



UN Decade on Ecosystem Restoration 2021–2030—What Chance for Success in Restoring Coastal Ecosystems?

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THE CHALLENGE

On 1 March 2019, the United Nations (UN) General Assembly (New York) declared 2021–2030 the “UN Decade on Ecosystem Restoration.” This call to action has the purpose of recognizing the need to massively accelerate global restoration of degraded ecosystems, to fight the climate heating crisis, enhance food security, provide clean water and protect biodiversity on the planet. The scale of restoration will be key; for example, the Bonn Challenge has the goal to restore 350 million km² (almost the size of India) of degraded terrestrial ecosystems by 2030. However, international support for restoration of “blue” coastal ecosystems, which provide an impressive array of benefits to people, has lagged. Only the Global Mangrove Alliance (<https://mangrovealliance.org/>) comes close to the Bonn Challenge, with the aim of increasing the global area of mangroves by 20% by 2030. However, mangrove scientists have reservations about this target, voicing concerns that it is unrealistic and may prompt inappropriate practices in attempting to reach this target (Lee et al., 2019). The decade of ecosystem restoration declaration also coincides with the UN Decade of Ocean Science for Sustainable Development, which aims to reverse deterioration in ocean health. If executed in a holistic and coordinated manner, signatory nations could stand to deliver on both these UN calls to action.

COASTAL ECOSYSTEM VALUES, THREATS, AND DECLINE

Coastal wetlands, such as seagrass beds, mangrove wetlands, salt marshes, macroalgal, and seaweed beds, shellfish reefs, tidal freshwater wetlands, and coral reefs, are remarkable features of tropical and temperate coastlines. They provide vital services, including coastal protection, fisheries production, blue carbon capture, and pollutant removal and detoxification (Nagelkerken et al., 2015). Many marine fauna utilize coastal habitats as critical nursery areas, for shelter and feeding, yet these habitats are increasingly at risk from agri- and aquaculture, industry and urban expansion (Seto et al., 2011). Indeed, these systems are subject to what may be called “a triple whammy” of increasing industrialization and urbanization, an increased loss of biological and physical resources (fish, water, energy, space), and a decreased resilience to the consequences of a warming climate and sea level rise (Elliott et al., 2016). This has given rise to the complete loss, modification or disconnection of natural coastal ecosystems globally. For example, almost 10% of the entire Great Barrier Reef coastline in Australia (2,300 km) has been replaced with urban infrastructure (e.g., rock seawalls, jetties, marinas), causing massive loss and fragmentation of sensitive coastal ecosystems (Waltham and Sheaves, 2015). Global loss of seagrass reached around 7% of seagrasses area per year by the end of the twentieth century (Waycott et al., 2009). Approximately 40% of the global mangrove has been lost since the 1950s (Valiela et al., 2001) with more than 9,736 km² of the world's mangroves continuing to be degraded in the 20 years period between 1996 and 2016 (Thomas et al., 2017). Saltmarshes are drained when coastal land is claimed for agriculture, and deforestation is an increasing threat to shoreline vegetation (such as mangroves) when coastal land is appropriated for urban and industrial development (Valiela et al., 2001), both of which may result in the degradation of blue carbon storages and increasing greenhouse gas emissions (Atwood et al., 2017). These accumulating pressures and impacts on coastal ecosystems are neither isolated nor independent, rather they are synergistic, with feedbacks and interactions that cause individual effects to be greater than their sums (Duarte et al., 2008). In the year before the ecosystem restoration Decade commences, there is a critical knowledge deficit inhibiting an appreciation of the complexity of coastal ecosystems that hampers the development of responses to mitigate continuing impacts—not to mention uncertainty on projected losses of coastal systems for some of the worst-case future climate change scenarios.

THE COST AND FEASIBILITY OF “COASTAL” ECOSYSTEM RESTORATION ACTIONS

So, how can coastal wetland ecosystems benefit from the UN Decade on Ecosystem Restoration? The magnitude of the challenge implied by the Declaration raises important questions when considering coastal ecosystems for each signatory nation. What actions are necessary? Have we identified/mapped areas

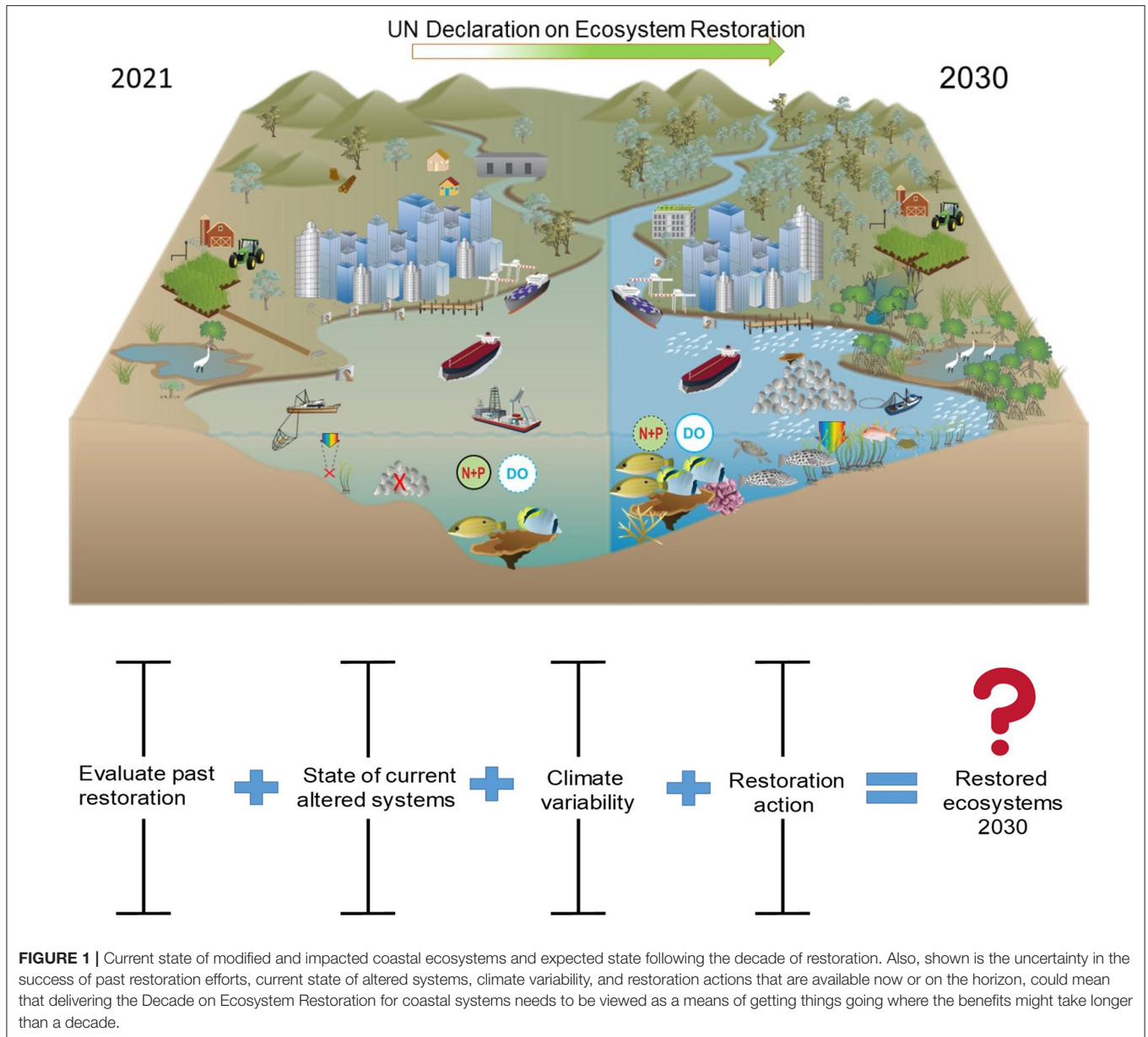
that would be suitable for restoration, and conversely should we move toward landscape approaches to coastal ecosystem restoration rather than the generally patch-specific approach at present? What investment opportunities are available over the next decade (and in the future to cover burgeoning maintenance and long-term monitoring costs that extend far beyond typical 3–5 years budget timeframes)? Have we business cases for restoration projects that demonstrate a strong return on the investment to attract government and private capital to accelerate restoration efforts? How, and where are the results/lessons to be reported (e.g., peer reviewed journals)? How vulnerable are restoration projects to climate change impacts? These questions all need answers before we know whether the decade on ecosystem restoration will make real impact beyond a declaration of intent. Indeed, given many unknowns (and variability around unknowns), and lack of convincing restoration success on which to base a decade of action (Figure 1), there is considerable uncertainty of whether it is possible to predict the outcome of a decade on coastal ecosystem restoration with any certainty.

TRANS-DISCIPLINARY TEAMS

Looking forward into the next decade, coastal habitat restoration will truly require a trans-disciplinary approach with skills drawn from engineering, modeling, ecology, chemistry, hydrology, social sciences including economics, financial, and project planning, governance, and integrated land, and sea spatial planning and management. Coastal ecosystems are at least as complex as terrestrial ecosystems, although arguably more dynamic, with the added gravity of the “triple whammy”—future development expansion that further alters shoreline ecosystems, loss of biodiversity and environmental conditions (e.g., water quality), and changing climate which alters sea level in many complex ways. Indeed, restoration measures will need to be judged against the moving baseline of climate change. To achieve success, coastal restoration solutions require a “prioritization process” involving coordinated, science-informed actions, community engagement, and involvement where appropriate and careful staging of construction, and engineering to tackle the most pressing problems. Major research institutes, engineering companies, and government agencies seem to be already awakening to the global potential and need for coastal ecosystem restoration. The scientific community is also realizing that restoration is inherently a collaborative operation, (<https://www.wri.org/publication/integrating-green-gray>). The faster we establish these partnerships, the faster we will commence large scale projects with meaningful ecosystem restoration outcomes, and advance toward achieving the UN declaration target.

OBJECTIVE SETTING TO INCREASE THE SCALE OF PROJECTS

We need to adequately define restoration success metrics that will be critical to assess outcomes on the basis of values shared by all stakeholders, including ecosystem services, societal goods



and benefits, and avoid impacts. **Table S1** gives examples of coastal ecosystem restoration projects and challenges that deliver local improvement, although at landscape scales too small for any meaningful regional benefit. Coastal ecosystem restoration is still in an “innovation phase” which means that failures will occur but, if rigorously assessed, these failures could deliver a learning curve toward a positive return on investment—giving more confidence to investors. Examples of projects with clear beneficiaries and investment return exist [e.g., Mekong Delta mangrove restoration of ~1,500 km² for protecting levees (Nam et al., 2016), and the Chesapeake Bay oyster reef restoration which generated improvements in commercial fisheries (Lipcius and Burke, 2018)], but clearly more, projects are needed to tap into similar funding pipelines if we are to successfully scale-up coastal ecosystem restoration.

The Declaration needs to be accompanied by international frameworks and national road maps detailing the steps to achieve substantial effect, including a major scaling-up to ecological-meaningful projects and coordinated management actions (Cormier and Elliott, 2017). At this point, entering the last year before the decade, it is unclear that the political or financial commitments necessary to achieve success are deployed (or even deployable) by each signatory nation.

ADEQUATE SUCCESS FOR SUSTAINED FUNDING MODELS

How we fund large-scale coastal restoration needs to be expanded. For instance, in moving beyond the somewhat limited and inconsistent public funding sources, obtaining

access to private capital requires robust quantification and risk management but, if successful, can unlock major funding necessary for capital, monitoring/evaluation and maintenance costs. However, restoration costs are uncertain due to an apparent deficiency in shared knowledge—either the costs are not presented or fully known yet (when considering on-going maintenance; Bayraktarov et al., 2016). Additionally, quantifying the return on investment from restoration efforts requires substantial improvement and support. Many coastal restoration actions are not monitored to conclusion (moreover, “conclusion” is usually poorly defined in restoration projects), which hinders reliable quantification of costs and benefits and blurs the ability to define “success” (Elliott et al., 2016). The funding required to achieve the scale of coastal ecosystem restoration necessary to deliver on the Sustainable Development Goals (SDGs), will exceed the financial capacity of nation states and will require additional commitments from beneficiary industries, sectors that contributed to historical ecosystem losses, as well as corporations, private citizen groups, non-governmental advocates, and philanthropic benefits. Additional restoration financing could be accessed via exciting new financial instruments, including payment for ecosystem services, green bonds, biodiversity offsets, carbon credits, debt-for-nature-swaps, and water quality credit markets (Herr et al., 2015). These funding models can work well for coastal ecosystem restoration, but progress has been, and will probably continue being slow, in comparison to the scale of habitat loss.

POLICY ALIGNMENT

Support for coastal ecological restoration from all areas of government/public/NGO, including politics, policies, administrations and legislation, is critical at more regional levels. Success will require coordination, possibly via an overarching organization (for each signatory nation, and reporting to the UN) supported by a network of restoration hubs or centers. An example is the Greater Florida Comprehensive Everglades Wetland Research Plan that has an established network of resources and restoration projects completed, with more underway (Mitsch, 2019). Such an overarching regional organization could act as a repository of knowledge, as well as providing the outlet for reporting on the success of progress. Yet, the institutional and governance arrangements necessary to drive the UN Decade on Ecosystem Restoration to successful outcomes have not yet been considered, and is now a matter of urgency if the goals are to be reached.

WHAT CHANCE OF SUCCESS—THE VERDICT

The restoration Declaration is welcomed. It aligns with the stewardship of emerging movements toward the development of sustainable “blue economies,” “blue growth,” and “blue resources.” It recognizes the need for sustainable use of our oceans, seas and coastal resources for economic growth, improved livelihoods and jobs, while preserving these ecosystems

(and is particularly powerful when tied with the UN Decade of Ocean Science for Sustainable Development and efforts toward achieving UN SDG 14, Life Below Water). Restoration of coastal ecosystems is categorically necessary, given that about half of coastal ecosystems have been lost since the start of industrialization, (Valiela et al., 2001; Waycott et al., 2009), but we should not do so at the expense of polluting nearby freshwater ecosystems which has happened in the Florida Everglades (Mitsch, 2019). We still need to halt ongoing coastal ecosystem losses, nowadays achieved using biodiversity offsets (**Table S1**). As we approach the decade of action, we urgently need to agree on the specifics of coastal ecosystem restoration outcomes, measures of success and appropriate scientific evaluation metrics, coordination, technological developments, funding, market pipelines, and institutional arrangements, governance, and platforms to disseminate the learnings (what are we learning and what should we be learning?). For example, can realistic and meaningful measures of success be equally applied to coastal ecosystems like the Everglades, San Francisco Estuary, Pearl River Estuary (China), Moreton Bay (Australia), all of which are experiencing very different hydrological alterations, drivers of land loss, climate patterns, and have different socioeconomic and cultural values (e.g., systems that support communities reliant on subsistence fishing)? Considering this enormous range of restoration contexts is it constructive to define success measures that are broad (and therefore possibly vague) enough to cover the range of scenarios outlined here? We need a clear framework that both designs and delivers coastal ecosystem restoration projects at both local scales and increasing broader scales. This needs strong governance, and support from governments, beneficiary industries, corporations and communities. Strong financial business cases are needed now, to incentivize and build confidence in restoration as we start to open the pipeline to government and private capital investment. Given the constraints, uncertainties and barriers mentioned here, we are optimistic that one Decade would deliver on the goals, but we are prepared to provide the scientific support and evaluation to ensure worthwhile large scale restoration projects emerge. We now call on leaders in other areas (such as government, industry, finances, technology) to also rally in support of the UN Decade on Ecosystem Restoration.

AUTHOR CONTRIBUTIONS

All authors contributed to the discussion points and prepared the **Table S1**. NW wrote the manuscript text, while all authors edited the manuscript text. NW and MS prepared the figure.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2020.00071/full#supplementary-material>

REFERENCES

- Atwood, T. B., Connolly, R. M., Almahsheer, H., Carnell, P. E., Duarte, C. M., Lewis, C. J. E., et al. (2017). Global patterns in mangrove soil carbon stocks and losses. *Nat. Clim. Chang.* 7, 523–528. doi: 10.1038/nclimate3326
- Bayraktarov, E., Saunders, M. I., Abdullah, S., Mills, M., Beher, J., Possingham, H. P., et al. (2016). The cost and feasibility of marine coastal restoration. *Ecol. Appl.* 26, 1055–1074. doi: 10.1890/15-1077
- Cormier, R., and Elliott, M. (2017). SMART marine goals, targets and management—is SDG 14 operational or aspirational, is “Life below water” sinking or swimming? *Mar. Pollut. Bull.* 123, 28–33. doi: 10.1016/j.marpolbul.2017.07.060
- Duarte, C. M., Dennison, W. C., Orth, R. J., and Carruthers, T. J. (2008). The charisma of coastal ecosystems: addressing the imbalance. *Estuar. Coast.* 31, 233–238. doi: 10.1007/s12237-008-9038-7
- Elliott, M., Mander, L., Mazik, K., Simenstad, C., Valesini, F., Whitfield, A., et al. (2016). Ecoengineering with ecophysiology: successes and failures in estuarine restoration. *Estuar. Coast. Shelf Sci.* 176, 12–35. doi: 10.1016/j.ecss.2016.04.003
- Herr, D., Agardy, T., Benzaken, D., Hicks, F., Howard, J., Landis, E., et al. (2015). *Coastal “Blue” Carbon. A Revised Guide to Supporting Coastal Wetland Programs and Projects Using Climate Finance and Other Financial Mechanisms.* Gland: IUCN. doi: 10.2305/IUCN.CH.2015.10.en
- Lee, S. Y., Hamilton, S., Barbier, E. B., Primavera, J., and Lewis, R. R. (2019). Better restoration policies are needed to conserve mangrove ecosystems. *Nat. Ecol. Evol.* 3:870. doi: 10.1038/s41559-019-0861-y
- Lipcius, R. N., and Burke, R. P. (2018). Successful recruitment, survival and long-term persistence of eastern oyster and hooked mussel on a subtidal, artificial restoration reef system in Chesapeake Bay. *PLoS ONE* 13:e0204329. doi: 10.1371/journal.pone.0204329
- Mitsch, W. J. (2019). Restoring the Florida Everglades: comments on the current reservoir plan for solving harmful algal blooms and restoring the Florida Everglades. *Ecol. Eng.* 3:100009. doi: 10.1016/j.ecoleng.2019.07.009
- Nagelkerken, I., Sheaves, M., Baker, R., and Connolly, R. M. (2015). The seascape nursery: a novel spatial approach to identify and manage nurseries for coastal marine fauna. *Fish Fisheries* 16, 362–371. doi: 10.1111/faf.12057
- Nam, V. N., Sasmito, S. D., Murdiyarto, D., Purbopuspito, J., and MacKenzie, R. A. (2016). Carbon stocks in artificially and naturally regenerated mangrove ecosystems in the Mekong Delta. *Wetlands Ecol. Manage.* 24, 231–244. doi: 10.17528/cifor/data.00030
- Seto, K. C., Fragkias, M., Güneralp, B., and Reilly, M. K. (2011). A meta-analysis of global urban land expansion. *PLoS ONE* 6:e23777. doi: 10.1371/journal.pone.0023777
- Thomas, N., Lucas, R., Bunting, P., Hardy, A., Rosenqvist, A., and Simard, M. (2017). Distribution and drivers of global mangrove forest change, 1996–2010. *PLoS ONE* 12:0179302. doi: 10.1371/journal.pone.0179302
- Valiela, I., Bowen, J. L., and York, J. K. (2001). Mangrove forests: one of the world's threatened major tropical environments. *Bioscience* 51, 807–815. doi: 10.1641/0006-3568(2001)051[0807:MFOOTW]2.0.CO;2
- Waltham, N. J., and Sheaves, M. (2015). Expanding coastal urban and industrial seascape in the Great Barrier Reef World Heritage area: critical need for coordinated planning and policy. *Mar. Policy* 57, 78–84. doi: 10.1016/j.marpol.2015.03.030
- Waycott, M., Duarte, C. M., Carruthers, T. J., Orth, R. J., Dennison, W. C., Olyarnik, S., et al. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proc. Natl. Acad. Sci.* 106, 12377–12381. doi: 10.1073/pnas.0905620106

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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