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Short Note

Social Media in the Service of Conservation: A Case Study of Dolphins in the Hellenic Seas

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The Hellenic Seas host a high diversity of cetaceans. With seven confirmed resident species, Greek waters are among the most important marine areas in the Mediterranean Sea. The Delphinidae family is represented by the common bottlenose dolphin (hereafter bottlenose dolphin) (*Tursiops truncatus* [Montagu, 1821]), the striped dolphin (*Stenella coeruleoalba* [Meyen, 1833]), the short-beaked common dolphin (hereafter common dolphin) (*Delphinus delphis* [Linnaeus, 1758]), and the Risso's dolphin (*Grampus griseus* [Cuvier, 1812]), with the first three species listed identified as the most abundant in this region (Frantzis et al., 2003). Nevertheless, knowledge on the distribution of these megafauna is still at an unsatisfactory level, and further investigation is needed, especially on local populations (Frantzis, 2009) in such a critical area as the Hellenic Seas, where five different areas are considered important for the biology of different cetacean species (Notarbartolo di Sciara & Bearzi, 2010).

Studies on cetacean distribution are key elements to a better understanding of their basic ecology and for developing appropriate management and conservation strategies. Given that they also function as umbrella species, effective conservation efforts for cetacean populations are essential for increasing protection of all marine biota (Roberge & Angelstam, 2004). To conduct either ship- or aerial-based cetacean surveys requires considerably large budgets. In addition, survey success can be negatively impacted by limited time availability—for instance, due to rapidly changing weather conditions. Over the last decade, due primarily to the lack of substantial funding, research effort in Greece has been limited, which has resulted in the present data deficiency on cetacean distribution in Greek waters (Nortabartolo di Sciara & Bearzi, 2010).

The widespread use of social media is emerging as a major trend in modern society. In 2013, 1.73 billion people used a social media platform at least once, with predictions anticipating that by 2017, this number will increase to 2.55 billion (eMarketer, 2013). This increase in the use of social media has garnered the attention of researchers from different scientific fields. Part of this interest lies in the association of social media with tourism (Hvass & Munar, 2012) and, more specifically, in its importance for travelers willing to share their travel stories (Xiang & Gretzel, 2010). Among the latter, boaters and sea lovers are particularly keen on sharing their experiences and encounters at sea. Nowadays, all social media platforms offer the possibility of manual tagging, geo-tagging, or automatic geo-tagging. Taking advantage of this feature, we can gather location information included in videos posted to social media sites; in this way, non-scientists meaningfully contribute to scientific research whether they intend to or not (Bonney et al., 2009b). By tracking video uploads from maritime tourists, fishermen, and others to Web-based sharing platforms such as YouTube, potentially valuable information on cetacean distribution can be obtained. Considering that maritime tourism is one of the most important industries in Greece, with an upward course (Diakomihalis, 2007), the possibility of videos posted to social media as a new tool must be explored—especially under the current harsh economic conditions which severely restrict funding for science (Katsanevakis et al., 2015).

The present study investigates the distribution of delphinids in the Hellenic Seas using online shared videos from people (e.g., maritime tourists and sea professionals) navigating through Greek waters. Web video material was gathered through two independent searches (S-I and S-II) using simple search queries on YouTube as the leading video sharing platform (Ricke, 2014). To prevent any bias, S-I and S-II were performed independently by one observer each. Assuming that the total number of existing YouTube videos depicting dolphin encounters in the Hellenic Seas at the time of the study (September 2014) was n_{yt}, S-I aimed to retrieve a number of videos as close as possible to n_{yt}. The S-II search was conducted as a more stochastic video search in order to establish whether simpler searches could yield video collections valid as subsamples of n_{yt} (i.e., representative in terms of total number of species and frequency of occurrence of each species). As a rule of thumb, both searches were restricted only to videos shared in personal user accounts and not in official YouTube channels from research projects, institutes, or nongovernmental organizations (NGOs) in order to secure independency in our video sample collections.

S-I searches were based on "species/location" queries made either directly within YouTube or via Google Search by restricting the search only to YouTube videos (i.e., selecting "Any source/ youtube.com"). The search was initiated using the generic query "dolphins Greece" in English, followed by a second search round including two more specific queries: "dolphins Ionian" and "dolphins Aegean." The resulting videos were placed in a YouTube list, which was then enriched through a twofold approach: (1) using more specific search terms such as common names of dolphins (e.g., striped dolphins) and geographic information referring to names of Greek islands, provinces, or popular coastal areas; and (2) deploying the full array of search tools offered by YouTube (e.g., geo-tags, lists of related videos, lists of suggested videos, and recommended channels) and those of Google Search, including filters on video quality, time, and duration.

S-II searches consisted of a much simpler query within YouTube using the terms "Dolphin*" and "Greece" followed by a second search round based on different queries using popular areas of the Hellenic Seas as location parameters (* is used in Web searches to denote a word in a search phrase). Similar to S-I searches, videos from S-II searches were also placed in a YouTube list. Double entries or different fragments of the same footage were used only once in the final analysis in order to ensure that each dolphin sighting was represented exclusively by a unique video. Moreover, videos with more than one sighting were also excluded.

Subsequently, each video from S-I and S-II searches was observed following the exact same procedure in order to identify the dolphin species shown (Figure 1). Species identification was primarily based on markings and color patterns in the dorsolateral area of the dolphin's body. In most cases, this was a relatively easy and straightforward process. On a few occasions, when the species could not be reliably determined or confirmed (e.g., dolphin far away, dorsolateral area not visible), videos were recorded as "unidentified." Based on the geo-referenced data available from each video included in the analyses, each video was identified to one of 25 locations in the study area (Figure 2). Video quality as displayed in YouTube; video duration; and any other information that could be extracted from examination, including dolphin behavior and observer's behavior toward dolphins, also were documented. Dolphin behavior was recorded as one of the following categories: aerial, bow-riding, wake-riding, percussive, feeding, or traveling as proposed by Acevedo & Würsig (1991)

To determine if species identification was dependent on the quality and duration of the footage, all videos were assigned a value of 0 or 1, depending on if the dolphin species was unidentified or identified, respectively. This binary information was subsequently analysed using a function of video duration (continuous variable) and video quality (discrete, ordered variable) using a Generalized Linear Model (GLM) with a binomial error distribution and a logit link. Finally, the frequency of occurrence of different dolphin species for S-I and S-II searches was compared using χ^2 contingency table analysis.

The searches produced 437 videos for S-I and 77 for S-II. The percentage of overlapping entries between both searches was quite low (2.7%; n = 14). Combined, the two searches yielded 500 unique videos. Of these, 12% (n = 58) had only general geographic descriptors, such as "Greece," "Hellas," and "Greek Sea(s)," without any further details about the exact location. Of the remaining videos (n = 442), 60% (n = 301) originated in the Aegean Sea, 27% (n = 135) in the Ionian Sea, 1% (n = 5) in the Cretan Sea, and 0.2% (n = 1) in the Cretan Passage, while there were no confirmed videos uploaded for the Levantine Sea (southeast Greece). Of the 25 identified locations (Figure 1; Table 1), the largest number of videos were from the Cyclades (n = 54) followed by the Dedocanese (n = 37) and the Sporades Islands (n = 35). The areas with the lowest number of posted videos were the Patraikos Gulf and the Creatan Passage, each with only one sighting.

Dolphin species were identified in 85.8% (n = 433) of the videos. GLM analysis showed that species identification was clearly dependent on dolphin behavior. When bow-riding, the probability of the dolphin species being identified increased by a factor of 7 (Table 2). On the other hand, neither video duration nor its relation with bow-riding behavior (i.e., amateurs tend to produce longer videos when dolphins were bow-riding)

Figure 1. Frame captures from YouTube videos showing morphological characteristics of each species: (a) bottlenose dolphin (*Tursiops truncatus*), (b) Risso's dolphin (*Grampus griseus*), (c) common dolphin (*Delphinus delphis*), and (d) striped dolphin (*Stenella coeruleoalba*)

had any significant effect on species identification success.

In regards to species frequencies, the most prevalent were the bottlenose dolphin (48%; *n* = 209), the striped dolphin (31%; *n* = 138), and the common dolphin (19%; *n* = 83). Mixed groups of striped and common dolphins were found only in two videos (0.4%), while Risso's dolphins were seen in one video (0.2%). The prevalence of bottlenose dolphins, striped dolphins, common dolphins, and unidentified species did not differ significantly between the two searches (Figure 3; χ^2 test: $p > 0.1$); however, the Risso's dolphin was only detected in S-I searches.

A common practice for studies that use data provided by non-scientists is to validate their findings with results from scientific literature (Bonney et al., 2009a; Dickinson et al., 2012; European Commission, 2013). The results of the present study (Table 2; Figure 3) were consistent with existing literature on the prevalence and distribution patterns of delphinids in the Hellenic Seas (Frantzis, 2009). Furthermore, the present findings coincide with smaller scale studies on cetacean distribution conducted in (1) the inshore waters of the Amvrakikos Gulf (Bearzi et al., 2008a; Gonzalvo et al., 2015) and the Evoikos Gulf (Zafeiropoulos & Merlini, 2003; Bonizzoni et al., 2014), where the only cetacean species present is the bottlenose dolphin; (2) the Thracian Sea (Altuğ et al., 2011; Ryan et al., 2013); and (3) the Gulf of Corinth, where mixed groups of striped and common dolphins were also reported (Frantzis & Herzing, 2002; Frantzis et al., 2003; Bearzi et al., 2011). It is noteworthy that in the latter area, both studies by Frantzis & Herzing (2002) and Bearzi et al. (2011) suggested hybridization between striped and common dolphins as a result of group intermixing—a possible case of hybridism in which the dolphin seemed to be of intermediate pigmentation was observed in a

Figure 2. Map of Greece with all the 25 locations of the Hellenic Seas used in the analysis; the numbers correspond to those presented in association with a location in Table 1.

video from that location, although pigmentation patterns do not necessarily imply hybridization.

An important discrepancy between our results and the up-to-date literature was observed for the North Ionian Sea (Corfu-Paxos-Antipaxos Islands), where the number of videos with common dolphin sightings was rather high. However, this may be explained by the fact that the expansion of this species' range in this particular area might be a relatively recent event given that the video material used was mostly collected within the last 10 y. These animals could have originated from the nearby area of the Inner Ionian Sea Archipelago, formerly considered a hotspot for common dolphins, where the species recently suffered a precipitous population decline as a result of overfishing of their main prey (Bearzi et al., 2008b; Piroddi et al., 2011). The generally wide-range nature of common dolphins (Genov et al., 2012), coupled with foraging difficulties this species might face (e.g., in the Archipelago), might have driven them to expand their range across a much wider area in search of alternative food resources. This is supported by recent observations of a few common dolphins in the North Ionian Sea that had been previously photo-identified in the Inner Ionian Sea Archipelago (J. Gonzalvo, unpub. data, 1998-2014).

The fact that a Risso's dolphin and mixed groups of striped and common dolphins were only detected in S-I searches could be attributed to their very low occurrence in Hellenic waters (Bearzi et al., 2011). The appearance of these relatively rare cases in a collection of less than 400 videos, such as S-II, is, therefore, highly unlikely. The unique sighting of Risso's dolphins was reported in the area of Agion Oros Gulf. According to Frantzis (2009), two of the areas with the highest density of Risso's dolphins are the Myrtoon Pelagos and the waters around the Chalkidiki Peninsula where the video was recorded. Although the species is considered to be present in all parts of the Hellenic Seas, it should be kept in mind that this information is primarily based on stranding data.

Table 1. Distribution of species in the Hellenic Seas (Aegean Sea, Ionian Sea, and Cretan Sea) suggested from analysis of videos posted to YouTube in the present study: Tt = *Tursiops truncatus*, Sc = *Stenella coeruleoalba*, Dd = *Delphinus delphis*, Mix = mixed groups of *Stenella coeruleoalba* and *Delphinus delphis*, and Gg = *Grampus griseus*.

Area		Tt	Sc	Dd	Mix	Gg
1	Corinth Gulf	■	■	■	■	
2	Agion Oros Gulf	■	■	■		■
3	Toronaios Gulf	■	■			
4	Cyclades Islands	■	■	■		
5	Dodekanese Islands	■	■	■		
6	Inner Ionian Sea Archipelago	■	■	■		
7	North Aegean (Limnos-Mytilini-Chios Islands)	■	■	■		
8	North Ionian (Corfu and Paxoi Islands)	■	■	■		
9	Argo-Saronikos Gulf	■	■	■		
10	South Ionian (south of Kefallonia)	■	■	■		
11	Sporades Islands	■	■	■		
12	Thracian Sea	■	■	■		
13	Argolikos Gulf	■	■			
14	Cretan Sea	■	■			
15	Cretan Passage		■			
16	Lakonikos Gulf		■	■		
17	Messiniakos Gulf	■	■			
18	Pagasitikos Gulf	■		■		
19	Amvrakikos Gulf	■				
20	North Evoikos Gulf	■				
21	South Evoikos Gulf	■				
22	Kythira Islands		■			
23	Myrtoo Pelagos		■			
24	Patraikos Gulf		■			
25	Thermaikos Gulf	■				

Citizen science is defined as scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions (Bonney et al., 2009a). Though citizen science has contributed much to some fields (e.g., ecology; European Commission, 2013), there are some biases and problems resulting from projects with this design such as patchy data collection and reliability (Gardiner et al., 2012; European Commission, 2013). In the present study, although videos were uploaded to YouTube by non-scientists, analysis of the footage was exclusively conducted by experienced scientists in order to maximize the quality of the data and the reliability of species identification. In addition, since no project design or volunteer training was required, the method is practically costless if the time invested by the researchers is not considered (Bonney et al., 2009a; Dickinson et al., 2012; European Commission, 2013).

Nevertheless, there are a number of challenges using videos uploaded to YouTube. Uneven distribution of videos is considerable: video uploads were greater from touristy areas (e.g., Cyclades and Dedocanese Islands), while there were fewer, or no, videos from more remote locations with less maritime tourism (e.g., Thracian Sea). This potential disadvantage was not relevant since the goal of this study was to test if the method presented herein poses a valid tool to provide reliable preliminary information on the cetacean species present in areas where such knowledge is null or very limited. More decisive are limitations derived from the behavior, ecology, and abundance of the animals studied; species with low population densities will inherently have lower probabilities of detection and are, therefore, less

Table 2. Coefficients of the binomial Generalized Linear Model (GLM) used to analyze the identification of dolphin species in YouTube videos as a factor of footage duration and bow-riding behavior

Source of variation	Coefficient	SE	*p*
Null	0.47	0.30	> 0.1
Duration	0.02	0.13	> 0.5
Bow-riding	1.95	0.48	< 0.001
Duration * bow-riding	0.31	0.25	> 0.5

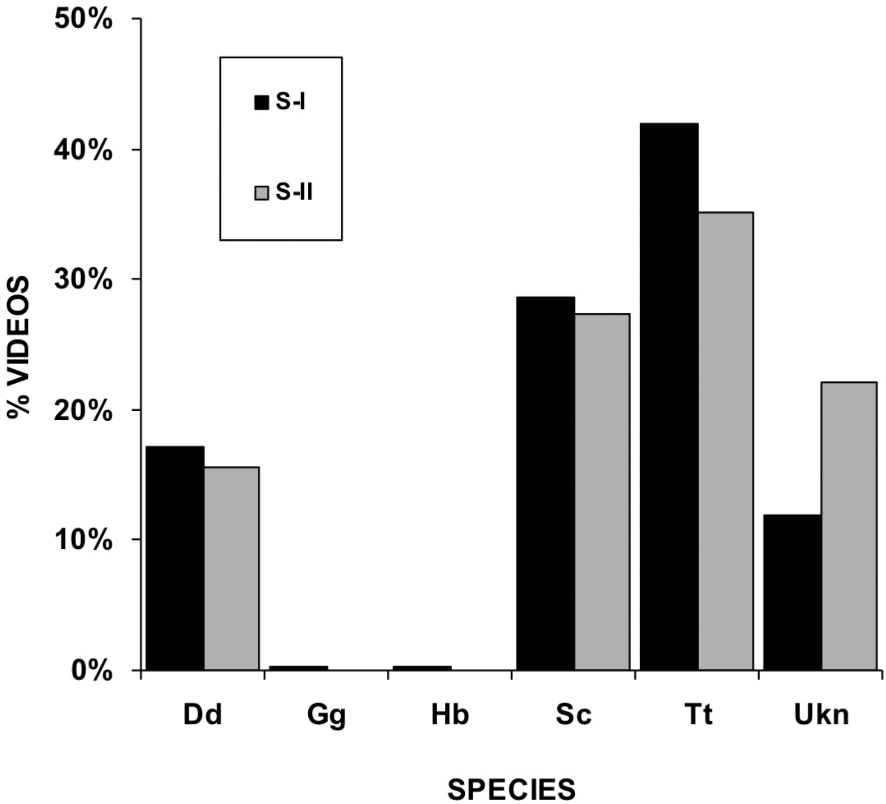

Figure 3. Percentages of videos per species found by two independent searches, S-I and S-II; Dd = *Delphinus delphis*, Gg = *Grampus griseus*, Hb = mixed groups of *Stenella coeruleoalba* and *Delphinus delphis*, Sc = *Stenella coeruleoalba*, Tt = *Tursiops truncatus*, and Ukn = unknown.

likely to be included in the dataset. Elusive animals like Cuvier's beaked whales (*Ziphius cavirostris* [Cuvier, 1823]; Cox et al., 2006) are by default less likely to be spotted even by experienced observers; and species with preferences for isolated habitats, such as the critically endangered Mediterranean monk seal (*Monachus monachus* [Hermann, 1779]; Notarbartolo di Sciara et al., 2009), will also be affected by the same limitations. Such disadvantages can be decreased by the large number of videos uploaded on YouTube, or any other online video sharing platform, from potential observers, which creates opportunities for research at unprecedented spatial and temporal scales (Dickinson et al., 2012; European Commission, 2013).

Considering the only assumption we made was in accepting the location tags provided by YouTube users as correct, it is likely that the accuracy of this method will increase in the near future. The increasingly popular and widespread use of global positioning system (GPS)-enabled cameras and phones (Raper et al., 2007) offers, among many other tools, the possibility of automatically geo-tagging photos (Serdyukov et al., 2009), which will contribute to better quality data and increased accuracy when accessing YouTube videos and determining exactly where that footage was taken. Finally, in order to optimize the species identification in future studies focusing on dolphin videos, it would be advisable to exclusively use videos of bow-riding animals. In our case, this approach significantly diminished the percentage of unidentified animals from 13.40 to 4.9% (χ^2 test: $p < 0.01$).

Environmental issues are declining worldwide in the public's perception (GlobeScan, 2013); conservation concerns and support seem to be shifting away from the center of the general public's attention possibly related to the current economic crisis (Katsanevakis et al., 2015). Consequently, conservation research has been given a lower priority in the agenda of policymakers with fewer funds made available. Poor research effort will result in knowledge gaps leading to inefficient conservation planning. The high consistency found between this study's results and the available literature suggests that accessing videos uploaded to social media can be a reliable source of information on dolphin presence and distribution in Hellenic waters and offers a valid complementary tool to traditional research studies, particularly for areas with little prior knowledge and limited resources.

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