POLICY BRIEF

European Coastal Wetland Indicators: A proposal for monitoring policy processes across space and time

KEY MESSAGES

- **Coastal wetlands are vital natural assets** that store carbon, protect shorelines, purify water, control floods, and support threatened species.
- **Conserving and sustainably managing wetlands** is crucial to achieving the EU Green Deal and fulfilling core EU commitments to protect and restore coastal ecosystems.
- **A coordinated European monitoring framework** with clear, fit-for-purpose indicators is urgently needed to track wetland status, restoration progress, and policy performance.
- **Advanced tools**—including remote sensing, GIS, and modelling—combined with **collaborative stakeholder engagement**, can deliver high-quality, timely data.

Introduction

Coastal wetlands are invaluable for global change and biodiversity protection, as highlighted in major policy goals and international agreements, including the SDGs, the Global Biodiversity Framework by the CBD and the Ramsar Convention. In Europe, these ecosystems, being the smallest in terms of extent - covering less than 0.6% at EU-27 + UK[1] are widespread along all coastlines. They are found in coastal lagoons, estuaries, other transitional waters, fjords, sea lochs, and embayments.

Healthy coastal wetlands play a crucial role in stabilizing and protecting European shorelines by enhancing coastal resilience to storms and preventing coastal erosion. This protection service is achieved by retaining and accumulating sediment from terrestrial flood systems, which also benefits nearby agricultural activities by depositing nutrients and providing fresh water for irrigation.

Moreover, coastal wetlands, when functional / healthy, act as natural sponges during the wet European winters and springs, storing water and helping to regulate droughts and floods. They also serve as buffers against pollutants from land uses like agriculture, aquaculture, and domestic and industrial sewage, effectively removing or reducing a number of organic and inorganic pollutants (e.g., nutrients, heavy metals, hydrocarbons, pesticides). In addition to these vital functions, coastal wetlands support a high diversity of life forms, with many endangered flora and fauna directly connected to these habitats.

Furthermore, coastal wetlands support the regulation of hydrological fluxes and water quality, modulating peak flows by storing runoff and slowly releasing it over time, with positive impacts on water management and soil moisture. Healthy coastal wetland habitats are essential in the

carbon cycle. Their restoration holds significant potential for safeguarding soil carbon stocks and increasing carbon sequestration in Europe, earning them the designation of "blue carbon ecosystems." Scientific data also indicate that wetlands reduce exposure to climate-related effects and associated impacts on communities by increasing resilience to drought and flooding[2]. These ecosystems provide multiple services that help mitigate the impacts of climate change, making their conservation and restoration critical for both environmental and community well-being.

Achieving sustainable wetland management in the EU is crucial for several planned actions within the **European Green Deal**, which aims for climate neutrality, biodiversity protection, healthy soils, zero pollution, flood protection, nature restoration, and a circular economy. Key EU policies supporting coastal wetlands conservation and restoration include the **Habitats, Water and Birds Directives,** the **Marine Strategy Framework Directive,** the **Biodiversity Strategy for 2030**, the **Zero pollution action plan** and the **EU Nature Restoration Law**.

These policies set ambitious targets to be achieved by 2030, such as a 50% reduction in pesticide use, at least a 55% reduction in net greenhouse gas emissions, a 50% decrease in nutrient excess, and a 20% reduction in fertilizers. Furthermore, they aim to increase protected areas to 30%, implement restoration measures covering at least 20% of degraded areas, including wetlands, and halt land and sea degradation. The **European Climate Law,** the **Soils Strategy 2030,** the **Farm to Fork Strategy** as well as the **Common Agricultural Policy** also address the maintenance of wetlands and the enhancement of soil organic carbon in their scopes. In climate policy, the **EU LULUCF Regulation** mandates accounting for emissions and removals from wetlands starting in 2026, and the **Sustainable Carbon Cycles Communication** promotes wetland restoration, including coastal ecosystems, identifying blue carbon practices as key actions to upscale carbon farming by 2030. These comprehensive efforts underscore the importance of European wetlands in achieving broader environmental and climate goals.

In view of this comprehensive and demanding policy agenda, strong and comprehensive evidence, analysis, and holistic approaches are essential. This includes building on relevant policy instruments and supporting assessments[1] and a further call for more cohesive evidence highlighting the significance of these coastal ecosystems and their contributions to the diverse policy agendas. Meeting these demands requires establishing a performance monitoring and evaluation framework to ensure that the quality of evidence from national conservation actions and restoration programs on these ecosystems informs and facilitates policy development, responds to emerging needs, and supports a variety of objectives, goals, and targets.

Researcher tracking GHG emissions from a coastal wetland in Valencia, Spain. © LifeWatch ERIC / Università del Salento

New demands on wetland indicators

New demands on wetland indicators and supporting/ guiding tools to evidence-based assessments stem from the need to accurately assess the ecological status, resilience, and contributions of wetlands to climate and biodiversity policy goals as well as other cross sectoral policies. These indicators will be crucial for informing policy decisions, guiding conservation and restoration actions, and evaluating the effectiveness of management initiatives. In this context, indicators must assess changes in the status of coastal wetlands over time and answer what is required to be assessed/monitored to track progress and measure it against EU policy targets. They can provide a clear and quantifiable way of measuring whether the implemented regional and national strategies are successful in protecting and restoring the ecosystems. This ensures that resources are used efficiently and that policy interventions are having the desired impact within a predefined period established for each policy.

In addition, to effectively inform EU and national policies on coastal wetland performance, it is crucial to agree on baseline conditions, set a meaningful period for periodic assessment with relevant indicators to measure progress, and track progress over time to measure performance against set targets.

By leveraging the use of new technologies such as remote sensing, geographic information systems (GIS), advanced data analytics, modeling and machine learning in conjunction with measures taken *in situ*, countries can significantly enhance their capacity to understand trends and assess interventions in coastal wetland ecosystems. This integrated approach will provide a comprehensive understanding of ecological changes, help identifying effective conservation strategies, and support evidence-based decision-making for sustainable management and restoration efforts.

Figure 1. Achieving Sustainable Coastal Wetland Management in the EU: Key Actions and Policies


© Pete from Pixabay

Schematic representation of the initial proposal set of outcome policy indicators for the mid-term (2030) EU targets designed to assess the status and monitor progress related to European (continental) coastal wetlands.

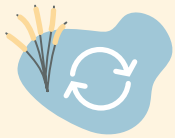
A proposal of fit for purpose indicators for measuring policy progress with coastal wetland targets

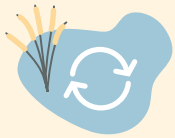
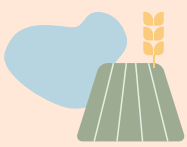
Here, we outline the selected eight outcome policy indicators designed to assess the status, trends, and policy targets related to coastal wetlands in response to the EU policies. They were selected according to the topic policy questions that needed to be addressed and described to address five thematic dimensions: wetland extent change (changes in the areal extent of the wetland habitats), ecosystem health condition, wetland connectivity (structural), wetland ecosystem service (indicators relating to the service of the ecosystem) and ecosystem conversion.

Associated Indexes and Metrics for Coastal Wetlands

In combination with the policy indicators, associated metrics provide quantitative measures to help translate the broad goals and objectives of the policies into specific, points for evidence-based action (Table 1). By focusing on key aspects such as habitat extent and condition, land use changes, restoration progress, greenhouse gas (GHG) emissions, and ecological connectivity, the proposed associated metrics are built up to offer a comprehensive framework for evaluating the health, restoration and services of coastal wetlands.

Table 1. Proposed set of policy outcome indicators and metrics to build evidence and foster greater integration between national and EU policies to streamline reporting processes. Indicators should be disaggregated per Country and EU level.

POLICY INDICATOR OUTPUT	METRIC TITLE	UNITS	DESCRIPTION
Extension of Coastal Wetlands Protected and Strictly Protected 	Total Coastal Wetland Extent in Protected Areas and in Strict Protected Areas	Percentage of area coverage (km^2)	Percentage change on spatial cover of total coastal wetlands protected and strictly protected from total protected areas
	Total Coastal Wetland Extent in N2000 sites	Area coverage (km^2)	Extent of coastal wetlands within the Natura 2000 network
	Total Coastal Wetland Extent designated as Ramsar and/in Natura 2000	Area coverage (km^2)	Total area of coastal wetlands designated as Ramsar sites and within the Natura 2000 network
	Total Coastal Wetland Protected as a Proportion of Coastal Wetlands	Percentage of area coverage (km^2)	Percentage change on spatial of coastal wetlands protected within designated areas as a percentage of the total coastal wetland extent. It offers a measure of the overall conservation coverage of coastal wetlands
Representativity of Coastal Wetland Habitats in Protected Areas 	Spatial cover of different coastal wetland habitats in Protected Areas	Percentage of area coverage (km^2)	Percentage on wetland extent data by habitat type and classifications (e.g. EUNIS 2022, HD Directive, Nature Restoration Law)
	Individual Coastal Wetland Habitat Extent in N2000	Area coverage (km^2)	Specific coastal wetland habitat types within the Natura 2000 network
Improved Coastal Wetland Health 	Coastal Wetland Knowledge	Proportion of sites with data available and habitat condition known	Measures the extent of knowledge available regarding the habitat condition of coastal wetlands, as outlined in Annex 1 of the Nature Restoration Law
	Coastal Wetland Habitat Condition	Percentage change in good condition of different coastal wetland habitats	Measures changes in the quality of various coastal wetland habitats (Annexes I, II, IV and V of HD Directive and Nature Restoration law) over time and per each biogeographic region. It includes factors such as vegetation health, soil quality, and water clarity.
	Coastal Wetland Biodiversity (Species) Condition	Percentage change in good condition of different coastal wetland species	Tracks changes in the condition of species diversity and abundance (referred to in Annexes II, IV and V to HD Directive and of the species covered by Directive 2009/147/EC.) within different coastal wetland habitats.
	Deterioration Status	Area coverage (km^2) of deteriorated coastal wetlands	Assesses the extension of total deterioration of coastal wetlands based on parameters such as pollution levels, Invasive species presence, drainage, and physical alterations.
		Level of deterioration of different types	
		Area coverage (km^2) of drained Coastal Wetlands and organic soils	
	Risk posed by invasive species	Percentage of area coverage to total coastal wetland area	Assesses the size of populations and extension risk posed by invasive species (species strictly regulated + species of concern) to natural coastal wetland ecosystems.
		Population size	
		Number of Invasive species	
Coastal Wetland Restoration Rate 	Hydrological Connectivity	Km of free-flowing rivers connected to coastal wetlands being restored	Evaluates changes in water flow patterns and connectivity between wetland areas
	Surface and Groundwater Restoration	Ecological and chemical threshold values	Based on WFD, it examines trends on water restoration efforts from multiple dimensions of surface and groundwater status, particularly quality and quantitative.
	Pollutant Reduction Effectiveness	Percentage decrease in concentrations of key pollutants	Evaluates the trend reductions in pollutant levels to meet the targets set by the Zero Pollution Action Plan, MSFD and WFD.
		Number of priority substances that met the targets (concentrations) per wetland	

POLICY INDICATOR OUTPUT	METRIC TITLE	UNITS	DESCRIPTION
Coastal Wetland Restoration Rate 	Barrier Impact Index	Percentage change in natural water flow patterns due to the elimination of barriers	Assesses the impact of physical barriers (e.g., roads, dams, levees, dikes, ports) on the ecological connectivity, hydrological flow (marine and coastal),
	Restoration Potential	National plans that prioritize coastal wetland restoration	Assesses efforts to help identify and prioritize areas for coastal wetland restoration
		Area coverage (km^2) of potential restored habitats from the proportion deteriorated	
	Restoration Progress	Area coverage (km^2) of habitats of coastal wetlands restored and under restoration	Percentage change in condition or extent specifically attributable to coastal wetland areas under active restoration or restored from the percentage of area deteriorated. Habitats refers to habitat types listed in Annex I of HD and Annex II of the EU Nature Restoration law.
		Number of countries with coastal wetland restoration in progress	
		Area coverage (km^2) of coastal wetlands with restored drainage systems	
Vulnerability to Climate-Related and Natural Disasters 	Coastal Wetland Vulnerability	Vulnerability Index score	Assess the vulnerability of coastal wetlands to various environmental stressors, particularly climate change impacts such as sea-level rise, storm surge, and increased frequency of extreme weather events
GHG Emissions Abatement from Coastal Wetland Land Use Conversion and Restoration 	Land Use Conversion Area	Percentage change of converted coastal wetland area	Proportion at which coastal wetlands are converted to other land uses over time (from reference reporting period) to assess the effectiveness of land use policies to conserve natural carbon sinks such as wetlands.
	Extended Coastal Wetland Habitat Loss/ Gain Ratio	Percentage of area coverage (km^2) of total coastal wetlands	Compares the area of wetland habitats lost to development or other uses against the area gained through conservation and restoration activities.
	GHG Emissions and Removals from Land Converted Wetlands	GHG emissions and removals /ha/year following wetland conversion	Tracks losses and emissions of CO_2, methane, and nitrous oxide, in CO_2 equivalents, resulting from the conversion of coastal wetlands to other land uses.
	GHG from Coastal Wetland Restoration	GHG emissions/ha/ year following wetland restoration	Tracks the net balance of CO_2, methane, and nitrous oxide, in CO_2 equivalents, from coastal wetlands restoration.
Share of Utilised Agricultural Area (UAA) under Supported CAP Commitments in Coastal wetlands 	Share of Agricultural Area in Coastal Wetlands	Area coverage (km^2) of land used for agriculture within coastal wetlands.	Tracks the adoption of sustainable agricultural practices and helps evaluate the impact of CAP policies on emission reduction and carbon storage
		Area coverage (km^2) of UAA within coastal wetlands that are managed under CAP-supported initiatives.	
	Agricultural Carbon Sequestration and GHG Reduction Index in Coastal Wetlands	Carbon sequestration Rate and GHG emissions/ ha/year from CAP Agriculture land in coastal wetlands	Tracks the adoption of agriculture lands to reduce emissions or to maintain or enhance carbon storage on agricultural land in coastal wetlands
Overall funding sources for coastal wetlands 	Coastal Wetland Funding	Euros invested per reporting period	Evaluate the overall funding landscape for coastal wetlands, assess the availability, from various sources, including government agencies, non-governmental organizations, international bodies, non-profit and private sector contributions

Sentinel 2-A false-colour image of the coastal wetland in Camargue Regional Natural Park. May 2018. © ESA

Integrating advanced technologies and collaborative approaches for monitoring coastal wetlands

To ensure accurate data collection, analysis, and interpretation, it is crucial to further develop relevant tools and knowledge. This includes advancing remote sensing technologies, improving modeling capabilities, and deepening our understanding of the ecological processes specific to coastal wetland habitats. Collaboration among scientists, policymakers, and local communities will be essential to refine these tools and tailor them to regional contexts. Such advancements will enhance monitoring and reporting, enabling more targeted and effective conservation and restoration efforts, and ultimately supporting the long-term sustainability of coastal wetland ecosystems in Europe.

The implementation of a comprehensive policy performance and monitoring framework for European coastal wetland with indicators will significantly improve our ability to track and understand the health and trends of these critical ecosystems. By integrating advanced technologies, this proposal outlines a robust science-based approach to monitoring policy processes based across both spatial and temporal scales. This framework as it is built, will fill gaps and nourish monitoring and assessment needs in Europe building on agreed approaches (Maes et al., 2020). The metrics will be useful for direct uptake by the second European Ecosystem Assessment that will inform the Biodiversity Strategy for 2030. It will also facilitate the timely detection of changes and emerging threats while supporting evidence-based decision-making, ensuring sustainable management and conservation efforts. Ultimately, by providing consistent and reliable methods, tools, and data, European countries will be better positioned to protect their coastal wetlands and contribute to broader environmental protection and climate resilience goals.

References and guideline documents

1. Maes, J. et al., 2020. Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment - supplement, EUR 30161 EN, Publications Office of the European Union, doi:10.2760/519233, JRC120383.
2. Sanchez-Arcilla et al., 2022. Barriers and enablers for upscaling coastal restoration. Nature-Based Solutions, Vol. 2, 100032.
3. Abdul Malak, et al., 2021. Carbon pools and sequestration potential of wetlands in the European Union. European Topic Centre on Urban, Land and Soil Systems, ISBN 978-3-200-07433-0.
4. Trombetti et al., 2022. Mapping and assessment of the state of wetland ecosystems: a Mediterranean perspective. Interreg Mediterranean Biodiversity Protection Community project. 84pp.

Annex

INDICATOR	EXPLANATION
Extension of Protected Areas and Strictly Protected Areas designated for Coastal Wetlands	Percentage of total coverage of coastal wetlands as well as for each coastal wetland habitat type within protected areas, including under strictly protected measures. It is a composite index with several metrics.
Representativity of Coastal Wetland Habitats in Protected Areas	It measures the extent to which various types of coastal wetland habitats are included and adequately protected within designated protected areas. This indicator assesses the effectiveness of policy conservation efforts in preserving the diversity of coastal wetland ecosystems.
Proportion of Increase on Coastal Wetland Health	This indicator assesses the condition and health of coastal wetland habitats (Annex 1 of HD) and species (Annex 2 of HD), the risk posed by invasive species and the degradation status. By tracking key components such as vegetation health, water quality, soil condition, and biodiversity, this indicator helps assess the effectiveness of policy conservation efforts such as Habitat Directive, the Nature Restoration law, the Zero pollution action plan and Ramsar Commitments.
GHG Emissions Abatement from Coastal Wetland Land Use Conversion and Restoration	It accounts for GHG fluxes to evaluate the carbon sequestration potential and climate mitigation benefits of coastal wetland conservation and restoration efforts. It considers natural coastal wetland areas and human-made wetlands (Wetlands converted to forests; Forests converted to wetlands; Wetlands converted to managed croplands; cropland converted to wetland) and managed wetlands based on each country's 2016/2017/2018 average LULUCF removals or emissions baseline.
Share of Utilised Agricultural Area under Supported CAP Commitments in Coastal wetlands	This indicator quantifies the extent of agricultural land use under Supported CAP Commitments to reduce emissions or to maintain or enhance carbon storage on agricultural land in coastal wetland.
Coastal Wetland Vulnerability to Climate-Related and Natural Disasters	This indicator measures the area of coastal wetlands in Europe currently under threat from climate-related and natural disasters and assesses the extent to which disaster risk assessments are incorporated into wetland management plans.
Coastal Wetland Restoration Rate	This indicator tracks restoration efforts across EU countries, reflecting commitments to enhance coastal wetland resilience and ecosystem services. It also measures the restoration of water quality and free-flowing rivers linked to coastal wetlands to increase spatial connectivity.
Percentage Increase in overall funding sources for coastal wetlands	This indicator tracks the total funding from various sources, including government agencies, non-governmental organizations, international bodies, and private sector contributions. It provides insights into the investment levels and financial commitments towards coastal wetland protection and restoration.

Bahia de Cadiz Natural Park. Andalucia, Spain.
© JUAN CARLOS MUÑOZ / Alamy

RESTORE4Cs is a Horizon Europe project that aims to evaluate the effects of restoration actions on wetlands' ability to mitigate climate change and deliver a range of ecosystem services, using an integrative socio-ecological systems approach. More information is available at: https://www.restore4cs.eu/

Citation:

Otero, M. M.[1], Abdul Malak, D.[1], Sanchez A.[1], Schröder, C.[1], Kampa, E.[2], Bueb B.[2], Elkina, E.[2], Guelmani, A.[3] ,Camacho, A.[4], Marangui, C.[5], Lillebø, A.[6], 2025.
European Coastal Wetland Indicators: A proposal for monitoring policy process across space and time. Policy brief. Restore4Cs project.

[1] European Topic Center, University of Malaga, Spain
[2] Ecologic Institute, Germany
[3] Tour de Valat, France
[4] University of Valencia, Spain;
[5] Italian National Research Council, Italy
[6] University of Aveiro, Portugal

PARTNERS