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Perspective

Beach Nourishment: Assessing the Environmental Impacts of Beach Nourishment

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DESCRIPTION

Beach nourishment, or the addition of sand to the beach to expand its breadth or sand volume, is a common coastal management practice for preventing coastal erosion. Beaches and the recreational, ecosystem, groundwater, and flood protection functions they provide are all threatened by increasing sea levels, storms, and limited sand resources around the world. As a result, beach nourishment strategies have evolved to include human safety and water recreation, groundwater dynamics, and environmental consequences in addition to increasing the time sand stays on the beach. We give a comprehensive review of beach nutrition in this Perspective, examining physical aspects of beach nourishment as well as ecological and socioeconomic implications.

Local vulnerability, sand supply, financial resources, government restrictions and efficiencies, and community attitudes of environmental danger, recreational purposes, ecological conservation, and social justice will all influence the future of beach replenishment methods. Co-located, multidisciplinary research investigations on the combined effects of nourishments, as well as explorations of alternative design options, are recommended to steer these internationally diverse nutrition practices.

Beaches are constantly changing, accumulating and eroding as a result of waves, currents, winds, storms, and sea-level rise. As a result, construction along the ocean's edge carries a high danger of property damage. The US Congress passed the Coastal Barrier Resources Act in 1982 to discourage overdevelopment of largely undeveloped coastal barriers along the Atlantic and Gulf coasts, recognizing the vulnerability of coastal development to shoreline erosion and flooding, as well as the value of fish and wildlife habitat.

Demand for built solutions to shoreline erosion is increasing as global warming causes a faster rise in sea level and increases the frequency and intensity of storms. The sand beach is a productive and unique environment that supports threatened and endangered sea turtles' seasonal nesting as well as dense concentrations of benthic invertebrates that feed surf fish, resident and migrating shorebirds, and crabs. The process of nourishment causes significant disturbance to beach and near shore coastal habitats and can lead to functional degradation. In the United States, permits for beach nourishment projects have generally required biological resource monitoring on the beach and at the dredging site.

The most commonly targeted organisms were benthic invertebrates, indicating their utility as ecological markers. Benthic invertebrates are generally sessile (enabling spatial patterns to indicate causality), may be sampled quantitatively without incurring a significant cost, are well documented taxonomically, and reveal ecologically meaningful and important patterns, even at coarse taxonomic discrimination levels. Few studies of beach nourishment have taken into account the effects on demersal fishes, and even fewer have taken into account the effects on shorebirds, despite the fact that both of these groups of species are valuable to humans and provide ecosystem services.

Many relevant physical habitat and biological response characteristics are regularly assessed in beach nourishment initiatives. Various percentages of studies measured turbidity, mean grain size, sediment grain-size distribution, and surface cover by hard substrata, sediment mineralogy, organic content, and compaction, surface topography, and habitat damage from gear contact among those that monitored habitat condition. Total biotic assemblage abundance, component taxa abundance, total biomass, biomass of selected taxa, size–frequency distribution of selected taxa, various species diversity indices, community composition, and some measure of physiological status of an important species were among the biological responses studied.

Beach nourishment is widely regarded as a short-term pulse disruption, mistakenly compared to natural sediment movements following a strong storm. Unusually coarse sediments are likely to linger on intertidal beaches for years,

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concentrating via wave action in the biologically most significant zone, the swash zone, where they can alternative invertebrate abundance and community composition for years. Enhancement of the fine sediment fraction during beach nourishment has the potential to cause a press disturbance long after the filling is completed, as wave energy erodes and exposes fill materials into which mud has been embedded over time, injecting biologically harmful turbidity into the surf zone. The biological effects of increasing turbidity during and after beach nourishment are never thoroughly investigated for methodological and biological reasons.

Beach nourishment studies' outcomes are frequently tainted by a lack of compelling evidence, analysis, or interpretation. In our sample, 73 percent of the studies' authors misread at least some of their findings. When capacity to detect even big impacts was impaired by high natural variability and inadequate replication, failure to address the power of the study design usually led to incorrect conclusions of absence of impacts. The science scholarship in these investigations was inadequate. A significant number of beach nourishment studies only did a cursory job of citing and synthesizing relevant scientific material.