

Newborough Sand Dune Rejuvenation Project

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ABSTRACT: Sand dunes are typically dynamic systems, undergoing periods of erosion and accretion. However, the majority of Welsh sand dunes are in a static state, despite a plethora of statutory protections. Many species adapted to living in harsh dune environments are thus declining at an alarming rate. Morfa Dyffryn is Wales’ bench-mark dune site for pioneer habitat conditions and there is a precedent to emulate the bare mobile sands seen there at other sand dune sites across Wales, with a target conservatively set at 10-15%. A large-scale mechanical intervention was undertaken to tackle the stabilisation problem at Newborough via three intervention phases since the winter of 2012-13 and, to date, 14 hectares of new bare sand has been created. This brings the total areal coverage of mobile bare sands at this site up by 1%, to a total of 4%, although it is still far from the 1940s levels of 51%.

1. INTRODUCTION

Newborough is located on the southern tip of Anglesey (Figure 1). The area is a key part of the Anglesey Area of Outstanding Natural Beauty (AONB), it is also a Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI) and a Geological Conservation Review (GCR) site.

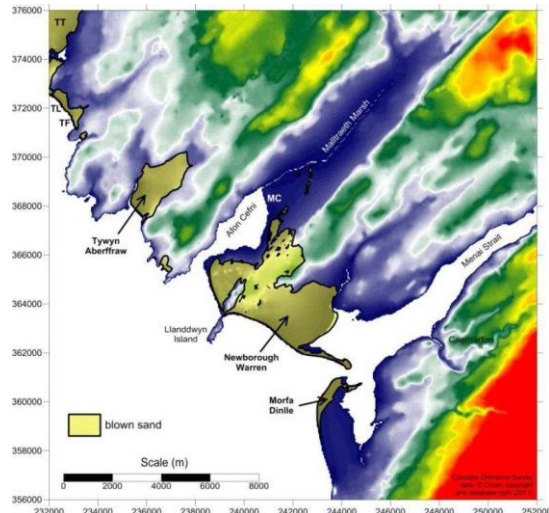


Figure 1. Regional setting of Newborough Warren and neighbouring dune systems at Tywyn Aberffraw, Morfa Dinlle, Tywyn Fferam (TF), Tywyn Llyn (TL) and Tywyn Trewan (TT). MC = Malltraeth Cob embankment. Elevations taken from Ordnance Survey Land-Form data (50 m grid), and the extent of blown sand based on British Geological Survey 1:50,000 scale and Soil Survey of England and Wales 1:250,000 scale maps. Taken from; Pye and Blott (2012).

Newborough’s designated features include areas of rocky shore, shingle ridges, estuary and dune habitats – such as mudflats, saltmarsh and sandy foreshore, strandline, fore-dunes, mobile and more stable dunes, areas of bare sand, wet dune slacks and dune heath. There are also fresh-water lakes and ponds. These habitats vary in their proportion and location in response to naturally changing geomorphological and hydrological processes.

The two estuaries (Figure 1); the Afon Menai (mouth of the Menai Strait) and Afon Cefni form a dynamic coastal system characterised by distinctive coastal landforms. Natural processes powered by wind, waves and tides continuously modify beaches, dunes, slacks, estuarine flats and shingle ridges (Figure 2).



Figure 2. Schematic of broad scale coastal processes Taken from; WoW SMP2, 2011.

The Newborough dune system consists of three main elements (Figure 3):

1. dunes which have developed and moved inland behind Traeth Penrhos on the north side of Ynys Llanddwyn (Llanddwyn Island) (i.e. in Malltraeth Bay)
2. dunes which have developed and moved inland behind Traeth Llanddwyn on the south side of Ynys Llanddwyn (i.e. in Llanddwyn Bay)
3. dunes which have developed on the sand and shingle barrier spit which extends in a south-easterly direction from Newborough Warren towards Abermenai Point (Trwyn Abermenai).



Figure 3 Main locations mentioned in the text (base 2009 aerial photograph). Taken from; Pye and Blott (2012).

2. SAND DUNE REJUVENATION

Sand dunes are inherently dynamic, undergoing periods of erosion and accretion and constantly changing in response to weather, climate, succession and management (Howe *et al.*, 2012). However, all of the Welsh sand dune systems have become increasingly stable (Pye *et al.*, 2014), resulting in major losses of pioneer and early successional habitat such as bare sand, sparsely-vegetated dunes and open dune slacks to fixed dune grassland and mature slacks. Mobile dunes currently occupy just 6% of the entire Welsh dune resource, compared to over 70% in the 1950s.

The three most important factors which control the scale, form and dynamism of sand dune systems are wind energy, sand availability and the nature of

vegetation cover (Pye and Blott, 2012). The degree of overall mobility within a dune field at any moment in time is determined by the balance between a number of drivers (Table 1). This balance typically changes over time, and is reflected by episodes of mobility and stabilisation, which are naturally characteristic of dune systems.

Table 1. Drivers of dune dynamics (after Pye & Blott, 2012).

Dune Mobility	Dune Stability
High wind speeds	Low wind speeds
Low rainfall	High rainfall
High temperatures/High rates of evaporation	Low temperatures/Low rates of evaporation
Nutrient deficiency limiting plant growth	Nutrient excess promoting plant growth
High rates of littoral sand supply	Low rates of littoral sand supply
Coastal erosion	Coastal progradation
High visitor pressure	Low visitor pressure
Low-level management measures	High-level management measures e.g. marram planting

The immediate sources of sand for dune formation are adjacent sand flats. The foreshore, the area of sand between the mean low water and high tide levels, provides 10-20% of the sand. The proportion depends on areas of the foreshore drying out at least temporarily, and thus being blown by the wind followed by accumulation above the normal limits of the tide. Predominantly the sand in the backshore (mean high tide to dunes) provides the majority of the dune-building sand (80%) as this area is only submerged during storms or high tides (Ranwell and Boar, 1986).

2.1. Newborough

At Newborough Warren, 51% of the blown sand area comprised bare sand in the 1940s compared to 3% in 2009. Pioneer dune slack habitat is all but absent at Newborough, with remaining areas being small, fragmented and of poor quality (Bratton, 2012). In contrast Boyce (2015), found 5,784m² of pioneer dune slack habitat at Morfa Dyffryn and confirmed the observation that Morfa Dyffryn is probably the most dynamic dune system remaining in Wales.

Focused geomorphological assessment was carried out at 12 sand dune sites across Wales including

Newborough Warren (Pye and Blott, 2012). Pye and Blott (2012) listed a number of options for increasing dune mobility at Newborough ranging from small to large scale interventions, including;

- (a) Vegetation density / height reduction
- (b) Sand supply and sand mobility enhancement
- (c) Wind speed and sand transport enhancement

Due to the scale of the stabilisation problem at Newborough, large scale mechanical intervention was undertaken, consisting of; excavation of breaches in frontal dunes, new deflation basins and troughs; stripping of rank vegetation and localised placement of excavated sand.

Work began at Newborough in the winter of 2012-13. Initially a 4 ha area of bare sand was created in the inner dunes as a trial, termed Phase 1. Further opportunity was presented the following winter and Phase 2 was undertaken in the forest area directed by Welsh Government, with approximately 3.9 ha created at Zone 1 West and 3.5 ha at Zone 1 East. Phase 3 was completed in the winter of 2014-15 with 6.6 ha of bare sand created in the foredunes of the Warren (Figure 4 and Table 3).

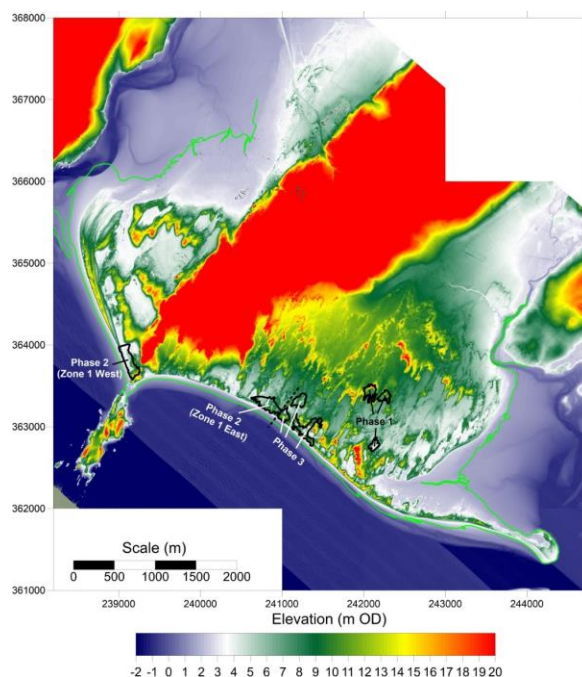


Figure 4. Locations of Phases 1, 2 and 3 dune restoration works at Newborough, overlaid on LiDAR DEM flown on 9 April 2014. Taken from; Pye and Blott (2015a).

Table 3. Bare sand created at each of the rejuvenation sites. See KPAL; 2013, 2014 and 2015a-d monitoring reports.

Newborough	Bare sand created (ha)
Phase 1	3.96
Winter 2012-2013	
Phase 2	Zone 1 West 3.85
Winter 2013-2014	Zone 1 East 3.54
Phase 3	6.63
Winter 2014-2015	
Total	14.44

3. CONCLUSIONS

The Newborough site in 2009 consisted of 1222 ha of intact dune of which 40 ha was calculated as bare sand, equating to 3% of the site. Morfa Dyffryn, on the Meirionnydd coast, is Wales' bench-mark dune site for dynamic processes, see Pye and Blott (2012). There is a need to be emulating the dynamic processes to achieve figures in the order of 30 to 40% pioneer habitats, including 10 to 15% bare sand, on senescent dune systems such as Newborough. The management work to date, as of 2015 monitoring, has provided an extra 14.4 ha of bare sand which raises the percentage by an extra 1% of bare sand at Newborough to a total of 4%, although it is still a long way from the 1940s levels of 51%.

Unfortunately, the 2016 monitoring results were not available in time for this paper. However, the initial 4 ha area of bare sand created in the inner dunes as phase 1, at the latest survey March 2015, showed the bare sand area had increased by 0.5 ha. This depicted that even in the inner dunes where wind speeds and fresh sand supply are relatively low, the bare sand area is currently increasing, although modestly.

As a result of the management interventions, the aim is that within the near future, Welsh dunes will be more dynamic and self-sustaining, supporting extensive areas of pioneer and early successional habitats and be able to maintain that dynamism without the need for regular intervention (Howe *et al.*, 2012).

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