

WORKING WITH NATURE ALONG OPEN COASTS - PAST, PRESENT AND FUTURE

Sam King, International Coastal management, sam@coastalmanagement.com.au
Leslie A. Jackson, International Coastal management, a.jackson@coastalmanagement.com.au
Bobbie Corbett, International Coastal management, b.corbett@coastalmanagement.com.au
Martin Mulcahy, International Coastal management, m.mulcahy@coastalmanagement.com.au
Aaron Salyer, International Coastal management, a.salyer@coastalmanagement.com.au
Zack Lindenbergh, International Coastal management, zack@coastalmanagement.com.au

INTRODUCTION

Faced with the escalating challenges posed by climate change, such as rising sea levels, intensified storm events, and environmental unpredictability, the field of coastal engineering has been shifting towards developing solutions that promote and preserve environmental resilience and sustainability (Morris, Boxshall and Swearer, 2020). These solutions seek to enhance or work with nature and natural processes, rather than against them. While there are opportunities to incorporate nature and natural processes into shoreline protection works at inshore and estuarine coastal environments with milder wave conditions, such as the Huon Mundy oyster reefs (King *et al.*, 2023), there are fewer effective nature-based options available for higher-wave energy open coasts. This paper explores past project examples and experiences of the various approaches to working with nature, including along high-wave energy open-coastal environments; the present state of nature-based solutions, their challenges, and opportunities; and how we may be able to better work with nature in the future to produce the best outcomes for our coastlines through building resilience, sustainability and preserving of coastal values. It should also be noted that this paper serves to continue the conversation on future nature-based practices.

WORKING WITH NATURE

The increasing shift towards working with nature is driven in part by the need to improve coastal resilience and sustainability to climate change impacts, such as more extreme storms and sea level rise. There are also many additional social, environmental, and economic benefits that could be achieved (Cohen-Shacham *et al.*, 2016; Bilkovic *et al.*, 2017), including:

- Enhancing ecosystem health, resilience, biodiversity, and abundance.
- Carbon sequestration (Blue Carbon)
- Preserving coastal community values, preferences, amenity, and aesthetics.
- Reconciliation with Traditional Owners.
- Eco-tourism opportunities
- Improved fisheries
- Sustainable long-term maintenance

There are many approaches to how engineers can develop coastal solutions to the benefit of nature or in collaboration with nature. These approaches vary in their intention, definition, scope for environmental benefit and coastal protection capacity, and includes:

- Using sustainably sourced or environmentally friendly materials and construction practices,
- Design features to restore marine habitats or ecologies (eco-engineering), or infrastructure to enhance the nature capacity of the environment (IENCE) (Boak, McGrath and Jackson, 2000).
- Using or mimicking natural processes and areas for coastal protection (Green Infrastructure)
- Restoring ecologies and processes that deliver coastal protection services (Nature-based solutions / Living shorelines)(Morris *et al.*, 2018).
- Engineering with Nature (USACE Initiative) to not only harness natural processes for coastal protection, but also to consider social and economic benefits to local communities and regions (Bridges *et al.*, 2014).

While each of these approaches should be considered as part of the options assessment for coastal solutions, the preference should be for natural processes to deliver as much of the coastal protection as possible for each site, with the focus on nature-based solutions. However, it is not always possible for these natural processes to provide sufficient coastal protection alone or an optimised solution for each site, particularly for high-wave energy open coastlines. Open coasts exposed to extreme storms and high-wave energy come with a range of challenges for the implementation of nature-based solutions, such as:

- Need for immediate coastal protection (ecological processes take time to properly establish).
- Magnitude of erosion during severe weather can undermine beach and dune vegetation.
- High wave energy can impose significant loads to natural systems and may result in damage and loss of protection capacity following events.
- Ecological incompatibilities (highly dynamic sediment conditions, water depths, wave energy)

While open-coast rock seawall can provide great coastal protection, they do not protect the beach (Boak, 2000).

THE PAST

Coastal engineering is a relatively new area of specialisation that has seen great advances in design and construction capabilities since World War 2. During this experimental era, many nature-based solutions were developed from a need for practical and cost-effective solutions, rather than for ecological restoration. Our understanding of the natural environment and anthropogenic impacts also developed. This paper

explores past project examples and experiences of the various approaches to working with nature, particularly for the open coast. For open coast and high wave energy environments, a hybrid nature-based solution is often required, such as dune management and beach vegetation practices in conjunction with buried seawalls, or nearshore nourishment (Jackson and Corbett, 2023), sediment bypassing & backpassing in conjunction with artificial reefs (Boak et al., 2000). These solutions are well proven on open coasts and can maintain beach amenity and improve resilience whilst ensuring sufficient protection during severe events. Environmental values can be improved further with the use of sustainable materials and substrates for marine habitat and ecologies.

The following project cases will be discussed in this paper:

- Various dune management & vegetation practices from the Gold Coast (Figure 1).
- Beach Nourishment in Queensland.
- Policy for the beneficial re-use of sand destined for disposal (i.e., basement excavation and flood basin dredging) for public beach nourishment.
- Suitably located, buried seawalls that allow beaches and dunes to naturally absorb and react to cyclic erosion and accretionary trends, only being exposed in significant erosion events.
- Artificial Reefs (Figure 2)



Figure 1 - Wide manmade dunes along the Gold Coast Australia.

THE PRESENT

More recently, there has been a push by coastal communities for more innovative and nature-based solutions, such as the Oceanside Re:Beach Design Competition (Nelson, 2023) and the Biden-Harris roadmap for nature-based solutions to fight climate change, strengthening communities and support local economies in the United States. A range of guidelines and resources now exist to help develop nature-based solutions, such as the Australian Guidelines for the Implementation of Nature Based Methods for Coastal Hazard Risk Reduction (Morris *et al.*, 2021) and the USACE Engineering with Nature toolkit. As the industry is actively planning for climate change adaptation, this is the ideal time to consider long-term strategies to accommodate nature-based solutions whilst ensuring sufficient coastal protection. This paper explores the present state of nature-based solutions, their challenges, and opportunities.



Figure 2 - Narrowneck Artificial Reef on the Gold Coast, Australia.

THE FUTURE

Beaches and coastal economies are expected to be impacted or destroyed by the effects of climate change in the future and coastal managers will need to pro-actively plan robust and sustainable strategies to address this. This paper considers the opportunity for improvements to how we work with nature, such as through integrated coastal management systems and approvals processes that can accommodate various nature-based elements in conjunction with conventional coastal engineering options in a way that maintains coastal values and beach amenity, whilst ensuring coastal protection and supporting communities and economies. Pilot projects with on-going research and follow-up monitoring is also recommended to continue the development of nature-based guidelines.

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