Basic Information

This section contains basic information about the dataset, suitable for a minimal metadata entry.

Title: Commercial whale watching in British Columbia

Dataset ID: whale-watching-bc

Status: Completed

Quality Control: Completed

Summary:.
These commercial whale watching data are comprised of two datasets. First, the 'whale_watching_trips_jun_sep_british_columbia' data layer summarizes commercial whale watching trips that took place in 2019, 2020 and 2021 during the summer months (June to September). The second data layer, 'wildlife_viewing_events_jun_sep_british_columbia' contains estimated wildlife viewing events carried out by commercial whale watching vessels for the same years (2019, 2020 and 2021) and months (June to September). Commercial whale watching trips and wildlife viewing events are summarized using the same grid, and they can be related using the unique cell identifier field 'cell_id'.

The bulk of this work was carried out at University of Victoria and was funded by the Marine Environmental Observation, Prediction and Response (MEOPAR) Network under the 'Whale watching AIS Vessel movement Evaluation' or WAVE project (2018 – 2022). The aim of the WAVE project was to increase the understanding of whale watching activities in Canada's Pacific region using vessel traffic data derived from AIS (Automatic Identification System). The work was finalized by DFO Science in the Pacific Region.

These spatial data products of commercial whale watching operations can be used to inform Marine Spatial Planning, conservation planning activities, and threat assessments involving vessel activities in British Columbia.

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Cite this data as: Serra-Sogas, Norma; Nesdoly, Andrea; Murray, Cathryn. Commercial whale watching in British Columbia. 2022.

Start Date: 2019-06-01

End Date: 2021-09-30

Contact Information

This section contains contact information for the data creator and program manager.

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General

General metadata compatible with the Canada Open Data metadata standard.

Topic Category: oceans

Date Completed: 2022-08-01

Date Published: 2022-09-27

Update Frequency: As needed

Dataset Level: Dataset

Keywords (GoC Thesaurus): whales

Science

This section contains metadata specific to the Science branch at DFO.

Science Keywords: AIS, Automatic Identification System

Theme: Marine Mammals

Methods:
Encoded Canadian Coast Guard (CCG) Automatic Identification System (AIS) data (2019, 2020 and 2021) was decoded by Andrea Nesdoly using scripts developed in Python. This allows access to vessel information such as vessel positions, timestamp, vessels unique identifier or MMSIs (Maritime Mobile Service Identity), vessel speeds and course.

Afterwards, the AIS data was cleaned by removing entries that met the following criteria:
• duplicate AIS messages received within a 10 second timespan;
• stationary docked vessel in a harbour;
• invalid vessel positions with speed over ground greater than 70 knots; and
• invalid vessel positions with a sudden change of direction.

A list of commercial whale watching vessels based in British Columbia and Washington State and their corresponding MMSIs (Maritime Mobile Service Identity) was compiled from the whale watching companies and Marine Traffic (www.marinetraffic.com). This list was used to query the cleaned CCG AIS data to extract AIS positions corresponding to commercial whale watching vessels.

AIS data was then divided into three subregions: south coast Vancouver Island including Puget Sound, west coast of Vancouver Island, and north-east Vancouver Island. Datasets containing commercial whale watching trips and wildlife-viewing events were generated for each sub-region. A commercial whale watching trip was defined as a set of consecutive AIS points belonging to the same vessel departing and ending in one of the previously identified whale watching home ports. Each identified trip received a unique identifier.

A classification model (unsupervised Hidden Markov Model) using vessel speed as the main variable was developed to classify AIS vessel positions into wildlife-viewing and non wild-life viewing events. Each commercial whale watching trip was analyzed using the classification model to identify one or more wildlife-viewing events. Each wildlife-viewing event received a unique identifier.

Commercial whale watching trips in the south and north-east of Vancouver Island were limited to a duration of minimum 1 hour and maximum 3.5 hours. For trips in the west coast of Vancouver island the maximum duration was set to 6 hours. Wildlife-viewing events duration was set to minimum of 10 minutes to a maximum of 1 hour duration. These duration thresholds were applied after exploratory analysis were carried out in R and adjusted based on feedback from commercial whale watching operators. The same thresholds were applied for each year.

Cleaned AIS positions with whale watching trip information for each sub-region and year were imported to ArcGIS Pro to complete the following data processing:
1. Imported AIS vessel positions were saved as a point feature dataset.
2. Tracks were then generated using the tool 'Point to Tracks Segments'.
3. Tracks from each sub-region and same year were combined using the tool 'Merge'.
4. Tracks belonging to the summer period (June 1 to September 30) were saved as a separate layer.
5. Tracks were dissolved using the trip unique identifier to obtain one field entry for each whale watching trip.
6. Whale watching trip datasets for each summer period were intersected with a grid of 500 by 500 meters resolution.
7. Summary statistic tables were extracted for each year using the cell unique field and calculating the number of trips and distance travelled within the cell.
8. Output tables (one for each year) were then joined back to the grid dataset using the cell ID field, and then saved as a new dataset.
9. Undesired fields were deleted and remaining fields renamed.

AIS positions representing wildlife-viewing events for each sub-region and year were imported to ArcGIS Pro to conduct the following data processing;
1. Imported AIS vessel positions were saved as point feature dataset.
2. Positions found within the boundaries of harbours and marinas were eliminated to remove the likelihood of false positives.
3. Positions found in narrow passages or very shallow waters (i.e., Fraser Delta) were also removed to reduce the number of false positives.
4. From the remaining points, tracks were generated using the tool 'Point to Tracks Segments'.
5. Tracks longer than 2000 meters were deleted as well as tracks with an estimated speed greater than 14.5 knots.
6. Wildlife-viewing tracks belonging to the summer period (June 1 to September 30) were saved as a separate layer.

7. Summer wildlife-viewing tracks were intersected with the same grid used in the whale watching trip analysis of 500 by 500 meters.
8. The duration of the wildlife-viewing events per grid cell was calculated using the estimated speed per cell (this is carried over from the 'Points to Tracks Segments' tool) and the distance travelled per cell (this is automatically calculated after the intersection).
9. Wildlife-viewing events from each sub-region and same year were combined using the 'Merge 'tool.
10. Summary statistic tables were calculated for each year using the cell unique field and calculating the number of wildlife-viewing events and event duration per cell.
11. Output tables (one for each year) were then joined back to the grid dataset using the cell ID field, and then saved as a new dataset.
12. Undesired fields were deleted and kept field renamed.

Data Sources:
Oceans Network Canada (ONC) provided encoded AIS data for years 2019, 2020 and 2021, within a bounding box including Vancouver Island and Puget Sound used to generate these products. This AIS data was in turn provided by the Canadian Coast Guard (CCG) via a licensing agreement between the CCG and ONC for the non-commercial use of CCG AIS Data. More information here:
https://www.oceannetworks.ca/science/community-based-monitoring/marine-domain-awareness-program/

Molly Fraser provided marine mammal sightings data collected on board a whale watching vessels to develop wildlife-viewing events classification models. More information about this dataset here:
https://www.sciencedirect.com/science/article/pii/S0308597X20306709?via%3Dihub

Scripts or Software Routines: .
Andrea's GitHub link: https://github.com/nesdolya/WAVE_public

Spatial Data Quality:
Location information (lat/long) in CCG AIS data is acquired from GPS units on board vessels and they are estimated to be within 100 meter of positional accuracy. Vessel positions were converted to tracks by a straight line. The distance between vessel positions varied as it depends on the speed of the vessels (e.g., the lower the vessel speed, the lower the transmission rate and the large the gap between positions). Some tracks crossed over land or had unrealistic trajectories. Note that vessel track sections going over land were not removed from the dataset to maximize the amount of data used in the analysis. Because data was going to be aggregated over several months using a relatively coarse grid these inaccuracies in the data would not have a great impact overall.

Whale watching trip data was cleaned by applying trip duration thresholds identified after exploratory data analysis and adjusted based on feedback from commercial whale watching operators. The wildlife-viewing events datasets was cleaned by removing large track segments (greater than 2000m) and/or segments with estimated speeds over 14.5 knots. Tracks were aggregated using a grid with 500 by 500 meters cells. Any original positional inaccuracies from the AIS data positions (approx. 100 meters) are inconsequential.

Positional Accuracy: AIS position accuracy is 100 meters

Attribute Accuracy: Attributes expected to reflect real-world conditions.

Logical Consistency:
Note that vessel track sections going over land were not removed from the dataset to maximize the amount of data used in the analysis. Because data was going to be aggregated over several months using a relatively coarse grid these inaccuracies in the data are not expected to have a great impact overall.

Completeness:
The whale watching trips dataset and the wildlife-viewing dataset does not cover the entirety of the BC coast, only the southern half and extending to Washington State waters. This was the original area of interest for the WAVE project and no AIS data was requested for other parts of BC. Nevertheless, the bulk of whale watching activities take place in these areas with only one other known whale watching company based in Prince Rupert.

The datasets only represent whale watching activities during the summer months of June, July, August and September, for three different years: 2019, 2020 and 2021. These are the months with the highest number of whale watching trips in the area of interest.

These datasets only includes whale watching vessels equipped with AIS transponders. However, not all whale watching vessels actively operating in BC are equipped with AIS, although this number has increased since 2019. The number whale watching vessels in the south Salish Sea reported by Soundwatch was 138 vessels, out of which 43 carried AIS (31% of the fleet). In 2021, the number of vessel engaged in whale watching in the same area was 65 (drop caused by COVID-19) but 53 were equipped with AIS (81% of the fleet). The uptake of AIS by commercial whale watching vessels operating in BC and WA state in 2019 is due to the introduction of new regulations by Transport Canada (https://gazette.gc.ca/rp-pr/p2/2019/2019-05-01/html/sor-dors100-eng.html) and WA state regulations (https://wdfw.wa.gov/licenses/commercial/whale-watching).

Also, it is important to note that the whale watching industry was greatly affected in 2020, and to a lesser extent in 2021, due to COVID-19 restrictions. Most companies had to reduce operations (including the reductions in their fleet) starting the spring of 2020 because of the drop in tourism.

Absence Data:
Zero values, '0', indicate no whale watching vessel tracks or wildlife-viewing event tracks intersected with the grid cell.

Uncertainties:
The main source of uncertainty is with the conversion of AIS point locations into track segments, specifically when the distance between positions is large (e.g., greater than 1000 meters).

Use Restrictions: Data is restricted to DFO Science for spatial analysis only. Intended to assist in marine spatial planning

Temporal Coverage: Not provided

References:
Nesdoly, A. 2021. Modelling marine vessels engaged in wildlife-viewing behaviour using Automatic Identification Systems (AIS). Available from: https://dspace.library.uvic.ca/handle/1828/13300.

Collaboration: No collaboration outside of DFO

Confidentiality: Not Protected