

**ACBA 7005**

# **Evaluation of Carmarthen Bay Management Plan**



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# Table of Contents

|                                                                             |    |
|-----------------------------------------------------------------------------|----|
| 1.0. Introduction .....                                                     | 2  |
| 1.1. Coastal Riparian Habitat Management.....                               | 2  |
| 1.2. The coastal and marine site management in the United Kingdom .....     | 3  |
| 2.0. Carmarthen Bay .....                                                   | 3  |
| 2.1. Overview of Carmarthen Bay and Gower: A Coastal Gem of Wales.....      | 3  |
| 2.3. Geographical features.....                                             | 5  |
| 2.4. Carmarthen Bay habitat and vegetation .....                            | 5  |
| 2.5. Wild life and animal species in the Study Area .....                   | 10 |
| 2.6. Land use practices in the Carmarthen Bay .....                         | 12 |
| 3.0. Challenges within the study area .....                                 | 13 |
| 4.0. Management Practices in the Carmarthen Bay and associated area .....   | 14 |
| 5.0. Recommendations for future management practices of the study area..... | 17 |
| Conclusion: .....                                                           | 18 |
| References .....                                                            | 18 |
| Appendix 1 .....                                                            | 21 |

## **1.0. Introduction**

### **1.1. Coastal Riparian Habitat Management**

Riparian habitats serve as essential ecosystems that exist at the land-water interface, acting as critical zones for biodiversity, water quality management, and ecological resilience. Riparian habitats play a distinct role in the watershed landscape as a transition zone between terrestrial and aquatic ecosystems (Wissmar and Beschta, 1998). Marine coastal riparian habitats are dynamic and essential ecosystems that exist at the boundary between the terrestrial and marine environments. According to Richardson et al. (2007), transitional habitat between the sea and land is usually neglected due to the different backgrounds of oceanic and terrestrial biologists, although it is vital for species and processes that span the boundary. They provide a variety of ecological functions, including as coastal stability, habitat for varied marine life, carbon sequestration, and recreational activities. Marine riparian vegetations consist of several types of grasses, sedges, shrubs, and trees. Several other fish and invertebrate species residing lower on beaches compared to the ocean riparian use various altitudes as spawning sites because they are sedentary or have a relatively narrow home range (Levings and Jamieson, 2001).

Coastal riparian habitat serves as a natural buffer against erosion and storm damage, stabilizing shorelines and mitigating the effects of coastal risks. They serve as critical nursery sites and feeding grounds for a variety of economically significant fish species, hence benefiting coastal economies and communities. Coastal vegetation, such as mangroves and salt marshes, store massive amounts of CO<sub>2</sub>, which helps to reduce climate change. Additionally, marine coastal riparian ecosystems provide opportunities for recreation, tourism, and cultural activities, which contribute to the well-being and identity of coastal communities. Despite their significance, marine coastal riparian ecosystems face a variety of challenges, including coastal development, climate change, urban runoff and pollution, and invasive species.

Effective management of marine coastal riparian habitats requires a holistic approach. Adopting ecosystem-based methods to coastal planning and management, taking into account the interconnectivity of land and sea, and including stakeholders in decision-making. It is critical to protect existing habitats while also recovering degraded or destroyed ecosystems through reforestation, revegetation, and habitat improvement programs. To strengthen these habitats, strategies include implementing zoning restrictions, land-use planning, and development policies that emphasize coastal habitat conservation and minimize habitat disturbance are important. In addition, actions to limit pollutant inputs into coastal seas, such as drainage management techniques, wastewater treatment, and marine litter cleanup activities, are required. By applying science-based management techniques, addressing significant difficulties, and encouraging stakeholder engagement, it is possible to effectively protect and restore these unique habitats, ensuring their long-term health and resilience in the face of persistent threats and environmental changes.

## **1.2. The coastal and marine site management in the United Kingdom**

As an island nation, the United Kingdom is endowed with vast coastlines, diverse maritime species, and important marine resources. The UK's coastal areas are under enormous socioeconomic demand for development and exploitation, for tourist, port infrastructure, residential development, and more recently for environmental mitigation initiatives, controlled realignment sites, and compensatory habitat. Developing an efficient coastal and marine governance framework is challenging owing to conflicting activities and complicated legal and administrative arrangements (Fletcher and Potts, 2008). The UK Conservation of Habitats and Species Regulations 2010 incorporate the Habitats Directive into national legislation (The Stationary Office, 2010). The regulations incorporate particular measures for maritime areas and specify 'capable' and 'relevant' authorities. The Regulations mandate the statutory nature conservation advisory agency to advise other relevant authorities on conservation objectives for management. Effective collaboration between relevant authorities and suitable government departments is required to ensure the identification and implementation of significant management practices (Bullimore, 2014).

The UK has established a network of Marine Protected Areas (MPAs) to conserve and manage marine biodiversity and habitats. This network includes sites designated under national and international frameworks, such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Marine Conservation Zones (MCZs), and Ramsar Sites. The UK government, decentralized administrations, municipalities, and other stakeholders work together to implement Integrated Coastal Zone Management (ICZM) principles via planning, regulation, and stakeholder engagement (Ballinger, 2002). Also, the UK government adopts fisheries management strategies to ensure that fish stocks are used sustainably while also protecting maritime ecosystems. Several conservation groups, academic institutes, and government agencies conduct research and monitoring to evaluate the state of marine biodiversity, identify conservation priorities, and influence management choices. Furthermore, the British government invests in coastal defense and flood risk management strategies to safeguard coastal regions and ecosystems, such as natural flood control, beach replenishment, and managed retreats.

## **2.0. Carmarthen Bay**

### **2.1. Overview of Carmarthen Bay and Gower: A Coastal Gem of Wales**

Carmarthen Bay and Gower, situated along the southern coast of Wales, stand as a testament to the natural beauty and ecological richness of the region. Carmarthen Bay and Estuaries in southwest Wales is the location of a Special Area of Conservation (SAC), two Special Protection Areas (SPA), and a RAMSAR site, all of which are designated for habitat and species features listed in the European Community Habitats and Birds Directives, the RAMSAR Convention, and domestic legislation (Bullimore, 2014). Carmarthen Bay is situated in the southwest of Wales, bordered by the counties of Carmarthenshire, Pembrokeshire, and Swansea.

Carmarthen Bay Special Area of Conservation (SAC) consists of three areas, including;

- Laugharne and Pendine on the Carmarthenshire coast to the south of St Clears
- Around Pembrey on the Carmarthenshire coast south west of Kidwelly
- Whiteford on the north west of the Gower peninsular

The SAC covers 1206 hectares and includes three Sites of special scientific interest. It is mostly made up of sand dunes and related habitats. Whiteford National Nature Reserve (NNR) also forms part of the area of the SAC; this comprises 782 hectares.

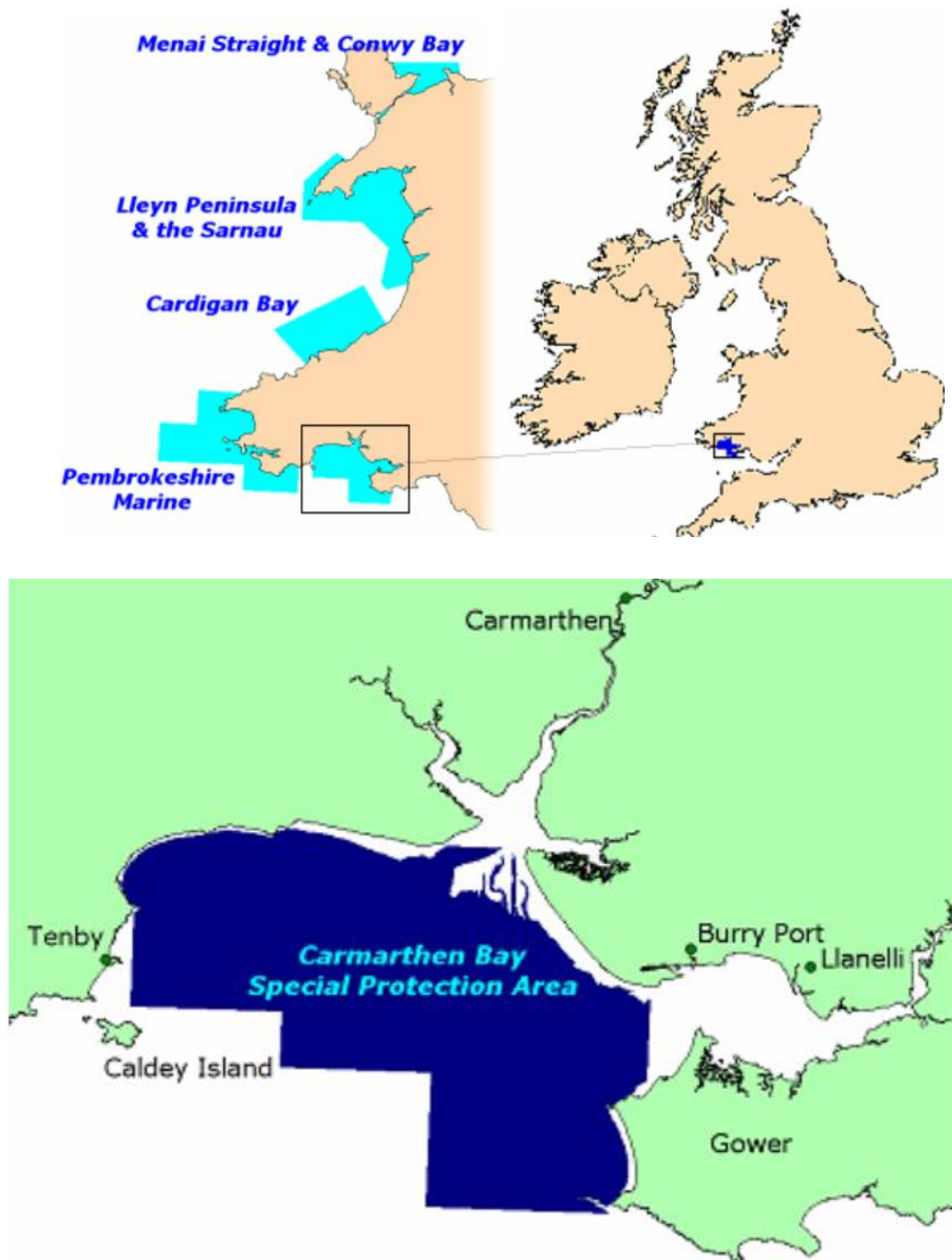


Figure 1: Carmarthen Bay and SPA in south-west Wales, United Kingdom.

### **2.3. Geographical features**

Carmarthen Bay and Gower encompass a diverse range of geographical features. The rough coastline of Gower is highlighted by magnificent cliffs, such as those at Worm's Head and Three Cliffs Bay, which provide stunning views of the Bristol Channel. The region has numerous pristine sandy beaches, particularly Rhossili Bay, which is regularly listed as one of the greatest beaches in the world due to its golden sands and rolling dunes. The region is dotted with historic landmarks, including medieval castles, ancient burial mounds, and prehistoric standing stones, offering glimpses into the area's rich past. Mumbles and Laugharne are charming coastal communities with scenic ports, historic houses, and local artisanal shops. The bay is home to several estuarine systems, including the Towy (Tywi) and Taf estuaries, which are characterized by extensive mudflats, salt marshes, and tidal creeks. Carmarthen Bay is a shallow bay with many seabed types, including mud, sand, and rock. However, the bulk of the bottom is sandy. It also includes the entire Caldey Island and its surrounding seas.

Carmarthen Bay is formed by geological features, filled with mobile substrata, and influenced by the hydrographic regime. The Bay is largely surrounded by Carboniferous and Devonian limestones and sandstones. Natural hard substrata in the intertidal zone include bedrock (Wharley Point), cobble and boulder scars (Wharley Point, Ferryside, Salmon Point Scar, Whiteford), and cobble mussel beds (Salmon Point Scar, Ginst Point, Whiteford Point). However, these areas are not well represented in comparison to other inlets in Wales (Natural Resource Wales).

### **2.4. Carmarthen Bay habitat and vegetation**

Carmarthen Bay, located along the southern coast of Wales, boasts a diverse array of habitats and vegetation, contributing to its ecological richness and scenic beauty. Its coastline is characterized by a diverse range of natural features that contribute to its scenic beauty and ecological significance. These habitats along the land-sea boundary are dynamic and change throughout time. These ecosystems contribute to the unique landscape of Carmarthenshire and its overall characteristics. In addition to the intrinsic worth of these ecosystems and the species they sustain, they offer a variety of natural advantages including; establishment of free coastal defenses, food provision, namely fish and shellfish, tourism and recreation, agriculture (salt marsh lamb and seaweed fertilizer), sand and gravel for the industry. The region under conservation comprises sea inlets, tidal rivers, estuaries, mud flats, sand flats, lagoons (including saltwork basins), salt marshes, salt meadows, salt steppes, shingle, sea cliffs, and islands.

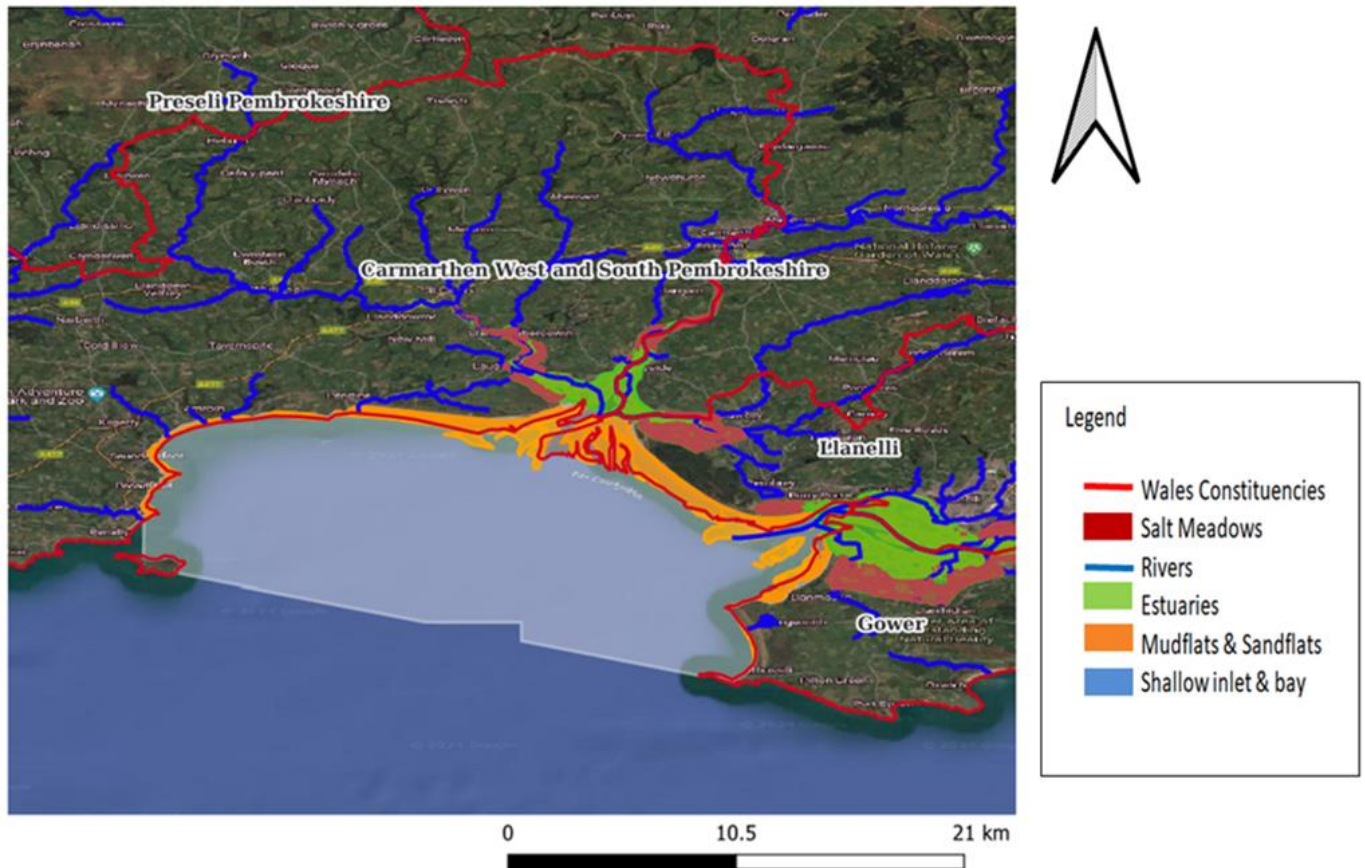


Figure 2: Geographical profile of the study area

### 1. Coastal sand dunes:

Coastal sand dunes are dynamic ecosystems that emerge as wind-blown sand accumulates near the beach. Wind, waves, and vegetation interact to create these environments, producing a range of dune types. The Laugharne and Pendine Burrows dunes, located on the northern side of Carmarthen Bay, constitute part of a sandy barrier spit complex that has expanded eastwards from Dolwen Point to the Three Rivers estuary. These sand dune systems consist of many zones, such as embryonic and mobile dunes, semi-fixed dunes, fixed dune grassland, and dune slacks (damp depressions between dunes ridges). In the 1980s and early 1990s, fixed dune vegetation communities predominated within the inland dunes, while semi-fixed dune, foredune, and tiny patches of embryo dune communities were limited to near-beach regions, primarily towards the eastern end of the system (Pye *et al.*, 2014.; Bennett *et al.*, 2020).



Figure 3: Coastal sand dunes, Carmarthen Bay

Coastal sand dunes feature a unique array of plant species that have adapted to the harsh and dynamic dune habitat. Marram grass (*Ammophila arenaria*) is a dominating plant in the foredune zone, having extensive roots that assist to maintain sand and prevent erosion. Other dune vegetation species are sea holly (*Eryngium maritimum*), sea rocket (*Cakile maritima*), sea bindweed (*Calystegia soldanella*), and sand couch (*Elytrigia juncea*). Pioneer species like sea sandwort (*Honckenya peploides*) and sea spurge (*Euphorbia paralias*) are frequently found in the most active and unstable sections of the dunes. Plants in coastal sand dunes have evolved various adaptations to survive in the harsh dune environment, including; salt tolerance drought resistance, and wind tolerance (Natural Resource Wales).



Figure 3: Marram grass (*Ammophila arenaria*)

## 2. Coastal Saltmarsh

Coastal saltmarshes are intertidal habitats that form in sheltered areas where tidal waters bring in saltwater and sediments, creating conditions suitable for salt-tolerant vegetation to thrive. These ecosystems are made up of low-lying, marshy landscapes with seasonally inundated mud flats, streams, and channels, as well as salt levels that change depending on the tide. These salt marshes are recognized as significant natural capital, offering multiple ecosystem services to coastal communities and environmental advantages such as carbon storage, producing habitat space for a wide range of secondary animal and algae species, and lowering pollution (Bennett *et al.*, 2023). Carmarthen bay is home to a significant 'Atlantic salt meadow' type saltmarsh community. Upper saltmarsh transitions into a variety of ecosystems, including sand dunes, machair, coastal shingle, freshwater marshes, and woodlands. The vegetation is adaptable to salty environments, changing water levels, and anaerobic soils. These plants play important roles in stabilizing sediments, trapping organic matter, and providing habitat and food for a variety of wildlife. Common plant species found in coastal saltmarshes include saltmarsh grass (*Puccinellia maritima*), sea lavender (*Limonium spp.*), sea aster (*Aster tripolium*), and glasswort (*Salicornia spp.*).



Figure 4: Coastal Saltmarsh



Figure 5: Saltmarsh grass (*Puccinellia maritima*)

## 3. Estuarine habitats

Carmarthen Bay, encompasses a range of estuarine habitats due to its unique geographical features. Estuarine habitats are transitional zones where freshwater from rivers meets and mixes with saltwater from the sea, resulting in dynamic and diverse ecosystems. It is home to several estuaries, each with its own unique characteristics and ecosystems including Loughor estuary, Towy estuary, Gwendraeth estuary and Burry inlet. The Burry Inlet area is a functional unit with significant sediment and biota interchanges, accounting for around 3.4% of the UK's estuary resources. Estuaries have diverse physiographies and hydrodynamic regimes, allowing for various combinations of wave exposure and tidal streams.

The estuaries have both subtidal and intertidal ecosystems, with both types of ecosystems being more prevalent in this special area of conservation. In addition to the truly marine environments and associated animals, the estuary ecosystem includes a diverse range of coastal and terrestrial habitats, with transitions from marine communities to brackish, maritime, freshwater, and terrestrial ecosystems occurring under undisturbed or untouched conditions. Some common estuary plants and vegetation types found in Carmarthen Bay include; Common cordgrass (*Spartina anglica*), Small cordgrass (*Spartina maritima*), Sea lavender (*Limonium sp.*), Samphire (*Salicornia sp.*), Eelgrass (*Zostera sp.*), Green algae (*Enteromorpha sp.*), Glassworts (*Salicornia sp.*) and Marsh samphire (*Salicornia europaea*). These plants and vegetation species have critical ecological functions in Carmarthen Bay estuaries, providing food and habitat for a wide range of animals, stabilizing sediment, and contributing to overall ecosystem health.



Figure 6 and 7: Estuarine habitats in Carmarthen Bay

#### 4. Woodlands and coastal scrub habitats

Woodlands and coastal scrub habitats surrounding Carmarthen Bay are characterized by a mix of coastal and terrestrial plant species adapted to the region's maritime climate and varied topography. Coastal forests around Carmarthen Bay are made up of a combination of deciduous and coniferous tree species. Common deciduous trees include oak (*Quercus sp.*), ash (*Fraxinus sp.*), beech (*Fagus sylvatica*), and sycamore (*Acer pseudoplatanus*), while coniferous species such as Scots pine (*Pinus sylvestris*) and coastal pine (*Pinus pinaster*) are also found. Wildflowers, ferns, and mosses such as bluebells (*Hyacinthoides nonscripta*), wood anemones (*Anemone nemorosa*), primroses (*Primula vulgaris*), and bracken (*Pteridium aquilinum*) often carpet woodland floors. Scrub habitats on Carmarthen Bay's coastal dunes are frequently dominated by salt-tolerant shrubs and grasses that thrive in sandy, well-drained soils. Woodlands and coastal scrub habitats in Carmarthen Bay provide important ecosystem services, including erosion control, carbon sequestration, and habitat for a variety of wildlife (Packham and Willis, 1997).

Overall, Carmarthen Bay's habitats support a rich diversity of plant and animal life and provide important ecosystem services such as nutrient cycling, water filtration, and coastal protection. Figure 8 illustrates the vegetation and habitat cover in the study area.

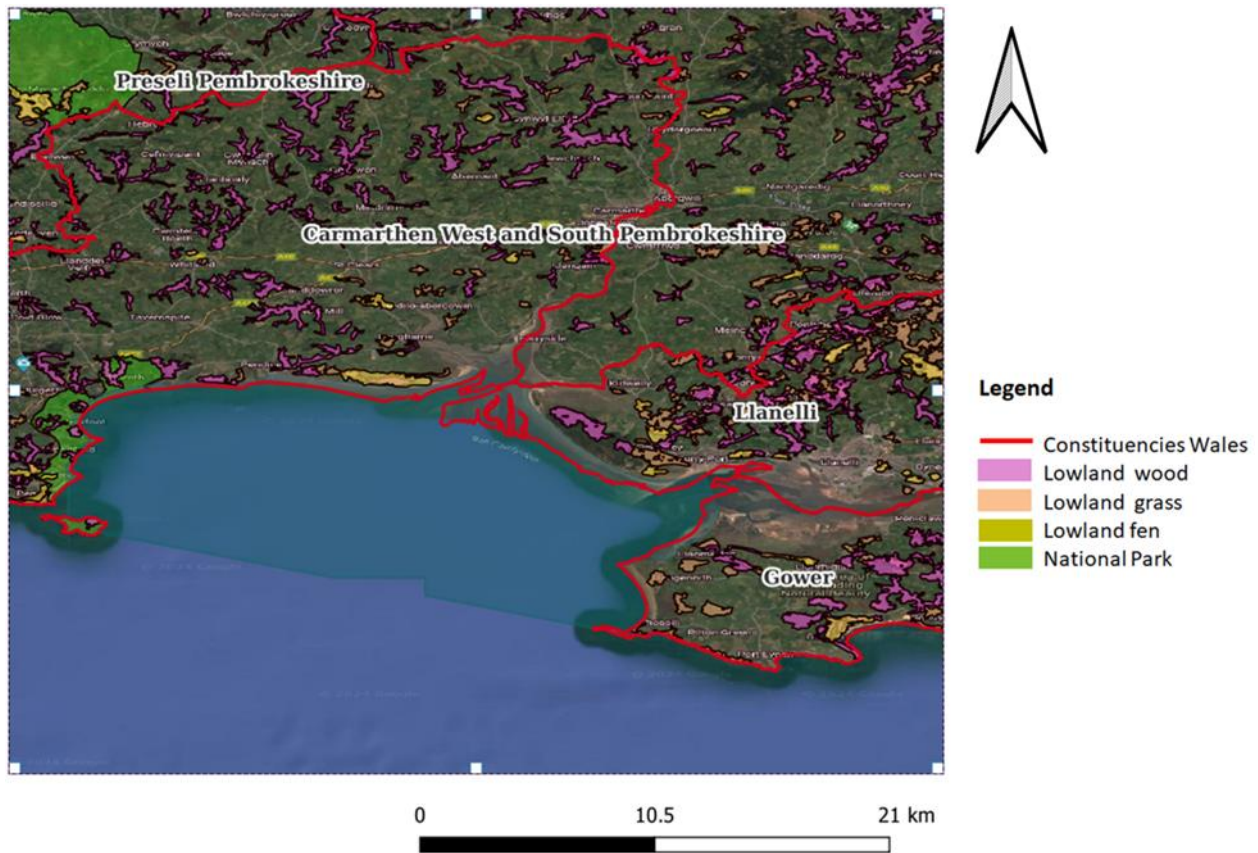


Figure 8: Vegetation and habitat cover in the study area

## 2.5. Wild life and animal species in the Study Area

Carmarthen Bay is a diversified and environmentally rich location that serves as home to a wide range of wildlife and animal species. The Joint Nature Conservation Committee has designated Carmarthen Bay and estuaries as a Special Area of Conservation under the Directive on the Conservation of Natural Habitats and Wild Fauna and Flora. (European Union's Habitats Directive, 92/43/EEC). Carmarthen Bay Special Area of Conservation (SAC) was identified in 2004 as a network of locations with good specimens of five species recognized as important and vulnerable in Europe including; Allis shad (*Alosa alosa*), Twaite shad (*Alosa fallax*), River Lamprey (*Lampetra*), Sea Lamprey (*Petromyzon marinus*) and Otter (*Lutra lutra*).

Carmarthen Bay is renowned for its diverse bird populations, particularly in its estuarine habitats and coastal marshes. It is a birdwatcher's paradise, with a diverse range of seabirds, waders, and ducks calling its coastlines home. Carmarthen Bay serves as a refueling and rest stop for birds during migration, but some may even spend the winter here. The study area is the most significant location, accounting for over 50% of the non-breeding population, with peak numbers ranging from 17,000-22,000 birds.

In 2003, Carmarthen Bay Special Protection Area (SPA) became the first in the UK to be established under the EU Birds Directive for the common scoter sea duck, *Melanitta nigra*. Curlews, redshanks, oystercatchers, and dunlins are often seen foraging in mudflats and saltmarshes during low tide. Ducks such as mallards, teal, and wigeons, as well as geese and swans, frequent the bay's estuaries and freshwater habitats. Gulls, terns, and cormorants can be spotted along the coastlines, cliffs, and offshore islands. Special Protection Areas (SPAs) such as Burry Inlet and Gwendraeth Estuary provide critical breeding, feeding, and overwintering grounds for these bird species (Burton *et al.*, 2010).

Carmarthen Bay provides important habitat for a variety of marine mammal species, contributing to the region's biodiversity and ecological health. Marine mammals in Carmarthen Bay are protected by many national and international conservation laws, including the Wildlife and Countryside Act and the EU Habitats Directive. Grey seals (*Halichoerus grypus*) are the most prevalent pinniped species in Carmarthen Bay. They are frequently spotted hauling out on sandbanks, rocky coastlines, and isolated islands in the bay. Harbor seals (*Phoca vitulina*) are another kind of seal found in there, however they are less abundant than grey seals. Bottlenose dolphins (*Tursiops truncatus*) are rarely observed in the bay, especially in further offshore seas. Harbour porpoises (*Phocoena phocoena*) are small cetaceans commonly found in coastal waters. Other marine mammal species such as minke whales, common dolphins, and Risso's dolphins may occasionally visit Carmarthen Bay, especially during seasonal migrations. Terrestrial habitats surrounding Carmarthen Bay are home to mammals such as European rabbits, brown hares, and European otters. Reptiles such as common lizards and adders may be found in coastal dunes, heathlands, and grasslands.

Carmarthen Bay supports a diverse array of fish and shellfish species due to its varied habitats. Flounder (*Platichthys flesus*) are found in shallow coastal waters and estuaries and Dab (*Limanda limanda*) are also found in coastal waters and estuaries and are prized by anglers for their delicate flavor. European Sea Bass (*Dicentrarchus labrax*) are highly prized sportfish and commercial species and can be found in a variety of habitats, including rocky shores, estuaries, and offshore reefs. Thick-lipped Mullet (*Chelon labrosus*) are commonly found in estuarine habitats and are known for their ability to tolerate a wide range of salinities, from freshwater to full seawater. Cockles (*Cerastoderma edule*) are valuable for commercial fishery and found buried in sandy or muddy substrates in intertidal areas. Mussels (*Mytilus edulis*) are another commercially important shellfish species found in the bay's intertidal zones and estuaries. They form dense beds and provide important habitat for other species. Edible Crab (*Cancer pagurus*) are also found in the area, one of the largest crab species in UK waters and are harvested commercially for their meat. European Lobster (*Homarus gammarus*) are commonly found in rocky habitats and offshore reefs and are highly prized in the seafood industry.

Carmarthen Bay supports a variety of invertebrate species, including crustaceans, mollusks, and insects. Crabs, shrimp, and various species of clams and snails are commonly found in the bay's intertidal habitats. Insect species such as butterflies, bees, and beetles are abundant in the surrounding terrestrial habitats.

## 2.6. Land use practices in the Carmarthen Bay

Land use practices in Carmarthen Bay and its associated areas encompass a variety of activities due to its diverse ecosystems and economic importance. Carmarthen Bay is well-known for its abundant fisheries, which support many local villages. Fishing activities include both commercial fishing and small-scale, traditional fishing operations aimed at species such as mackerel, herring, and shellfish. The picturesque coastline attracts tourists and visitors, promoting a variety of tourism-related activities such as beach visits, water sports, and coastal walks. Industrial activities, including manufacturing and energy production, are present in the region. Carmarthen Bay serves as an important maritime transportation route, with ports facilitating the movement of goods and passengers.

Agricultural land use techniques in Carmarthen Bay are diverse and important for the sustainability of local communities and businesses. The fertile soils surrounding Carmarthen Bay support arable farming that involves the cultivation of crops such as wheat, barley, oats, and various vegetables. Livestock farming is prevalent in the area, with sheep and cattle cultivating being a traditional agricultural activity. Dairy farming is another significant agricultural activity in the region, with farmers producing milk and dairy products. Many farms in the region uses mixed farming, which includes both arable and livestock production. Agroforestry practices, which involve the integration of trees and shrubs into agricultural landscapes, are gaining attention in the area. A growing number of farmers in the area are adopting organic farming practices, which prioritize the use of natural inputs and sustainable management techniques. The following map represents the agricultural landuse in the region based on the UK government agricultural landuse classification system.

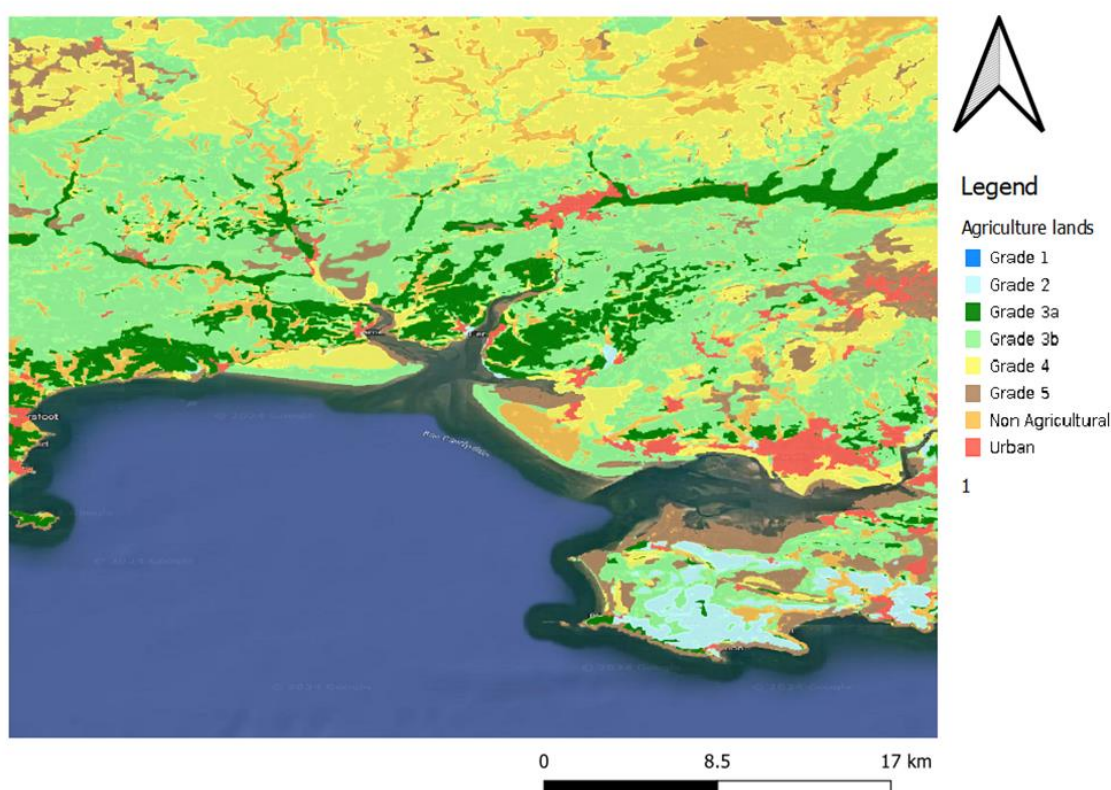


Figure 9: Agricultural landuse classification in the study area

According to the above map, grade 1, 2, 3a, 3b, 4 and 5 represent excellent quality agricultural land, very good quality agricultural land, good quality agricultural land, moderate quality agricultural land, poor quality agricultural land and very poor quality agricultural land respectively (UK government agricultural land use classification system).

### **3.0. Challenges within the study area**

The Carmarthen Bay area faces a range of natural challenges that can impact the environment, communities, and local economies. Carmarthen Bay is prone to coastal erosion caused by natural processes such as wave action, tidal currents, and storm surges. Erosion endangers coastal ecosystems, infrastructure, and assets, necessitating management methods. The Carmarthen Bay area is prone to storm events, including intense rainfall, high winds, and storm surges, especially during the winter months. Storms can cause flooding, coastal erosion, and property damage, impacting local residents, businesses, and transportation networks. Rising sea levels, caused by climate change, are a long-term threat to the Carmarthen Bay area.

Human activities such as urbanization, agriculture, and industrial development can degrade natural habitats in the Carmarthen Bay area, threatening biodiversity and ecosystem health. Habitat loss and fragmentation can impact wildlife populations, including migratory birds, fish species, and coastal flora. Pollution from a variety of sources, including agricultural runoff, urban runoff, and industrial discharges, may negatively affect water quality in Carmarthen Bay and its surrounding rivers, estuaries, and coastal waterways. Poor water quality can destroy aquatic ecosystems, limit recreational activities, and endanger human health. Over several centuries, historical modifications and constraints on these estuaries and bay created limitations to normal estuary evolution further described in Appendix 1: Table 1 (Bullimore, 2014).

Higher sea levels increase the risk of flooding, especially during storms, which can cause damage to coastal communities, crops, and infrastructure. High tides, combined with storm surges or heavy rainfall, can exacerbate the risk of coastal flooding, particularly in low-lying areas and estuaries. In Carmarthen Bay, storms originating from the Atlantic Ocean or the Bristol Channel can generate powerful surges that inundate coastal areas, particularly during high tides. Coastal erosion, caused by wave action, tidal currents, and storms, can degrade natural coastal defenses such as beaches, dunes, and salt marshes. Degraded coastal ecosystems are less efficient in mitigating the effects of flooding, making nearby regions more vulnerable to floods (Bennett and Karunaratna, 2020).

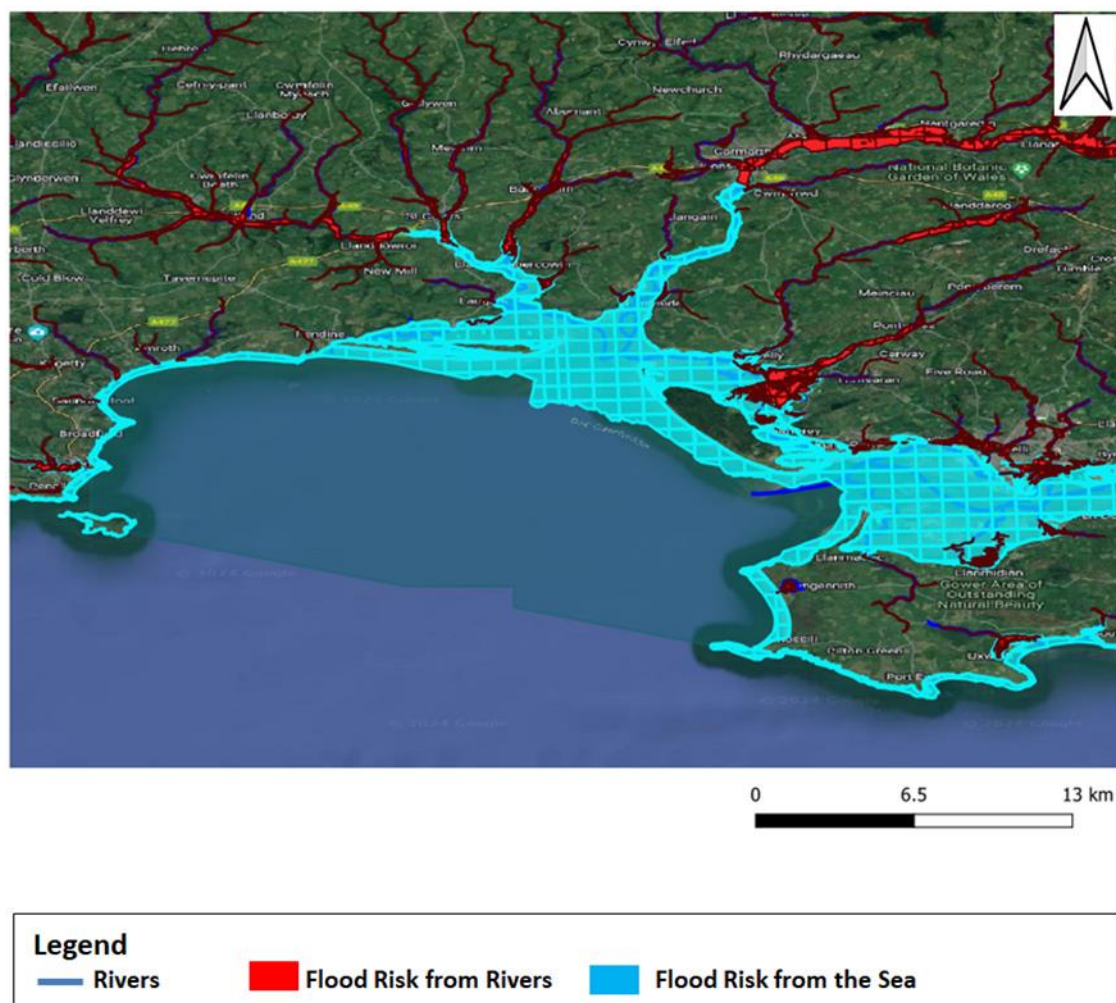


Figure 10: Flood risk from the rivers and the sea within the study area

#### 4.0. Management Practices in the Carmarthen Bay and associated area

Management practices in Carmarthen Bay and its associated area encompass a range of strategies and policies aimed at preserving the ecological health, supporting sustainable industries, and ensuring the well-being of local communities. Following government instructions (DETR/WO, 1998), the site's competent authorities decided to work together as a partnership to successfully achieve the Habitats Directive's objectives. To meet the requirements of the Habitats Directive, conservation objectives attempt to conserve habitat and species characteristics at a favorable conservation status within the site. The form of management and degree of protection necessary will vary spatially and temporally due to their differences in conservation importance and their sensitivity and susceptibility to change as a result of human intervention (Bullimore, 2014).

Seascape sensitivity in Carmarthen Bay involves assessing the vulnerability of the coastal environment to human activities and development pressures while considering soft constraints. Soft constraints refer to factors that are not legally binding but are nonetheless important considerations in coastal management and planning.

Some key aspects of seascape sensitivity and soft constraints in Carmarthen Bay are ecological sensitivity of the seascape, recreational and aesthetic values, economic activities and livelihoods and climate change resilience. By integrating these soft constraints into seascape sensitivity assessments and coastal planning processes, policymakers, planners, and stakeholders can work together to safeguard the natural and cultural heritage of Carmarthen Bay while promoting sustainable development.

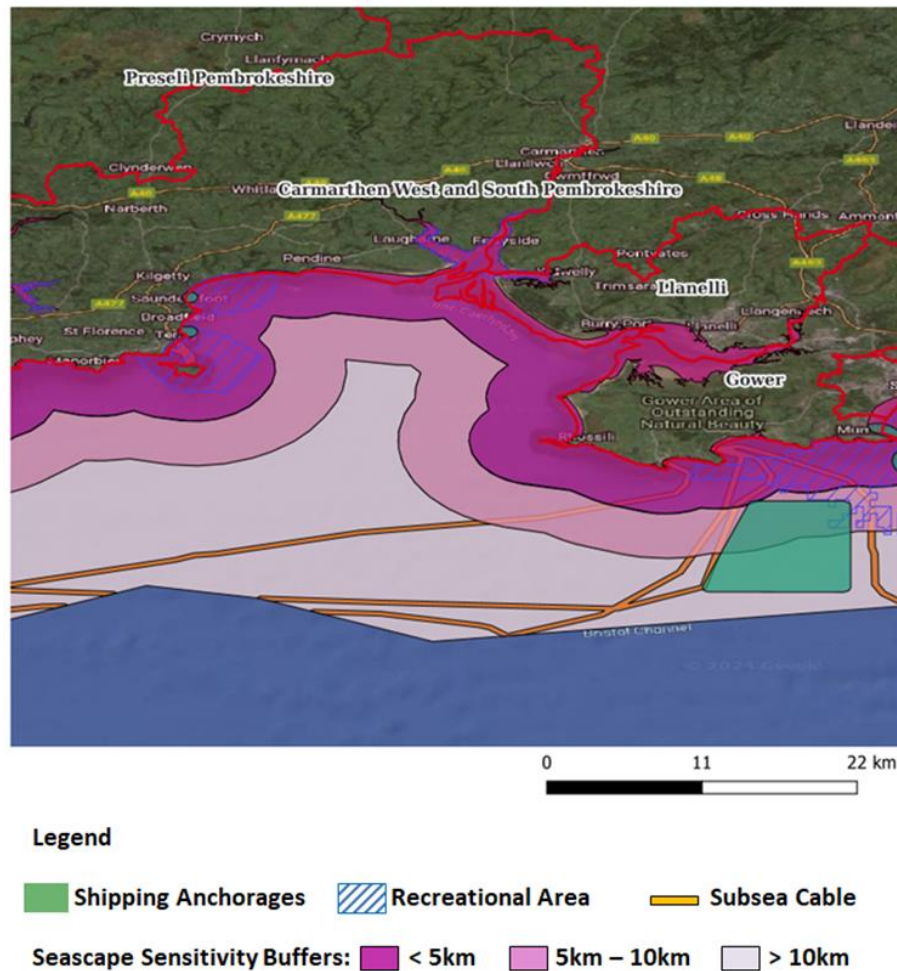


Figure 11: Seascape sensitivity buffers in the study area

Carmarthen Bay has a varied range of maritime habitats and species, therefore conservation measures will most likely include the designation of protected areas, the implementation of fishing quotas and boundaries, and the monitoring of biodiversity. Sustainable fishing practices are crucial for maintaining fish stocks and supporting the livelihoods of local fishermen. This might involve licensing regulations, seasonal closures, and efforts to combat illegal fishing. Regular monitoring of habitat conditions and species populations is essential for assessing the effectiveness of management practices and identifying any emerging threats. Research initiatives may focus on understanding habitat dynamics, species interactions, and the impacts of climate change. An integrated approach to habitat management takes into account the relationships between different ecosystems while also addressing several objectives such as biodiversity protection, flood risk reduction, and sustainable natural resource use.

The Water Framework Directive outlines a comprehensive framework for river basin management. The Floods Directive outlines a comprehensive strategy for flood risk management planning. A flood risk management strategy has been developed for consideration with the river basin management plans. Monitoring and improving water quality in Carmarthen Bay are likely priorities to safeguard public health and protect aquatic ecosystems. This may involve wastewater treatment initiatives and pollution control measures. Natural Resources Wales has adopted the ecosystem approach with a range of partners and sectors in innovative ways to achieve their management targets. Some partnership projects in the management catchment include; Rainscape (Llanelli) Sustainable Urban Drainage Management, South West Area Shellfish Waters Investigation, Pembrey Water Vole Project, Afon Taf fish passage improvement project 2011 and Clear Stream Swansea.



Figure 10 and 11: Afon Taf fish passage improvement project 2011

There are many local measures for this area in the Natural Resource Wales Carmarthen Bay Management plan including;

- Acidification restoration
- Address air pollution
- Address point source pollution
- Complete first cycle investigation
- Drainage and water level management
- Dredging and silt management
- Improve fish passage and habitat
- Improve flows and water levels
- Manage invasive nonnative species
- Mine water and contaminated land remediation
- Mitigate impacts of flood and coastal defences
- Mitigate impacts of shipping, navigation and dredging
- New Investigation
- Other sustainable land and marine management
- Reduce impacts of other physical modifications
- Reduce pollution from septic tanks
- Reduce pollution from sewage discharges
- Specific habitat and feature works
- Sustainable access and recreation management

- Sustainable aggregate extraction
- Sustainable agricultural practices
- Sustainable fisheries management
- Sustainable marine development
- Sustainable woodland and forestry management
- Tackle misconceptions and urban diffuse pollution
- Waste management

By implementing these habitat management practices, Carmarthen Bay can work towards conserving its rich biodiversity, supporting ecosystem resilience, and promoting the sustainable use of its natural resources for the benefit of both wildlife and local communities.

## **5.0. Recommendations for future management practices of the study area**

Strengthening future management practices for Carmarthen Bay requires a holistic and forward-thinking approach that addresses the complex interactions between ecological, socioeconomic, and governance factors. Develop an integrated management framework that considers the interconnectedness of various habitats, species, and human activities in the study area is critical. This framework should include ecosystem-based management concepts, along with collaboration among government agencies, local communities, non-governmental organizations, and other stakeholders. Ecosystem-based approaches involves considering the ecological functions and services provided by different habitats and species when making management decisions. Integrate climate change adaptation strategies into management plans to address the increasing impacts of climate change on the area is important. This may include implementing measures to enhance coastal resilience, protect habitats from sea-level rise, and mitigate the effects of extreme weather events. It is vital to promote greater community engagement and participation in management processes through outreach, education, and decision-making. Empowering local populations to take ownership of conservation activities can result in more effective and long-term benefits. Establishing multi-stakeholder forums and advisory groups can facilitate dialogue and coordination such as government agencies, academia, industry, and civil society organizations. Also, regular monitoring, evaluation, and feedback loops are essential for refining management strategies over time. This scientific information is crucial for evidence-based decision-making and assessing the effectiveness of management interventions. Therefore, allocate resources for research and monitoring programs to improve understanding of Carmarthen Bay's ecosystems, species populations, and human activities is essential. An other approach is nvest in capacity building and training programs to enhance the skills and expertise of managers, practitioners, and stakeholders in ecological monitoring, habitat restoration techniques, and community engagement strategies. Secure long-term funding and institutional support for management efforts to ensure continuity and sustainability may involve exploring innovative financing mechanisms, such as public-private partnerships or conservation finance initiatives. By implementing these recommendations, Carmarthen Bay can strengthen its management practices, enhance ecosystem resilience, and ensure the long-term sustainability of this valuable coastal ecosystem for future generations.

**Conclusion:**

Carmarthen Bay, located along the southern coast of Wales, is a picturesque and ecologically diverse area renowned for its stunning landscapes, rich biodiversity, and cultural heritage. The coastline of Carmarthen Bay is characterized by a mix of sandy beaches, rugged cliffs, and sheltered coves, offering diverse coastal landscapes. Carmarthen Bay has a broad range of ecosystems and vegetation types, including coastal sand dunes, salt marshes, woods, and offshore islands. These habitats sustain a diverse range of species while also offering valuable ecosystem services and recreational possibilities for visitors. Overall, Carmarthen Bay and associated area is a biodiverse and ecologically significant area that provides essential habitat for a wide range of wildlife species, making it a valuable asset for both conservation and recreation. This area has a number of natural challenges that may have an influence on the environment, people, and local economy. To address these challenges of in the study area, a comprehensive approach to coastal management is necessary. Management practices in the Carmarthen Bay and its associated area encompass a range of strategies and policies aimed at preserving the ecological health, supporting sustainable industries, and ensuring the well-being of local communities. Strengthening future management practices for Carmarthen Bay requires a holistic and forward-thinking approach that addresses the complex interactions between ecological, socioeconomic, and governance factors.

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**Appendix 1:** Table 1. Significant historical interventions and modifications of Carmarthen Bay & Estuaries

| Date                                              | Modification                                                                                                            | Effects                                                                                                   |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| From early 1600s                                  | Sea defences and enclosures.                                                                                            | Decline in area of salt-marsh; >2400 ha lost.<br>Reduced tidal prism.<br>Increased sediment accumulation. |
| From early 1800s                                  | Sea-walls and hard defences.                                                                                            | Restricted estuary migration.                                                                             |
| 1830s                                             | Docks and harbours.                                                                                                     | Locally modified sediment transport.                                                                      |
| From early 1800s in east,<br>early 1850s in west. | Railways and associated bridges.                                                                                        | Restricted estuary migration.                                                                             |
| Late 1890s/1950's                                 | Construction of channel training wall to improve navigational access to port of Llanelli, and its subsequent breaching. | Substantial modification of sediment transport, main tidal channel and intertidal habitats.               |
| 19 <sup>th</sup> & 20 <sup>th</sup> centuries     | Land claim, urbanisation and infrastructure.                                                                            | Area of Burry Inlet decreased from 8254 ha in 1876 to 7060 ha in 2000.                                    |
| 1940s and 1970s                                   | Hard coastal defences of military facilities.                                                                           | Locally modified sediment transport.                                                                      |