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Editorial: Advances in sandy beach ecology during the Anthropocene

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Editorial on the Research Topic

Advances in sandy beach ecology during the Anthropocene

Sandy beach ecology research has long been framed by unique ecological paradigms, mostly related to physical-biological coupling. Efforts in testing classical hypotheses, however, have often been hindered by isolated and short-term focus on anthropogenic effects. Local observational studies and meta-analyses are facing important challenges in providing mechanistic understandings of how different human stressors influence synergistically ecological patterns and processes. Thus, innovative takes to hypotheses, and manipulative experiments are needed. A range of combined state-of-the-art methods, including emerging technologies, exploration of fields like netnography, and citizen science are becoming imperative to provide an advancement of research, keeping it connected with society.

This Research Topic provided an opportunity to original research that confronts such challenges, considering the intertwined role of the biophysical environment, effects of human activities, and the resulting biological patterns. The Research Topic represents a sample of current research, aware of constraints and challenges, yet proposing fresh insights, and paving the road for studies on sandy shores in the Anthropocene.

Currently, only 15% of the global coastal zones remain unscathed by anthropogenic activities (Williams et al., 2022). Consequently, over the past few decades, studies delving into the responses of biodiversity to anthropogenic stressors have addressed spatio-temporal patterns, bridging local with global scales (Defeo et al., 2009). However, the lack of long-term and harmonized data represents a limitation of these studies, hampering the depiction of critical information such as the tipping

points of the system. A characteristic of this Research Topic is therefore a focus on data and designs especially thought to tackle this limitation.

Augusto et al. compared the responses of sandy beach community to local urbanization in two sparsely distributed periods (1997–1998 and 2012), confirming that community descriptors remain higher on more conserved beaches, while abundance of indicator species such as the mole crab *Emerita brasiliensis* (Schmitt, 1935) decreased even in conserved areas. This extends questions related to beach conservation status by integrating the metapopulation concept, and its application in terms of protection of “source” populations, allowing to project findings in a context of long-term data.

While the use of indicator species has been prevalent in sandy beach studies, the scarcity of organism-level metrics can limit the ability to prematurely detect environmental changes, being essential to early-warning conservation efforts (Costa et al., 2020). The burrowing behavior emerges as key adaptation of beach resident fauna for coping with both natural and human-induced environmental changes. The depth of burrows of the sandhopper *Atlantorchestoidea brasiliensis* (Dana, 1853) was examined by Abude et al. as a response to urbanization. Deeper burrows were present on beaches with unrestricted access, underscoring the typical phenotypic adaptability of beach animals, leading to differential allocation of energies under different risks of physical disturbance of the substrate.

Non-resident beach fauna, such as sea turtles, also heavily relies on behaviour for their populations’ thriving, while nesting habitat is critical to ensure reproductive success. To date, the effect of urbanization on nesting beach selection has been controversial. Nonetheless, Costa et al. found higher frequencies of loggerhead turtle nests on less-urbanized beaches along 62 km of monitored coastline in Southeastern Brazil, along with a higher occurrence of false crawls on urbanized sites. However, coastal erosion seems the most urgent threat to nesting loggerheads in the area, with authors advocating for nature-based solutions such as the reconstruction of dunes and replanting of native vegetation.

The effects of a basic set of solutions, such as the installation of perimeter sand fencing, discontinuation of mechanical grooming and vehicle traffic, and the introduction of native dune plant seeds, were found by Johnston et al. to play a pivotal role in enhancing the resilience of sandy shores. Sediment accretion increased in a restored site, largely due to the presence of sand fencing and dune vegetation. Notable formation of a foredune ridge and the expansion of native plant species propitiated the presence of dune invertebrates and threatened shorebird roosting. These findings are promising, yet they exemplify a limited number of applied management actions within the context of beach conservation.

Coastal erosion is indeed a critical issue in most countries worldwide. Out of the global beaches’ database analysed by

Bozzeda et al. (2023), 32% were in fact found to be affected by erosion of various magnitudes. These erosion rates are amplified by beach dissipativeness; thus, local factors might enhance the impact of sea level pressure anomalies, intensified onshore winds, increasing warming rates, and rising sea levels. On the other hand, urbanization only partially explained erosion trends, particularly in microtidal reflective and intermediate beaches, underscoring the long-term threat of coastal squeeze faced by sandy shores. These findings could be used as baselines for conservation and management. However, is the societal component of the system ready to act for sustainability?

After a conference of Brazilian researchers to discuss the problems reported here, Corte et al. provided an opinion article in this respect. The country is consistently prominent in producing research articles on sandy beaches (Lercari, 2023), however the hundreds of ecology-related publications are not mirrored by actions undertaken to mitigate the issue of erosion and unplanned urbanization issues and the consequences on biodiversity. Effective management in fact largely relies on governance, which is still not ideal within the country. This case-study can also be upscaled to a global context, where information produced needs to be mainstreamed into effective actions.

In conclusion, this Research Topic adds information around critical knowledge gaps in the ecology and conservation of sandy beaches in response to the main stressors. The emphasis on urbanization and erosion as characteristics of the Anthropocene highlights the need of considering complex systems and compound variables. Their connection to the risk of habitat loss, and possible conflicts around these environments that sustain the welfare of billions of people, needs to be considered in further research, and tied to solutions. To do so, the complexity of Anthropocene needs to be fully acknowledged and considered in the design of studies. This would provide scientific sound information capable of sustaining transformative social actions.

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References

Costa, L. L., Fanini, L., Zalmon, I. R., and Defeo, O. (2020). Macroinvertebrates as indicators of human disturbances: A global review. *Ecol. Indic.* 118, 106764. doi: 10.1016/j.ecolind.2020.106764

Defeo, O., Mclachlan, A., Schoeman, D. S., Schlacher, T. A., Dugan, J., Jones, A., et al. (2009). Threats to sandy beach ecosystems: A review. *Estuar. Coast. Shelf Sci.* 81, 1–12. doi: 10.1016/j.ecss.2008.09.022

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Lercari, D. (2023). Sandy beaches: Publication features, thematic areas and collaborative networks between 2009 and 2019. *Estuar. Coast. Shelf Sci.* 281, 108211. doi: 10.1016/j.ecss.2023.108211

Williams, B. A., Watson, J. E. M., Beyer, H. L., Klein, C. J., Montgomery, J., Runting, R. K., et al. (2022). Global rarity of intact coastal regions. *Conserv. Biol.* 36, e13874. doi: 10.1111/cobi.13874