SC/66b/WW/08

Whale and Dolphin Tracker: An Application for Data Collection on Platforms of Opportunity

Currie, J.J., Stack, S.H., McCordic, J.A., Kautman, G.D.

INTERNATIONAL WHALING COMMISSION

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Currie, J.J.,* Stack, S.H., McCordic, J.A., Kaufman, G.D.
Pacific Whale Foundation, 300 Ma`alaea Road, Suite 211, Wailuku, HI, USA 96793
Contact email: research@pacificwhale.org

Abstract

The whalewatching industry and other platforms of opportunity (PoPs) have the potential of making valuable contributions to the understanding of cetacean populations, contributing to the protection of natural resources and an enhanced understanding of poorly studied species. As such, there has been significant growth in utilizing data collected from PoPs. Pacific Whale Foundation (PWF) Eco-Adventures operates a fleet of 9 eco-tour vessels and has utilized these vessels since 2010 for opportunistic data collection and development of sustainable management practices. The PoP program utilized researchers onboard whalewatch vessels as dedicated observers who recorded detailed information on all cetacean encounters and marine naturalists who logged sightings on mobile web-application called Whale and Dolphin Tracker. The PoP programs have been shown to be cost-effective alternatives to dedicated research vessels, with the additional benefit of having whalewatch vessels contribute directly to the management and monitoring of marine mammals. To date, these programs have logged over 15,000 sightings of 10 different cetacean species, contributing significant data on abundance and spatial/temporal distribution of species. Adapting such programs to the global whalewatching industry has the potential to benefit cetacean populations worldwide.

Introduction

The utilization of vessels as platforms of opportunity (PoP) for data collection can be observed in current literature (*e.g.*, Constantine, 2001; Hellrung *et al*., 2001; Evans and Hammond, 2004; Kaufman *et al*., 2011; Cid *et al*., 2013; Davidson *et al.*, 2014), and utility of such contributions to cetacean research and management has been highlighted by the International Whaling Commission (IWC). Recent discussions have called for improved and streamlined methods for platforms of opportunity (PoPs) to collect information on cetacean distribution and abundance (IWC, 2015).

There are multiple clear benefits to expanding a standardized PoP data collection methodology throughout various regions. Studying cetacean populations, especially in isolated areas, can be costly, time consuming, and logistically difficult (Kiszka *et al*., 2004). As such, basic information such as abundance and distribution of some cetacean species is still poorly understood. Of the 75 species within the Balaenidae, Delphinidae, Iniidae, Phocoenidae, Physeteridae, Platanistidae, and Ziphiidae families evaluated for the IUCN Redlist, a total of 55% (n=41) were considered data deficient (IUCN, 2016). In addition to traditional systematic research surveys, alternative data collection methodologies such as platforms of opportunity (PoP) could be employed to aid in data collection of these poorly studied species (Moura *et al*., 2012).

Worldwide there are thousands of vessels that could easily incorporate opportunistic data collection and make an invaluable contribution to cetacean data collection. Implementing a shared web-based application on various PoP throughout the eco-tourism sector could greatly enhance cetacean monitoring efforts. Such efforts are especially needed in areas where baseline data are lacking and limited funding is available (Kaufman *et al*., 2011). The success of a PoP-based system would require: (1) a streamlined user interface; (2) an electronic recording and submission system; (3) standardized data recording methodologies; and (4) an online centralized database. The existence of such a system could benefit various organizations such as the IWC and the National Oceanic and Atmospheric Administration (NOAA) which could easily access this database of sightings organized according to species and regions.

The focus of this paper is to showcase how Whale and Dolphin Tracker can provide a simple streamlined data collection platform thatcould be used to contribute to the protection and enhanced understanding of cetacean species.

Evolution of Pacific Whale Foundation's Eco-tours into Platforms-of-Opportunity

In 2000, PWF Eco-Adventures began utilizing their vessels as PoP by having the marine naturalists/guides log all cetacean sightings during each trip (Hellrung *et al*., 2001). The realization that these vessels could operate 365 days/year during varying sea states and gather large volumes of sighting data led to the development of a web-based application in 2010 called Whale and Dolphin Tracker (WDT). This application replaced the tedious paper-based recording system and allowed for real-time recording of cetacean sightings by species. Since then, WDT has undergone several revisions to improve user interface and adjust recorded metrics. In 2011 PWF launched a Research-on-Board (ROB) program which sent a trained researcher on PWF Eco-Adventure vessels to collect supplementary data not possible with the marine naturalist-run WDT program.

Using data collected from both eco-tour and research vessels, PWF developed "Be Whale Aware" guidelines. These guidelines were designed to help promote responsible whalewatching while minimizing negative impacts to whales and ensuring the safety of both humans and wildlife during whale watch activities. The creation of these guidelines showcases how research and eco-tourism can work collaboratively to develop new regulations.

A brief overview of each data collection and survey methodology is provided below along with details on potential conservation and management outcomes. For comparison purposes, systematic research surveys completed by PWF's research department during the same time period are also described.

Research-On-Board

The ROB program at PWF was implemented to determine the types of data that could be collected with a dedicated researcher stationed on a platform of opportunity, specifically whalewatches operated by PWF Eco-Adventures. Detailed information on data collection and survey protocols are outlined in Currie *et al*. (2016), and a basic overview is provided here. Data were collected by a single observer scanning the surface of the water and collecting data during two whalewatch trips/day from December to April. Data included vessel speed, GPS location, weather information, distance and angle to pods, group size, and behavior. When possible, researchers also collected identification photos to be used in the respective photo-identification catalogs for each species.

By stationing a researcher on board whalewatching vessels, the Pacific Whale Foundation research team was able to make the most of the whalewatching efforts in terms of the higher number of trips and increased overall survey effort with minimal additional costs. Additionally, the ROB program allowed for more data to be collected than possible with marine naturalists, whose first priority is narrating tours. Data from the ROB program can provide information on species abundance, habitat use, site fidelity, and interspecies interactions, contributing to conservation and management efforts.

Whale and Dolphin Tracker

In depth details on the build and data collection methodologies of WDT have been outlined in Kaufman *et al*. (2011) and Davidson *et al*. (2014), respectively, with updates and basic information discussed below. The features for the WDT program consist of a mobile web-based interface that can be accessed via a username and password. The data entry process involves marine naturalists/guides logging sightings using a mobile device on all PWF Eco-Adventure trips. The data fields and types included with each sighting are presented in **Appendix Table 1**. Where possible, data fields were set to populate automatically or presented as a preset list of variable to choose from, allowing for reduced variability in submitted data. If photo-identification or other usable behavior or morphological images are obtained during a particular sighting, the digital photo files can be uploaded to the system and associated with the sighting. All sightings are archived on PWF servers and uploaded to a live sightings map available to the public. Each user maintains unobstructed access to all sightings they have logged and can easily export the data for analysis or uploading to mapping software.

Joining WDT is simple and offers the ability to customize data fields for research organizations (**Figure 1**). Recognizing that PoP studies run by different organizations may

require specialized fields, WDT has been developed to allow organizations to request customized data fields to suit their preferences. However, a default set of basic data fields are provided to all users upon creating an account logging in, which represents the minimal data to be collected that can contribute to meaningful analysis.

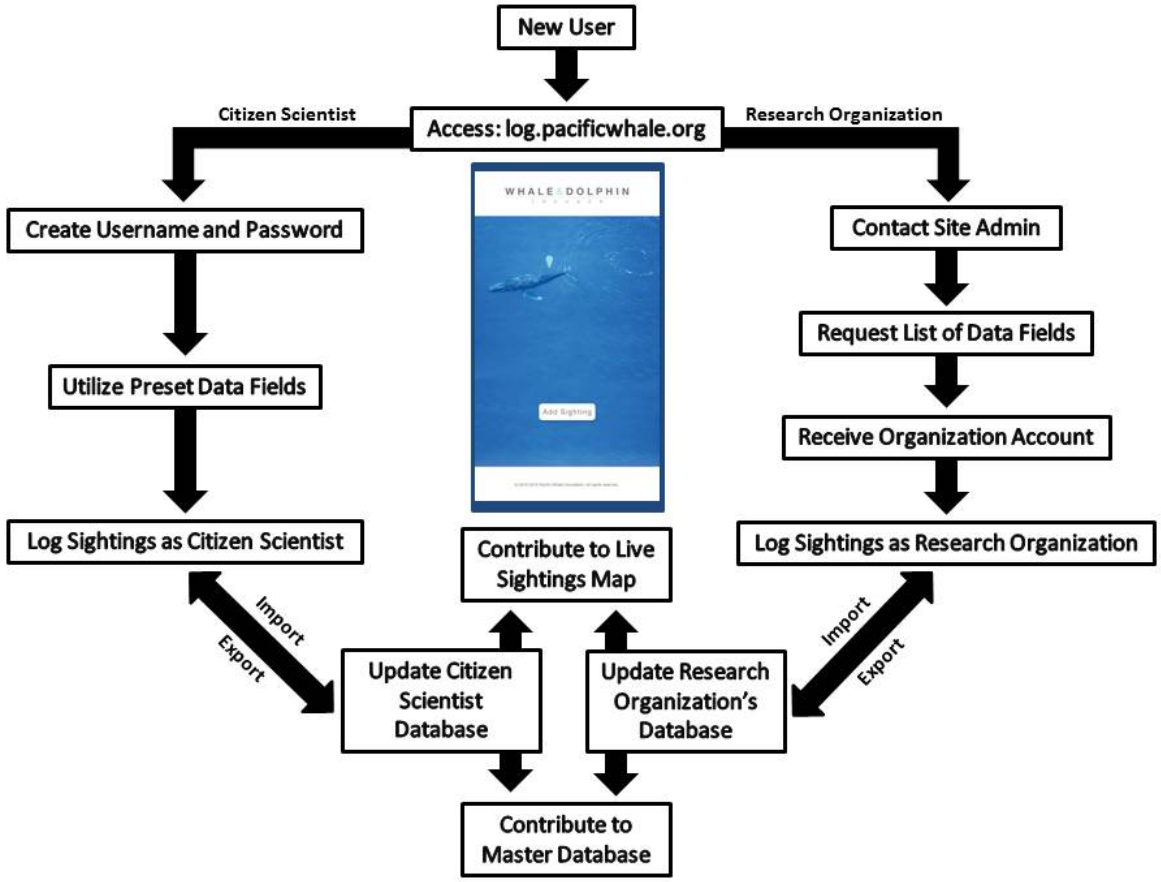

Figure 1: Schematic representing the two ways to join Whale and Dolphin Tracker based on user type.

The large volume of data collected from PWF's Eco-Adventure cruises alone highlights the potential large scale contribution PoP can offer with minimal additional investment (**Table 1**). Furthermore, preliminary analysis of data collected using WDT (Davidson *et al*., 2014) showed comparable results to previously published works on the spatial and temporal distribution of various species.

Table 1: Comparison of opportunistic and systematic surveys conducted from January 1, 2013 – December 31, 2015 within the four-island region of Maui, Hawaii.

	Eco-Tour Vessel Research on Board	Eco-Tour Vessel Whale and Dolphin Tracker	Research Vessel Systematic Research
Distance Surveyed (nm)	7,094	116,683	14,735
Number of Encounters	1,476	9,113	807
Number of Species Encountered	7	11	7
Days on Water	281	1,061	232

Systematic Research Surveys

Data were collected from a dedicated research vessel approximately twice/week using systematic line transect methodologies (Buckland *et al*., 2004). Observations were made by two designated observers and the boat operator while a fourth person acted as a data recorder. Data were collected on humpback whales if the initial sighting occurred within distance criteria described in Stack *et al*. (2013). Odontocete encounters initiated a focal follow, where photo-ID and behavioral data were collected. The following data were additionally recorded for all species: time and location (latitude and longitude) of sighting, vessel speed, age class, distance from boat, angle to group, and direction of travel. Environmental variables were also recorded at the beginning of each transect line and as they changed throughout the surveys.

Systematic surveys are widely used in cetacean research to estimate the density and/or sizes of wild animal populations with detailed methods described by Buckland *et al.* (2001; 2004; 2015). This rigorous sampling design ensures data collected adheres to strict assumptions associated with this method of data collection and subsequent analysis. As such, PWF's research department utilizes systematic transect surveys to assess the population structure, life history characteristics, habitat preferences, and home ranges for the whale and dolphin species found within the Maui four-island region. These data can be used to guide species-specific management techniques and provide better protection for the species, but it is expensive and time consuming to gather.

Comparison of Survey Effort

The differences in survey methodologies becomes quickly apparent when track effort is compared among ROB, WDT, and systematic surverys (**Figure 2**). The ROB surveys had dense coverage of a smaller portion of the survey area since the program was only completed on whalewatches; WDT surveys had dense coverage of the majority of the four-island region but lacked effort beyond scheduled trip routes; and systematic surveys had equal coverage of set survey area but had lower overall survey effort.

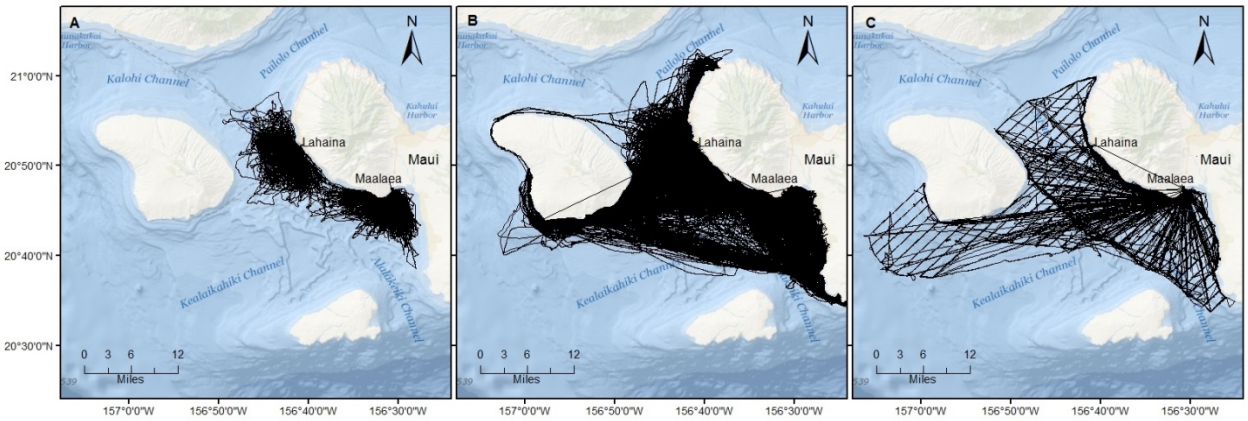

Figure 2: Line effort recorded for (A) Research on Board, (B) Whale and Dolphin Tracker, and (C) Systematic surveys completed within the four-island region of Maui from January 1, 2013 to December 31, 2015, depicting differences in spatial coverage for each method.

Recommendations for Scaling Platform of Opportunity Programs

Platforms-of-Opportunity have the potential of making valuable contributions to the understanding of cetacean populations by providing alternate, long-term sources of information (Moore *et al*., 1999; Kiszka *et al*., 2004; Williams *et al*., 2006). Despite some biases inherent with PoP surveys, data can be used in ecological models providing information on cetacean ecology (Moura *et al*., 2012) and distribution (e.g. Moore *et al*., 1999; Felix and Botero-Acosta, 2011). These data can then feed into species management and conservation plans contributing to the protection of marine resources (*e.g.*, Constantine, 2001; Evans and Hammond, 2004; Timmel *et al*., 2008; Felix and Botero-Acosta, 2011).

Management of species, particularly in areas where minimal data exist, should utilize all potential avenues of data collection. PoPs such as eco-tour vessels or marine mammal observers are viable alternatives to systematic surveys and often go out in in heavier environmental conditions, during varying hours, providing considerable effort not possible with systematic surveys alone. Indeed, there are various trade-offs between systematic and opportunistic surveys:

- Systematic surveys generally have additional details associated with sightings and the ability to gather additional information as needed. However, this usually requires a dedicated research team which can be expensive and time consuming.
- PoPs generally have limited time with specific pods and are constrained by schedules, which preclude dedicated data collection. However, trips have substantial spatial and temporal coverage.

Overall, opportunistic surveys collect large amounts of data with continuous temporal coverage, and systematic surveys collect smaller amounts of data with even spatial coverage.

Utilizing PoPs would allow for filling in of temporal and/or spatial gaps that may arise from a single survey method. Recent advances in analytical techniques to quantify habitat use in marine ecosystems (Guisan & Thuiller, 2005; Redfern *et al*., 2006) (*e.g*., species distribution models) have proven effective for analysis of data collected on PoPs. Furthermore, recent work has focused on utilizing both systematic on opportunistic data collection to increase observations and provide additional survey effort to evaluate populations (Muir *et al*., 2015).

Whale and Dolphin Tracker (WDT) serves as a scalable, effective means of collecting data from PoPs. The Pacific Whale Foundation ROB program provided a similar benefit in terms of additional effort and sightings compared to the systematic surveys; however, such a program requires access to a research organization that is willing and able to provide trained observers for eco-tourism trips. WDT could be made available on PoPs world-wide and would be relatively easy to implement on a large scale, requiring minimal investment in equipment and staff training (Kaufman *et al*., 2011). The streamlined electronic recording and submission allows WDT sightings to be logged in less than one minute with no post-processing required by data recorder. Implementing WDT on eco-tour vessels would greatly improve companies' contributions to scientific research. Regular use of WDT would also encourage collaboration between research groups, contributing to long-term database of sightings for use in future scientific projects.

Acknowledgments

We wish to thank Pacific Whale Foundation's members and supporters for providing the funding necessary to conduct this study. We are grateful to PWF's Eco-Adventure Tours crew (naturalists and captains) for their support of WDT and for contributing daily to the sighting logs

and tracks. Our gratitude goes to our volunteers and all research interns between 2013 and 2015. This research was conducted under NMFS permit
#16479.

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APPENDIX – Supplementary Materials

Table 1: Complete list of data fields currently utilized in Whale and Dolphin Tracker (accessed at log.pacificwhale.org)

Name	Field Type	Field Value	User Input
Type of Sighting	Dropdown Menu	-No Sighting -Whale -Dolphin	Manual Selection
Sighting Date and Time	Date/Time	MM/DD/YYYY – HH:MM	Automatic
Species	Dropdown Menu	-Humpback Whale -Bottlenose Dolphin -Spinner Dolphin -Spotted Dolphin -False Killer Whale -Melon Headed Whale -Pilot Whale -Sperm Whale -Hawaiian Monk Seal -Other Species	Manual Selection
Location	Latitude/Longitude	DD.DDDD°, -DDD.DDDD°	Automatic
Total Adults, Calves, and Unknown	Numeric	##	Manual Entry
Total Count	Numeric	##	Manual Entry
Behavior	Checklist	-Bow Riding -Breaching -Foraging -Travelling -Milling -Resting -Surface Active	Manual Selection
Swell Height (m)	Dropdown Menu	0 1 2 3 4 5+	Manual Selection
Wind Speed (kts)	Dropdown Menu	<1 1-5 6-10 11-15 16-20 20+	Manual Selection
Wind Direction	Dropdown Menu	NW N NE E SE S SW W	Manual Selection
Trip Departure Time	Time	HHMM	Manual Entry
Boat Name	Text	Full_Name	Manual Entry
Recorder Name	Text	Last_First	Manual Entry
Additional Comments	Text		Manual Entry