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(RESEARCH ARTICLE)

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Cetacean citizen science: Using iNaturalist as a tool to study whales and dolphins

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Abstract

Cetaceans are commonly observed in open water or near shore habitats by citizen scientists, recreational boaters, tourists, and researchers. Sightings representing images with known time and location data may include an assortment of behaviors are readily visible, and can provide distribution data for future monitoring, validate beach strandings, or highlight localities where species occur. However, to date, there is no assessment across species of the presence, distribution, and behavior of North American cetaceans of the increasingly utilized citizen science application iNaturalist. To this end, this short communication presents distribution and temporal trends on presence, mortalities, and behaviors present in cetaceans within the USA. These findings highlight iNaturalist as a powerful tool and the potential application of this app for future cetacean research and environmental management.

Keywords: Environmental Biology; Behavior; Zoology; Biology

1. Introduction

Cetaceans are frequently observed in North America near shore or in open water by recreational and tourism boating operations, and in some cases by beachgoers who observe strandings or mortalities, both in coastal and open-ocean habitats [1,2]. In addition, a variety of behaviors can be readily observed by recreationalist for cetaceans including breaching, jumps, swimming, spy hopping, etc. [3,4,5,6]. Previous use of citizen science data for whales includes accessing sighting reports compiled on monitoring websites [7], on social media and iNaturalist for southern right whales [8], and incorporating citizen science whale watch data [9]. Moreover, citizen science sightings can enable researchers and managers to obtain local species distribution, seasonality, and group size data on cetaceans [10]. Standard methods for observing cetacean behavior include obtaining data from satellite imagery [11], traditional vessel surveys [12], and more recently drones [13]. Therefore, monitoring which incorporates citizen science approaches has the potential to provide researchers with a cost effective method for cetacean distribution and behavioral data.

These citizen science observations representing images with known time and location data may include an assortment of behaviors are readily visible, and can provide distribution data for future monitoring or highlight localities where strandings occur. However, to date, there is no assessment across species of the presence, distribution, and behavior of North American cetaceans of the increasingly utilized citizen science application iNaturalist. To this end, this research article presents distribution and temporal trends on presence, mortalities (strandings), and behaviors present in cetaceans within the USA. This research article reports on the species presence, documentation of behavior, and distributional trends of whales on the popular citizen science application iNaturalist within the USA. These findings highlight iNaturalist as a powerful tool and the potential application of this app for future cetacean research and conservation management.

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2. Material and methods

Data was obtained for this short communication from iNaturalist by searching, accessing, and downloading 1) a "full dataset" of observations of all cetaceans, and by 2) manually assessing images across species, or a "subset of observations". The author completed a search for "Cetaceans" or "infra-order Cetacea (Whales)", in the Explore tab of iNaturalist (www.inaturalist.org) on 18 March 2024 and subsequently downloaded data as a csv file. Additional Search parameters included location = USA, and "wild" and "research grade". Search was further filtered by only including observations up to 31 December 2023, in order to investigate whether annual observations were increasing annually, and to not bias sample size for year at the time of this publication. Observations for this full dataset were sorted across species and year. A Pearson Correlation was run on year and number of observations, with 2000 as the start year, to determine if the number of observations increased over time. This was the first year in which the total number of observations for all whales was five or above. Data was normally distributed.

A subset of observations (total of 3,219 images) were manually characterized between 18 March 2024 to 29 March 2024 for behavior, mortalities, and seasonal trends of dead strandings. For cetaceans with less than 200 observations (31 species), all images were assessed, while for species with over 250 observations, a subset of available images were characterized for each species (200 for 12 species). Behaviors noted included typical cetacean behaviors, fluke, spy hopping, breaching, blowing, jumping, parental care of mother and calf, etc. [14,15]. If five or more individuals were in an observation, it was noted as a "pod" group. In some instances, multiple images within the observation were examined, or text information from the observation was incorporated to identify a "pod" group. In observations where a dead cetacean carcass was present (mortality), the month of observation was recorded and repeat observations were excluded from analysis. Moreover, instances of bones or skulls left from harvesting were noted but excluded to determine mortality month across species. Primarily descriptive statistics on distribution across states and behaviors observed on iNaturalist cetaceans within the United States are reported for this short note.

3. Results

In total, there were 21,512 observations of cetaceans across 44 species for the United States with over 7,500 observers and 2,800 identifiers. The highest number of observations across all species were for Common bottlenose dolphin (7,275), humpback whale (6,018), gray whale (1,684), orca (1,667), common dolphin (912), harbor porpoise (907) and Risso's dolphin (731). Cetaceans represented by between 200 to 500 observations included spinner dolphin (481), blue whale (264), fin whale (253), Pacific white-sided dolphin (253), and Dall's porpoise (250). The remaining 32 Cetacean species had less than 200 observations.

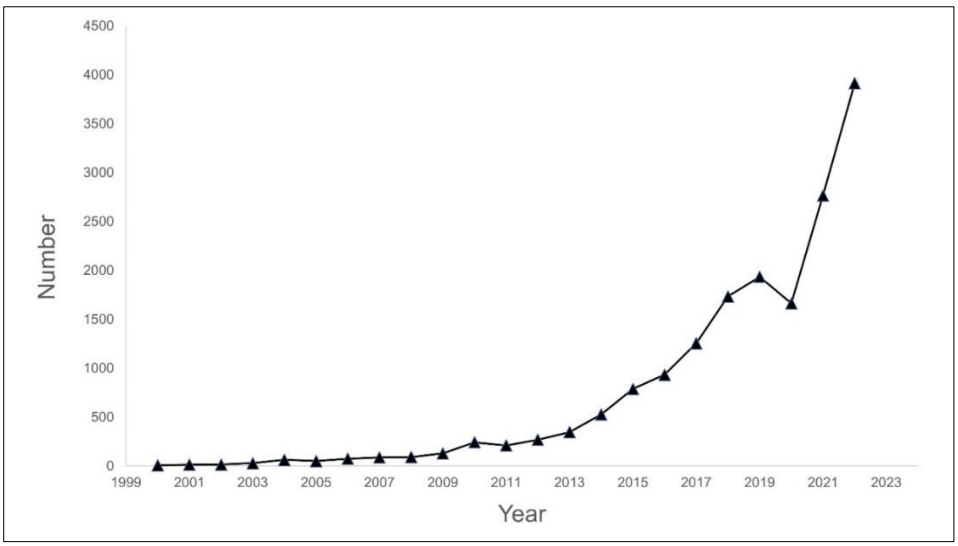

Figure 1 Number of observations of cetaceans per year on iNaturalist, up to 2023 indicating annual increase across time

Twelve species had between more than 10 and under observations, while twenty species were represented by less than 10 observations. Across species, the states with the highest number of whale observations included California (9,338), Alaska (2,643), and Florida (1,991; Table 1). Based on the full database, the number of observations across all cetaceans

increased annually, $r(22) = 0.837$, $p < 0.001$ (Figure 1). Months with the most number of observations total included summer, i.e., ~36.3% of observations occurring June to August.

The subset of manually characterized images resulted in the majority of images representing live cetaceans (83.17%) versus dead (12.83%). Mortalities were represented across several species (Figure 2). For observations of a dead cetacean where month was recorded (i.e. a carcass) which totaled 295, mortalities were distributed across all months, with the highest number of mortalities per month across all species was July (13.6%), followed by May (11.2%), and August (10.5%). For behaviors characterized from subset of live observations, the most frequent image included an observation of individual swimming (75.9%), swimming in a pod (7.9%), fluke (5.2%), blow (3.6%), jumping/backwards or sideways jumping (2.6%), parental care (1.5%), spy hopping or surfacing behavior (1.3%), and feeding (0.6%). Interestingly, several observations of feeding included group bubble feeding in humpback whales (Figure 3).

Figure 2 Representative images from iNaturalist showing (A) polar bear feeding on bowhead whale, (B) striped dolphin mortality due to shark attack, (C) harbor porpoise mortality scavenged by bald eagle, and (D) orca observed attaching common dolphin. Images obtained from iNaturalist under Creative Commons, from following users: Barna Takats, joescience1, Tim C. (bend2000), and Davis Provan

Additional observations of note across species included ecological interactions such as scavenging of harbor porpoise by a bald eagle, seagulls feeding on striped dolphin carcass, a polar bear feeding on bowhead whale, and vultures near a pygmy sperm whale mortality. Some mortalities were still in open water, including a beluga, sperm whale, harbor porpoise apparently killed by boat propeller, and a blue whale with potential ship collision with blunt force trauma as indicated by notes for observations. One mortality of a striped dolphin was reported as due to gunshot, while a northern right whale dolphin and a Common bottlenose dolphin was due to shark attack, with bite outline clearly visible. One observation of a North Atlantic right whale included two adult individuals repeated clasping, belly to belly and swimming indicative of potential copulation or reproductive behavior. Lastly, a common dolphin was observed at top speed socializing directly below another individual, while several images included orcas feeding or harassing other cetaceans.

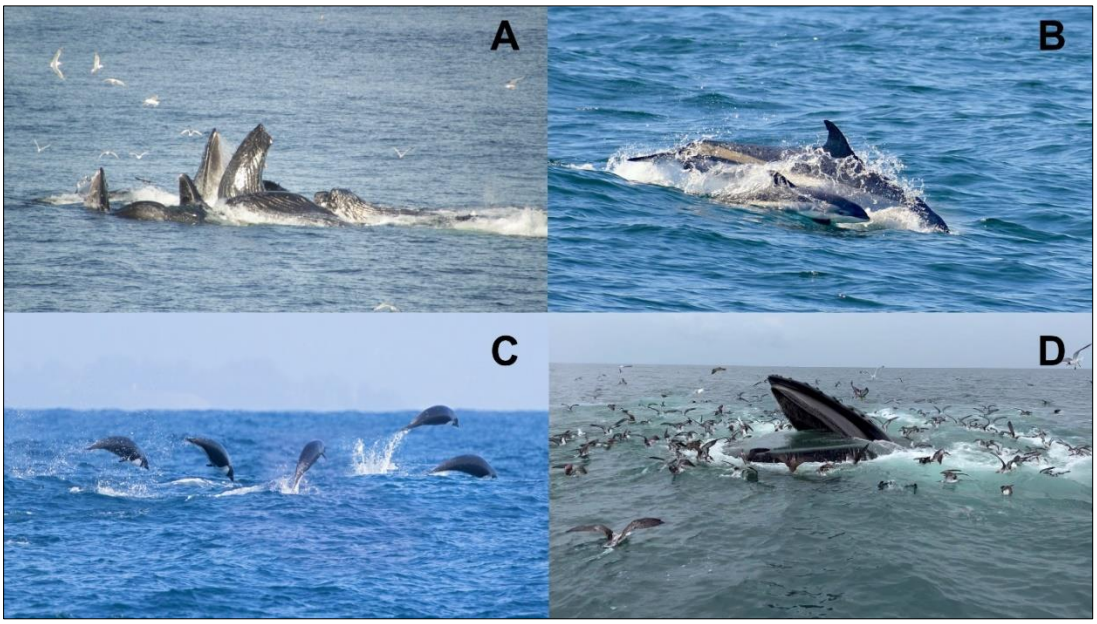

Figure 3 Representational behavioural observation images of cetaceans on iNaturalist, including (A) group bubble net feeding in Humpback whales, (B) parental care in Atlantic White sided dolphins, C) Pod of Northern Right Whale Dolphins jumping, and D) feeding in Humpback whale individual. Images obtained from iNaturalist under Creative Commons, from following users: fratercula640, Dean Hester, Markc666, and glide2277

4. Discussion

This research article presents novel data across cetacean species represented in an increasingly utilized citizen science application. In summary, iNaturalist appears to be a complementary method for monitoring cetacean behavior, mortality, distribution, when compared to more traditional survey methods, albeit with some caveats. While some species were less represented on iNaturalist, they may still be useful for monitoring mortality locations. For example, observations for the long-finned pilot whale were all mortalities (carcasses on beach), however the total number of observations was only seven. This was similar for Cuvier's beaked whale. Therefore, the high incidence of mortality could be biased due to a low number of total observations for some cetaceans or overall rarity of some populations. Moreover, at least two mortalities for the Common Dolphin, mentioned domoic acid, within the text of observation, indicating the general public's knowledge of potential issues, or factors associated with mortalities, even though it was not possible to determine based on an image if this was related to specific mortalities. This has previously been noted as present as a marine biofilm present in several marine mammals in California [16]. However, some stranding of live cetaceans included text information in observation that indicated rescue and rehabilitation by a variety of marine mammal rescues from either local state, federal, and private entities (aquaria, etc.). Interestingly, for the bowhead whale, many images include whale carcass or bones left after harvesting by permit of indigenous Inupiat, as well as one observation of a polar bear feeding on carcass. Future research could compare population trends with presence on citizen science platforms like iNaturalist or in combination with other local citizen science monitoring programs or conduct research on spatial patterns of "hot spots" for strandings using GIS [17].

Parental care was observed across several species (Common bottlenose dolphins, orcas, harbour porpoises, etc.), indicating iNaturalist may provide researchers with data on this important behavior, as cetacean calves are often dependent on mothers for survival and protection [18]. Several observations also included feeding behaviors, of note the observations for humpback whales which included images showing "bubble net" feeding group behavior of multiple (~3-7) individuals. In addition many images of humpback, gray whales, blue, and North Atlantic right whales were taken by observers which showed only the fluke in image observation. Spy hopping surfacing behavior was readily observed for several species including orca, short-finned pilot, North Atlantic right, common minke, gray, and humpback whales. Indeed whale watching data may allow for photographic evidence of behaviors, and has allowed documentation of successful observation of birth in whales [19].

Table 1 State standard abbreviation and number of cetaceans per state on iNaturalist full dataset reported in this short communication listed alphabetically

State	Number
AL	151
AK	2,643
CA	9,338
CT	4
DE	126
FL	1,991
GA	115
HI	1,184
LA	158
ME	271
MD	85
MA	629
MS	99
NH	24
NJ	539
NY	187
NC	328
OR	379
RI	21
SC	511
TX	865
VA	326
WA	1,538

One caveat of this research article, is that each observation represents a “snapshot of time” in that actual pod sizes of some groups of cetaceans may be larger, or if 1-3 individuals were in image observation, it may misrepresent pod size, e.g., if images failed to capture the entire pod near the surface. In addition, pod size is highly variable across cetaceans, ranging from one to twenty [20,21]. However, in some cases textual information conveyed pod size or observations included multiple images. In addition, some behaviors were likely influenced by observers taking the image, which included citizen scientists on whale watching tours, or recreationalist boating, all of which whose presence, speed or proximity of boat, etc., may have resulted in cetacean behaviors observed being somewhat biased as observer was present. For whale-watching observations, previous research has indicated behavioral responses to observers varies by species [22]. While behavioral assessment of cetaceans should consider observer bias, iNaturalist observations may represent “anecdotal” reports of single events [23], which may still be of interest to researchers quantifying behaviors and distributional presence across species. While iNaturalist has the potential to be a useful tool for citizen science, researchers should consider the challenges of using images for cetaceans, as there is an inherent bias in species distribution, unequal spatial and temporal coverage, and possible misidentification for some species where images show a portion of morphology, etc. However as citizen science observations continue to increase, new methods such as open source automated recognition and identification software could be applied, possibly resulting in utilizing data from repeated observations of dorsal fins for mark-recapture [24]. Subsequently, images which show ample portions of

body length of cetaceans could utilize deep learning to extract morphological measurements for body condition, as has been applied for cetaceans in drones [25].

While limited in comparison with more traditional survey methods for cetaceans, this research article represents a novel methodological advance in accessibility of data and seasonal monitoring to complement ongoing population assessment trends and incidents of mortalities alongside documentation of behaviors. Obtaining distribution data on presence of cetaceans via the free iNaturalist platform can enable assessment of high-use habitats across the United States as a complementary method to abundance data derived from traditional surveys [26], in addition to highlighting the need for future conservation protection efforts around these areas. Marine taxa with greater richness are often well represented on iNaturalist [27], indicating that this platform can lead to monitoring not only cetaceans, but also other vertebrates and invertebrates marine biodiversity. This novel short communication finds that annual observations are increasing across cetacean species, indicating iNaturalist may provide a valuable tool for future monitoring by citizen scientists. This may prove vital, given the consideration that many species, especially the great whales are still facing threats even though they are protected under the Marine Mammal Protection Act [28] and that clearly strandings and mortalities are still occurring and require further investigation and research. As there remain gaps in knowledge for some cetacean localities related to conservation, in part due to large area of coastlines across the world [29], citizen science monitoring via iNaturalist holds much promise for future marine management and documentation of seasonal strandings and mortalities as well as behavioral observation across cetacean species. Lastly, researchers may be able to further engage the public by promoting use of this increasingly utilized citizen science application and database.

5. Conclusion

The findings of this research indicate that iNaturalist holds much promise for the future study of Cetacean behavior, environmental biology, and conservation research. Moreover, as this freely available database continues to increase in use, the benefits of utilizing citizen science observations are great given the number of dolphins, whales and likely other species inhabiting marine environments. Therefore, future work should focus on using this citizen science application and database to monitor at risk species in both aquatic and terrestrial environments. In conclusion, this study highlights an approach which can be applied to not only other taxonomic species, but also to other geographic regions around the world, where population declines may be threatening local biodiversity.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The author declares that this short communication does not have any conflict of interest.

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