HMCS Yukon: A Case Study in Marine Citizen Science

Abstract

The HMCS Yukon is a 366 ft long former Canadian warship that was sunk in about 100 ft of water off the coast of San Diego, California ( 32.7800, -117.2853) in 2000 to act as an artificial reef. The first scientific study of the marine life on the Yukon was done in 2005 by the San Diego Oceans Foundation and Dr. Ed Parnell of Scripps Institution of Oceanography.

This study will document the current changes in the marine biodiversity that has colonized the shipwreck since the previous study. High resolution cameras and iNaturalist, a citizen science app which is maintained by the California Academy of Sciences, were used to inventory the taxonomic diversity of marine life on the HMCS Yukon as of 2020.

Introduction

In 2000, The HMCS Yukon, a 366 ft long former Canadian warship was sunk in about 100 ft of water off the coast of San Diego to act as an artificial reef. The first scientific study of the marine life associated with the Yukon was done in 2004 by the San Diego Oceans Foundation and Dr. Ed Parnell of Scripps Institution of Oceanography. In 2003, the authors as well as several other advanced divers, were invited to be some of the early Yukon Research Divers after it sank.

The scientific usefulness of artificial reefs has been the subject of some controversy over the years, with many arguments on both sides of the issue, a debate which is beyond the scope of this study.

Parnell used a program consisting of trained volunteer divers to conduct fish counts on permanently established transect lines, as well as photographing quadrats attached to the hull and deck. No data were collected inside the vessel for safety reasons.

“The volunteer program was successful as a pilot program for implementing fish and invertebrate studies using trained volunteers. The results indicated that fish count data were consistent among the most experienced fish counters. However, because the study was voluntary, sampling effort was random.” Parnell (2004)

A major disadvantage of this method was that, with the exception of one or two quadrates which were photographed on a semi-regular basis, most of the data were collected by divers trained in visual recognition of fish species—a method which is only as good as the divers’ fish ID training. Some divers were better at species recognition than others, so this affected the quality of the data obtained by this method.

Parnell says about this study,

“One of the greatest concerns for the monitoring project was the accuracy and precision of the divers This is a serious concern for professional research divers and is of even greater concern for volunteer divers. This issue has been addressed in a rigorous study in Florida that was specifically designed to test the abilities of trained volunteer divers to record environmental parameters and to count fish (Halusky et al. 1994). The divers were able to successfully record most of the environmental parameters, but there were many problems with the fish counts that were attributed to insufficient training and variable levels of skill among the divers (Parnell, 2005).” .

And, this is to say nothing of variable conditions on the ship, which included low visibility, strong currents and depth-related narcosis.

2015 Ocean Sanctuaries Begins Diver Survey

Having been involved in the above described initial diver survey of the Yukon in 2003, we aware of the limitations of the methodology. Not only did it rely on a diver’s ability to identify marine species from brief training, but, without a photograph, it was not a photographically documented encounter with a given species. It was only a ‘best guess,’ which is not scientifically reliable data. Shortly after these initial diver surveys were done, in the mid-to-late 2000s, small, portable and inexpensive high definition cameras, such as the Go Pro became widely available, allowing more divers to take both video and still photographs underwater.

AI Revolution

This development, combined with a contemporary revolution in the field of Artificial Intelligence (AI), allowed would-be citizen science divers to upload their photographs to iNaturalist (a wildlife database maintained by the California Academy of Sciences) which uses a smartphone app developed by Scott Loarie and his team at iNaturalist and the California Academy of Sciences, using neural networks to compare photographs taken by the user to their database of over 30,000 species of plants and animals (Bear, 2017).

“Users upload their observations to the web portal. These observations are identified and vetted by the online community first, in order to become Research Grade observations. Users create Guides to help other users identify species. Observations that aren’t validated are considered Casual observations. Research Grade’ observations are eventually uploaded into the GBIF database and used by Projects within iNaturalist (Boone, M. E., & Basille, M., 2019).

While not yet perfected, nonetheless, the AI in iNaturalist can identify photographs of most flora and fauna down to at least the genus level and, with the above-mentioned accuracy safeguards in place, photographs of species are identified with a high degree of accuracy--depending on the taxa category. 6

Since the early 2010s, there has been a small cadre of advanced divers in San Diego who know how to use upload photographs taken on the Yukon and upload them to iNaturalist, which is used to collect and store photographic and taxonomic data obtained from the Yukon.

Methodology

The methodology used was simple.

1. Advanced divers volunteer to take photographs while doing their normal dive on the Yukon--being certified divers, they are responsible for their own safety and are not 'diving for Ocean Sanctuaries,' thus avoiding liability issues.

2. Divers randomly take photographs of vertebrates and invertebrates during the normal course of their dive.

3. Upon returning home, they upload their photographs to their account in iNaturalist, being sure to add it manually to Ocean Sanctuaries' 'Yukon Marine Life Survey' Project' selected from a drop-down menu on their page. This ensures that their photographs go into Ocean Sanctuaries' Project iNaturalist database, which is maintained by the California Academy of Sciences.

4. Once uploaded, the photographs are first scanned by iNaturalist's AI algorithm, which compares it to their database of over 30,000 species of flora and fauna, including marine life.

5. The photographs are then further vetted by marine biologists or experienced marine naturalists at CASA for determination of 'Research Grade' classification.

6. All Ocean Sanctuaries' data is 'open source,' meaning it is accessible to the general public, as well as any naturalists or marine scientists who wish to examine it. The only requirement is to have an iNaturalist account to view data.

7. Transect lines were not used, due to general safety reasons. Transect lines left behind from the 2004 study remain on the wreck and over time, based on our personal experience, have become entanglement and safety hazards, so they were not used.

Observations

Between 2015 and 2020, Ocean Sanctuaries' citizen science divers (9 total) have entered a total of 237 observations, which included 58 Species, from 2015 to 2020. Please see references below for specific examples.

Most species were sessile or free-swimming fish, but, others documented on or near the ship, could not be considered 'native' to the artificial reef, because they were salp species, such as Twin-sailed Salp (Thetys vagina) which drift with the currents and were simply observed in or around the ship on a particular day.

Discussion

How is this data being used by scientists? To quote from the iNaturalist Data Export page: " [The database] GBIF ingests most of our Research Grade, licensed observations, and their export tools are excellent. GBIF exports also come with a DOI you can cite if you publish research based on the data you export, and these citations are enormously helpful to us as they allow us to see how iNat data gets used."

Please see reference below for data sources.

Conclusion

This paper was designed for two purposes: 1) to compare the methodologies used in the two studies (Parnell’s in 2005 and Ocean Sanctuaries’ in 2015, respectively) and 2) to provide an updated species inventory for the Yukon for the years between 2015 and 2020. As far as we are aware, there were no other formal marine life studies done on the Yukon in the years between 2004 and 2015—most likely due to the inherent difficulties of doing such studies that depth (100 ft.), which, as mentioned earlier, often involve cold water, strong ocean currents and sometimes, nitrogen narcosis.

One final purpose was to demonstrate how recent changes in both data collection methods (photographic equipment) and data analysis (iNaturalist’s use of AI) have revolutionized citizen science. It is hoped that studies done using such methods will demonstrably add value to both marine science itself and as well as to the field of citizen science.

References

Bear, M. The Citizen Science Revolution and Artificial Intelligence, Elsevier, Sci Tech Connect, November 17, 2017, available at (<http://scitechconnect.elsevier.com/citizen-science-revolution-artificial-intelligence/>)

Boone, M. E., & Basille, M. (2019). Using iNaturalist to Contribute Your Nature Observations to Science (pp. 1–5) available at <https://journals.flvc.org/edis/article/view/107698>

iNaturalist Forum, available at https://forum.inaturalist.org/t/identification-quality-on-inaturalist/7507

Parnell, E. Ecological Assessment of the HMCS Yukon Artificial Reef

off San Diego, CA, January 7, 2005.

Unpublished pdf, p. 2 (this study is not hosted online, but is available upon request). Scripps Institution of Oceanography, Integrative Oceanography Division,

University of California, San Diego, La Jolla, CA 92093-0227

Prepared for: The San Diego Oceans Foundation

P.O. Box 90672

San Diego, CA 92169-2672

http://www.sdoceans.org

Parnell, 2005, p.10)

Parnell, 2005, p. 12)

Data Availability Statement:

Survey data are available here:

Ocean Sanctuaries Yukon Marine Life Survey on iNaturalist:

<https://www.inaturalist.org/projects/yukon-marine-life-survey>

Taxonomic List

<https://www.inaturalist.org/lists/589807-Yukon-Marine-Life-Surveys-Check-List?rank=species&view=taxonomic>

GBIF Data Export

GBIF.org (29 April 2020) GBIF Occurrence Download available at <https://doi.org/10.15468/dl.hjgjae> , License CC BY-NC 4.0, File 0 Bytes Simple Involved datasets 1

Acknowledgements:

Dr. Ed Parnell, for his pioneering efforts to establish a citizen science-bases survey of the artificial reef HMCS Yukon.

Ocean Sanctuaries Founder Barbara Lloyd for her contributions to data collection on the Yukon in both studies, as well as to orca researcher Josh McInnes for his initial peer review of this paper, as well as the 7 other Yukon research divers who assisted us in data collection.