The ecology of bottlenose dolphins (*Tursiops truncatus*) in the Hauraki Gulf, New Zealand

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Abstract

Bottlenose dolphins (*Tursiops truncatus*) are one of the most studied cetacean species in the world. In New Zealand, this species is classified as *Nationally Endangered* and studies are generally limited to just a few known core areas. Herein, I examine the use of social media in citizen science as a means of collecting occurrence data of bottlenose dolphins in the inner Hauraki Gulf. A dedicated research vessel was employed to verify data collected by citizen scientists. This study also investigated the habitat selection of bottlenose dolphins at Great Barrier Island, an area only recently described for its importance to the north-eastern North Island population. Data collected for a behavioural budget and whistle repertoire were recorded on a dedicated research vessel with the aim of understanding habitat selection. Environmental variables were used to model behavioural states in order to determine how habitats were utilised by the dolphins. The whistle repertoire was assessed to understand how it correlated with behavioural states and group dynamics.

A total of 260 sightings of bottlenose dolphins were reported by citizen scientists between April 2015 and July 2016. Only 42 of these were independent reports. Of the total number of reports, 73.5% did not identify a dolphin species. Citizen scientists identified three species of cetacean. Killer whales (*Orcinus orca*) were often reported correctly, however all five reports of common dolphins (*Delphinus delphis*) were misidentified, and 33.3% (n=5) of the reports identifying bottlenose dolphin were either unconfirmed or misclassified. Researchers' verifying the identity of the species reported was the most useful method of confirming citizen science reports in this study (34.8%). Citizen scientists failed to detect dolphins on only three occasions that the research vessel or platform of opportunity did. Yet, citizen scientists were able to detect bottlenose dolphins more often than either the research vessel or platform of opportunity.

The number of independent citizen science reports, research vessel encounters and platform of opportunity encounters for bottlenose dolphins were similar over each austral season. Notably, only the platform of opportunity had encounters over summer, both of which were in deeper water, outside of the study area. Bottlenose dolphin group size was often underestimated by citizen scientists in this study, though rigid comparisons were not possible for group size or behavioural state due to small sample sizes. The proportion of total reports varied temporally between seasons, and was highest in the mornings for autumn and winter, but peaked during the afternoons in spring. Bottlenose dolphins did not appear to use the study area frequently and were usually recorded travelling.

The majority of behavioural observations at Great Barrier Island were made during winter and spring. Bottlenose dolphins were recorded between 13.5 and 24.1°C and in depths of 1.8 to 55.3m. The largest group sizes were recorded in autumn while the smallest group sizes were recorded most often in spring and summer. While the largest group sizes were recorded in the warmest sea surface temperatures and greatest depths, there was no significant difference between group size categories. Resting made up the largest proportion of the behavioural budget (32.1%), while foraging (8.2%) and socialising (9%) were rarely recorded. The models predicted that the behavioural budgets at Great Barrier Island were determined primarily by abiotic factors (e.g. depths and sea surface temperature).

The mean whistle rate, calculated as the number of whistles per minute per dolphin, recorded at Great Barrier Island for bottlenose dolphins was 0.50 (SD=0.53) and the highest whistle rate was recording during foraging (1.17, SD=0.98). There was no significant difference in whistle rates between group size categories. Whistles recorded lasted on average 0.84s (SD=0.52), with a mean frequency of 11.6kHz (SD=2.34). The parameters with the highest variation were the number of inflection points, length, and frequency range of whistles. The Ascending whistle type was the most commonly recorded, and particular whistle types were correlated to behavioural state and group size category.

This study represents the first instance that citizen science utilised social media in the Hauraki Gulf and suggests there is potential for continued monitoring of bottlenose dolphins with citizen science, if recommendations are applied. It also presents the first behavioural budget and whistle repertoire for bottlenose dolphins at Great Barrier Island. This study reported a unique behavioural budget and acoustic parameters that imply its importance for the north-eastern North Island population. Continued monitoring of this population is recommended to ensure this population is managed appropriately.

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ANOVA	Analysis of variance
BOI	Bay of Islands
ca.	Circa (approximately)
DE	Dolphin Explorer
df	Degrees of freedom
e.g.	Exempli gratia (for example)
etc.	Et cetera (and so forth)
GBI	Great Barrier Island
h	Hour
hp	Horse power
Hz	Hertz
i.e.	Id est (that is)
IHG	Inner Hauraki Gulf
IUCN	International Union for Conservation of Nature
kHz	Kilohertz
km	Kilometre
m	Metre
MMPR	Marine Mammals Protection Regulations
NA	Not applicable
NIWA	National Institute of Water and Atmospheric Research
p	P-value
POP	Platform of opportunity
RV	Research vessel
s	Second
SD	Standard deviation
SE	Standard error
SST	Sea surface temperature
USA	United States of America
WDWNS	Whale and Dolphin Watch - North Shore
WDWW	Whale and Dolphin Watch Whangaparaoa
X^2	Chi-square statistic