Emerging digital tools for marine and freshwater conservation

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Potential aquatic flagship species identified based on their popularity (relative internet search frequency); presented are top-ranked marine (killer whale, Orcinus orca, and great hammerhead, Sphyrna mokarran) and freshwater species (hippopotamus, Hippopotamus amphibius, and platypus, Ornithorhynchus anatinus) [Davies et al. 2018. PLOS One 13:e0203694]. See the paper for image attributions.

The digital revolution in the age of big data is creating new research

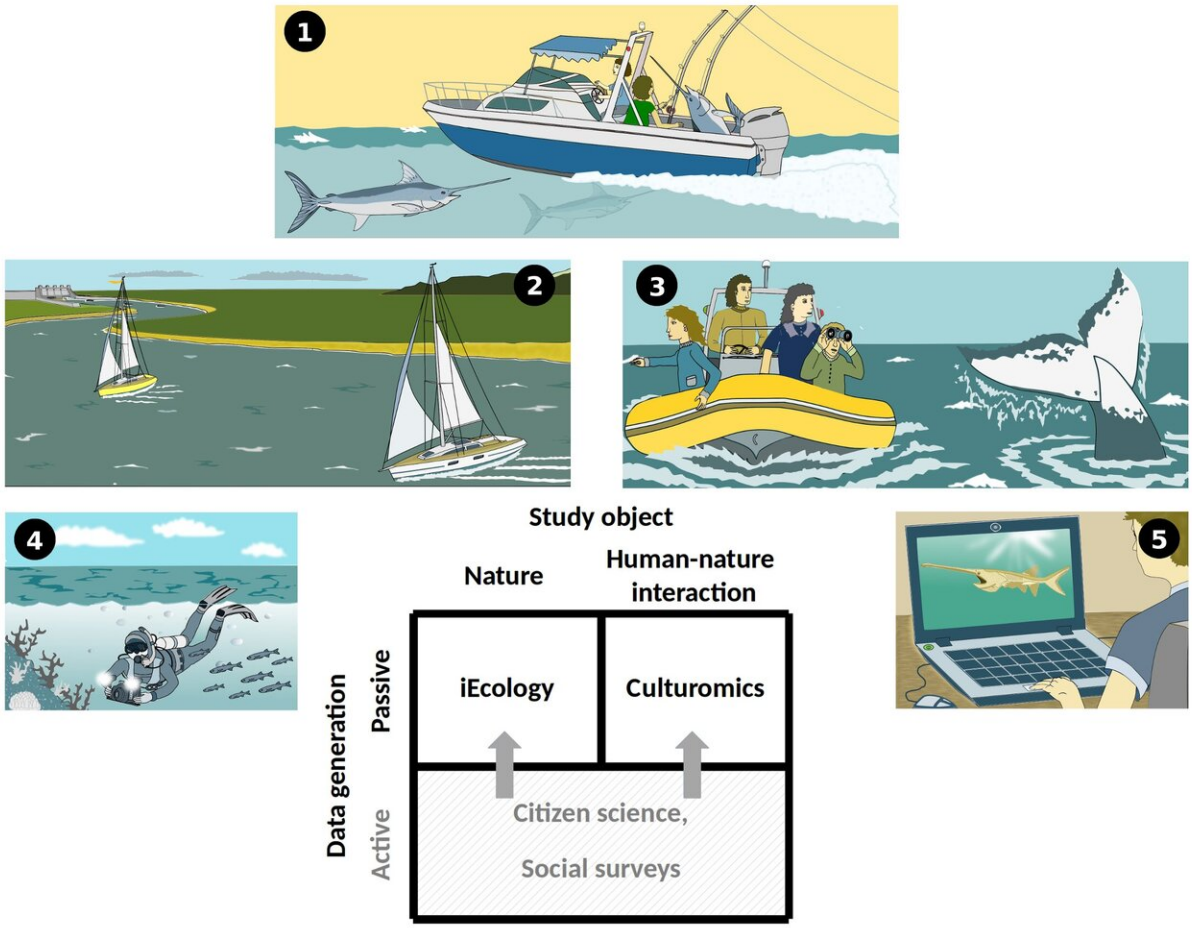
opportunities. Approaches such as culturomics and iEcology promise to provide huge benefits and novel sources of information for ecological research, and conservation management and policy. In a recent publication, an international research team led by the Biology Center of the Czech Academy of Sciences is looking at the opportunities and challenges of applying these tools in aquatic research.

Freshwater and marine coastal habitats are severely threatened by a range of human impacts, including habitat loss, damming, invasive alien species, pollution, climate change, and overfishing. However, aquatic research is more challenging compared to research done on land due to logistical difficulties of working in aquatic environments and the low visibility and detectability in water.

Furthermore, current research and monitoring are also insufficient to cope with the changes and impacts that frequently occur faster than they can be actively monitored and understood. "A greater challenge still is to conduct high-quality social science research to understand human values, attitudes, behaviors, and knowledge towards aquatic environments, necessary for effective management and conservation," explains Professor Kate Sherren, researcher at Dalhousie University, co-author of the study.

According to a paper published recently in the journal *PLOS Biology* promising avenues to deal with these challenges may be found in culturomics and iEcology, two emerging research areas based on the analysis of online data resources. Conservation culturomics focuses on the study of human-nature interactions through the analysis of digital data, and it has found important application in conservation science. iEcology is focused on studies of ecological patterns and processes based on digitally stored ecological data, generated for other purposes. "These two research fields are essentially mining digital data generated by people as part of their daily lives. This provides us with new insights

regarding aquatic systems at low sampling costs and high spatio-temporal resolution," explains Ricardo Correia, researcher at the Helsinki University, another author of the study.

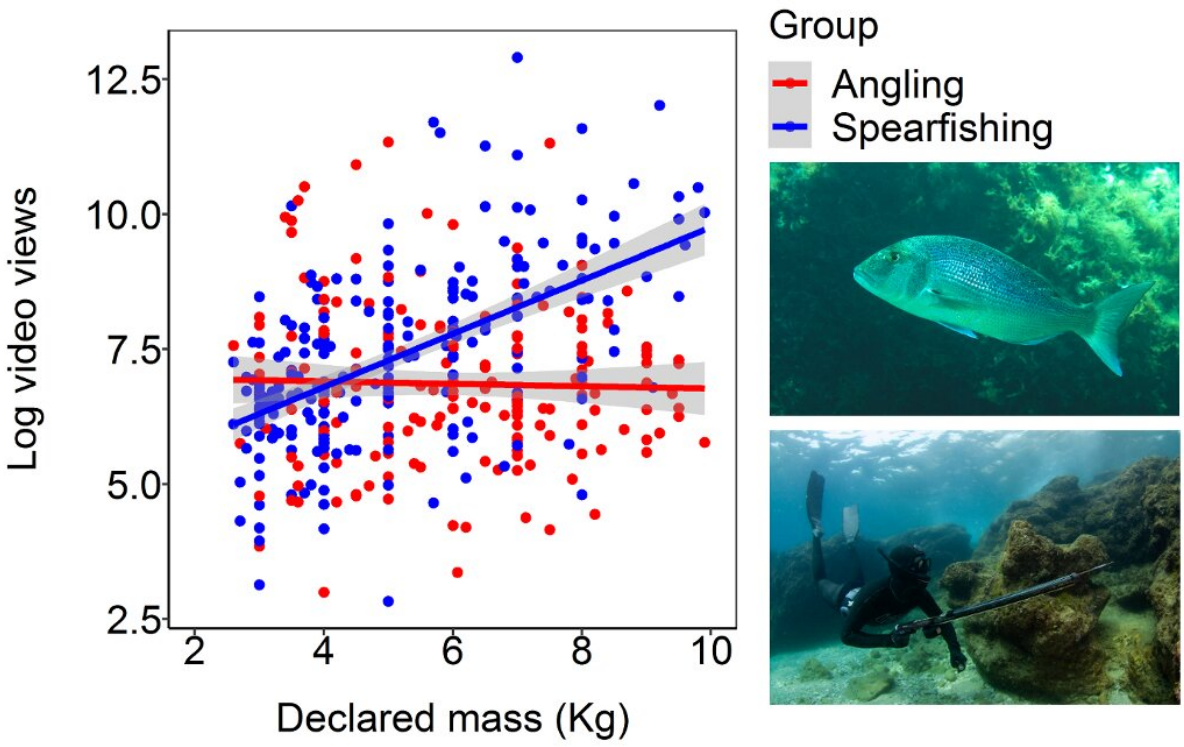


Conceptual diagram with key differences among culturomics, iEcology, and other related approaches such as citizen science and social surveys. Differences are based on the object of study (human–nature interactions or nature itself) and the type of data generation (passive or active). Data sets generated by citizen science, social surveys, and other approaches can also represent data sources for iEcology and culturomics, as indicated by arrows. Drawings illustrate some applications of culturomics and iEcology for aquatic research: 1) fisheries management; 2) social impact assessment; 3) detection, mapping, and monitoring of threatened, rare, and alien species; 4) ecosystem status and anthropogenic

impacts; and 5) identification of aquatic flagship and umbrella species.

"Culturomics and iEcology have been applied mostly in the terrestrial realm, and the opportunities they can provide in marine and freshwater ecosystems are yet to be properly explored," says Ivan Jarić, lead author of the study and researcher at the Biology Center of the Czech Academy of Sciences. "With this in mind, our aim was to advocate expanding such applications to the aquatic realm, to discuss the relevance and potential of such applications, but also to present associated challenges and limitations."

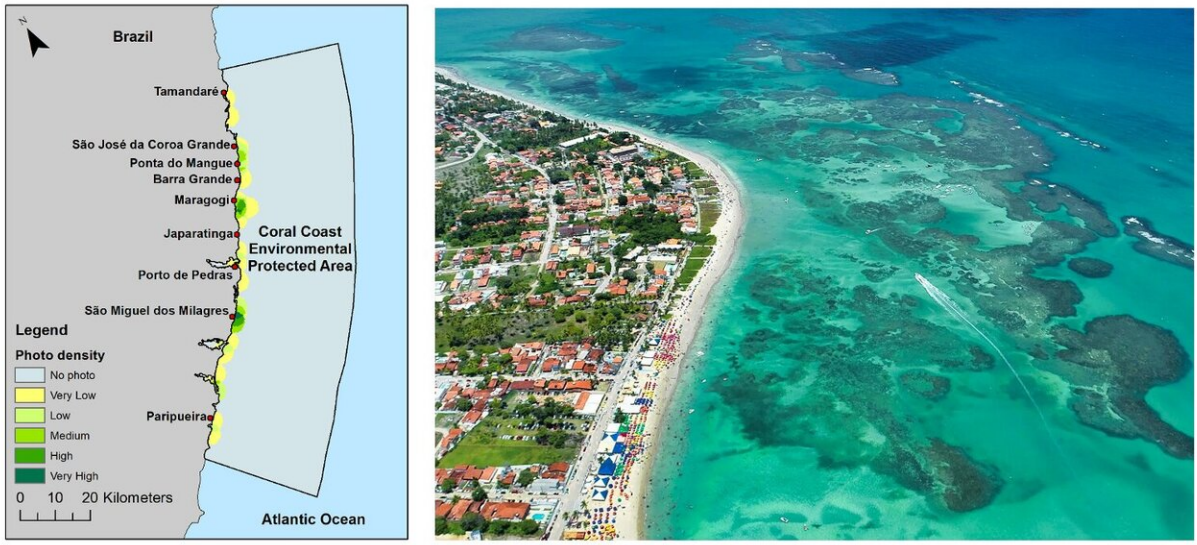
The study identified six key areas in which culturomics and iEcology are likely to have the highest impact: management of protected areas, fisheries, flagship species identification, detection and distribution of threatened, rare, and alien species, assessment of ecosystem status and anthropogenic impacts, and social impact assessment.



Social engagement of marine recreational anglers and spearfishers targeting common dentex (Dentex dentex), an iconic species for Mediterranean fisheries, based on videos posted on YouTube [Sbragaglia et al. 2019. ICES J Mar Sci, fsz100] Credit: David Mandos

The study also emphasizes that the use of these methods for aquatic research also faces certain challenges. "Digital data can be affected by various cultural, political, and socioeconomic factors, and they may be biased towards more active users and specific social groups," says Andrea Soriano-Redondo, from CIBIO/InBio in Portugal, one of the authors. "Also, uneven spatial coverage of the internet and its users is even more pronounced in the aquatic realms. Generally, our data coverage decreases with distance from shore and water depth, and centers mainly around urban and recreational areas."

The authors also stressed abiding by sound ethical practices when using such data. Researchers need to protect people's sensitive information, as well as restrict access to data regarding rare and threatened species such as their precise locations, which can be misused for poaching and unsustainable harvest.

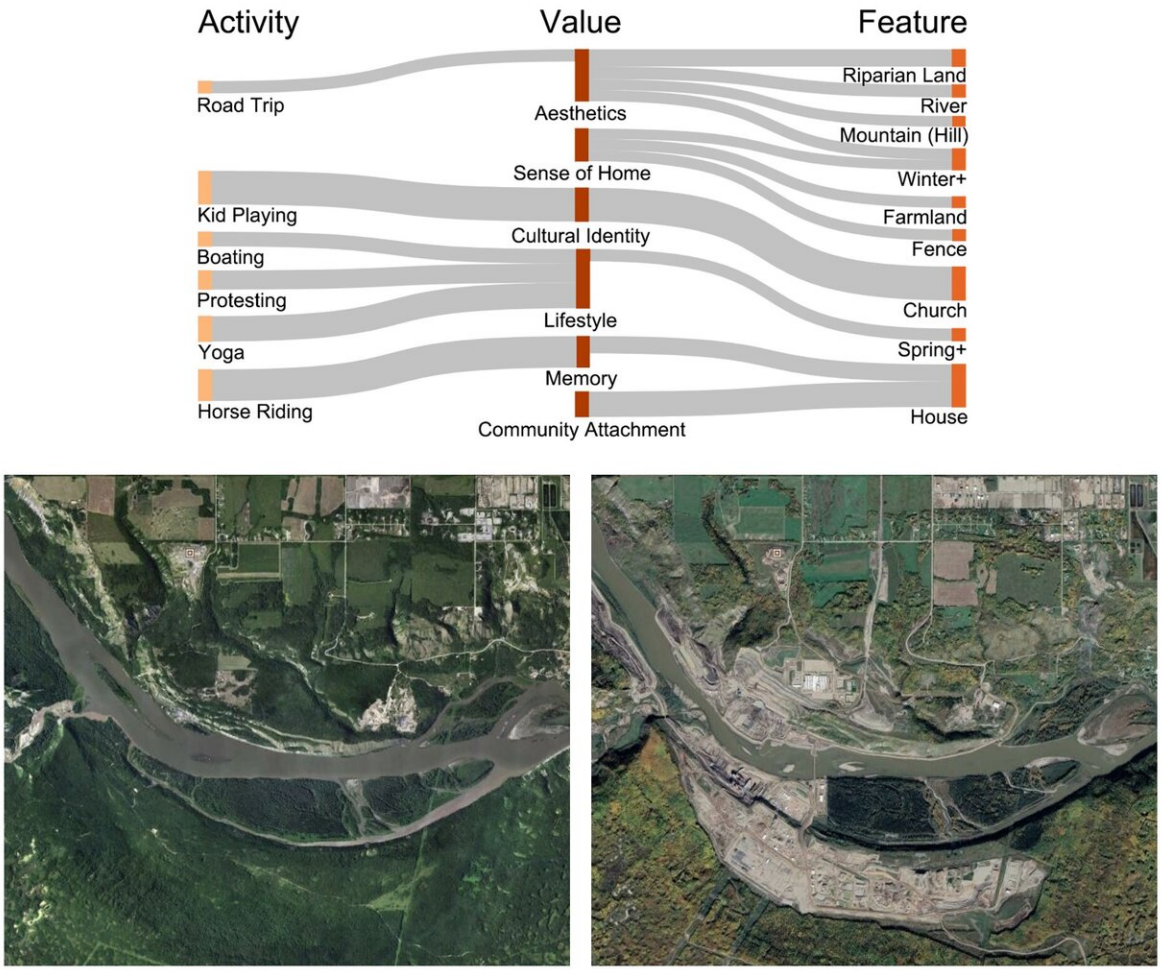


Mapping of cultural ecosystem service hotspots in a marine protected area, based on social media photographs [Retka et al. 2019. Ocean Coast Manage 176:40-48] Credit: Jobosco

Nevertheless, when deployed in the right context, while being aware of their potential biases, culturomics and iEcology are ripe for rapid development as low-cost research approaches based on data available from digital sources.

"Their increasingly diverse applications for aquatic ecosystems will be further enhanced by emerging technologies such as automated web

crawling and data processing, machine learning, automatic species identification, apps, and ecoacoustics," says Uri Roll from the Ben-Gurion University of the Negev, another author of the study. "We ultimately envision a global digital observatory of Earth, an online platform established for continuous collection and processing of key digital data from a wide variety of sources, with a near real-time information provided on ecosystem changes and human–nature interactions."



Conceptual landscape perception map, based on statistical relationships between activities, values, and features coded from landscape images and captions on

Instagram, from the proposed headpond area of the now-approved Site C dam, Peace River, British Columbia, Canada [Chen et al. 2019. Soc Nat Res 32:1114-1122]; below - satellite images of the Site C dam location, south of Fort St. John, before and during the dam construction (in 2012 and 2019). Credit: Biology Centre of the Czech Academy of Sciences

With the right tools and expertise, digital data represent a rich and unique resource for both aquatic and terrestrial research. "Aquatic culturomics and iEcology are likely to provide valuable support to monitoring progress towards the Sustainable Development Goals and the Post-2020 Biodiversity Goals of the Convention on Biological Diversity," says Ivan Jaric regarding the importance of the findings.

More information: Ivan Jarić et al. Expanding conservation culturomics and iEcology from terrestrial to aquatic realms, *PLOS Biology* (2020). DOI: 10.1371/journal.pbio.3000935

Provided by Biology Centre of the Czech Academy of Sciences