New meta-analysis shows engineered hard shorelines are a threat to ecosystems

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Shoreline hardening, defined as the installation of structures to prevent erosion or provide flood protection, is a common practice worldwide. Over 22,000 kilometers of shoreline have been hardened in the United States alone, and many major coastal cities, such as Hong Kong and Sydney, have 50% or more of their shorelines protected by artificial structures. With growing urban populations and rising seas, these trends are expected to continue. However, despite a growing chorus of conservation practitioners advocating for more nature-based approaches to coastal protection, the science on shoreline hardening's effects has failed to keep pace.

To address this shortcoming, a team of marine ecologists led by Rachel K. Gittman of Northeastern University conducted a meta-analysis of 54 existing studies on shoreline hardening. The results, described in the journal *BioScience*, highlight stark ecological effects of shoreline hardening and of seawalls in particular. "Biodiversity was 23% lower along shorelines with seawalls when compared with that of natural shorelines," observed the authors. Moreover, Gittman and her colleagues noted that overall organism abundance was 45% lower in seawalled areas.

The authors describe the possible mechanisms underlying this phenomenon, including the loss of shoreline habitat: "Because they are typically placed in the high intertidal zone, installation of a seawall and to a lesser extent, a riprap revetment, can sever the connection between upland and intertidal habitat, reflect wave energy and alter sediment

transport, and potentially increase the depth of the intertidal and nearshore subtidal zones."

Despite this, one potentially encouraging finding was that biological diversity and the abundance of organisms were not demonstrably altered by other forms of shoreline hardening, such as riprap and breakwaters. The authors report that "some shore-protection structures may serve as surrogate habitats for native epibiota where natural hard substrates, such as oyster reefs and mussel beds, have been lost to overharvest, erosion, and poor water quality." However, Gittman and her colleagues caution that such structures may enable invasive species or have other unintended consequences: "In general, additional studies examining the ecological effects of riprap revetments and breakwaters are needed to inform future decisions on the consequences of selecting these types of structures."

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