



## Salt Marshes: Ecology Functions and Threats in Coastal Ecosystems

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### Abstract

Salt marshes are globally significant coastal wetlands characterized by salt tolerant vegetation and periodic tidal inundation. They occupy transitional zones between terrestrial and marine ecosystems and provide critical ecosystem services including carbon sequestration, coastal protection, nutrient cycling, and biodiversity support. Despite covering only a small fraction of Earth's surface, salt marshes have outsized ecological and socio economic value. However, these ecosystems face growing threats from sea level rise, land use conversion, climate change, and human disturbance. This article reviews the structure and ecological importance of salt marshes, highlights key functions and services, and discusses major challenges and conservation needs for their sustainability.

**Keywords:** Salt Marshes, Coastal Wetlands, Blue Carbon, Ecosystem Services, Tidal Marsh Ecology, Sea Level Rise, Biodiversity

### Introduction

Salt marshes are intertidal ecosystems found along sheltered coastlines, estuaries, bays, and tidal creeks where saline and freshwater mix. They are dominated by halophytic (salt-tolerant) grasses, herbs, and shrubs, and occur predominantly in temperate and subtropical regions of the world. Globally, salt marshes have been mapped across tens of millions of hectares along coastlines of North America, Europe, Australia, and Eastern Asia, with largest extents in temperate zones where tidal ranges and sediment supply favor their establishment.

These unique wetlands form at the interface of land and sea and play essential roles in coastal ecology. Salt marsh sediments slowly accrete over time, driven by tidal deposition and plant growth, allowing them to keep pace with modest sea-level rise [1]. Vegetation such as *Spartina* spp. stabilizes sediments and traps organic matter, fostering high primary productivity and supporting food webs that include invertebrates, fish, and birds.

Salt marshes are recognized for their blue carbon storage the

sequestration of carbon in plant biomass and long-term burial in anaerobic sediments which can be more effective per unit area than many terrestrial forests. However, despite their ecological significance, salt marshes have experienced dramatic loss due to coastal development, pollution, and sea-level rise, making their conservation a priority for climate adaptation and biodiversity protection [2].

### Ecological Functions and Services of Salt Marshes

Salt marsh ecosystems are among the most productive on Earth, characterized by high rates of primary production by salt-tolerant vegetation. This productivity supports diverse animal communities and contributes to significant carbon accumulation in sediments — a key aspect of the blue carbon concept. Salt marsh soils can store large amounts of organic carbon over centuries due to slow anaerobic decomposition in waterlogged environments. Globally, the carbon stored in salt marsh sediments contributes substantially to coastal carbon budgets despite occupying relatively small total area compared to terrestrial ecosystems.

This long-term carbon storage has practical relevance for climate mitigation strategies. The ability of salt marshes to sequester carbon has been recognized by international climate frameworks, highlighting their value as nature-based solutions that complement emissions reduction efforts [3].

Salt marshes serve as natural buffers along coasts, attenuating wave energy and reducing the impact of storm surge and flooding on inland areas. The dense vegetation and sediment structure dissipate wave forces, lowering flood heights and protecting infrastructure and human settlements. In hydrological terms, salt marshes regulate water flow, trap sediments, and filter pollutants, ultimately improving water quality and reducing turbidity in estuarine and coastal environments.

Moreover, marsh surfaces can reduce erosion and facilitate vertical accretion that helps these landforms keep pace with gradual sea-level rise, although rapid rise rates can exceed their capacity to adapt. Salt marshes support a wide range of plant and animal species, acting as important nursery habitats for juvenile fish, crustaceans, and waterbirds. Invertebrates, such as crabs and polychaete worms, contribute to nutrient cycling and sediment structure through bioturbation, further enhancing habitat complexity and productivity. These habitats sustain species that are directly important to commercial fisheries and serve as key stopover sites for migratory bird species [4].

The biological diversity of salt marshes contributes to resilient food webs and supports recreational and cultural values for coastal communities. Despite their ecological benefits, salt marshes are under significant pressure. Accelerated sea-level rise due to climate change poses a major threat: if accretion cannot keep pace with rising water levels, marshes may drown, leading to habitat loss and carbon release. Research indicates that many salt marshes globally are already declining due to rising tides, erosion, and altered sediment dynamics.

Human activities including coastal development, land reclamation, pollution, and hydrological alterations further degrade marsh habitats and reduce their ecological function. Nutrient runoff from agriculture can cause eutrophication, reducing plant health and altering community structure. Encouragingly, restoration efforts

such as managed realignment and replanting have shown promise in rebuilding salt marsh structure and function, though success often depends on long-term monitoring and adaptive management. Conservation strategies must therefore integrate protection of existing marshes, restoration of degraded areas, and policies addressing broader drivers such as climate change to ensure the resilience of these vital ecosystems [5].

## Conclusion

Salt marshes are dynamic coastal wetlands that provide **multiple ecosystem services**, including carbon sequestration, coastal protection, nutrient cycling, and biodiversity support. Their capacity to store carbon and buffer coastal communities against storm impacts makes them invaluable in the context of climate change and sustainable coastal management. However, accelerating sea-level rise, habitat loss, and human pressures continue to threaten salt marsh stability and function. Effective conservation and restoration strategies — supported by scientific understanding and long-term monitoring —

are essential to safeguard these ecosystems for ecological, economic, and societal benefits. Recognizing salt marshes as critical components of coastal resilience and climate mitigation frameworks remains central to global environmental stewardship.

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