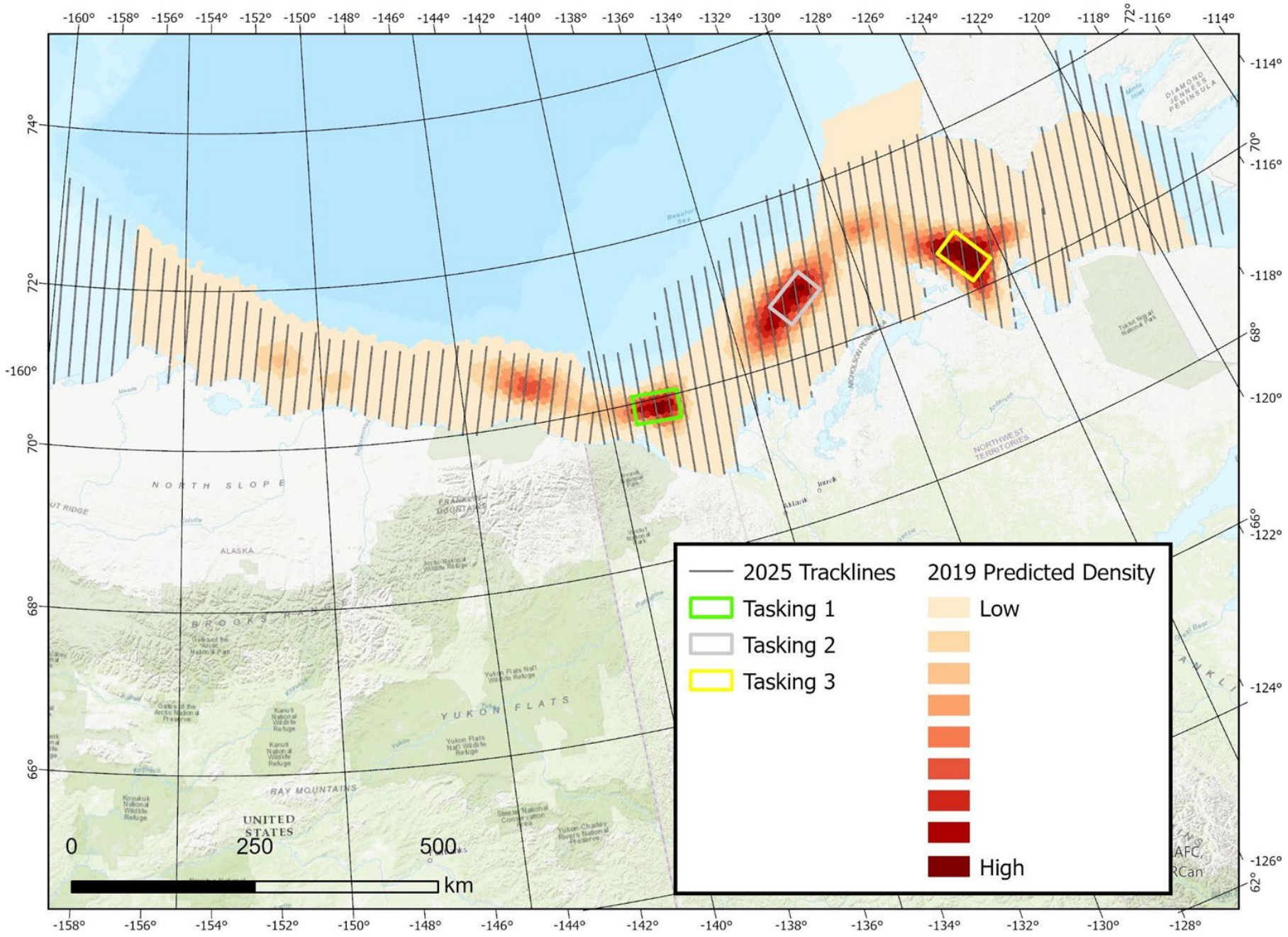
North Atlantic Right Whales in Cape Cod Bay 2020-2024

Data Export

Export confirmed whale annotations for external analysis and reporting.

Download BAS CSV

Download WhaleMap CSV



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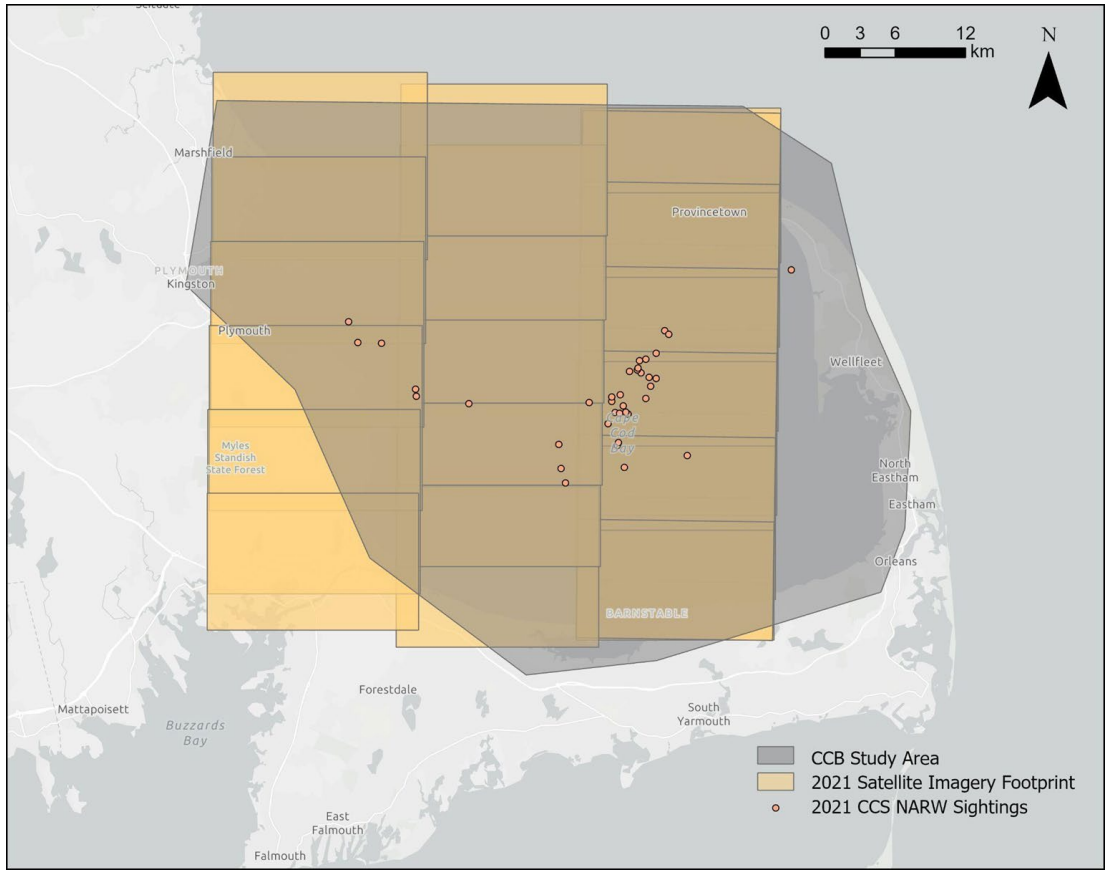
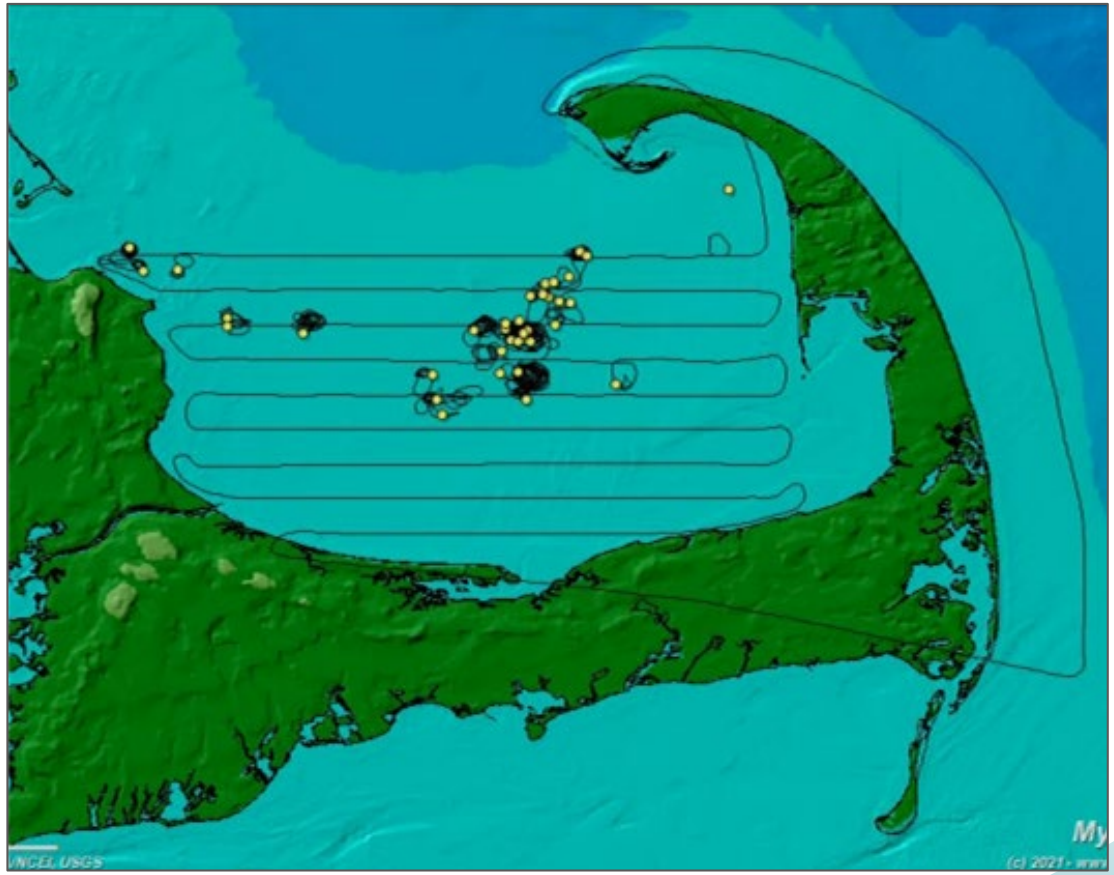

0 3 6 12
km
N
Marshfield
Provincetown
PLYMOUTH
Kingston
Plymouth
Wellfleet
Myles
Standish
State Forest
North
Eastham
Eastham
Orleans
BARNSTABLE
Forestdale
Mattapoisett
Buzzards
Bay
South
Yarmouth
East
Falmouth
Falmouth
CCB Study Area
2021 Satellite Imagery Footprint
2021 CCS NARW Sightings



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