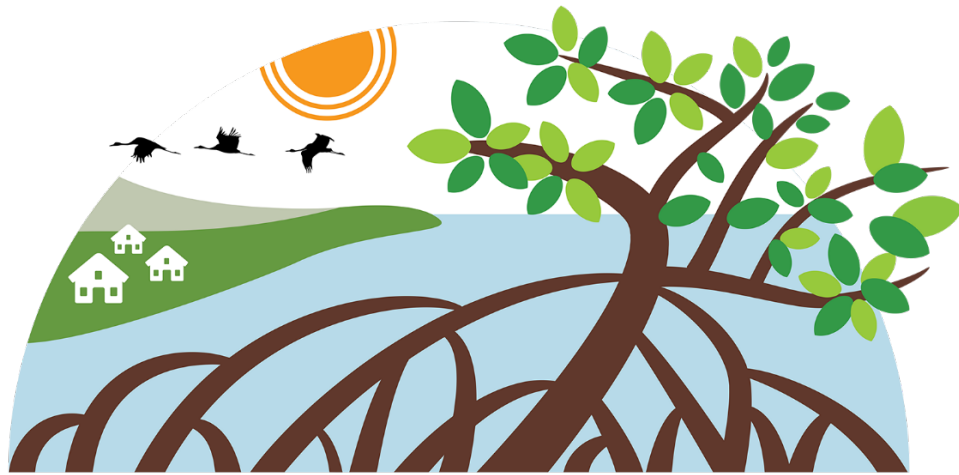


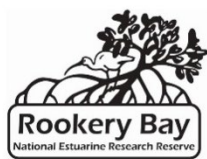
# Glossary for the Mangrove Coast Collaborative Project



MANGROVE COAST COLLABORATIVE

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COLABORACIÓN EN MANGLES COSTEROS



## Acknowledgments

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## Background

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The Mangrove Coast Collaborative (MCC) (2020-2024) is a collaborative science project funded by the National Estuarine Research Reserve (NERR) System Science Collaborative. The MCC was initiated in the aftermath of the 2017 hurricane season with the goal of increasing understanding and enhancing the resilience of mangrove ecosystems and surrounding communities following hurricane impacts. Through a multidisciplinary team, the MCC investigated the effects of Hurricanes Maria and Irma on Jobos Bay NERR (southeastern Puerto Rico) and Rookery Bay NERR (southwestern FL), respectively, assessing patterns in recovery, effects to ecosystem services, and strategies for decision-making. Achieving this goal required the combined expertise of geoscientists, ecologists, social scientists, educators, practitioners, coastal managers, and local knowledge holders in both regions. Project advisory committees were formed at the outset of the project to provide input on the project approach and feedback on products. The participants of these committees spanned geographies, disciplines, and cultures, and as such, contributed distinct perspectives. During meetings with our advisory committees, we quickly discovered the need for a shared lexicon of terms used in the context of the project. The MCC Terminology Team (Terms Team) was formed to address this need.

The MCC Terms Team is a group of experts in mangrove ecosystem ecology, hydrology, restoration, resource management, ecosystem services, and collaborative engagement. The group, consisting of both project team members and project advisory committee members, worked over the course of 18 months to define terms used during the MCC Project. The Terms Team considered several perspectives and consulted with specialists as we sought to find best-use definitions for the project. The process of creating a project glossary included careful consideration of terms requiring definition, the context in which terms are used in different ways by different user groups, and the primary audience for the glossary (end-users of the MCC). We solicited feedback from project advisory committees at several points, specifically requesting input into whether terms captured our shared understanding and whether additional terms should be considered. This process provided for a shared understanding and ensured that all terms requiring definition were included in the glossary. As a result, the definitions presented here are considered within the context of ecosystem science and management to help us focus our conversations among team members, stakeholders, and end-users.

## Usage Note

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References associated with each term include those which the Terms Team found most influential to the definitions adopted and believed to be the most useful for the Mangrove Coast Collaborative network. Definitions may include examples of the term being used, related terms, and discussions of varying contexts of usage based on the discipline. Related terms are those that have similar meanings and are often used interchangeably with the term which we chose to define. As this is a project focused on mangrove coastlines, several terms are defined in reference to mangroves and we do not attempt to define those terms for other systems or more generally. Finally, we do not provide a general definition for the term *resilience* as there are multiple types of environmental resilience. Instead, we chose to define two types of resilience that are particularly meaningful to the MCC project: *ecosystem resilience* and *social resilience*.

## Terminology Team Members

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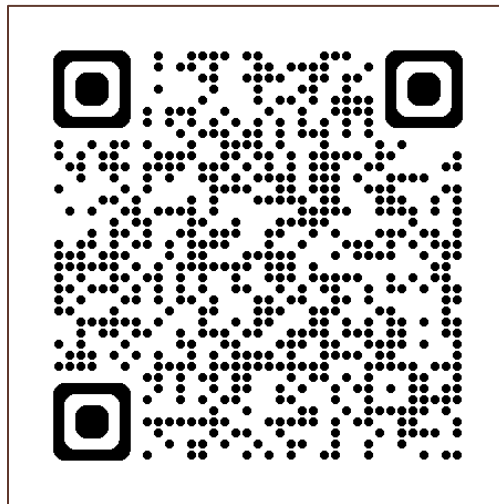
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To learn more about the **Mangrove Coast Collaborative**, scan the QR Code above or visit the website here: [Mangrove Coast Collaborative / Colaboración en Mangles Costeros: Understanding Links between Degradation, Recovery, and Community Benefits | NERRS Science Collaborative](#)

## Terms and Definitions

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**Adaptive capacity** – The ability of a system to maintain critical functions and processes during changing or new environmental conditions.

References: Angeler & Allen, 2016; Chambers et al. 2019

**Adaptive management** – A strategy of natural resources management responsive to past, current, and predicted environmental and social change that prioritizes ecosystem functioning and services. Management actions may include protection or conservation, remediation, rehabilitation, and restoration. Note: The definition adopted here differs from the one used by experimental management communities, as described in the CERP Adaptive Management Integration Guide (RECOVER 2010).

Reference: Bosire et al. 2008

**Altered hydrology** – The modification or alteration of an established hydrologic regime of a wetland or body of water by direct or indirect anthropogenic action with potential impacts to geomorphology, hydrology, and/or ecology of the system. In coastal wetlands, this typically leads to changes in environmental resources and stressors that alter ecological function, structure, and processes.

References: Poff et al. 1997; Twilley & Rivera-Monroy 2005

**Co-production** – A collaborative process among managers, scientists, and stakeholders to define the scope and context of a problem, form research questions, determine appropriate methods and outputs, collect data, make scientific inferences, and develop strategies for the appropriate outcomes of the generated information.

Reference: Beier et al. 2017

**Coupled human-environment system** – A framework to recognize the adaptive capacities and feedbacks between natural and human-built systems, which informs vulnerability assessments and resilience planning.

Reference: Turner et al. 2003

**Ecosystem function** – The circulation, transformation, and accumulation of energy and matter through processes, structure, and composition of abiotic and biotic components of a system. Ecosystem functions may be directly or indirectly linked to ecosystem services.

Related term: Ecological Function.

References: Odum 1953, Evans 1956, Miller & Reed 1965, Odum 1969

**Ecosystem health** – An imperfect health or medical metaphor used, especially in the policy and decision-making realm, to assist in guiding or creating a “bottom line” for sustainable development. This metaphor is used to describe impacts on ecosystems and their integrity due to both human and non-human causes and is measured against “norms”, providing a standard for assessment of large-scale ecosystems and a framework for developing preventative and restorative (curative) practices. The concept can be traced to Aldo Leopold in the 1940s and his concept of land sickness and James Hutton’s writings from 1788 on the earth’s capabilities of self-maintenance.

References: Rapport 1995; Rapport et al. 1995

**Ecosystem integrity** – The ability of an ecosystem to support and maintain ecological processes and a diverse community of organisms. It has been used as a proxy for ecological resilience (IPBES 2019).

Examples of indices used to measure ecosystem integrity include: the Mean Species Abundance (MSA) index and Biodiversity Intactness Index (BII).

Related term: Ecological integrity has been criticized (alongside ecosystem integrity) as a bad fit for conservation and restoration ecology (Rohwer & Marris 2021). But see Karr et al. 2022 for a cogent argument for the value of this term, including the assertion that ecological assessments with the ability to quantify losses due to human impact are based on the concept of ecological integrity.

References: IPBES 2019; Rohwer & Marris 2021; Karr et al. 2022

**Ecosystem resilience** – The ability of an ecosystem to resist, tolerate, and adapt to chronic and/or acute stress events (e.g., hurricane impact) while retaining similar function and structure without shifting into an alternate stable state (e.g., a freshwater system transitioning to a brackish system).

References: Brand & Jax 2007; Chambers et al. 2019

**Ecosystem services** – The benefits that flow from nature to people; for example, the production of food and timber; life-support processes such as water purification and coastal protection; and life-fulfilling benefits such as places to recreate or to be inspired by spiritual or religious connections with nature.

Related term: Nature’s Contributions to People (IPBES, 2019; Diaz et al. 2018)

References: National Ecosystem Services Partnership, 2014; Hassan et al., 2005

**Habitat enhancement** – A management action to create a new set of environmental conditions for the purpose of establishing a new ecological system or function. Examples include “created wetlands,” “artificial reefs,” “living shorelines”. Although see Lewis 1990 which differentiates between wetland enhancement and wetland creation.

References: Lewis 1990; White et al. 1990

**Hydrogeomorphic classification** – A classification of wetlands that includes the following three components: (1) geomorphology (the physical ground-surface structure as it relates to the geological make-up of the ecosystem, modulated by physical control factors); (2) water source (precipitation, surface flow, or groundwater flow); (3) hydrodynamics, specifically the motion of water and its capacity to do work (e.g., sediment movement; facilitating salt). Note: the above is a general classification for all wetlands and not specific to mangroves. For mangroves, typologies exist based on geomorphic setting, sedimentary setting, or a combination of the two (i.e., coastal environmental settings) and are summarized in Worthington et al. (2020). Mangroves are also classified according to geophysiological types (fringe, basin, riverine, and dwarf).

Related terms: biophysical typology, mangrove ecotype, ecogeomorphological type

References: Lugo & Snedaker 1974; Woodroffe 1992; Brinson 1993; Balke & Friess 2016; Worthington et al. 2020

**Hydrologic regime** – Description of hydrologic conditions that includes the following parameters: water depth, flood duration, frequency of flooding, timing of flooding (seasonal, for example) of a wetland. This term is adapted from the term “flow regime” that also incorporates the watershed.

Reference: Poff et al. 1997

**Hydrological stress** – A change in the hydrologic regime that reduces the performance of an ecosystem below some optimal rate. Channelization, damming, and partial changes in hydroperiods are potential hydrological stressors to mangrove ecosystems.

Reference: Lugo 1978

**Hydroperiod** – A pattern of the duration, frequency, and depth of flooding due to a combined influence of tidal and freshwater inflow, rainfall, atmospheric pressure, wind, and drainage capacity of the wetland. Hydroperiod is an important factor determining mangrove growth capacity and species composition.

References: Chen & Twilley 1998; Krauss et al. 2006, 2008

**Indicators** – Ecosystem factors that resource managers use to describe the ecological condition of a system. For example, as it relates to wetland assessments, the US EPA has developed metrics and indices of biological integrity (EPA 2002). For mangroves, key indicators of a restored or rehabilitated mangrove include: multi-generational trees; seedling generation; sapling recruitment and establishment; indicator species/biodiversity; hydrologic drainage; nutrient and organic material processing; sediment accumulation; and food and habitat for wildlife.

References: EPA 2002; Bakhtiyari et al. 2019

**Mangrove** – Tropical and sub-tropical tree and shrub species occurring within the intertidal zone and adjacent areas that play a major role in vegetative community structure, having the ability to form homogenous stands. Mangroves exhibit some combination of the following biophysical adaptations to survive in coastal conditions: vivipary, aerial roots (pneumatophores, root knees, buttress roots, etc.), and salt tolerance (exclusion or extrusion). Mangrove ecosystems in the eastern United States and Caribbean are composed of three dominant species: *Rhizophora mangle* (red mangrove), *Avicennia germinans* (black mangrove), and *Laguncularia racemosa* (white mangrove), but may include mangrove associates, e.g. *Conocarpus erectus* (buttonwood). The term is used to denote both individuals and communities.

References: McNae 1969; Lugo & Snedaker 1974; Tomlinson 2016

**Mangrove die-off** – Extensive tree and sapling mortality within mangrove ecosystems due to either or both non-anthropogenic and anthropogenic causes on acute or chronic time frames, including drought, increased temperature, and hydrologic alteration. Examples include Fruit Farm Creek (RBNERR), Gulf of Carpentaria die-off (Australia).

Note: This term is not found in historical literature; however, we recognize that it is a colloquial term that has been used more commonly among stakeholders.

Alternative term: Mangrove mortality.

Related Terms: Ghost Forests (areas of standing dead trees in former forests); Mangrove Heart Attack (mortality resulting from hydrologic stress)

References: Jimenez et al. 1985; Lewis et al. 2016

**Mangrove ecosystem degradation** – A transitional state resulting from one or more stress factors caused by anthropogenic drivers or the effect of anthropogenic activities on natural drivers. Degraded mangroves are indicated by loss of diversity, structure, function and associated services, and/or the ability to recover within an expected period of time following disturbance.

Note: Whereas ecosystem ecologists may use more precise indicators (temporal and spatial) for this term, natural resource managers may need to use this term to justify and describe management actions.

References: Jimenez et al. 1985; Yando et al. 2021

**Mangrove ecosystem stressor** – An external factor (or multiple factors) that may drive transformation or loss of mangrove ecosystem structure and/or processes if the capacity of the system to absorb and adapt to the stress is exceeded. Examples described by Lugo (1978) and Lugo et al (1981) include: 1) those that alter energy sources (damming/channelization), 2) those that remove a portion of resources

(e.g., nutrients) before they can be used, 3) those that remove photosynthate before it can be used/stored (herbivore outbreak), 4) those that remove soil nutrients/biomass, 5) those that affect metabolism. Stressors can be chemical, physical, climatic, or biotic.

References: Lugo 1978; Lugo et al. 1981; Lewis et al. 2016

**Mangrove expansion** – Establishment and growth of mangroves into adjacent habitats, either displacing other vegetation types or colonizing bare soil. It includes both poleward migration associated with less frequent freeze events and increased winter temperature minimums, and inland migration associated with changing environmental controls including sea level rise, sediment movement, and tropical cyclone impact. Increasing tidal inundation and tropical cyclones allow for the establishment of propagules into new habitats.

Related terms: Mangrove encroachment; Mangrove migration; Mangrove range shifts

References: Hamylton et al. 2023; Osland et al 2016; Saintilan et al. 2014

**Mangrove rehabilitation** – A management action to reinstate a level of ecosystem functioning sufficient to provide ongoing, defined ecosystem services and a capacity to absorb and recover from episodic events.

References: Field 1998, Abelson et al. 2016, Gann et al. 2019, Ellison et al. 2020

**Mangrove restoration** – A management action (typically hydrologic) within a past or current mangrove habitat to promote sustained ecosystem functioning and native species composition, and environmental conditions (see “indicators”) relative to a reference model.

Reference: Ellison et al. 2020

**Nature-based solutions** – Actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges using adaptive and efficient mechanisms that benefit people and the environment.

References: CEQ (2022); IUCN (2020)

**Pre-emptive rehabilitation** – A management action to identify and ameliorate ecosystem stress before a critical shift in ecosystem function and structure occurs; e.g., die-off following a hurricane.

Reference: Lewis et al. 2016

**Resist-Accept-Direct (RAD)** – A natural resource management tool that considers multiple ecosystem outcomes and services to people in the context of climate change, sea level rise, and/or anthropogenic other landscape changes. The options for RAD focus on a three-point spectrum of management action types:

- “Resist” management actions focus on maintaining current or historic ecosystem conditions such as structure, composition, and/or function.
- “Accept” decisions allows the system to change without management intervention.
- “Direct” management interventions will facilitate new ecological conditions that include adaptation to emergent climate conditions.

Managers can apply any of three approaches either alone or in combination. Each option represents trade-offs among management goals, societal values, and available resources.

References: Lynch et al. 2021; Schuurman et al. 2022

**Social resilience** – The capacity of human communities to withstand and adapt to impacts from disasters and/or chronic stress by responding or reorganizing in ways that maintain human health and safety, community integrity and identity, and ability to support human well-being.

References: Chapin et al. 2010, Biggs et al. 2015; [Saja et al., 2021](#); [IPCC 2023](#)

**Tipping Point** – The critical threshold in an ecosystem where an irreversible shift of function and structure occurs, leading to ecosystem transformation. Observed tipping points in mangrove systems have been attributed to a combination of a long-term chronic stress (e.g., extensive flooding; high salinity) and typically an acute disturbance event (e.g., major storm or disease outbreak).

References: Scheffer et al. 2001; Dakos et al. 2019; Magness et al. 2021

**Vulnerability** – The extent to which an ecosystem is susceptible to loss or change in function/structure as a result of exposure to a perturbation or stressor, including the effects of long-term climate impacts. Vulnerability assessments are concerned with the spatial aspects of exposure and susceptibility.

References: Turner et al. 2003; Amaral et al. 2023; Lecina-Diaz et al. 2024

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