

History of human influence on sand-dune stability on the Sefton Coast

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1. Summary

Human use of the Sefton Coast dates back to the Mesolithic period, though the small populations probably had little impact on the landscape until much later. Norsemen settled the coast in the 9th and 10th centuries, many current place names indicating that the dunes were dominant features in the lives of the people at that time. The vagaries of weather and tide on such an exposed coast resulted in the loss of at least two Domesday townships by the mid-12th century, while great storms and their sandy aftermath feature prominently in the literature from the 16th century onwards. Evidently, the dune system was unstable for several centuries, tenants of the two manorial estates being required to plant ‘starr’ grass (Marram *Ammophila arenaria*), with penalties enacted for its cutting. The use of the dunes for livestock grazing and as managed Rabbit *Oryctolagus cuniculus* warrens may have resulted in further damage to the fragile vegetation.

In recent centuries, many human activities, coupled with natural processes, have caused increasing dune fixation, while others led to instability. Thus, from at least the 18th century, some areas of duneland were levelled to create fields especially for asparagus farming. This probably contributed to dune fixation but much more important was the planting of about 300 ha of conifers, mainly Corsican Pine *Pinus nigra* subsp. *laricio* from the late 19th century. The maturing trees had a major impact on the ecology of the dune system, including creating shelter that encouraged scrub development. The estates also introduced Sea Buckthorn *Hippophae rhamnoides* at the end of the 19th century. Following the demise of Rabbits, due to myxomatosis, in the late 1950s, this invasive spiny shrub spread rapidly, to be followed in more recent times by the garden escape, Japanese Rose *Rosa rugosa*. Other important influences on dune fixation were the development of nine major golf courses at the turn of the 20th century, tipping of waste materials on the dunes in several places, the construction of major military facilities, including a rifle range and an airfield, and major housing developments.

Marine erosion since 1906 at about 4 m per annum along a 5 km frontage at Formby Point removed embryo and mobile dunes, squeezing the dune coastline against pine plantations to the rear. Longshore drift of sand eroded from Formby Point has combined with foreshore accretion from the nearby Ribble Estuary to create the 4 km-long 'Birkdale Green Beach'. Over 50 ha of new dune, dune-slack and saltmarsh have formed since 1986 between Ainsdale and Birkdale. This has provided much needed pioneer habitat for characteristic dune species but has also cut off sand-supply to adjacent frontal dunes.

Mainly from the 1940s to the 1960s, parts of the duneland were rejuvenated, at least temporarily, by large-scale commercial sand extraction. However, being a threat to coastal defences, this industry was ended by planning controls and the extensive low-lying sand quarries soon became re-vegetated.

Informal recreation has long been an important activity on the coast, increasing greatly from the 1930s when land began to be purchased by the local authorities, thereby lifting access restrictions. Recreational hotspots rapidly became denuded of vegetation resulting in damaging sand-blow, the Sefton Coast Management Scheme (later the Sefton Coast Landscape Partnership) being established in 1978, partly to restore the severely damaged frontal dunes. Other mobile dunes that threatened infrastructure were stabilised by the local authorities in the early 1970s. However, one of the largest open features on the coast, the Devil's Hole blow-out at Ravenmeols, dating from the early 1940s, survived this period of intensive management unscathed. The occurrence of bare sand in much of the dune system now seems closely linked to recreational trampling.

As the dunes became more stable over the past five decades, there was a rapid spread of tree and shrub species. Controlling scrub became a preoccupation of conservation land-managers, clearing selected areas of scrub being supported by the introduction of livestock grazing to control regrowth and encourage recolonisation by Rabbits.

Although the Sefton dune system is one of the most biodiverse in northwest Europe, many of its characteristic species and habitats depend on dune dynamics and the presence of bare sand. Concern is mounting that increasing sand fixation, due to vegetation overgrowth, is threatening this diversity. Climate change will probably exacerbate several of the problems described.

2. Introduction

Extending for about 20km between the estuaries of the Mersey and Ribble in northwest England and covering 2100ha, the Sefton Coast sand-dune system is the largest in England and the fourth largest in Britain, though it has lost up to half its original extent to past development. It is recognised as one of the most important examples of this habitat in northwest Europe, supporting many iconic species of wildlife, such as Natterjack Toad *Epidalea calamita*, Sand Lizard *Lacerta agilis*, Dune Helleborine *Epipactis dunensis* and Northern Dune Tiger Beetle *Cicindela hybrida*, amongst many other sand-dune specialists. About 1200 higher plants and over 3300 invertebrates have been recorded in the dunes, making this area an international hotspot for biodiversity (Smith, 2009a).



Typical dune landscape, Ravenmeols Sandhills Local Nature Reserve

In recognition of its national and international significance, most of the dune system has been designated a Site of Special Scientific Interest (SSSI), a European Special Area of Conservation (SAC) and a RAMSAR site, while the adjacent foreshore is a European Special Protection Area (SPA). Also reflecting this interest are two National Nature Reserves (NNRs), two Local Nature Reserves (LNRs), a County Wildlife Trust nature reserve and a National Trust estate, the latter having been considerably enlarged in 2017 by the acquisition of the Lifeboat Road and Ravenmeols dunes from the local authority.

For many centuries, the duneland was modified for human uses, some of these causing instability and sand-blow, while others led to dune fixation, this being an increasing trend in recent decades. This report summarises the effects of various land-uses, as far as is known, with particular reference to impacts on sand-dune stability.

3. Overview – land uses and their impacts

3.1. Early history

The Sefton Coast has a history of human occupancy going back to the Mesolithic period. Thus, an exceptionally early settlement dated around 8000 BP (before present) has been excavated over several years at Lunt on the R. Alt floodplain about 5 km inland from the present-day coastline. Further evidence comes from large numbers of human and animal footprints described from sun-baked silts on the shore at Formby Point; these date from the late Mesolithic and early Neolithic (5-6000 BP) and include the footprints of Red Deer, Roe Deer, Wild Boar and the globally extinct Aurochs (Burns, 2014; Roberts, 2014), showing that habitats were subject to considerable grazing pressure and disturbance at that time. A Neolithic wooden trackway of about 5700 BP excavated on Hightown beach may imply woodland management (Cowell, 2008), this being supported by the discovery of two Neolithic stone axes near Hightown. By the middle Neolithic (c. 4800 BP), pollen analysis indicates cereal farming was widespread in the area (Cowell, 2008) and it can be inferred that this would have been accompanied by the grazing of domestic livestock, though the earliest direct evidence for this seems to be footprints of Iron Age (2500 BP) oxen in a peat layer of a possible dune-slack at Formby Point (Plater *et. al.*, 1993)



Neolithic footprints in silt on Formby beach

Hunter-gatherers and early farmers may not have had a major impact on coastal landscapes but studies of pollen and charcoal in the Formby Point silts point to a well-established dune system with slacks, drier ridges and areas old enough to form dune-heath. The nature of some charcoal fragments suggests that the heath might have been fire controlled, while other carbonaceous particles raise the possibility of early smelting activity (Roberts & Worsley, 2008).

There are rather few artefacts associated with the coast from the Roman and Anglo-Saxon periods, Philpott (2008) making the point that the extensive dune coverage makes it difficult to identify features or collect material. However, in the 9th and 10th centuries, the area was occupied by Scandinavians, probably descendents of Vikings who had earlier settled in Ireland and the Isle of Man (Philpott, 2008). There are many place-names on the Sefton Coast dating from that time, including Ainsdale, Birkdale, Formby and Ravenmeols. The frequent use of the word ‘meols’ (meaning a sandbank or sandhill),

in Wirral as well as Sefton and ‘hawes’ (a hill) indicates that dunes were a important topographic feature in the lives of local people. However, nothing is known directly about Norse settlements along this coast, though a low population density is inferred (Harrop, 1985; Philpott, 2008).

3.2. Middle Ages to 19th century

Eleventh century monastic records provide evidence of agricultural reclamation and livestock grazing along the coast, though no detail of their extent. However, the vulnerability of human settlement here to the vagaries of weather and tide is demonstrated by the apparent loss to erosion of Domesday townships of Ravenmeols and Argameols before the mid-12th century (Lewis, 2008; Philpott, 2008). Great storms and their after-effects feature prominently in literature from the sixteenth century onwards, on one occasion, in 1739, sand being blown up to 1.5 km inland at Formby and Ravenmeols.

Until the 18th century, livestock (cattle and sheep) were grazed on commons in the dunes and, although there were regulations to control this activity (Lewis, 2008; Morton, 1981), it may have contributed to dune instability. Stray animals were kept in ‘pinfolds’ to be released on payment of a fine, Pinfold Lane at Ainsdale being a reference to this practice (Harrop, 1985). Sand-blow problems were reflected in attempts to consolidate the dunes by the planting of Marram, known locally as ‘starr’, this being a requirement of a tenancy from the landowner, and the establishment of Rabbit warrens (Harrop, 1985; Lewis, 2008; Philpott, 2008). Thus, ‘Hawlookers’ were appointed by manorial courts at Ainsdale and Birkdale and penalties enacted to ensure that Marram was planted and maintained. In 1742, an Act of Parliament was passed “for the more effectual preventing of the cutting of starr” It is thought that the Romans introduced Rabbits to Britain. For many centuries they were kept in managed warrens, Rabbit meat and fur being valuable commodities. Warrens were certainly in use on the dunes from the early 15th century, continuing as an important land-use until the late 19th century (Harrop, 1985). Rabbits are significant managers of dune vegetation (Potter & Hosie, 2001) and may have exacerbated the impact of livestock grazing until myxomatosis greatly reduced their numbers in the mid-20th century.

Especially near to Formby, the growing of asparagus became an important duneland industry from the 18th century onwards. This involved the creation of fields by levelling the dunes, resulting in slacks at Formby Point being infilled (Smith, 2009a; Yorke & Yorke, 2008). The loss of undulating topography and the planting of field boundary hedges to provide shelter probably contributed to dune fixation in the longer term.



Asparagus field, National Trust estate Formby Point



Former asparagus field in the snow at Formby Point, showing relict ridge-and-furrow

Throughout the 19th century, it seems that sand-blow continued to be a problem for the Formby and Weld-Blundell manorial estates that had owned most of the dune system since the early 16th century (Foster, 2000; Kelly, 1973). In their ‘Voyage round Great Britain’, Ayton & Daniell (1814-1825) evocatively describe the dynamic nature of the dunes at Formby Point in 1813 as follows:

“Many of them were full sixty feet in height, rising precipitously on all sides. They were all thinly sprinkled with sea bent, and exhibited a scene of frightful and irredeemable barrenness Along the shore, above high-water mark, there is a prodigious accumulation of loose, dry sand, which is continuously driving into the interior A hard wind was now blowing from the westwards; and the shore, which is left dry for a breadth of more than a mile, was covered in a cloud of loose sand about a foot high, which seemed to rise from it like smoke”

In 1857, public notices advised that fines could be levied on anyone cutting, carrying away or being in possession of starr (Holden & Newton, undated), this being Ayton and Daniell’s ‘sea bent’. Reflecting upon the effects of sand-blow, Ashton (1909) wrote:

“It would be difficult to find a district where blowing sand has inflicted so much loss upon farmers and landowners, nor upon cultivated land only”.

3.3. Late 19th and 20th centuries

3.3.1. Dune development

Dune instability in earlier centuries may have been influenced by over-grazing but also by climatic factors and by greater sand-supply from the shore, as evidenced by the enormous height of some of the dunes that were formed during this period. For example, a series of large dunes at least 15m high formed in the Birkdale frontal strip after the railway (now occupied by the coast road) was built along the upper beach in 1888. It has been suggested that, when lower sea-levels prevailed and before the channel into the R. Mersey was trained at the end of the 19th century, more sand was blown up from the intertidal zone (Smith, 2009a).

The east-west orientation of the many large dune-slacks at Birkdale and Ainsdale shows that most were created by wind erosion when vegetation was sparse enough to permit this process. Core sampling of a typical Ainsdale NNR slack (no. 100) by O'Garra (1976) suggested that its floor dated to the 1890s. The large quantities of sand emanating from these slack basins no doubt contributed to the extensive 'links sand' habitat east of the present-day duneland. Much of this was subsequently developed for housing, military activities and golf courses, some undeveloped fragments now supporting decalcified dune-heath (Gateley, 1995). A hundred years ago, the dunes were still open and sparsely vegetated, as shown by an early aerial photograph of the Ainsdale area dated about 1920 (Smith, 2009a).



Ainsdale dunes in about 1920, showing a high proportion of bare sand (Sefton Council archive)

3.3.2. *Golf Courses*

Nine major golf courses were developed between 1873 and 1912, accounting for about 550 ha, more than 25% of the dune system. Two were subsequently closed, being developed for housing and the Woodvale airfield (Smith, 2009a). Although large areas of duneland remain as 'roughs' and much of the dune topography remains, there is little

doubt that the presence of the courses has added to the stability of the system. All the courses are drained, several include planted trees and shrubs, Rabbits are controlled and bare sand is not tolerated, except in bunkers.

3.3.3. *Military activity*

The military services have been major users of duneland since 1860 when Altcar Rifle Range (now Altcar Training Camp) was established on land reclaimed from the sea at the mouth of the Alt Estuary. Being one of the most important training facilities in the country, much of the 204 ha estate has been converted into ranges with supporting infrastructure but the seaward dunes remained unaltered. However, being undisturbed, they have become increasingly overgrown by dense vegetation in recent decades (Smith, 2009a), control of Rabbits on the estate perhaps contributing to this process. Formed in 1985, the Altcar Conservation Advisory Group has promoted scrub control, the excavation of scrapes for Natterjack Toads and changes to the mowing regime on the ranges with beneficial results for their rich wildlife.



Altcar Training Camp Natterjack Toad breeding scrape

Military training also took place on the, then, privately-owned Cabin Hill dunes until 1979 and may have helped to slow down vegetation overgrowth here. Immediately south of the ranges, the 8 ha Fort Crosby was constructed on Hightown dunes in 1906 to protect the mouth of the Mersey. Its guns were never used and the site was sold to Crosby Borough in 1957, being restored with the help of derelict land grants in 1983. The foreshore between Crosby and Ainsdale was requisitioned for military training in 1944, concern being expressed about the creation of breaches through the frontal dunes to allow access by tracked vehicles. This area was de-requisitioned between 1951 and 1958 (Smith, 2009a).

Woodvale Aerodrome (c. 130 ha) was created in 1941 from the requisitioned Freshfield Golf Course and two farms. Most of the airfield, which is almost level, comprises mown grassland, runways and buildings but its fringes support areas of dune-heath, 35 ha being purchased in 2004 by the Lancashire Wildlife Trust to establish the Freshfield Dune Heath Nature Reserve (Smith, 2009a).



Freshfield Dune Heath Nature Reserve

3.3.4. *Plant introductions*

The introduction of Sea Buckthorn by the manorial estates in about 1898 eventually had a dramatic effect on dune stability. It was used not only to assist sand fixation but also to create hedges along estate boundaries to exclude the public (Walmesley-Cotham, 1935). For several decades the spread of this invasive shrub with an ability to fix atmospheric nitrogen on its roots was restricted by heavy Rabbit grazing. However, after myxomatosis outbreaks in the late 1950s, it began to spread rapidly, this process apparently being exacerbated during the 1970s by drought, enabling the plant to invade slack basins at Birkdale and Ainsdale. Studies using a sequence of aerial photographs showed a six-fold increase in the area of dune scrub (mainly Sea Buckthorn) in three representative areas between 1945 and 1985 (Smith, 2009a). Birkdale Sandhills, in particular, changed out of all recognition from the 1970s to the 2000s, becoming heavily invaded by Sea Buckthorn but also other non-native woody species, such as White Poplar *Populus alba*, Grey Poplar *P. ×canescens* and Balm-of-Gilead *P. ×jackii*.



Sea Buckthorn (with orange berries) invading Birkdale Sandhills LNR

No doubt scrub invasion was also influenced by the abandonment of livestock grazing. Although there is little information on the timing of this, extensive grazing on the dunes

became uneconomic, largely disappearing by the early 20th century. An exception was at Cabin Hill where the eastern section, levelled by earlier sand-winning, was grazed by up to 30 cattle and a few horses until 1992, these being then replaced in winter by about 50 Herdwick sheep and, from 2010/11, five Shetland cattle in some years (Smith, 2012a).

More recently, another introduced shrub, Japanese Rose, has given rise to great concern. Known to be spreading on the Sefton Coast since the 1970s, this plant was the subject of a coastwide volunteer survey in 2014, a total of 500 patches being mapped, covering almost 6 ha. Some land holdings were heavily infested, others having few if any bushes. The pattern of distribution suggested an origin as a garden escape and from planting schemes, while presence on several frontal dune areas indicated dispersion of propagules via the sea (Smith & Deed, 2019). A separate study found that large patches on Birkdale dunes were growing at over 20% per annum, doubling in size every four to five years (Boardman & Smith, 2016).



Japanese Rose on Birkdale frontal dunes

3.3.5. *Forestry*

The greatest impact on sand mobility on the Sefton coast probably arose from forestry. Although the first plantation near Formby dates to the 1790s, the dunes were largely treeless (Ayton & Daniell, 1814-25) until tree planting began in earnest in the 1880s initially by the Formby estate, soon followed by Weld-Blundell, from Ravenmeols northwards to Ainsdale. By the 1930s, about 300 ha had been planted up, mainly using Corsican Pine *Pinus nigra* subsp. *laricio*, this proving more successful than other species. A prime objective was to produce a cash crop from land then viewed as “unprofitable waste” but sand-fixation and creating shelter for small-holdings and housing development were also major considerations, while it was also hoped to provide “an amenity for the district” (Smith, 2009a; Yorke & Yorke, 2008).



Conifer plantation on former dunes, Formby Point

Although some plantations were lost to marine erosion and others to fires, their extent had a major impact on the ecology of the dune system. As well as fixing the landscape and seeding into open habitats, the trees replace a biodiverse sand-dune habitat with one that is much less diverse; they acidify the soil, intercept precipitation and increase transpiration of ground water, leading to a lowered water-table in their vicinity. Plantations also create an effective windbreak, creating shelter which encourages colonisation of other woody plants, such as birch, poplars and Sea Buckthorn. Much of the woodland is situated behind an eroding dune frontage at Formby Point, so that open dune is being progressively squeezed into a narrowing zone between the beach and plantation edge (Smith 2009a; 2009b).



Coastal squeeze: pines eroding onto the beach, Formby Golf Course

In 1990, English Nature (now Natural England) began a phased programme of ‘dune restoration’ to remove about 40 ha of conifer plantation and scrub (the so-called frontal woodlands) in Ainsdale NNR. By 1996, two phases (20.5 ha) were completed, clear-felling being followed up by extensive winter grazing by Herdwick sheep. This had a

dramatically beneficial effect on duneland ecology, including recovery of specialised wildlife (Smith & Lockwood, 2011) and local remobilisation of sand in small blow-outs. However, adverse public reaction to tree-felling resulted in the final two phases being postponed and the work has still not been completed twenty-five years later.



Ainsdale NNR dune restoration area

Since 2002, the *Sefton Coast Woodlands Forest Plan* has sought to bring together all woodland owners to improve the condition of their holdings by selective thinning, felling over-mature compartments and replanting. However, Smith (2009b) claimed that additional plantings outside the existing woodland footprint were causing ecological damage. Indeed, Rooney & Houston (2009) pointed out that the Sefton Coast seems to be one of few places in Britain still planting pines on sand-dunes. A review initiated in 2012 (The Mersey Forest, 2013) aimed to refresh the original plan. It acknowledged the many constraints to forestry on the dunes and did not specifically recommend planting outside the existing woodland footprint.

3.3.6. *Waste tipping*

Dune fixation was also influenced locally by the disposal of waste materials of various kinds. Thus, from about 1956 until 1974, up to 22,000 tonnes a year of waste tobacco leaves from the British Nicotine factory in Bootle was tipped on abandoned asparagus fields and former sand-workings at Formby Point. The main tip, dominated by Common Nettle *Urtica dioica*, covered about 7 ha within the National Trust estate. Since then, marine erosion has exposed the peat-like bands of waste in sand cliffs, large blocks of material collapsing onto the beach during storm surges. Demolition waste from Harington Barracks at Formby was also dumped in the dunes at Formby Point to create a large carpark. For many years, this material has been eroding onto the beach, causing a major disposal problem for the National Trust.



Nicotine waste eroding onto the beach at Formby Point



Rubble eroding from National Trust carpark, Formby Point

An area of about 1.3 ha in the Birkdale frontal dunes was used for the disposal of beach-cleanings in the 1970s and 1980s and now supports abundant Japanese Rose. From about 1942 until the early 1970s, rubble from Liverpool bomb-sites and other sources was tipped between Blundellsands and Hightown to form an embankment in an effort to slow down coastal erosion (Smith, 2009a). Material washed out of the embankment has produced an artificial ‘shingle’ beach with plants characteristic of this habitat but the bank cut off sand supply to the narrow dune belt along this frontage. All these operations have added to dune stability.

3.3.7. *Sand-winning*

Less easy to quantify is the impact of sand-winning on dune fixation. Beginning on a small scale before the Great War, the sale of dune-sand for various commercial purposes was well established by the 1940s, hundreds-of-thousands of tonnes being removed between Hightown and Birkdale up to the early 1970s. The history and extent of this

industry at Formby Point was researched by Crosby (2007) and its ecological impacts by Smith (2007a). Smith pointed out that sand-winning would have reversed, for a time, the trend towards vegetation overgrowth, providing opportunities for open dune flora and fauna, perhaps including breeding sites for the Natterjack Toad. However, the extensive low-lying sand quarries lacked the varied topography of the former landscape, often leading eventually to greater stability and the development of coarse grassland or scrub.



Former sand quarry, now overgrown, Ravenmeols

In places, sand-winning created large breaches in the frontal dunes, threatening coastal defences and leading Formby Urban District Council to seek controls during the 1950s under the Town & Country Planning Act 1947 (Crosby, 2007). At Cabin Hill, the frontal dune belt was so weakened that, in 1970/71, the Mersey & Weaver River Authority constructed, at great public expense, a secondary sea-defence in the form of an 800 m long barrier bank. The large borrow-pits from which sand was excavated to create the bank became important Natterjack Toad breeding sites, leading to the establishment of

Cabin Hill NNR. A large deflation area at Lifeboat Road, Formby, initiated by sand-winning but exacerbated by recreational pressure during the 1960s and 1970s, was eventually stabilised by the Sefton Coast Management Scheme in 1985 (Smith, 2009a). Another large breach at Ravenmeols was partially repaired but remains as a mobile feature to the present-day.



Mobile features at Ravenmeols originating from past sand-winning (Google Earth)

Sand-winning by Southport Corporation from 1952 to 1963 took 800,000 tonnes from the frontal dunes south of Ainsdale-on-Sea, creating a series of large slacks (Smith, 1999). The most recent 'sand-winning' event took place in 2011, when Sefton Borough Council removed 30,000 tonnes from a 4 ha dune ridge at Crosby to use for beach replenishment for coast protection purposes at Hightown, 5 km to the north. High winds the following winter resulted in severe sand-blow from the extraction site, affecting adjacent parkland and residential properties. Much of the sand deposited at Hightown was subsequently

washed away, especially during the 2013/14 winter storm-surges, though it contributed to a useful rise in beach levels (Smith, 2012b). Marine erosion at Hightown has continued to the present-day.



Sand-blow at Crosby Coastal Park in the 2012 winter



Dune erosion at Hightown, 2020

3.3.8. *Informal recreation*

Having a tendency to produce dune instability, informal recreation has been a major land-use on parts of the coast since early 19th century (Smith, 2009a). However, most of the duneland south of Birkdale remained in private hands with greatly restricted access until the manorial estates began to be sold off. In 1928, Southport Corporation bought 3700 acres (1540 ha) from Weld-Blundell in Birkdale and Ainsdale, including the foreshore, built the Ainsdale Bathing Centre in 1933 and allowed carparking on the beach (Foster, 2000). Thousands of summer visitors soon caused severe damage to the adjacent sandhills, blowing sand partially infilling the nearby Sands Lake. Beach carparking was finally restricted by the Council in 1993. Coupled with changes to mechanised beach-cleaning (McAleavy, 2010), this encouraged development of embryo dunes and ‘Green Beach’ features north of Ainsdale-on Sea.

After World War II, Formby Point became another popular recreation venue, although Sefton Council did not have full control of the land around Lifeboat Road until 1978. The National Trust purchased its estate, centred on Victoria Road, in 1967. Lack of management to take account of visitor pressure resulted in dunes at main access points being denuded of vegetation. Thus, by the mid-1970s, it was possible to see the sea while standing in the Victoria Road car-park, the frontal dunes having disappeared, while the Lifeboat Road area was a scene of devastation (Smith, 1999; 2009a). A perceived threat to the coast protection function of the dunes was central to the formation of the Sefton Coast Management Scheme, this becoming the Sefton Coast Partnership in 2001. Denuded areas were restored between 1979 and 1985 using brushwood fencing to trap sand. Steep, unstable, slopes at Lifeboat Road were bulldozed, followed by Marram planting. Further increases in visitor numbers on the National Trust estate, resulted in some of the re-vegetated dunes being mobilised again from about 2000, producing extensive sand-sheets either side of the Victoria Road carpark.



Sand-sheet north of National Trust carpark, Formby Point

Also, in the early/mid 1970s, heavy recreational pressure combined with the effects of drought caused sand-blow in the frontal dunes between Ainsdale and Birkdale leading to the formation of a series of botanically-rich slacks (Smith, 2006) and threatening to inundate the coast road. In 1972, Southport Corporation arranged for sand to be removed from two large mobile dunes north of Ainsdale-on-Sea, the bare sand subsequently being stabilised using a layer of sewage sludge. Similar work was carried out the following year on a large dune, ‘Little Balls Hill’, just north of the Ainsdale NNR boundary. This time stabilisation was achieved using a straw and bitumen mulch (Smith, 1999).



Use of sewage sludge to stabilise sand at Birkdale, 1972

In addition to human trampling, off-road driving of vehicles, mainly motor-cycles, caused considerable damage to Council-owned dunes during the 1970s and early 1980s. This dangerous and illegal activity was eventually brought under control in the mid-1980s by a newly introduced Ranger Service.

One of the few sizeable areas of mobile sand on the present-day dunes is at the ‘Devil’s Hole’ Ravenmeols, this being a 4 ha active blow-out. Aerial photographs show that it began to form in the early 1940s, probably due to a World War II bomb explosion. The blow-out breached the winter water-table in the early 1990s, botanically rich dune-slack vegetation forming since 2003 (Smith, 2017). No attempt was made to stabilise this feature during the heyday of the Sefton Coast Management Scheme, perhaps because of its location well away from infrastructure and the fact that it did not impact coast protection. The blow-out is continuing to develop, due both to its inherent instability and to heavy recreational pressure.



The Devil's Hole blow-out, Ravenmeols, after a wet winter

Up to the 1980s, the usual response of site managers to drifting sand was to erect sand-trapping fences and to plant Marram and trees/shrubs in an attempt to stabilise the landform. A major conference in the Netherlands, followed by the publication of *Perspectives in Coastal Dune Management* (van der Meulen *et al.*, 1989), highlighted a move towards recognising the importance of dune dynamism and the role of natural processes in their management for coast protection, recreation and nature conservation. Despite this change in approach, with a few exceptions, such as Devil's Hole and other parts of the National Trust estate and the youngest sections of Birkdale Green Beach, frontal dunes on the Sefton coast, have become heavily vegetated, most remaining bare sand being caused by human trampling. This is particularly apparent in areas with restricted access or remote from main access points, as at Altcar Training Camp and Cabin Hill NNR where the dunes are almost completely fixed, with hardly any bare sand (Smith, 2012a).

3.3.9. *Marine erosion & deposition*

From about 1845 until the early years of the 20th century, Formby Point grew seawards, partly because of active management by the estates to build new dunes (Doody, 1999). This period also seems to have coincided with high sand-supply from the shore. However, marine erosion took over in 1906 and now affects about 5 km of dune frontage. The average rate of loss is about 4 m per annum, most damage occurring during storm-surges. For example, on 5th December 2013, about 8 m were lost in one tide, an estimated 5.3 ha of duneland being destroyed that winter (Smith, 2014). Overall, Formby Point has retreated by more than 400 m since the early 20th century.



Marine erosion at Formby Point

Research into the reasons for this erosion suggests that it may be linked to the training of the Mersey shipping channel at the turn of the 20th century. This seems to have reduced sand-supply to the foreshore, stimulating the growth of Taylor's Bank south of Formby Pont and focussing more wave energy on the steepened beach at the Point (Smith, 2009a). Erosion has taken out strand-line, embryo and mobile dune habitat, adversely affecting biodiversity along the eroding stretch. Sand from Formby Point is transported along the coast by longshore drift, most of it moving northwards. Foreshore accretion is

rapid between Ainsdale and Southport, no doubt influenced by the proximity of the Ribble Estuary. Since 1986, this has resulted in the development of ‘Birkdale Green Beach’, a mosaic of dune, dune-slack, fen, wet woodland and salt-marsh habitats up to 150 m wide, extending for over 4 km between Ainsdale-on-Sea and Birkdale and now covering over 60 ha (Smith, 2007b). This feature is still developing southwards and has contributed younger, more open habitats with considerable biodiversity benefits. However, it has also cut off sand-supply to the frontal dunes to the east. These have rapidly become over-vegetated and invaded by Sea Buckthorn.



Youngest Green Beach feature, Ainsdale-on-Sea

3.3.10. *Scrub control*

Scrub control on the dunes has been a preoccupation of conservation land managers since the 1960s. It began on a small scale at Ainsdale NNR using hand-tools but gathered momentum in the 1980s when machinery was used at Birkdale Sandhills LNR. In the early 1990s, similar work was undertaken at Ainsdale Sandhills LNR under a Natterjack Toad Species Recovery Programme (Smith, 2009a). There were also smaller-scale scrub

removals at Ravenmeols LNR and Cabin Hill NNR. However, preventing the rapid recolonisation of scrub has always been a problem, requiring repeated follow-up work and/or the introduction of grazing livestock with expensive and visually intrusive fencing and other infrastructure. During the mid-1990s, the Sefton Coast Management Scheme, assisted by an EU-funded LIFE-Nature project, cleared mainly Sea Buckthorn scrub from Ainsdale LNR and Birkdale frontal dunes. A team of volunteers, the ‘Buckthorn Bashers’ had some success from 2012 onwards in controlling the shrub by hand-cutting it annually in dune-slacks and on ridges totalling about 15 ha north of Shore Road, Ainsdale. A 2010-2014 Landscape Partnership Scheme, part funded by Heritage Lottery, included scrub management projects, especially at Birkdale LNR, where large areas of scrub were felled during the winter from 2010/11 to 2013/14. Parts of the reserve were fenced and winter cattle grazing introduced from 2014/15 under the terms of a Higher Level Stewardship agreement, further scrub removal taking place subsequently. From 2017, *Gems in the Dunes*, part of *Amphibian & Reptile Conservation’s Back from the Brink* project, organised volunteers or engaged contractors to remove scrub from various sites, including parts of Ainsdale LNR, Falklands Way, Queen’s Jubilee Nature Reserve Cabin Hill NNR and Altcar Training Camp.



Volunteer ‘Buckthorn Bashers’ Birkdale frontal dunes

During the 2020/21 winter, large-scale mechanical removal of scrub from several Ainsdale LNR slacks was organised by the local authority. Bushes were pulled up by the roots and buried in large pits. This created large areas of bare sand where little had been present previously. Also, during this period, Natural England commissioned scrub removal, mostly of birch and Lodgepole Pine, from the Montagu Road Triangle, an area of relict dune-heath at Freshfield.

Despite these operations, many parts of the dune system are still afflicted by dense and growing scrub patches, especially of Sea Buckthorn and Japanese Rose, increasing the fixation of dune landscapes. It is hoped that the forthcoming *Dynamic Dunescapes* project will be able to address some of these issues.



Mechanical removal of scrub from slacks at Ainsdale LNR

3.3.11. *Grazing*

From 1990 onwards, livestock grazing, mostly using ‘rare breeds’ sheep and cattle, was re-introduced to the coast’s nature reserves. The effectiveness of sheep and Rabbits in controlling scrub in slacks was researched in a 36-year study on Ainsdale NNR by Millett

& Edmondson (2013). They showed that grazing reduced the cover of woody plants, while increasing both grass and herb cover and species diversity. However, although it retarded succession in a valuable way, grazing did not entirely prevent this process taking place, leading the authors to suggest that re-establishment of disturbance to create new habitat, followed by grazing, may be a more successful strategy. Smith & Lockwood (2011) found that the interaction between winter sheep- and year-round Rabbit-grazing on Ainsdale NNR's 'dune restoration area' was a major factor in the increase of a rare plant, Field Gentian *Gentianella campestris*.



Herdwick sheep at Cabin Hill NNR

Rabbits continue to play an important role in some parts of the dune system; their grazing and burrowing induces spatial heterogeneity and maintains early successional stages with high numbers of species in fixed-dunes and the drier parts of slacks (Houston, 2008; Smith & Lockwood, 2011). However, their distribution is now patchy, large areas of the Sefton dunes no longer supporting many Rabbits. The resulting growth of coarse

grassland and scrub prevents their recolonisation, as Rabbits avoid coarser swards once established (Drees & Olff, 2001).

Houston (2008) reviewed several publications on duneland grazing with livestock, finding that its benefits outweighed the few negative side-effects. Conservation grazing was partly a ‘trial-and-error’ approach and had to be a long-term commitment. However, grazing alone did not counter all the problems associated with scrub development. For example, in a detailed study at Sandscale Haws, Cumbria, Pye *et al.* (2020) found that stock grazing over several decades played an important role in controlling the development of scrub and coarse grassland but had a limited impact on the extent of bare sand. Also, the sheep and cattle preferred to graze the dry dunes, resulting in standing crop increasing in the slacks. There are similarities to the observed effects of cattle grazing in Ainsdale Sandhills LNR. Here, the dry fixed dunes were well-grazed but the stock had little effect on vegetation succession in the wet-slacks, many of which became heavily colonised by scrub (personal observations), prompting the mechanised scrub removal project described earlier.

3.3.12. *Aerial deposition of nitrogen*

Overgrowth of vegetation may also be influenced by aerial deposition of nitrogen from industrial, domestic and agricultural sources, this having roughly doubled in Europe during the 20th century (Jones *et al.*, 2004). Although the amount of nitrogen deposition has fallen in recent years (Simpson *et al.*, 2014), it may still be having an impact on dune vegetation. Enrichment by plant nutrients (eutrophication) is known to promote the growth of coarse grasses and scrub in nutrient-poor dune systems, such as sand-dunes (Houston, 2008; Jones *et al.*, 2004).

3.3.13. *Dune dynamism*

Although the Sefton dune system is one of the most biodiverse in northwest Europe, many of its characteristic species and habitats depend on dune dynamics and the presence of bare sand. There is therefore concern that increasing sand fixation due to vegetation overgrowth threatens this diversity. For example, a 31-year study of the Natterjack Toad

on the Sefton dunes reported a 70% population decline, attributing this, in part, to overgrowth of vegetation affecting both breeding and terrestrial habitats of the toad (Smith & Skelcher, 2019). Similar problems afflict coastal dunes throughout Western Europe (Houston, 2008). Following ambitious projects in the Netherlands and Denmark, there is increasing interest in using heavy machinery to remobilise and rejuvenate overgrown dunes in Britain. Such management is currently underway on some Welsh dune systems (Howe *et al.*, 2012). Similar works, on a limited scale, are planned for the Sefton dunes under the auspices of the *Dynamic Dunes* project.

3.3.14. Climate change

Climate change is thought of as a modern phenomenon, though marked increases in temperature since 1750 were reported in Sefton nearly 60 years ago (Savidge *et al.*, 1963). Associated changes affecting the dune system include a longer growing season, increasing the likelihood of vegetation overgrowth, rising sea-levels impacting coastal erosion with consequential loss of mobile dunes and also weather extremes. The latter are predicted to include more prolonged droughts, especially in spring, coupled with higher winter rainfall, these having effects on the dune water-table. Using a groundwater model, Clarke & Sanitwong Na Ayutthaya (2010) predicted that the average water level in the dunes could fall by about 0.8 m by the end of the century. This would have major implications for plants and animals dependent on wet-slack habitat.

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APPENDIX 1

Review of individual land-holdings and their management since 1945 (from south to north)

Crosby Marine Park dunes

Area: 8.5 ha; **owner:** Sefton MBC; **acquisition:** not known; **conservation status:** Local Wildlife Site

Origin & management: Dunes began to form after park was reclaimed from Mersey Estuary in late 1960s. Removal of 30,000 tonnes of sand in 2011 for beach replenishment at Hightown. Extraction site fenced and partially replanted with Marram but severe sand-blow in 2011/12 winter. Heavy public pressure maintains some bare sand currently.

Crosby foreshore dunes

Area: 2.5ha; **owner:** Sefton MBC; **acquisition:** not known; **conservation status:** SSSI, SAC, SPA, RAMSAR.

Origin & management: dunes began to form on shore in 1990s. Heavy uncontrolled public pressure leads to sand-blow onto adjacent promenade; mechanically cleared at intervals, otherwise no management to date, though works are proposed.

Hall Road to Hightown dunes

Area: c. 55 ha; **Owner:** Sefton MBC; **acquisition:** 2011 (previously multiple owners); **conservation status:** Local Wildlife Site; northern part SSSI, SAC; proposed LNR.

Origin & management: Old established dunes. Southern 2 km fronted by rubble embankment tipped 1942-early 1970s, eroding to produce 'shingle' beach. Site of Fort Crosby restored back to dunes in 1983. Beach replenishment of 400m length in north by 30,000 tonnes of sand from Crosby in 2011. Much of this sand was overblown onto existing frontals, or eroded by high-tides producing some rise in beach levels. Moderate to light public pressure maintains some bare sand. Several Natterjack Toad scrapes created.

Altcar Training Camp

Area: 204 ha; **owner:** Reserve Forces & Cadets Association for the North West of England & the Isle of Man; **acquisition:** 1860; **conservation status:** Local Wildlife Site; part SSSI, SAC;

Origin & management: Formed by reclamation in late 18th century. Northern area sand-extracted after World War II. Frontal dunes little used, limited management for scrub clearance; recent mowing of fixed dunes in northern training area and creation of Natterjack Toad scrapes. Part of ranges behind dunes mowed after mid-July as flower-rich meadows; rest mowed regularly to keep sight lines clear. Since 1990, one million trees planted (mostly conifers). Large-scale mechanical removal of Japanese Rose from 2019.

Cabin Hill NNR

Area: 30 ha; **owner:** Natural England; **acquisition:** 2009 (previously leased since 1983); **conservation status:** NNR, SSSI, SAC.

Origin & management: Old established dune area increased by accretion during 20th century. Heavily sand-extracted in 1940s and 50s. Flood defence bank built in 1970/71 creating seasonally flooded borrow-pits used for breeding by Natterjack Toads, peaking in mid-1980s but declining subsequently. 1974 plans for a golf course rejected in 1993 after public inquiry. Older dunes fenced and winter-grazed by Herdwick sheep and, occasionally, Shetland cattle; Sea Buckthorn removed and scrapes created for

Natterjacks. Japanese Rose bushes dug out of frontal dunes. Low levels of public pressure.

Ravenmeols Sandhills LNR

Area: 132 ha; **owner:** National Trust; **acquisition:** purchased from Sefton Council 2017; **conservation status:** LNR (1983), SSSI, SAC.

Origin & management: Old established dune area added to by accretion during 20th century. Heavily sand-extracted after World War II, including breaches in frontal dunes. Large abandoned asparagus fields at the rear. Conifers planted on rear dunes from late 18th century but mainly about 1910. Also 6 ha of recent plantings, from 1998, managed under Sefton Coast Woodlands Forest Plan. Some limited recent scrub control and scrape excavation. Area includes Devil's Hole blow-out, a large caravan site, remains of speculative development at turn of 20th century and wartime relicts. Moderate public pressure, increasing in places.

Lifeboat Road, Formby

Area: 70 ha; **owner:** National Trust; **acquisition:** purchased from Sefton Council 2017; **conservation status:** SSSI, SAC.

Origin & management: Old established dune area, extended during 19th century. Back dunes afforested with conifers late 19th and early 20th centuries. Recent planting of 0.6 ha in 2004 managed under 2003 Sefton Coast Woodlands Forest Plan. Area heavily sand-extracted before and after World War II, up to 1970. Extensive disused asparagus fields. Fore-dunes severely damaged by informal recreation, restored by Sefton Coast Management Scheme, 1978-85. Marine erosion of frontal dunes since 1906 at average of 4 m per annum. Some Natterjack Toad scrapes. One of the chief recreation hot-spots on the coast with moderate to heavy public pressure.

Formby Point

Area: 168 ha; **owner:** The National Trust; **acquisition:** 1967; **conservation status:** SSSI, SAC.

Origin & management: Old established dune area, extended during 19th century. Back dunes afforested with conifers late 19th and early 20th centuries. 1995-2008 plantings of 3.2 ha, managed under 2003 Sefton Coast Woodlands Forest Plan. Marine erosion of frontal dunes since 1906 at average of 4 m per annum producing coastal squeeze against plantation frontage. Extensive disused asparagus fields. Nicotine waste tip (7 ha) active from c. 1956 to 1974. Fore-dunes at Victoria Road severely damaged by informal recreation, restored by Sefton Coast Management Scheme, 1978-85. Caravan site moved in 1983 due to erosion and sand-blow. A few Natterjack Toad scrapes. One of chief recreation hot-spots on the coast with heavy public pressure.

Cloven-le-Dale

Area: 9 ha; **owner:** private; **acquisition:** not known; **conservation status:** none.

Origin & management: Old fields used for horse-grazing by a stud farm; partially occupied by dune-heath.

Freshfield Dune Heath Nature Reserve

Area: 35 ha; **owner:** The Wildlife Trust for Lancashire, Greater Manchester and North Merseyside; **acquisition:** 2004; **conservation status:** part SSSI, SAC, Local Wildlife Site.

Origin & management: Mosaic of dune-heath, acid and neutral grassland, woodland and scrub on links sand, formerly part of Woodvale Airfield. Managed by scrub clearance, turf-stripping and summer grazing by rare-breeds livestock. Large number of ponds excavated. Part open to public since 2006.

Woodvale Airfield

Area: c. 130 ha; **owner:** Ministry of Defence; **acquisition:** 1941; **conservation status:** part SSSI, SAC, part Local Wildlife Site.

Origin & management: Requisitioned in World War II from golf course and farms. Almost level area of links sand supporting mown grassland and small areas of dune-heath. Limited management other than regular mowing.

Willow-bank Caravan Site

Area: c. 14 ha; **owner:** private; **acquisition:** unknown; **conservation status:** Local Wildlife Site.

Origin & management: Mosaic of dune-heath, acid grassland and scrub on links sand. No known management.

Ainsdale Sand Dunes NNR

Area: 339 ha; **owner:** Natural England; **acquisition:** 1965; **conservation status:** NNR, SSSI, SAC.

Origin & management: Old established duneland, increased by accretion in 19th century. Frontal dunes subject to erosion since 1906 at an average 4 m per annum producing coastal squeeze against plantation frontage. Over 100 ha of pine forest planted in early 20th century. Now managed under Sefton Coast Woodlands Forest Plan, including new plantings. 20 ha of frontal woodland and scrub removed in early 1990s, followed by winter sheep-grazing, to restore open dunes. Delays to removal of a further 20 ha due to public objection to tree felling. Many scrapes for Natterjack toads excavated in 1970s, reprofiled in 1990s. Apart from grazing enclosures, parts of reserve previously accessible by permit opened to public access several years ago. Low but increasing recreational pressure.

Ainsdale Sandhills LNR

Area: 88 ha; **owner:** Sefton MBC; **acquisition:** 1928; **conservation status:** LNR (1980), SSSI, SAC.

Origin & management: Old established dunes increasing slowly by accretion, unaffected by conifer planting. Bisected by coast road built 1967/68. Large slacks south of Ainsdale-on-Sea created by large-scale sand-winning, 1940s-1950s. Mobile dune threatening coast road stabilized early 1970s. Beach parking from 1930s restricted to smaller areas in 1993. Changes in mechanical beach-cleaning and use of stub-fencing in 1990s led to embryo dune development. Major scrub control programme in 1990s, part of inner dunes fenced and winter-grazed by sheep and, latterly, cattle. Several Natterjack Toad scrapes. Way-marked dune-trail since 1970s. Volunteer scrub control by *Gems in*

the Dunes. Mechanised scrub removal from eastern slacks, 2021. Heavy to moderate public pressure maintains some open sand.

Falklands Way

Area: 21 ha; **owner:** Sefton MBC; **acquisition:** 1928; **conservation status:** SSSI, SAC.

Origin & management: relict dune area left as a 'buffer strip' following development of Southbeach Park housing estate in 1968-70. Many trees planted in 1973 for screening purposes. Became badly scrubbed-up subsequently. North/south 'Falklands Way' established in early 1980s as unsurfaced way-marked footpath. Reinforced Ainsdale Link-path developed parallel to railway in 2011/12. Some scrub clearance in recent years by North Merseyside Amphibian & Reptile Group and *Gems in the Dunes*.

Kenilworth Road dunes

Area: 6 ha; **owner:** Sefton MBC; **acquisition:** 1928; **conservation status:** southern section SSSI, SAC; Local Wildlife Site.

Origin & management: relict dune area in two sections adjacent to housing development. Has become rapidly scrubbed up on periphery with many garden-escapes. Some scrub clearance in recent years by North Merseyside Amphibian & Reptile Group and *Gems in the Dunes*.

Birkdale Sandhills LNR

Area: 210 ha; **owner:** Sefton MBC; **acquisition:** 1928; **conservation status:** LNR (1980, expanded 1983), SSSI, SAC.

Origin & management: Old established dunes increasing by accretion, unaffected by conifer planting. Bisected by coast road built 1967/68. Sand-winning and stabilization of mobile dunes threatening coast road in early 1970s. Many scrapes for Natterjack Toads dug 1970s and 1980s. Development of 'green beach' on foreshore since 1986, now covering over 60 ha. Slacks in frontal dunes mostly created by sand-blow in 1970s. Scrub invasion in frontal dunes controlled during 1990s LIFE project but now returning. Volunteers removed Sea Buckthorn in limited areas since 2010. Severe scrub problem since 1980s on inner dunes now being addressed through Landscape Partnership Scheme

and Higher Level Stewardship to support scrub removal and livestock grazing. Moderate to light public pressure maintains some open sand.

Birkdale Common

Area: 10 ha; **owner:** Sefton MBC; **acquisition:** unknown; **conservation status:** proposed Local Wildlife Site.

Origin & management: some of oldest duneland on the coast, consisting of relatively level acid, sandy grassland, much used for informal recreation, especially dog-walking. Extensive scrub invasion on eastern and northern fringe. Grassland managed by mowing. Traversed east/west by access road to Royal Birkdale Golf Course and north/south by a cycleway constructed in 2010.

Queen's Jubilee Nature Trail

Area: 9 ha; **owner:** Sefton MBC; **acquisition:** 1928; **conservation status:** SSSI, SAC.

Origin & management: Reclaimed from foreshore and embryo dunes in early 1970s by building extension to the coastal road. Has gradually become over-mature and scrubbed-up in places. Developed as a 'nature trail' in 1991/92 by Sefton Council and Birkdale Civic Society. Scrapes for Natterjack Toads excavated in 1990s, subsequently reprofiled. Partial scrub clearance in spring 2014 by volunteers organised by Amphibian & Reptile Conservation. Further scrub clearance in 2021 by Sefton Council.

Southport Marine Lake dunes

Area: 6 ha; **owner:** various private; **acquisition:** not known; **conservation status:** Local Wildlife Site.

Origin & management: Relict dunes on western and northern fringe of Southport Marine Lake, cut off from shore when the coastal road was built in late 1960s. Some accretion continues from sand blown over the road from the shore during gales. Open conditions maintained by pedestrian trampling and grazing by Rabbits and Canada Geese. One private owner fenced off 4 ha in 2007 and cut down a large Sea Buckthorn clump. Fence soon broke down, allowing public access again, while Sea Buckthorn re-grew.

Golf Courses

Name	Area (ha)	Origin	Management
West Lancashire	75	1873 (extended 1921, 1961)	
Formby	119	1884	
Hesketh	54	1885	Some scrub clearance and sand-patching for Sand Lizards
Royal Birkdale	94	1889	Scrub clearance and creation of scrapes for Natterjack Toads, etc.
Formby Ladies	57	1896	
Southport & Ainsdale	58	1907	Turf-stripping to create bare-sand patches
Liverpool Banking & Insurance(Freshfield)	Unknown	1908	Requisitioned for Woodvale Airfield, 1941
Blundell	Unknown	1911	Closed 1935, built over
Hillside	66	1912	