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Social media in service of aquatic ecology

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Aquatic environments play a vital role in the sustainability of both human and ecological systems. The rapid expansion of human activities and overexploitation of these ecosystems increase environmental stress, leading to significant changes in its conditions and benefits at great social, economic, and ecological costs. In this context, aquatic monitoring is essential, as it is required for the development of species conservation strategies and the full incorporation of sustainability factors into aquatic planning and management. However, due to logistical and financial aspects associated with field studies and expeditions, in situ observation of aquatic species is often challenging. Gaps in aquatic species occurrence data, caused by detection difficulties and inconsistent surveying, result in incomplete estimates and poor descriptions.

As an alternative to address these knowledge gaps, scientists are increasingly turning to citizen science. This approach presents a novel opportunity for the development of knowledge discovery techniques. The overgrowing dissemination of information on social media, facilitated by smartphones equipped with Global Positioning System (GPS) and high-resolution cameras, is revolutionizing ecological research in aquatic environments. Social media offers a potentially cost-effective and less time-consuming monitoring strategy compared to traditional methodologies. It provides environmental and biodiversity observations that are not only publicly and easily accessed, but also geo-referenced, real-time, and long-term. This special issue sheds light on recent contributions that explore the use of social media to gain insights and address ecological questions across a wide array of aquatic environments. We, the editors of this special issue, as ecologists and data scientists, firmly believe that social media constitutes a valuable tool for aquatic ecology. This conviction holds true despite many challenges yet to be overcome, as shown by the different examples provided in this issue.

Social media has proven particularly relevant for the early detection and monitoring of non-native species in both marine and freshwater ecosystems. For example, the first record of the highly invasive Chinese Sleeper (*Perccottus glenii*) in the Elbe River basin in Czechia originated from a post shared by a fisherman on social media. In Cyprus, in the Mediterranean Sea, the cooperation of local fishermen through a citizen science project on Facebook also contributed to obtaining the first record of the alien decapods *Ixa monodi* and *Myra subgranulata*, as well as additional records of *Macrophthalmus indicus*.

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YouTube data also contributed to detecting the presence of tilapia on the Brazilian coast, highlighting the potential for a typically freshwater invader to spread through marine ecosystems.

Additionally, social media data played a key role in modeling the distribution of the non-native aquarium pet Sailfin Catfish (*Pterygoplichthys* spp.), with several areas high to moderately suitable for its colonization and expansion in India and Bangladesh. Social media platforms were also used to conduct online surveys about public perception regarding this aquarium pet and its release to nature. Of the interviewees, 70% answered that they would release the fish into freshwater environments if the fish grew larger and found it difficult to keep in their aquarium, and 86.6% were not aware that the deliberate introduction might result in negative impacts on ecosystems. In Brazil, the release of freshwater pets was monitored through YouTube videos, resulting in the first documented cases of intentional introduction for 17 species, mainly fish. The main motivations behind pet release were excessive growth, "agreeableness" (i.e., compassion and the pet owner's reluctance to euthanize the animal), and aggressive behavior.

Rare species were also detected using social media. For example, the stauromedusa *Lipkea ruspoliana* was first recorded in Portugal by a sighting published in the iNaturalist. A review of the cryptic group Staurozoa from Portugal and the global distribution of *Lipkea* is also presented. Moreover, recent records extracted from social media (85% of the total) suggest that the jellyfish *Drymonema gorgo* may not be as rare in Brazil as previously assumed due to the near absence of previous records. Social media platforms also served to obtain biological associations of this jellyfish with other species. Further, commonly found species are also frequent targets of social media investigations. For example, data from Instagram and iNaturalist were applied to train machine learning models for image classification of the venomous jellyfish *Physalia physalis*. The best results obtained were 94% accuracy and 95% precision, recall, and F1 score, effectively contributing to the automatic classification of social media images and the monitoring of this dangerous species.

A citizen science campaign conducted in Brazil on the platform iNaturalist and promoted through social media is also presented. The marine taxa with higher richness (Arthropoda, Mollusca, and Chordata) were well-represented in the platform, and 72% of the total records were likely being well-identified. Data from voluntaries obtained through social media were also used to assess the occurrence of the seahorse *Hippocampus reidi* in the Araruama lagoon, Brazil, providing new insights into the biological potential of seahorses to colonize new areas and tolerate extreme conditions. Fishes and macro-crustaceans were also the most recorded groups entangled in ghost nets in the investigation conducted in the Mediterranean Sea using YouTube videos. A total of 86 species were identified to be affected, with 10 of them considered threatened. Italy and Turkey reported a higher incidence of ghost fishing.

This special issue presents compelling examples of services provided by social media for aquatic ecology, whether by voluntary or passive citizen science. With approximately five billion users worldwide in 2024, these platforms are web-based services that allow people to create personal profiles, build virtual communities, establish connections, share interests, and disseminate multimedia. The increasing volume and scope of such content suggest that social media will increasingly play an important role in influencing and transforming aquatic ecology.