

ACBA7005 GIS and Habitat Management

Evaluation of Oxwich Bay National Nature Reserve

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1 INTRODUCTION

The Welsh Government has identified the management of flooding and coastal erosion as a national priority, with an aim to reduce the potential damage to property and the environment and protect lives and livelihoods from the impacts of increasingly more frequent flooding events. The focus is not only on building and fortifying flood defence infrastructure, but also on improving the nations water resilience by enhancing preventative measures that can minimise the impacts of flooding due to extreme weather events. Coastal Erosion and the prospect of rising sea levels threatens many low-lying seaside communities. The protection and careful management of coastal landscapes habitats is a key part to their protection and wider flood resilience strategy. *Natural flood management* refers to actions that restore, protect or emulate the natural processes of floodplains, catchments, rivers and coasts. Strategic tree planting, land and soil management, creation of water storage areas, enhancement of wetlands and realignment management of beach and dune systems can allow the landscape to work with natural processes, enabling effective management of the flow of water that minimises the risks of flooding to the built and natural environments. Well devised soft engineering strategies that enhance natural landscapes and create habitats can provide additional benefits to the environment and local communities, enabling wildlife to flourish whilst improving the wellbeing of local people. Strategies and actions that attempt to address flood risks in and around nature reserves and other protected sites must also be reconciled with conservation objectives and policy relevant to those habitats.

The Welsh Governments National Strategy for Flood and Coastal Erosion report emphasises the importance of multi-institutional collaboration on the issue of flooding (Welsh Government, 2020). With the availability of comprehensive and regularly updated mapping datasets, flooding and habitat data, informed and transparent decisions can be made that not only mitigate the risks of flooding, but benefit the habitats that wildlife depends on. GIS datasets of NRW flood maps are accessible on the Welsh governments Lle mapping portal¹ and have been utilised throughout this report. Utilising ariel and drone imagery along with GIS datasets to produce various maps², this report will explore the current conservation objectives and management practices of the Oxwich Bay National Nature Reserve both in terms of its habitat and wildlife, but also the role this habitat has to play in the overall flood mitigation strategy of the area.

2 OXWICH NATIONAL NATURE RESERVE

Oxwich NNR is a 228-hectare reserve located 11 miles west of Swansea on the southern coast of the Gower Peninsula. The reserve (see Figure 2.1) which covers the areas of Oxwich beach, Oxwich Burrows, Oxwich Marsh and Nicholaston woods contains a range of beach, dune, fresh and saltwater marshes, and woodland habitats. The beach at Oxwich Bay, which was named Britain's best beach in 2007 (BBC, 2007), was the site of the first aeroplane flight in Wales in 1911 (Johnson, 2022) and has been a landing point for several (now decommissioned) undersea communications cables (TeleGeography, 2022). Large portions of the beach and reserve are still owned by the historic estate of Penrice but is largely managed by Natural Resource Wales (NRW, 2022). Oxwich Bay is designated as a National Nature Reserve, Site of Special Scientific Interest and the woodland section is a Special Area of Conservation. Oxwich bay is one of the only places in where the incredibly rare Yellow Whitlowgrass (*Draba aizoides*) can be found. The South Gower coast is the only known location in the UK where this plant can be found and genetic analysis has revealed that this population is uniquely different to their European counterparts (BRS, 2022).

¹ <http://lle.gov.wales/home>

² All maps used within this report have been created by the author - except where explicitly referenced.

Oxwich National Nature Reserve

Area – 228.5 Hectares

Grid Reference – SS512874

Local Authority – City and Council of Swansea

Site ownership – Penrice Estate and City and Council of Swansea

Site Management – Natural Resource Wales

Site Designations – NNR, SSSI, (Partial) SAC

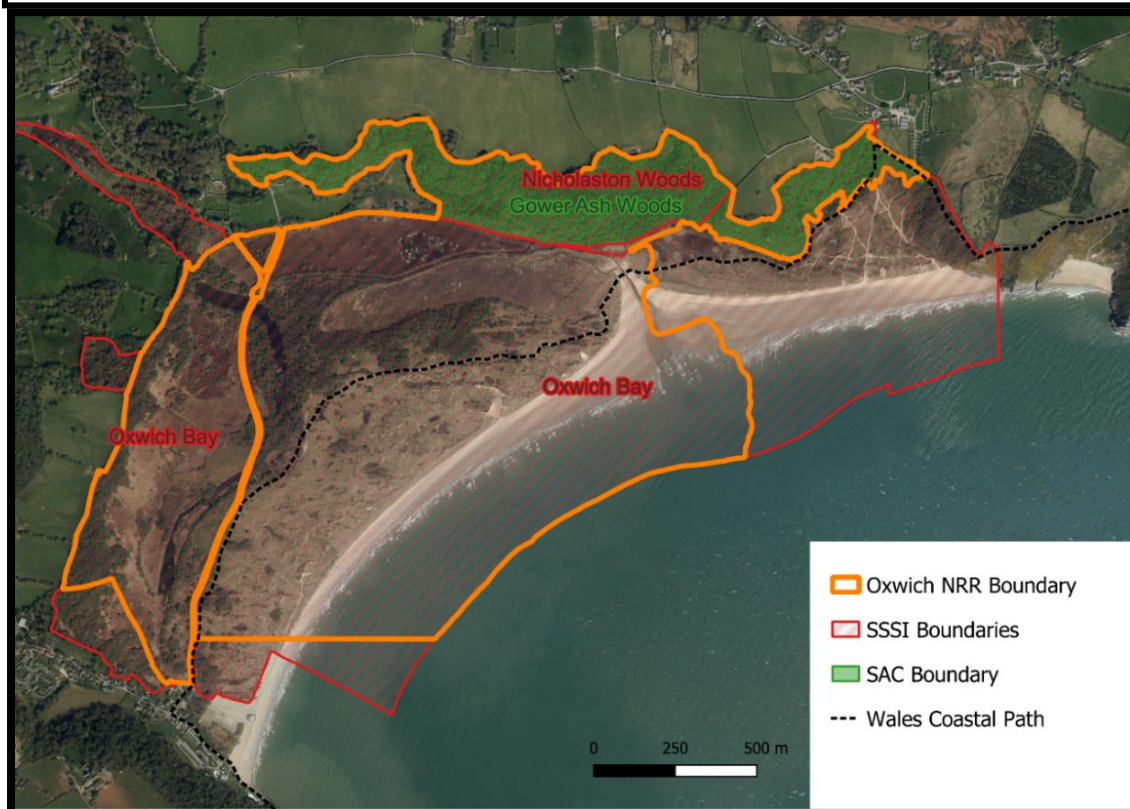


Figure 2.1 - Oxwich Bay National Nature Reserve with SSSI and SAC Boundaries

The reserve can be separated into three main habitat types – the beach and dune systems in the southeast sections, the saltwater and freshwater marshes in the middle and western areas, and the woodlands to the north. Nicholaston Brook cuts straight through the reserve, separating Nicholaston Woods from much of the marsh and the entirety of the beach and dune habitats. The beach front hosts a hotel, restaurant, as well as toilet facilities and is a popular destination for both tourists and locals alike. Boats and jet skis can be launched from the beach and with a water sports equipment rental in situ, a wide range of water-based activities are catered for. The Wales Coastal Path passes straight through the reserve, meandering behind the dunes and along the boundary with the marsh, crossing the footbridge near the mouth of Nicholaston Brook (See Figure 2.1). The dunes and marshes have long been recognised as being an important habitat for many rare species of plant, insect, bird and mammal, and are popular areas for bird watchers and nature enthusiasts. In addition to Oxwich being a national nature reserve it is also separated into two distinct SSSI's, *Oxwich Bay* which covers the beach, dune and wetlands, and *Nicholaston Woods* in the Northern part of the reserve. These woods are also included in the Gower Ash Woods Special Area of Conservation (SAC).

2.1 Geological profile

South Wales lies predominantly on bedrock developed in the Visean stage of the Carboniferous period. The majority of the of beach and dune areas in the southern parts of the reserve lie on top of the Bishopston Mudstone Formation which is composed of mudstone, siltstone and sandstone. This formation is characterised by dark to grey mudstones interbedded by beds of mid grey siltstone and minor pale grey quartzitic sandstones (BGS, 2022e). Nicholaston Brook flows largely over the Oystermouth Formation composed of dark grey argillaceous limestones and mudstones which are commonly weathered into decalcified rottenstone and grey, white and yellow clay (BGS, 2022d). The steep cliffs on which Nicholaston woods are perched upon are underlain by the Oxwich Head Limestone Formation - which predominantly consists of fine to coarse-grained, recrystalised skeletal packstones (BGS, 2022c) - the Hunts Bay Oolite consisting of mainly ooidal limestones (BGS, 2022a), and the High Tor Limestone Formation of fine to coarse-grained skeletal packstones with partings of shaly dolomite mudstones and siltstones (BGS, 2022b). The underly bedrock profile of Oxwich NNR can be seen in Figure 2.3 below.

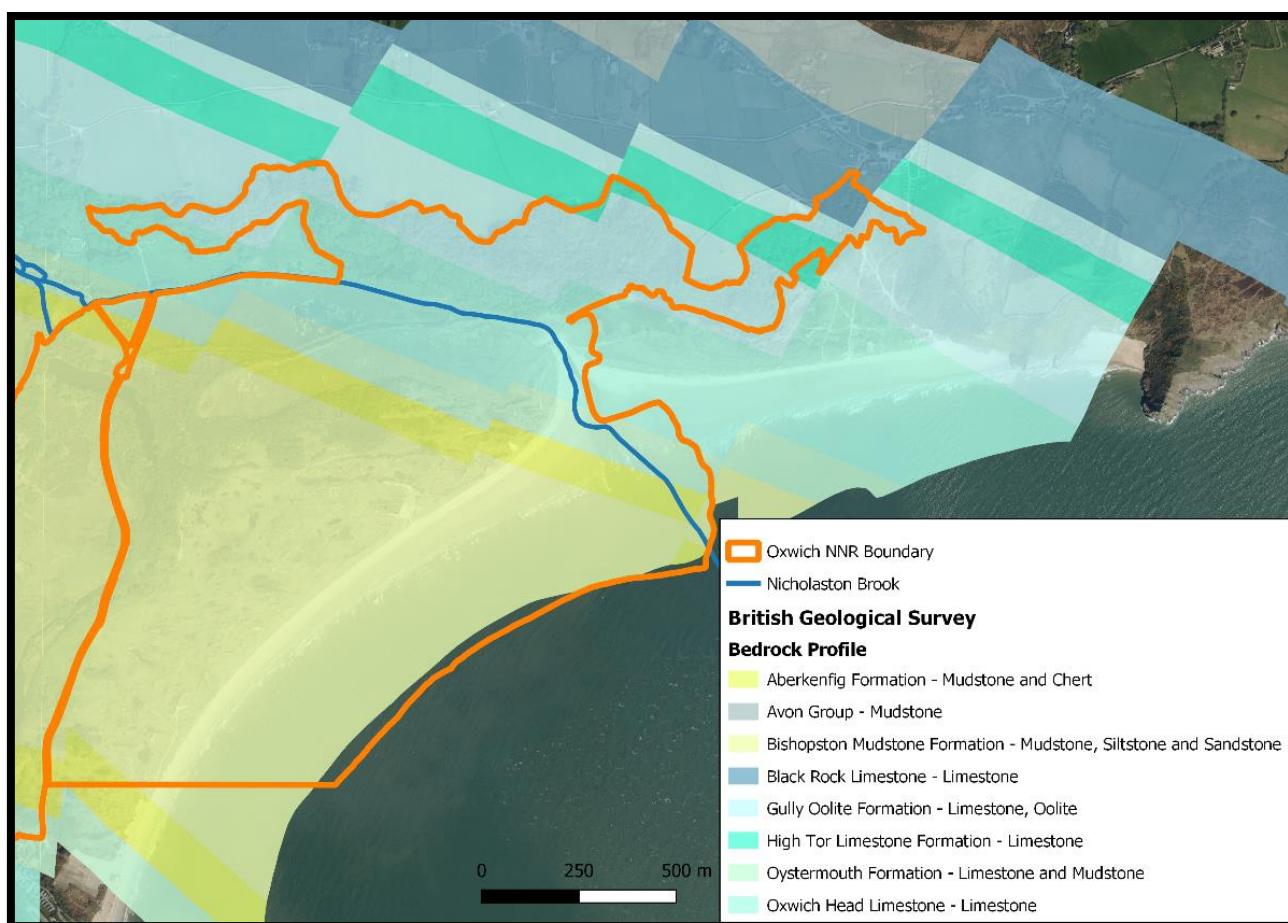


Figure 2.2 - Bedrock profile of the Oxwich Nature Reserve

2.2 Soil profile

The Oxwich Nature Reserve mainly consists of three soil types that generally demarcates the boundaries between the main habitats found within the site. The dune systems of Oxwich burrows are composed of Eolian Sand which is of a light to medium consistency. This soil is prone to wind erosion and soil run off in very wet conditions. The marsh areas consist of Riverine Clay and Floodplain Sands and Gravel which is not particularly susceptible to wind erosion or water erosion except in extremely wet conditions where some soil run off can be observed. The cliff and woodlands are composed of medium to light silty Limestone which can be susceptible to wind erosion and is vulnerable to erosion in wet conditions with sediment run off observed during rainfall events. Figure 2.3 illustrates the respective soil type regions throughout the reserve.

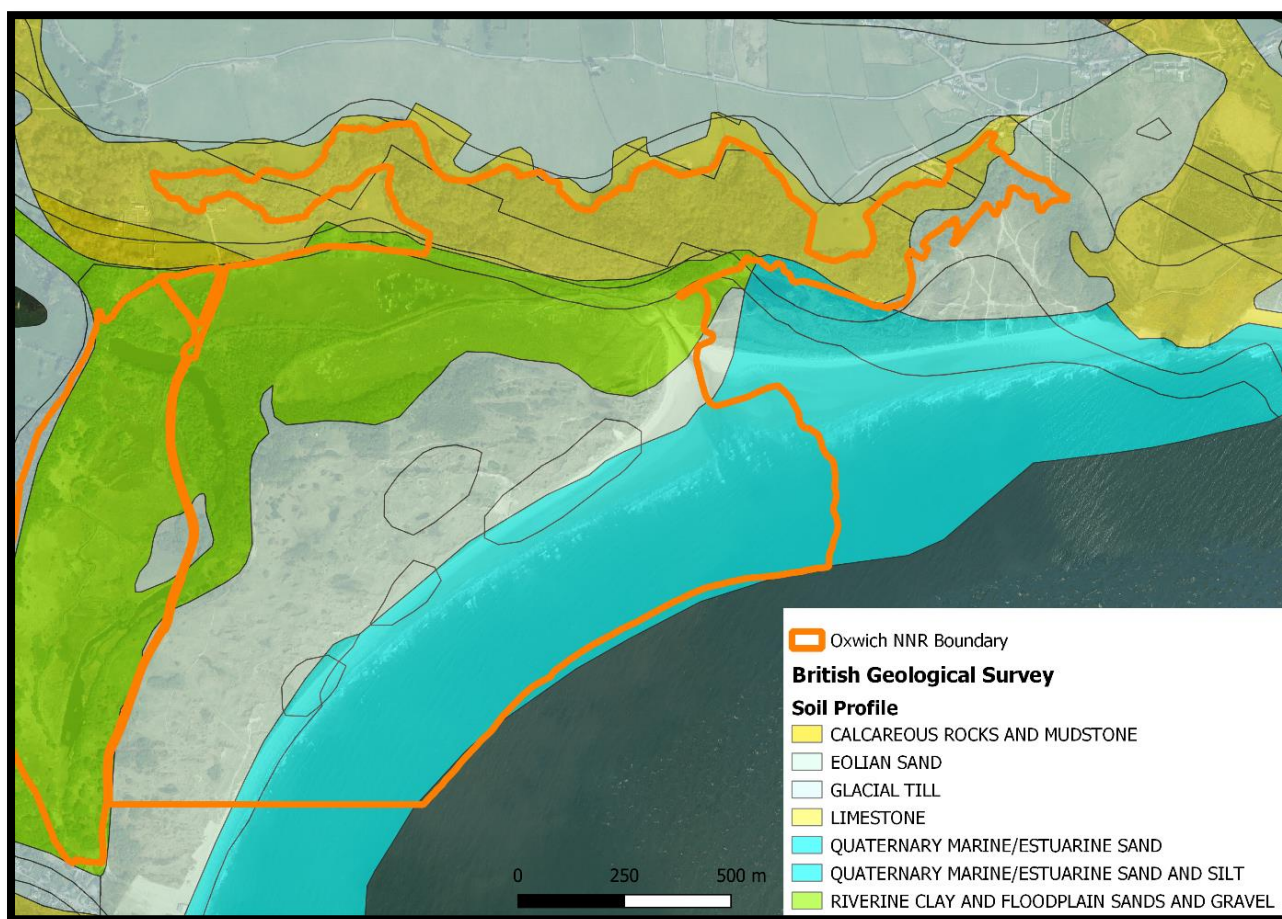


Figure 2.3 - Soil profile of Oxwich Nature Reserve

2.3 Oxwich National Nature Reserve Habitats

Three distinct habitats can be identified throughout the Oxwich NNR, the woodlands, the wetlands, and the dunes and beach. Between them over 600 species of plant have been recorded here over the years. Figure 2.4 below provides a detailed visual overview of the phase one habitat classification produced by Natural Resource Wales.

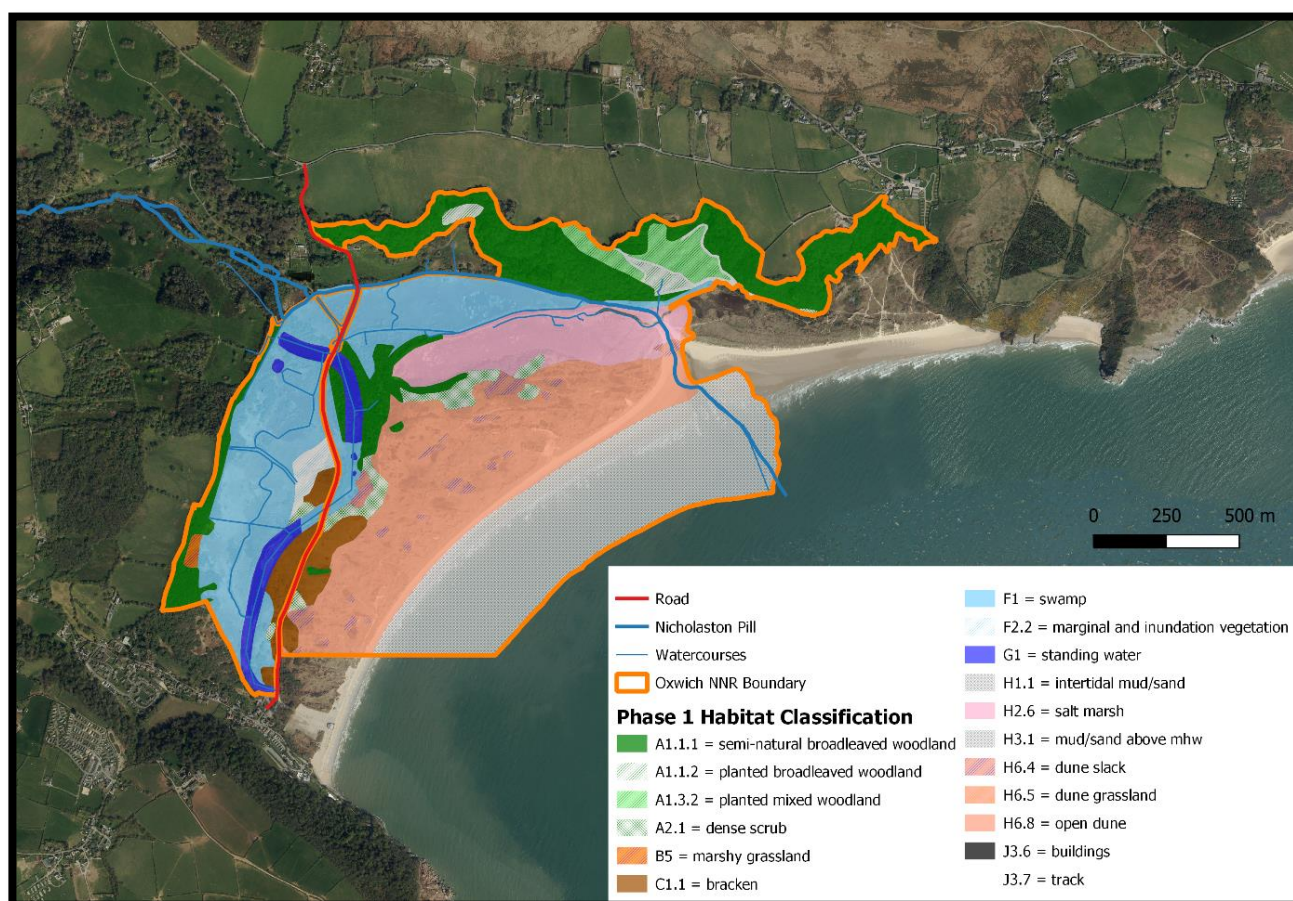


Figure 2.4 - Oxwich NNR NRW Phase One Habitat Classification

2.3.1 Nicholaston Woods - Woodland Habitat

The woodland located on the cliffs in the northern part of the site (see Figure 2.5) can be generally defined as *Tilio-Acerion* and largely consists of semi-natural broadleaved woodland, with small sections of planted broadleaved woodland and planted mixed woodland. The main species of trees that can be found here are Common Ash (*Fraxinus excelsior*), Sycamore (*Acer pseudoplatanus*), European Beech (*Fagus sylvatica*), Common Hazel (*Corylus avellana*) and English Oak (*Quercus robur*). Small populations of Giant Fir (*Abies grandis*), Wych Elm (*Ulmus glabra*), Common Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*) and Elder (*Sambucus nigra*) can also be found. Rare Rock Whitebeam (*Sorbus rupicola*) trees can also be found in small numbers within the woodland. Although a rare tree, it is categorised as *Least Concern* by the IUCN Red List (IUCN, 2015).

Small pockets of Wood Spurge (*Euphorbia amygdaloides*) and Butchers Broom (*Ruscus aculeatus*) can be found scattered through the woods as well as invasive Pontic Rhododendron (*Rhododendron ponticum*).



Figure 2.5 - Ariel shot of Nicholaston Woods (Drummond, 2022)

The woodland floor is dominated by English ivy (*Hedera helix*), Hart's-Tongue Fern (*Asplenium scolopendrium*) and both Common Lady and Male Ferns (*Athyrium filix-femina* and *Dryopteris filix-mas*). As can be seen in Figure 2.6, late spring brings a thick carpet of Bluebells (*Hyacinthoides non-scripta*) and swathes of fragrant Wild Garlic (*Allium ursinum*), with some less prevalent Garlic Mustard (*Alliaria petiolata*). Other flowers that can be found interspersed between the garlic and bluebells from spring through to summer are Robert Geranium (*Geranium robertianum*), Red Campion (*Silene dioica*), Wood Anemone (*Anemone nemorosa*), English Primrose (*Primula acaulis*), lesser celandine (*Ficaria verna*), Blue Bugle (*Ajuga reptans*) and Wood Speedwell (*Veronica montana*).



Figure 2.6 - English Bluebells amongst the Harts-Tongue, Common Lady and Male Ferns under the Ash canopy along the woodland slopes (Drummond, 2022)

2.3.2 Oxwich Burrows – Beach and Dune Systems

The main ridge that forms Oxwich beach and burrows is thought to have formed around 2,500 years ago, which in turn created the brackish lagoon that is now Oxwich Marsh (Ratcliffe, 1977). There is thought to have been little change in the shape and position of the beach and dunes since the 18th century (Pye, Saye & Blott, 2007).



Figure 2.7 - Oxwich beach and burrows as seen from the eastern end of the reserve (Drummond, 2022)

The NRW phase one habitat survey classifies the vast majority of the dune system as *open dune*, with small pockets of *dune slack* and one small area of *dune grassland* (see Figure 2.7). Large areas of *dense scrub* and *semi natural broadleaved woodland* lie on the northern periphery of the burrows and non-native trees of Monterey Cypress (*Cupressus Macrocarpa*) can be found occasionally throughout the dunes. Sea Holly (*Eryngium maritimum*), Seaside Sandplant (*Honckenya peploides*), and Oxford Ragwort (*Senecio squadlidus*) are prevalent throughout the burrows and several species of wild orchid can be found within the dunes such as Common Twayblade (*neottia Ovata*), Bee Orchid (*Ophrys apifera*), Pyramidal Orchid (*Anacamptis pyramidal*) and Southern Marsh Orchid (*Dactylorhiza praetermissa*). The rare and endangered Fen Orchid (*Liparis loeselii*) had previously been known to grow amongst the dunes but has not been seen in a number of years and is thought to now be extinct in this area.

The dune system in Oxwich Burrows is believed to have become *over-stabilised* - natural movement and shifts in the dunes have halted, meaning no dune slacks have formed in many decades. This over stabilisation has been caused by extensive vegetation growth and unchecked expansion of the woodland which has resulted in the loss of dune grassland and bare sand. In 2021 work was carried out to create several notches and scrapes behind the dunes to expose the bare sand and encourage the creation of new dune slacks (Braund, 2021).

2.3.3 Oxwich Marsh - Salt and Fresh Water Wetlands

Oxwich Marsh forms a meandering sinuous lagoon that leads from the mouth of Nicholaston Pill and continues behind the dunes of Oxwich Burrows and around the western flank of the nature reserve. Supporting extensive reed beds, wet woodland and scrub, it is noted in the Gower Woods SAC Core Management Plan as an important wetland habitat. As can be seen in Figure 2.8, This wetland is split into two distinctive habitat types, most of the area consists of freshwater swamp in the north and west with a small saltmarsh in the southeast area. The saltwater marsh and freshwater swamp are segregated by a sea wall which had been originally constructed in 1790 to facilitate the creation of freshwater lake and water meadows for grazing. Nicholaston Pill was partially trained and re-routed to its present position to achieve this. Prior to this re-engineering of the wetland, this entire low-lying area behind the dunes would have been entirely saltmarsh (Halcrow, 2012), lack of active management and maintenance of the constructed water meadows have led to the freshwater swampy conditions that are present today.

The Saltmarsh is dominated by tussocks of spiny rush (*Juncus acutus*) with some pockets of Chard (*Beta vulgaris*) and Wild Radish (*Raphanus raphanistrum*) and Sorrel (*Rumex acetosa*). Flowers of Sea Lavender (*Limonium vulgare*) and patches of Sea purslane (*Atriplex portulacoides*) can be seen along the banks of the saltwater channel that extends up into the marsh. A small population of Welsh mountain ponies graze the marsh which helps keep the grasses between the rush cropped short.



Figure 2.8 - Ariel Photograph of Oxwich Marsh. Saltmarsh is on the left (south), freshwater swamp on the right (north). (Drummond, 2022)

Storm surges and swells can flood the saltmarsh and large pieces of plastic and timber debris have been left deposited far into the saltmarsh by the retreating sea water. Figure 2.9 below shows the encroachment of sea debris far into the salt marsh.



Figure 2.9 - Marine debris deposited on the saltmarsh (Drummond, 2022)

The freshwater swamp is separated from the saltmarsh by a bund embankment which is reinforced by a combination of concrete walling and wooden barricade (Figure 2.10). The smaller watercourses within the freshwater wetland converge with the Nicholaston pill and form a single channel that leaves the freshwater marsh through a submerged tidal gate (Figure 2.11). This engineered feature acts to prevent sea water from progressing upstream at high tide and back into the freshwater marshland.



Figure 2.10 - Bund embankment between freshwater swamp and saltmarsh (Drummond, 2022)



Figure 2.111 - Tidal gate to prevent back flow of sea water into freshwater wetland (Drummond, 2022)

The freshwater marsh is dominated by Common reed (*Phragmites australis*). Present in smaller numbers around water bodies are Bulrush (*Typha latifolia*) and Lesser Bulrush (*Typha angustifolia*) and wetland flowers like Bogbean (*Menyanthes trifoliata*), Red Rattle (*Pedicularis palustris*) and Yellow Iris (*Iris pseudacorus*) can be found amongst the reed and rush. Soft Hornwort (*Ceratophyllum submersum*) which is uncommon to Wales can be found within the ponds in the swamp. The main pill channel runs alongside the southern boundary of Nicholaston woods with a slim strip of a wet woodland forming an interface between the woodland and wetland. Along here Sweet Flag (*Acorus calamus*) is shaded by young trees of Grey Willow (*Salix cinerea*) and Ash (*Fraxinus excelsior*). The bund embankment that runs alongside one of the large watercourses has sections of densely planted Blackthorn (*Prunus spinosa*) and Wild Cherry (*Prunus avium*) but is largely bare and unwooded. There are many degraded Ash snags veiled in the fungus *Parmeliaceae* scattered throughout the swamp with signs indicating that these trees may have succumbed to Ash dieback disease (see Figure 2.12).



Figure 2.12 - Ash snags throughout the freshwater swamp (Drummond, 2022)

2.4 Wildlife at the Oxwich NRR

Oxwich Nature Reserve is considered a nationally important habitat for both Wales and the UK. It is home to a wide range on animal species, some of which are considered extremely rare and seen in only a handful of places within the UK. Several rare species of bird and insects can be observed here, and hides have been installed to allow visitors to view them. Otters also have made a home here and can often be seen from the hides along the watercourses.

2.4.1 Birds

The woodlands and marsh at Oxwich are home to many bird species with bird ringing surveys carried out annually by the Gower Ornithological Society and their volunteers. Table 1 details the species and number of birds caught in Oxwich marsh between 2013 and 2019. Notable species of bird that visit and inhabit the woods and marsh include the Bittern (*Botaurus stellaris*), Marsh Harrier (*Circus aeruginosus*), Hen Harrier (*Circus cyaneus*), Eurasian Sparrowhawk (*Accipiter nisus*) and the Long-Eared Owl (*Asio otus*). There have also been sightings of rare individuals of Little Bittern (*Ixobrychus minutus*) and Purple Heron (*Ardea purpurea*).

Table 1 - Total numbers of respective bird species ringed at Oxwich Marsh between 2013 – 2019 (Gabb, 2020)

Species Name	Total	Species Name	Total
Swallow	3018	Grasshopper warbler	64
Blue tit	2096	Jack snipe	40
Goldfinch	1957	Coal tit	37
Greenfinch	1378	Treecreeper	35
Reed warbler	1218	Brambling	31
Chaffinch	1087	Yellow-browed warbler	21
Blackcap	1049	Grey wagtail	19
Sedge warbler	924	Firecrest	18
Chiffchaff	779	Starling	17
Siskin	775	Kingfisher	14
Great tit	742	Lesser redpoll	12
Reed bunting	642	Lesser whitethroat	7
Willow warbler	572	Skylark	7
Goldcrest	541	Sparrowhawk	7
Wren	414	Mute swan	6
Robin	403	Nuthatch	6
Dunnock	295	Marsh tit	5
Redwing	271	Water rail	4
Blackbird	245	Yellow wagtail	4
Meadow pipit	217	Green woodpecker	3
Pied/white wagtail	217	Magpie	3
Long-tailed tit	215	Whinchat	3
Snipe	206	Jay	2
Whitethroat	205	Mistle thrush	2
Cetti's warbler	158	Redstart	2
Sand martin	124	Willow tit	2
Great spotted woodpecker	119	Yellowhammer	2
House martin	113	Little bunting	1
Tree pipit	98	Pied flycatcher	1
Bullfinch	78	Wheatear	1
Stonechat	76	Wood warbler	1
Song thrush	75	Woodpigeon	1
Garden warbler	70		
Grand Total			20755

The freshwater wetland is a home for various species of wildfowl. Throughout the winter Northern Shoveler (*Spatula clypeata*), Gadwalls (*Anas strepera*), Common Scoter (*Melanitta nigra*) and the rare Green Winged Teal (*Anas crecca*) can be found here.

2.4.2 Insects

A variety of insects provide an important food source for the many birds found throughout the reserve. Some of the rare insect species found throughout the reserve include the Hairy Dragonfly (*Brachytron pratense*), Cepero's Ground hopper (*Tetrix ceperoi*) and the endangered Strandline Beetle (*Nebria complanata*). Oxwich is also home to populations of protected Small Blue Butterflies (*Cupido minimus*).

2.4.3 Mammals

Freely accessible survey data and information regarding mammal species within the Oxwich Nature Reserve was difficult to obtain, but in addition to Otters (*Lutra Lutra*), Lesser Horseshoe Bats (*Rhinolopus hipposideros*) and Greater Horseshoe Bats (*Rhinolopus ferrumequinum*) can be seen at dusk and are known to roost within the woodland and rocky cliffs.

3 FLOODING AND COASTAL EROSION

The Oxwich reserve lies at the bottom of the high cliffs that form the south Gower coastline. With most of the site no more than 15m above sea level, the landscape naturally forms a geological gulley that funnels water down from the cliffs and preceding valley into the sea. The wetlands found in the Oxwich Nature reserve owe their existence to the presence of the stable dune systems at Oxwich Burrows. The dunes in the burrows act as a natural barrier to the water which flows down from the geological escarpments that surround the bay which forms a sinuous marshy lagoon retaining water in wetland like habitat. This low-lying tidal floodplain had previously been drained and transformed into a series of water meadows in the eighteenth century.

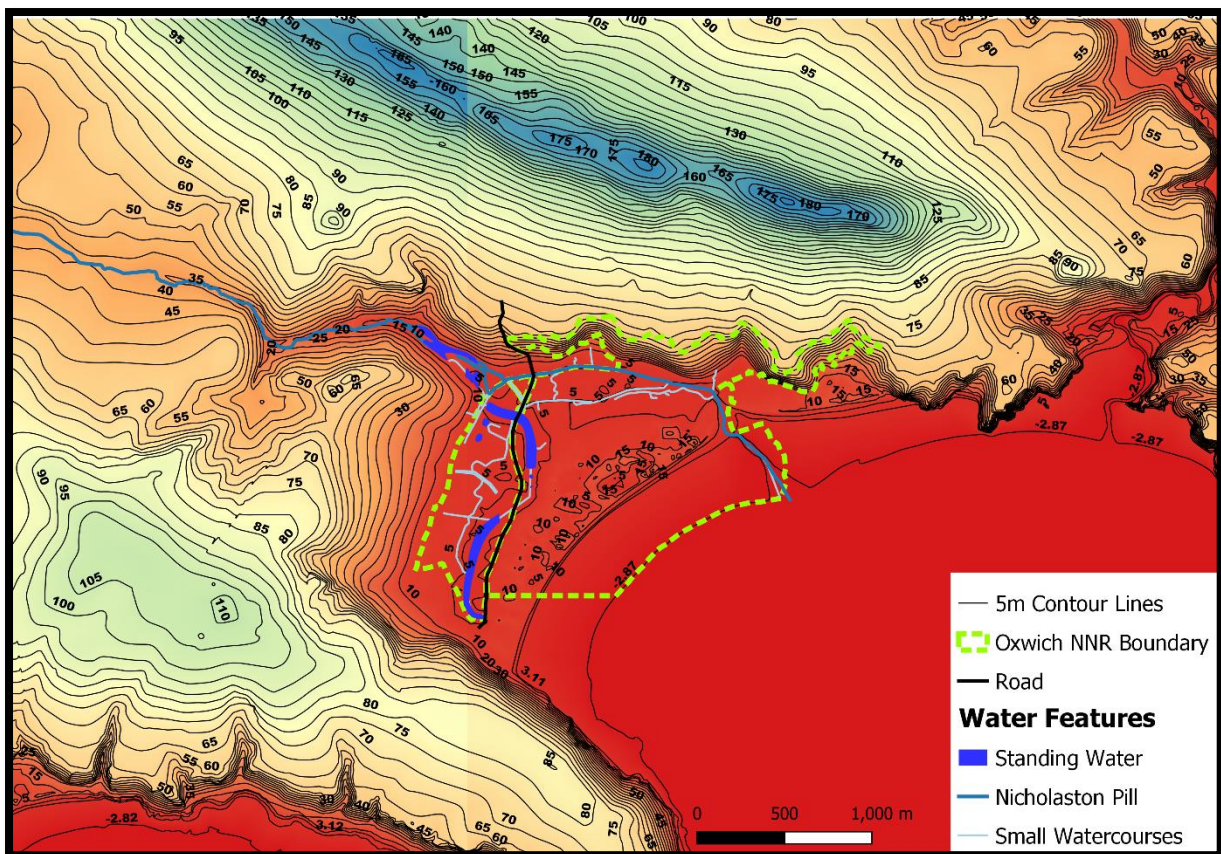


Figure 3.1 - A 5m resolution Digital Terrain Model of Oxwich Bay. Contour numerical values in meters

Water runoff from the cliffs and terrain into Oxwich valley does not often lead to localised flooding; due to the porosity of the limestone substrate, rainwater percolates through the rock, finding its way out through various springs found along the beach. Although, prolonged periods of intense rainfall can quickly saturate the soil and underlying limestone.

Impedance on the water that flows through the Nicholaston Pill and other watercourses is often the cause of any localised flooding events, heavy storms can blow the sand into the mouth of the pill and block it. This leads to water backing up within the wetland watercourses and occasionally further up the valley, flooding the road and local communities (BBC, 2013). Storm surges and high tides can also

cause the marsh to flood with seawater, often carrying with it a deluge of debris that ends up being deposited far inland on the wetland plain (See Figure 2.9). The 5m resolution Digital Terrain Model (DTM) in Figure 3.1 shows the topography of the reserve and reveals the vulnerability of the road and local community to localised flooding within the Oxwich bay and valley area, particularly as the primary road that leads down to the beach and village divides a large body of standing water.

Shown in Figure 3.2, NRW has identified the majority of the wetland areas in the Oxwich reserve as being at a high risk (greater or equal to 1 in 30) from fluvial flooding, the source being principally the Nicholaston Pill. A *Preliminary Flood Risk Assessment* produced by Swansea Council in 2011 also identified this wetland area behind Oxwich burrows as being vulnerable to flooding from surface water run-off (Sweeny, 2011). Some of the houses in the villages have already experienced flooding in previous years (PCC, 2006).

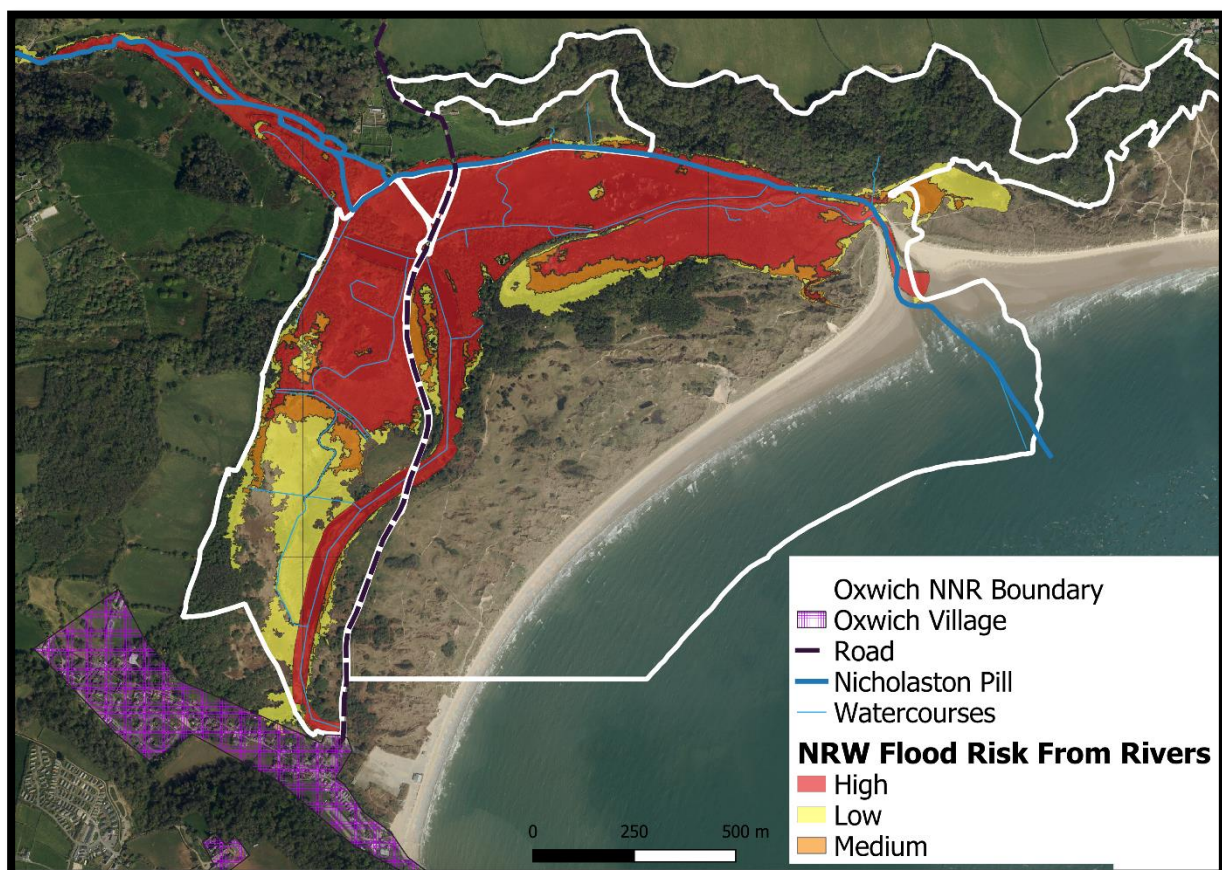


Figure 3.2 - Risks of fluvial flooding. High = 1 in 30, Medium = between 1 in 30 and 1 in 100, Low = between 1 in 100 and 1 in 1000 Annual Exceedance probability

In addition to the threats from river and surface water flooding, Figure 3.3 identifies Oxwich marsh as also being at high risk from sea flooding. This includes the primary road into Oxwich and parts of the low-lying areas in Oxwich village. Increased frequency of sea flooding at higher water levels through the low-lying wetland lagoon is likely to impact the condition of the freshwater areas of the marsh.

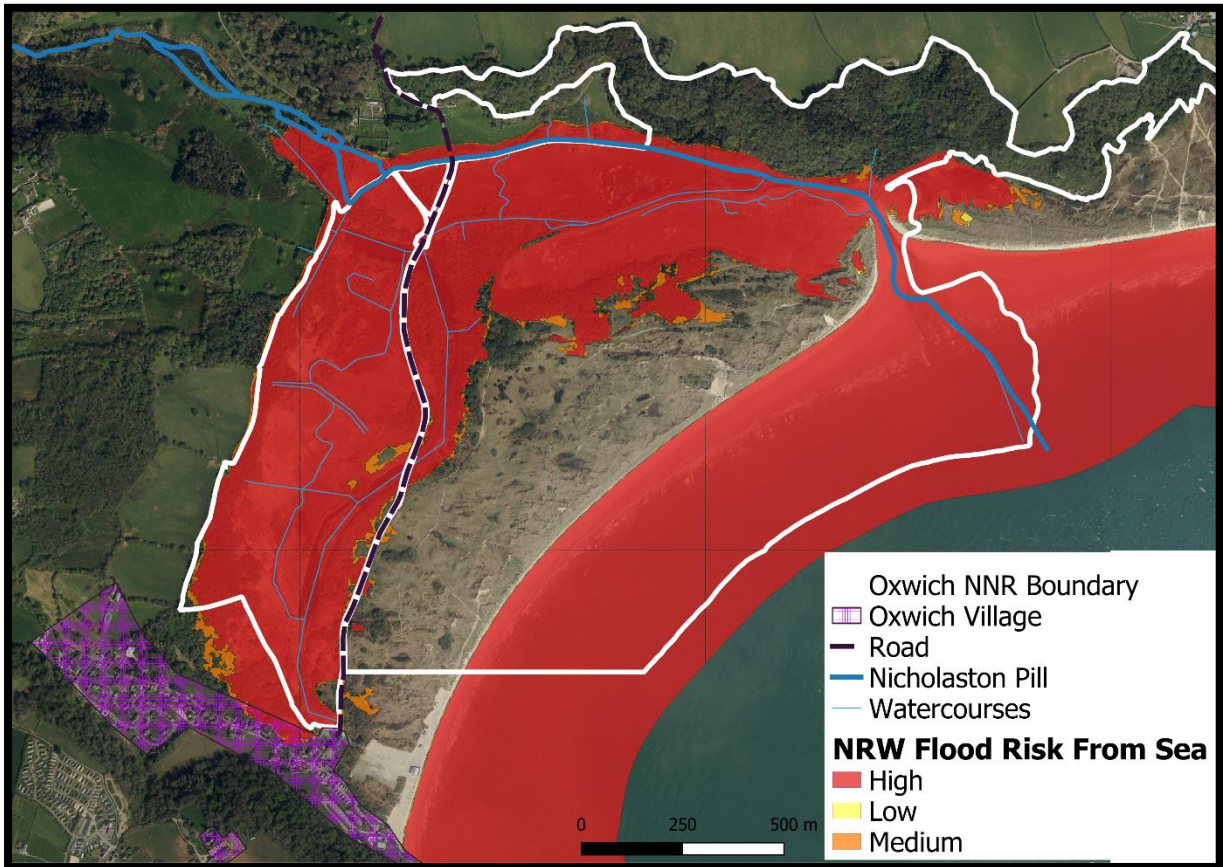


Figure 3.3 - Risks of sea flooding. High = 1 in 30, Medium = between 1 in 30 and 1 in 100, Low = between 1 in 100 and 1 in 1000 Annual Exceedance probability

4 MANAGEMENT OF THE OXWICH NATIONAL NATURE RESERVE

4.1 Current Management of The Reserve

The coastal and woodland areas of Oxwich National Nature Reserve are covered by specific documents that detail the management strategy in place for each feature. Documents relating the specific management of the wetland areas do not appear to be available on the internet and were unobtainable for the purpose of this report.

The National Strategy for Flood and Coastal Erosion Report (SWCG, 2012) covers the stretches of beach and dunes at Oxwich Burrows and outlines a *Managed Realignment* strategy for Oxwich Bay over the long term (50-100yrs). The dune system will be left to develop naturally with minimal inference with only any *managed realignment* interventions when necessary. Pressures on the dune system from visitors are to be monitored with a proposed recommendation to relocate the beach car park. The car park lies between the cliffs and the dunes and forms an opening in the natural sea defences of the coastline. This break in coastal defence creates a potential flood route into the village directly behind which poses a risk to local businesses and properties. If sea level rises enough, the potential costs of defending the coastal amenities and properties could exceed the value of the assets being protected. Private landowners would be able to fund the maintenance and fortification of existing sea defences, conditional to obtaining the appropriate permissions. Sea level rise and erosion could lead to the complete loss of the dunes, marshes and intertidal zone; the high cliffs behind the reserve prevent any progressive retreat of the dunes, leaving no other alternative but for the sand and soil to be potentially washed away over time. There are currently no plans in the short, medium and long term to build any sea defences along the undeveloped parts of the coastline which as a result could see an expansion of the intertidal habitat behind the Oxwich Burrows dune system. There is the potential for the dunes to narrow and even become cut off in sections if sea levels rise significantly and this is recognised as a natural process that will be left to run its course.

Nicholaston Woods is covered by the Gower Ash Woods SAC Core Management (Gjerlov, 2011). The woodland is managed by NRW who in previous years have removed some of the non-native trees, leaving others to fall naturally. Management of the woods is minimal and mostly consists of maintaining the footpaths and ensuring routes are free from fallen trees and debris. The Core Management plan produced by NRW (then CCW) in 2011 outlined the then current state of the woodland and its future conservation objectives. The report identifies Ash woodland as the key habitat to be prioritised in this SAC. The overall vision for the woodland is to allow the ash to dominate the canopy, complimented by some Sycamore, Oak and the remaining population of planted Beeches. Hawthorn, Spindle and Hazel will ideally fill the void between the canopy and Hart's tongue, Fern and Ramson. A 2008 survey of the woodland found it to be in an unfavourable condition. There was an over dominance of Sycamore and an excess of non-native species such as Beech, Spruce and Conifer. Proposed solutions to remedy the unfavourable condition of the woodland were the slow removal of Beech trees, allowing non-natives to fall naturally whilst removing any saplings that may sprout. Felling of Sycamores where possible is preferred over ringbarking as the latter has a tendency to cause Sycamores to produce a final flush of seeds that could propagate and further increase in their population. Regeneration of Ash was found to be poor, with too many gaps in the canopy identified.

Notably, the 2011 Gower Ash Woods Core Management Plan makes no reference to Ash Die-back disease (*Hymenoscyphus fraxineus*) anywhere within the document. This is likely due to the fact that



Figure 4.1 - Ariel Shot of Nicholaston Woods. Planted Conifer stands nestled amongst broadleaved species (Drummond, 2022)

Ash dieback was not a prominent issue in the UK at the time the core management plan was created. Signs of Ash die-back can be observed throughout Nicholaston woods and extensively within the areas of semi natural broadleaved woodlands within the low-lying dune and marsh areas. A good indication that an Ash tree is suffering from Dieback is the very late emergence of its leaves compared to other species



Figure 4.2 - Ash trees showing signs of Dieback amongst the Semi Natural Broadleaved Woodland along the dune and marsh (Drummond 2022)

Not currently identified in the NRW phase one habitat survey map are a number of pools of standing water in varying sizes that appeared rapidly within the swamp over the course of October 2019 (See Figure 4.3). It is not clear what the cause of this change is, but a preliminary assessment of Important Areas for Ponds report published in 2008 references reed cutting and silt removal works within the Oxwich wetlands in order to preserve and enhance standing water features that have been recognised as BAP Priority Habitats (Nicolet et al., 2008). There is a striking contrast between the two satellite images in the colouration of the Common reed within the freshwater swamp and coupled with the degradation of the trees this could indicate seawater ingress into the freshwater wetland.



Figure 4.3 - Comparison of satellite imagery showing a marked difference in the appearance of the freshwater swamp (Living Atlas, 2022)

4.2 Riparian Woodland Potential

The introduction of riparian woodland along watercourses can potentially provide a range of benefits to the functionality and ecology of rivers and their surrounding habitats. Trees can help to stabilise and strengthen the banks of rivers and streams, reducing erosion and trapping sediment in their roots. Riparian woodland can absorb excess nutrients that originate from agricultural surface run off and can improve the diffusion of water pollutants within riparian watercourses. Research has shown riparian woodlands can removed up to 20% of nitrates from associated watercourse (Peter et al., 2012).

Riverbank woodlands can provide shade to watercourses, lowering their overall temperature and reducing the rate of evaporation in the summer months. Improved shading of watercourses can moderate the growth of Filamentous Algae and other invasive species which can help maintain the health of water habitats in rivers and streams (EA, 2011). Conversely, the increased water demand from trees within riparian woodlands can draw additional water from rivers and reduce overall levels. Willow trees require a lot of water and large numbers within a riparian woodland can place additional water stress on a watercourse in the warmer months. Ash trees on the other hand can provide the opposite effect, marginally increasing water levels within a watercourse under certain conditions (Nisbet et al., 2015)

In addition to the benefits riparian woodlands can provide to the functioning of rivers and streams, riparian habitats can provide a habitat for a range of wildlife that are covered by Biodiversity Action Plans; wet woodland can for example provide protection and breeding sites for Otters (*Lutra lutra*).

4.3 Working With Natural Processes

Working with Natural Processes (WWNP) is a policy that aims to promote the restoration and enhancement of natural features such as rivers, wetlands and floodplains in order to better manage the flow of water across the landscape. Protecting and enhancing these features can help mitigate the effects of flooding by improving the ability of the landscape to absorb and redirect water which can reduce the impacts of flooding on vulnerable communities. A series of maps have been published on the Lle portal that indicate areas where natural features can be created or exploited to improve the natural processes that retain and dissipate excess water.

The planting of riparian woodlands along watercourses has been recognised as a potential strategy that can be used to attenuate fluvial flooding. Areas around rivers that contain existing woodland or peat, are close to roads and railways or are in urban locations have been excluded. With these considerations accounted for, the resulting maps indiscriminately project a 50m buffer zone along major UK watercourses. Figure 4.4 below projects this 50m layer onto Nicholaston and nearby minor water courses demonstrating the potential for riparian woodland creation within the Oxwich NNR.

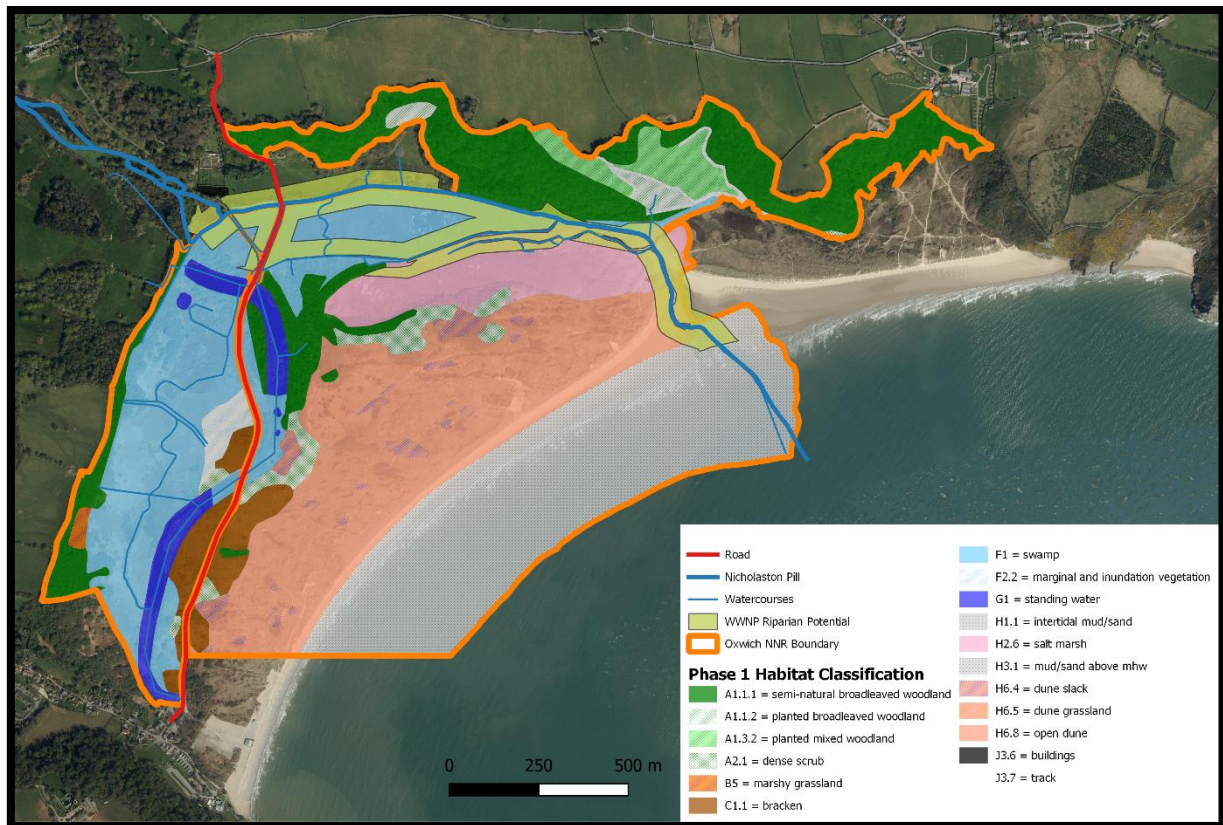


Figure 4.4 - WWNP potential for riparian woodland creation (lime green) projected along the main watercourses within Oxwich NNR and transposed over the existing habitat types

The WWNP Riparian Potential mapped projections suggests that wet woodland species could be planted along the Nicholaston Pill and the adjoining water course that runs along side the bund embankment interface between the freshwater swamp and the saltmarsh. This would then in effect connect Nicholaston woods to the areas of semi natural and planted broadleaved woodlands in the dune/marsh areas. There could be both potential benefits as well as adverse effects that result from this; planting trees along the bund embankment interface between the saltmarsh and the freshwater swamp could help to reinforce the embankment as the roots can help retain and stabilise the soil. Conversely, trees planted along the embankment could be detrimental to the grasses and vegetation that retains the soil across the embankment. The roots may also penetrate and damage the concrete and wooden sea wall and protective structures, weakening them and making them vulnerable to erosion from tidal waters.

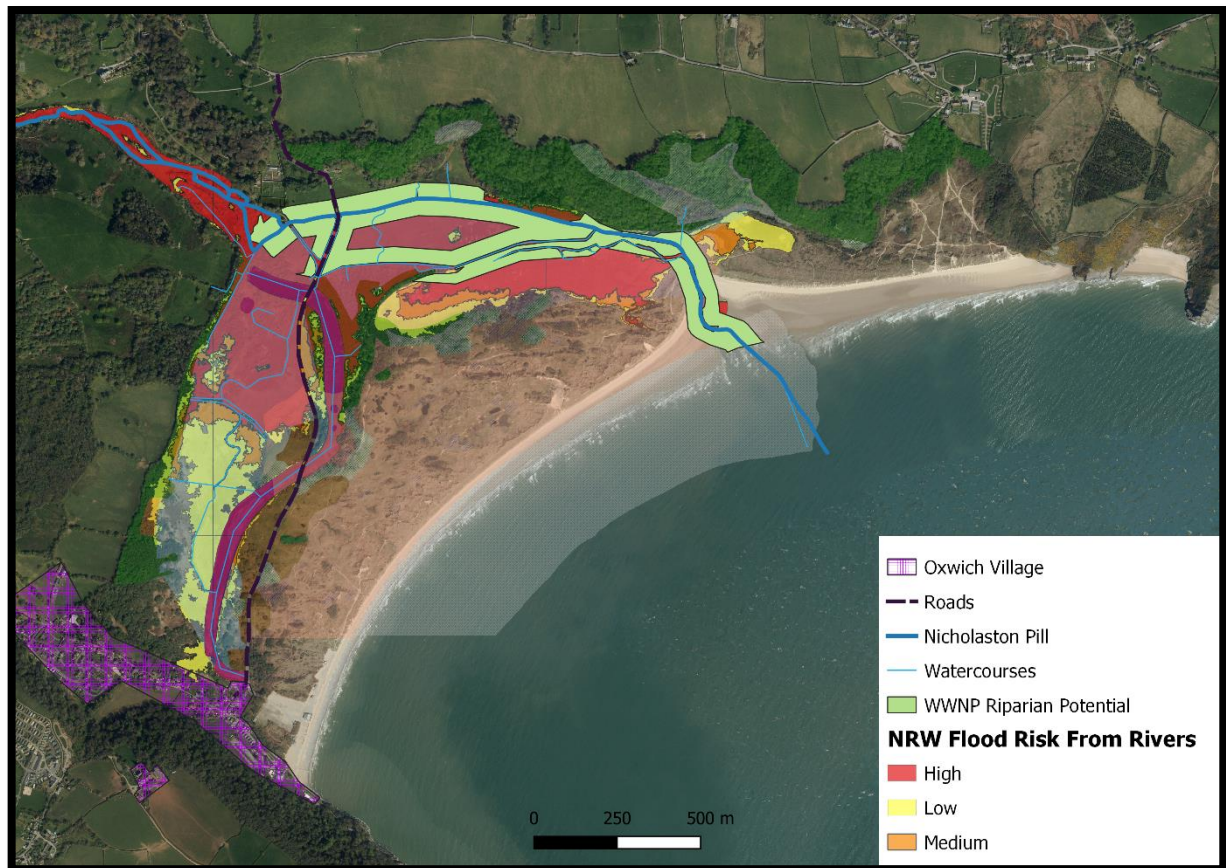


Figure 4.5 - Flood Risk from rivers with projected areas of riparian potential

The planting of significant areas of riparian woodland throughout the wetlands within the Oxwich reserve may not help to reduce the impacts of flooding originating from surface run off or the Nicholaston Pill but instead worsen it. Impeding the flow of water through the pill and watercourses could cause the water to back up further up the valley resulting in prolonged flooding of the road and wetlands which could spread into the village. This issue could be exacerbated if woody debris originating from the woodland is trapped within the channels blocking them and further obstructing the flow of water. Figure 3.2 and Figure 4.5 show that excess alluvial and fluvial water flow westerly, converging through the narrow area at western point of the swamp and exiting through the tidal gate. Any increase in sediment accumulation and slowing of water through this area is likely to restrict the ability of water to flow freely into the sea which could result in increased flooding in the areas behind.

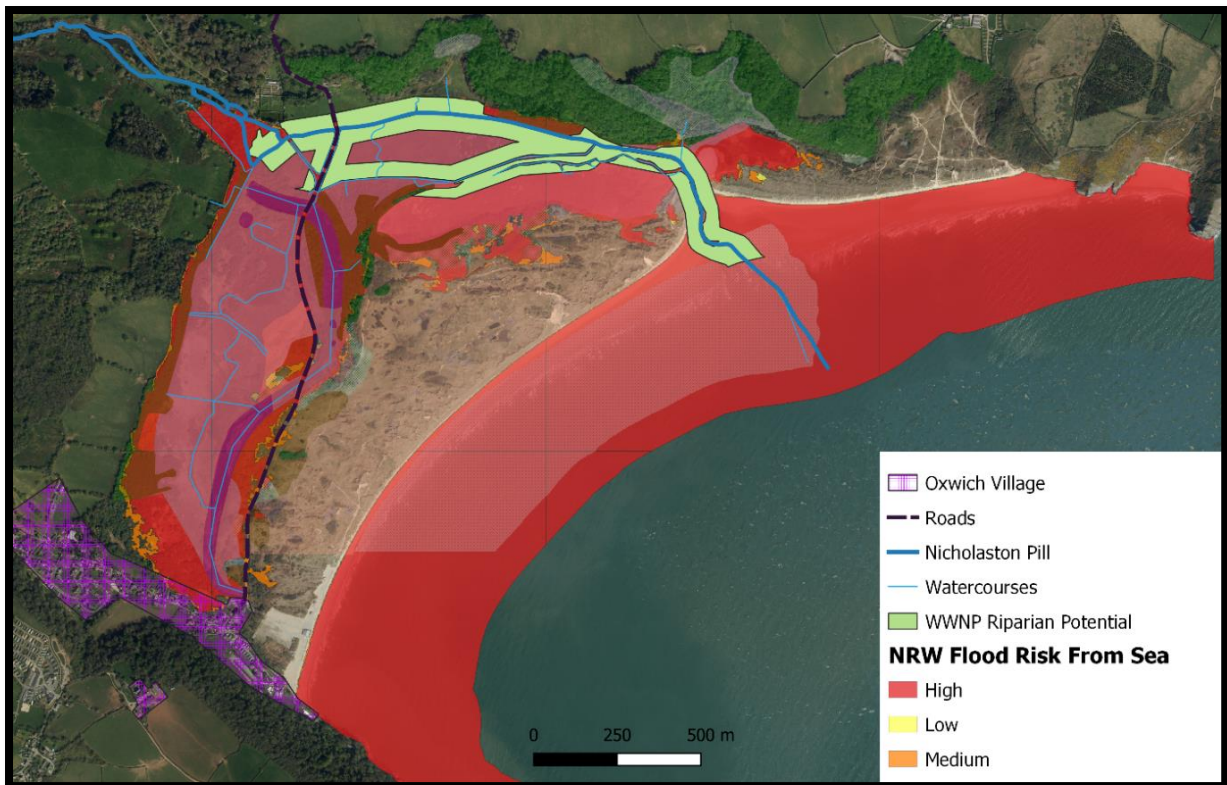


Figure 4.6 - Flood Risk from the sea with projected areas of riparian potential

The map in Figure 4.6 highlights the areas of the reserve vulnerable to sea flooding along with the watercourse sections that have been identified for potential riparian woodland. The NRW flood risk map shows that sea water could spill over the bund embankments and seawall structures and circumvent the bund completely, infiltrating through the areas of woodland on the eastern edge of the saltmarsh.

Riparian woodlands are not likely to be able to defend against this and a potentially more effective solution to defend the low-lying areas against the risks of sea flooding would be to extend the length and raise the height of the bund embankments that separate the saltmarsh from the rest of the wetland and dunes. Figure 4.7 shows the extent on bund embankment that could be created to retain seawater within the saltmarsh.

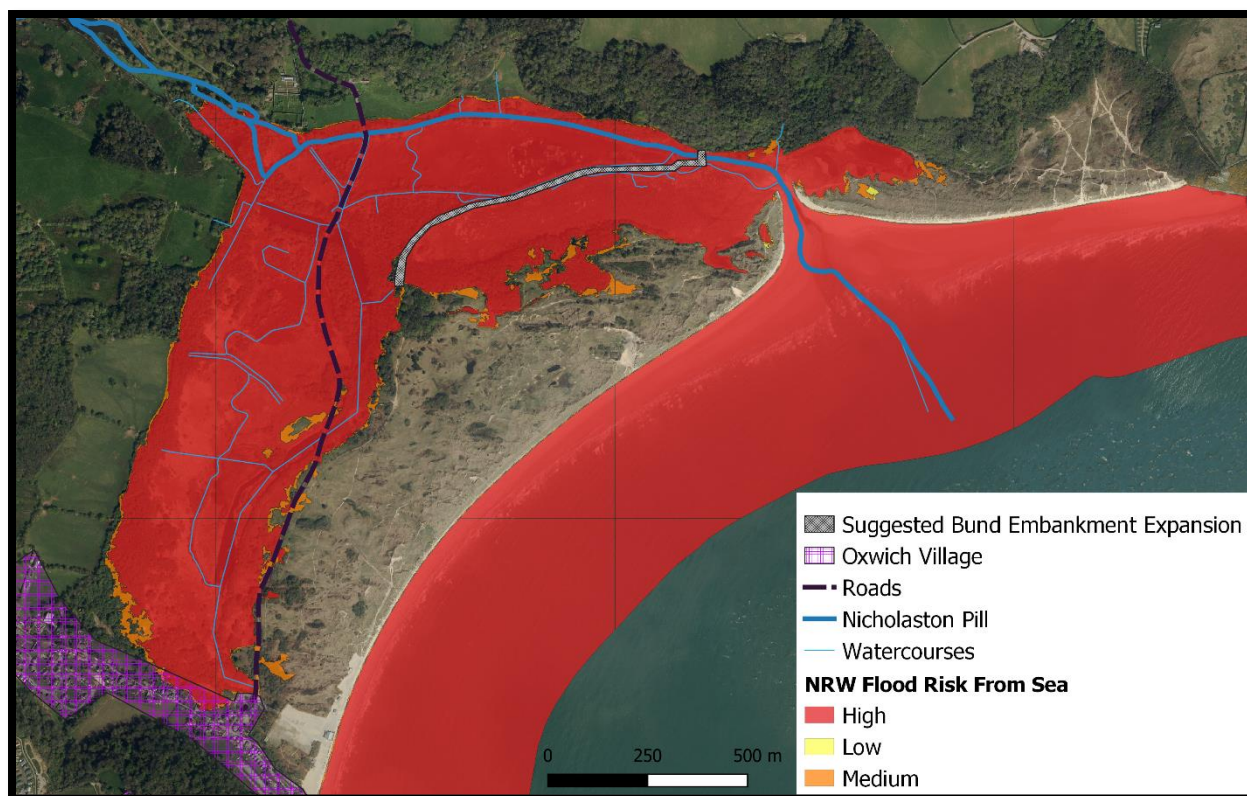


Figure 4.7 - Proposed enhancement of bund embankment to protect the low-lying areas west of saltmarsh

5 CONCLUSION

The lack of an available unified habitat management plan that covers the whole Oxwich National Nature Reserve meant that it was difficult to evaluate current management practices applied across the whole reserve. Although the Swansea Bay Shoreline Management Plan describes the management strategy for the beach and dunes, and the Gower Ash Woods SAC Core Management plan (albeit outdated) outlines the management approach used in Nicholaston woods, the lack of an available management plan for the saltmarsh and wetlands has made the assessment of this habitat challenging. The dramatic change in the visual characteristics of the freshwater wetland areas shown by the satellite imagery (See Figure 4.3) is an intriguing discovery lacking any documented explanation and warrants further exploration. The possibility that sea water has infiltrated into the freshwater areas should be investigated, possibly even as a research topic undertaken by another Environmental and Conservation student.

The prevalence of Ash dieback within the dune and marsh woodlands also needs addressing. Removal of these diseased Ashes in conjunction with the proposed improvements of the bund embankment could present an opportunity to enhance the natural flood defence capabilities of this area, creating a landscape that is impermeable to sea water infiltration. This could be undertaken as part of a long-term strategy to defend against rising sea levels and increasingly frequent storm surges.

Short term flood prevention strategies should focus on improving the ability of excess surface and fluvial run off to drain effectively through the wetland and pill and out into the sea. Maintaining drainage ditches and sewers whilst reducing blockages within watercourses can contribute to this. Management of sediment accumulation within the wetland watercourses and the mouth of the pill are rudimentary approaches that could prove highly effective in reducing the risks of flooding.

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