British & Irish Botany 5(1): 30-62, 2023

Changes to the coastal flora of Wirral, Merseyside (v.c.58)

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This pdf constitutes the Version of Record published on 14th February 2023

Abstract
Changes over more than 200 years in the landscape, vegetation and flora of coastal habitats of the Wirral peninsula in north-western England are described. These include the creation of new salt-marshes, following ongoing accretion of sediments as well as destruction of habitats following urbanisation and industrialisation. These changes led to the development of new Open Mosaic Habitats increasing floral diversity. The role of hybrids and new species to the Wirral coast is discussed in relation to changes in floral diversity with losses largely confined to species of totally destroyed and relatively nutrient poor habitats and occurring before 1900.

Keywords: biodiversity; habitat change; Open Mosaic Habitats; sediment accretion; hybrids; instability

Introduction

The Wirral peninsula extends for 27.4 km (17 miles) north-west of Chester. It is 8–12.9 km (5–8 miles) wide and bounded on the north-east side by the Mersey estuary, on the south-west side by the Dee estuary and on the north-west side by the Irish Sea.

The coast line was formerly fronted by salt-marshes, sand dunes and cliffs mostly of clay but in places by outcrops of sandstone (see Fig. 1 for the Wirral portion of Burdett's map of Cheshire 1777, and Fig. 2 for a map of current place names). On the Mersey estuary three inlets or pools provided muddy shore lines. These were Bromborough Pool, Tranmere Pool and Wallasey Pool, the latter extending inland for nearly 4.8 km (three miles) ending in Bidston Marsh through which the River Birket flowed.

Ormerod (1819) provided a detailed description of a largely rural landscape with few signs of the urbanisation and industrialisation that was to develop along much of the peninsula's coastline. Later, Mortimer (1847) provided a description of the early stages of industrial and urban development of Wirral.

Botanical exploration of the peninsula, mainly on the Mersey estuary side began in about 1800 through the work of John and Henry Shepherd, curators of the Liverpool Botanic Garden, and their co-workers (Greenwood *et al.*, 2018). T.B. Hall relied heavily on their records in his *Flora of Liverpool* (Hall, 1839). By that date the coastal landscape was already changing.

Figure 1. Burdett's map of the Wirral peninsula, part of his map of Cheshire 1777. Reproduced by courtesy of Cheshire History Association

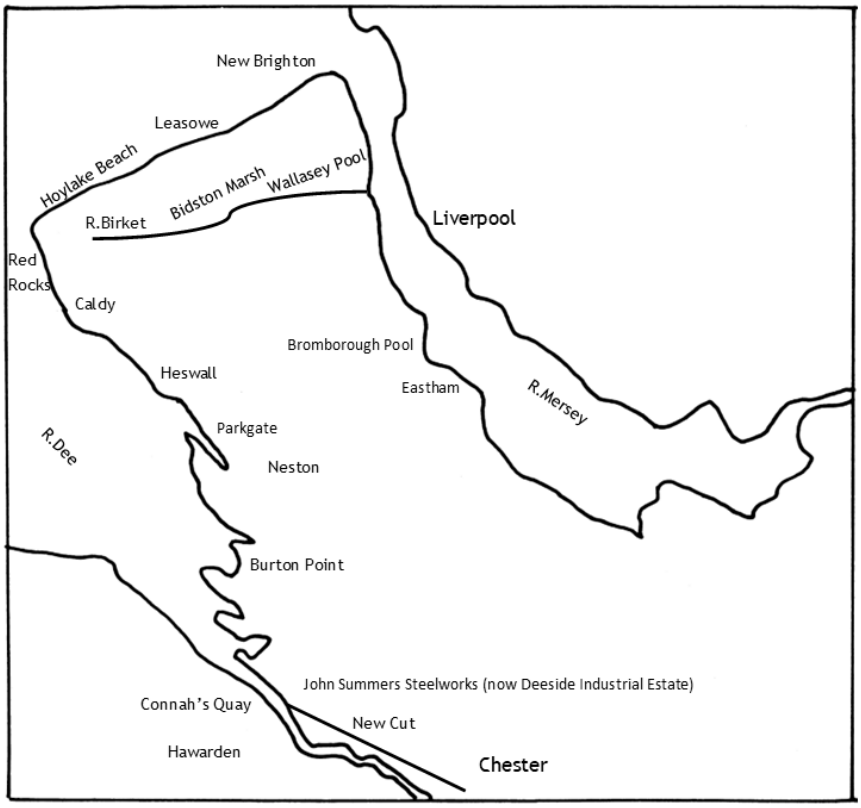

Figure 2. Map of the Wirral peninsula with approximate locations of selected places named in the text. Image: B.D. Greenwood

Landscape changes

Huge changes have taken place to the coastal landscape since the 18th century and this is clearly seen on the Dee estuary. The estuary had been silting up since Roman times and the first major development was an attempt to keep the port of Chester open by constructing the New Cut in 1737 (Chambers, 2014). The river was canalised for a distance of 10.8 km (6.7 miles) between Chester and Connah's Quay.

In the 18th century the estuary was full of sandbanks with indeterminate channels and with some marshes in the lee of Burton Point but more significantly on the Welsh side. Following the construction of the New Cut, marsh developed behind the embankments but was soon reclaimed for agriculture, much of it on the Cheshire side now known as Sealand. Further embankments and reclamation followed but erosion of the Welsh marshes then occurred. In 1898 construction of the Neston – Hawarden railway and the development of John Summer's steel works concluded reclamation of the salt-marsh. As the Dee estuary silted up further the salt-marshes extended down the estuary and are now developing on the north Wirral shore at Hoylake as well as at Red Rocks on the estuary itself. Both are notable and are discussed below.

Marker (1967), based on the work of Jenson (1949) described these changes to the Dee river channel, the construction of embankments and reclaiming of land for agriculture with subsequent changes to the location and extent of salt-marshes. The evidence suggests that since the 18th century whilst the continued silting of the estuary encouraged the development of salt-marshes these were quickly enclosed for agriculture. Thus, the present marshes are of relatively recent origin. De Tabley (1899) writing in the 1870s was able to describe the sandy shores downstream of Burton Point. This is reflected today in the presence of *Carex arenaria* on a sandy bank by the shore at Burton.

Today almost all the coast is bounded by hard surfaces starting with building a promenade at Parkgate on the Dee estuary in about 1800 (Greatorex, 2014). From the early 19th century further promenades and sea defences were built along many parts of the coast with major docks and industrial complexes built on the Mersey estuary including Wallasey Pool. Only a short stretch of 'natural', shoreline exists at New Ferry and Eastham on the Mersey estuary and on the Dee at Burton, Heswall and West Kirby. Nevertheless, remnants of sand dunes remain behind and in front of sea walls at various places on the coast and embryo dunes are starting to form in a few places, e.g. Heswall and Red Rocks.

Major sites and habitats

The Dee Marshes

Marker (1967) describes the salt-marshes in the Parkgate area. Up until the 1940s the succession of plant communities followed the fairly standard pattern for north-western England. The pioneer zones colonising bare mud were dominated by *Salicornia* species followed by mid-marsh zones with *Puccinellia maritima, Suaeda maritima* and *Tripolium pannonicum*. As the marsh matured, upper zones became dominated by *Festuca rubra* and, in wetter or freshwater irrigated areas, by *Phragmites australis*. However, *Spartina anglica* was planted at Connah's Quay in 1922 (Jensen, 1949) with later plantings in 1928 and 1929 (Taylor & Burrows, 1968) and by 1952 became the primary coloniser replacing *Salicornia* spp. Massey (1937) and McMillan (1945) describe the spread of *Spartina* and that by the 1940s the

marsh had reached Parkgate with its northern limit at the Boathouse. It reached Heswall by 1964 and today it is near Caldy with a secondary marsh at Red Rocks, West Kirby and Hoylake. A later description and the development of the lower and mid-marsh zones is provided by Huckle *et al.* (2000, 2004).

The vegetation of the salt-marshes today is very different to that described by Marker (1967), Taylor & Burrows (1968) and even Huckle *et al.* (2000, 2004). It is also much more complex. Silting of the estuary continues and the beach levels continue to rise. The pioneer coloniser of bare mud is *Spartina anglica* with some *Salicornia* spp. (SM6 *Spartina anglica* salt-marsh community *sensu* Rodwell, 1991-2000). Behind this zone is a very wide and complex zone of mid-marsh communities with *Puccinellia maritima, Tripolium pannonicum, Suaeda maritima* and *Cochlearia* spp. (see below), which can be seen at Heswall and West Kirby. However, it appears that as the marsh matures it becomes dominated by large areas of *Bolboschoenus maritima* (S21 *Scirpus maritimus* swamp) in wetter areas and the sterile *Elymus* x *drucei* in near monocultures (Figs. 3 and 4).

Figure 3. Neston mid-marsh salt-marsh communities with *Elymus* x *drucei* in middle distance

It is not known when *Elymus* x *drucei* became an important part of salt-marsh vegetation (see below). *Bolboschoenus* seems to be more prevalent at Parkgate whilst *Elymus* seems to become of greater importance downstream of the Boathouse and towards Heswall. The presence of *E.* x *drucei* dominating parts of the mid-marsh communities does not seem to have been generally reported or has been confused with higher zones with *Elymus athericus.* However, Gray & Scott (1987) remarked on

this possibility in relation to Morecambe Bay marshes. Rodwell (2000) recognised SM24 *Elymus pycnanthus* salt-marsh community but this covers both the mid-marsh zones now known to be dominated by *Elymus* x *drucei* and a narrower zone at the top or strand line of marshes which is dominated by *Elymus athericus,* a situation recognised by the Essex Wildlife Trust (Anon, undated).

Figure 4. Parkgate upper salt-marsh tall herb communities with *Calystegia sepium* in foreground and *Bolboschoenus maritimus* in middle distance

In the Heswall area parts of the mid-marsh communities consist of patches of *Atriplex portulacoides* forming SM14 *Halimione portulacoides* salt-marsh community. At the highest part of the marsh where freshwater irrigates the marsh large stands of *Phragmites australis* occur (probably a form of S26 *Phragmites australis-Urtica dioica* tall-herb community). This community occurs in various places from Burton to Heswall. At Burton it is replaced in places by S12 *Typha latifolia* swamp. Upstream of Burton Point there is an extensive freshwater marsh. In front of the Parade at Parkgate this highest zone is dominated by tall herb vegetation, probably a form of MG1 *Arrhenatherum elatius* grassland often composed of patches of different species, e.g. *Calystegia sepium, Epilobium hirsutum, Cyperus longus, Sonchus arvensis* (on drier places) interspersed with other tall herbs, e.g. *Arctium minus*, *Jacobaea vulgaris*, *Cirsium arvense, Urtica dioica, Phalaris arundinacea* and *Rumex crispus*. *Arrhenatherum elatius* is confined to large patches adjacent to the Parkgate Parade but downstream of the Boathouse become larger and by Heswall golf course dominate parts the grassland behind the sea wall. A feature downstream of Parkgate is the abundance of *Atriplex* taxa: *Atriplex prostrata* and *A. littoralis* and hybrids, often forming a distinct zone in the upper marsh. Further downstream at Heswall the

broad zones of *Elymus* x *drucei* are backed by a zone dominated by *Elymus repens* (SM28 *Elymus repens* salt-marsh community). *Elymus athericus* rarely forms a significant zone at the top of the marsh but it dominates a small area behind the sea wall by Heswall golf course.

Between Burton and Neston, the upper marsh zones are characterised by grasslands dominated by *Lolium perenne* with *Trifoium repens* and a little *Potentilla anserina* in damper patches interspersed, perhaps on slightly lower land, with *Elymus* spp. (Fig. 5). The marshes at Burton have been grazed by sheep since the end of the 19th century with up to 1600 animals on the marsh in summer (Booth, 1984). Many fewer are kept on the marsh today (Graham Jones, RSPB, pers. comm.). Elsewhere, as at Parkgate, cattle have been occasionally grazed on the marsh (Collard, 2022) but otherwise the marshes are not grazed. Aerial photographs suggest that the *Lolium perenne* grasslands follow a line of old sand banks.

Figure 5. Burton Marsh looking downstream towards Ness with sheep grazing a *Lolium perenne* pasture. *Bolboschoenus maritimus* in foreground

In north-western England the upper marsh zones, often grazed by sheep, are dominated by SM16 *Festuca rubra* salt-marsh community. This community does not seem to be well developed on the Dee but at Heswall the transition from mid-marsh communities to ones dominated first by *Puccinellia maritima* and then *Festuca rubra* do occur. *Juncus gerardii* is often a constituent of this vegetation. At Burton part of the upper marsh is dominated by *Juncus gerardii* with plentiful *Juncus articulatus*.

At West Kirby the upper parts of the mid-marsh are interspersed with shallow gutters. *Carex extensa* often becomes dominant with *Cochlearia* spp., *Tripolium pannonicum* and, in a strip by the footpath, *Blysmus rufus.* Towards West Kirby in muddier parts of the *Carex extensa* marsh large clumps of *Juncus maritimus* are established. Rodwell (2000) does not recognise a community dominated by *Carex extensa* but notes it can form an important part of SM19 *Blysmus rufus* salt-marsh

community. However, the *Carex extensa* community is adjacent to the zone of *Blysmus rufus* and with the presence of *Juncus maritimus* might be considered a variant of SM18 *Juncus maritimus* salt-marsh community. In the path itself and adjacent grassy areas *Trifolium fragiferum* occurs. Between the pioneer zone of *Spartina anglica* and the wide *Carex extensa* marsh a zone of *Glaux maritima* occurs in more sandy areas at the Hoylake end (possibly a form of SM13 *Puccinellia maritima* salt-marsh community, *Glaux maritima* sub-community). *Parapholis strigosa* is frequent in the upper zones of the marshes but downstream of Heswall often forms a narrow zone at the top of the upper marsh frequently bordering a footpath.

The Dee salt-marshes are notable for several reasons. They are of relatively recent origin having developed since the 1870s. Consequently, it is probable that there was a limited supply of salt-marsh species to colonise the accreting mud flats. The prevailing currents in the estuary are from south to north (Brew & Gardiner, 2022) suggesting sources for the new marshes originated in Wales rather than the remnants on the Mersey estuary or elsewhere. Secondly, the species composition of the mid-marsh zones as described by Marker (1967) and Taylor & Burrows (1968) lack some species that might be expected to be prominent, e.g. *Limonium* spp. and *Artemisia maritima.* Greenwood (2012) describes in more detail the vegetation of salt-marshes in northern Lancashire that might be expected in the Dee estuary. Thirdly, mid to upper marsh communities are dominated by near monocultures of *Bolboschoenus maritimus* and *Elytrigia* x *drucei* (see below). On possibly old sand banks where further accretion has occurred to produce more or less dry land conditions, *Lolium perenne* dominates.

Hoylake Beach

In addition to the Dee marshes salt-marsh vegetation has developed at Hoylake Beach (Fig. 6). Here, the geomorphology and factors encouraging plant growth are different. These are summarised by Brew and Gardiner (2022) who produced a report for Wirral Borough Council in connection with the debate on the future management of the Beach.

Ever since the Rev. Thomas Gisborne found *Catabrosa aquatica* on the beach in 1804 (as documented in the BSBI Distribution data-base: https://database.bsbi.org/) the vegetation has provoked interest and at times controversy. Until the end of the 18th century Hoylake then known as Hoose and Little Meols, was a remote area covered with sand dunes with only a few fishermen living in the area. However, in 1792 the Royal Hotel, now demolished, was built on the dunes and heralded the start of tourism. It was not until the mid-19th century that the town of Hoylake started to be established. Some idea of the beach habitat before any development took place is indicated by a photograph taken looking towards Hilbre Island in about 1885 (Young, undated). This shows a beach backed by sand dunes from which a glaze of presumably freshwater flows over the sand. It is this freshwater irrigation over a gently shelving sandy beach that gives it a special character. Despite the town replacing the sand dunes and a promenade constructed by 1895 the freshwater irrigation continues today.

Until the middle of the 20th century there is little information about vegetation that might have been present on the beach. Often none was present. From the 1950s there has been controversy as vegetation attempted to colonise the beach.

Thus, following concerns over the spread of *Spartina anglica* on the Dee marshes, Hoylake Parks and Foreshore Committee was worried at the spread of *Spartina anglica* on to Hoylake Beach. An article and photograph showing patches of *Spartina anglica* on the beach was published in the *Liverpool Echo* ('Racing grass causes creeping fear'. *Liverpool Echo* 12 November 1960).

Figure 6. Hoylake Beach looking north towards the lifeboat house. *Puccinellia maritima* in foreground, *Honckenya peploides* in middle distance with yellow-flowered *Cotula coronopifolia* beyond. Image: E.L. Greenwood

In recent years sediment accretion has occurred, further raising beach levels with a consequent acceleration of vegetation growth. Brew & Gardiner (2022) identified two plant communities as having become established. Most of the vegetation on a sandy substrate is SM13 *Puccinellia maritima* salt-marsh community with *Tripolium pannonicum, Salicornia* spp. and *Suaeda maritima*. At the West Kirby end the substrate is muddier with tidal pools persisting in places and here SM6

Spartina salt-marsh community tends to become established. Towards the promenade the vegetation becomes more varied with extensive sandy areas supporting sand dune plants, e.g. *Polygonum oxyspermum* subsp. *raii* and *Cakile maritima* whilst in others tall herbs occur including *Rumex crispus* subsp. *uliginosus*. In places where wetter conditions prevail *Bolboschoenus maritimus* is becoming established to form S21 *Scirpus maritimus* swamp.

As a consequence of the freshwater irrigation of the beach, species more characteristic of freshwater habitats occur. In addition to *Catabrosa aquatica* var. *uniflora* notable species include *Trifolium fragiferum, Triglochin palustris, Alopecurus geniculatus, Bidens tripartita* and *Juncus ranarius*. In dryer areas of stabilised sand *Puccinellia distans* is noteworthy whilst the garden escape, *Cotula coronopifolia*, makes a colourful display over much of the mid-marsh communities. By August 2022 over 200 species had been recorded from the beach and more are being found each year. Similar development of coastal vegetation on a sandy beach has been monitored over fifteen years at Ainsdale in north Merseyside (Smith & Lockwood, 2021). Further monitoring of the vegetation and flora of the beach will continue (J. Styles, pers. comm.).

A small salt-marsh (SM6 *Spartina anglica* salt-marsh; SM13 *Puccinellia maritima* salt-marsh community and a small freshwater irrigated marsh dominated by *Phragmites australis*, SM4 *Phragmites australis* swamp and reed-beds) also occurs at New Ferry on the Mersey Estuary.

Sand dunes

Formerly sand dunes lined the Wirral coast from New Brighton to West Kirby. Although sandy areas and relic fixed dunes have survived in several places the dune system has been largely destroyed by urbanisation and the building of sea defences. Most lost species (see below) are dune plants. Nevertheless, a few dunes with wet areas remain especially at Red Rocks between Hoylake and West Kirby. Here the extent of the dunes system has varied in extent but is currently expanding although fronted by developing salt-marsh. A report on the accretion of sand at West Kirby and Hoylake was described by Jemmett & Smith (2000) and points out that the extension of the West Kirby Marine Lake in the 1980s influenced this. Prior to the building of the extension erosion of the Red Rocks sand dunes was a problem (pers. obs.).

A number of typical sand dune plant communities have been identified. Pioneer colonizing communities consisting of SD4 *Elymus farctus* ssp. *boreali-atlanticus* foredune community and SD2 *Honckenya peploides-Cakile maritima* strandline community can be found at Red Rocks and also at Heswall. Also, at both Red Rocks and Heswall SD5 *Leymus arenarius* mobile dune community occurs before extensive areas of the dunes, at Red Rocks especially, are covered with SD6 *Ammophila arenaria* mobile dune community. Much less frequent on more stabilized dunes SD7 *Ammophila arenaria-Festuca rubra* semi-fixed dune community can be found especially towards West Kirby. On some of the more exposed dunes at the West Kirby end of the Red Rocks dunes, more acid conditions prevail and the dunes are tending to support SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland. On the nearby golf course, on mature dunes, patches of SD9 *Ammophila arenaria-Arrhenatherum elatius* dune grassland occur. On more recently formed

dune ridges, SD10 *Carex arenaria* dune community has developed with *Festuca rubra* often abundant (Fig. 7).

Figure 7. Red Rocks looking downstream towards Hoylake. *Ammophila arenaria* covered dunes in foreground; developing salt-marsh beyond. Image: B.D. Greenwood

At Red Rocks an extensive wetland area has developed. This is dominated by S4 *Phragmites australis* swamp and reed beds. Older parts of the marsh are invaded by *Salix cinerea* subsp. *oeleifolia* and *Alnus glutinosa*. In other areas a more mixed tall herb community occurs where there is a large stand of *Rumex hydrolapathum* first recorded in 2002. Open water is present in the winter months with *Ranunculus aquatilis* and *Plantago major* subsp. *intermedia* found on drying mud. At Leasowe, a dune pond has *Rorippa amphibia* and *Stuckenia pectinata*.

Amongst the notable plants still found on sand dune habitats are: *Jasione montana, Hieracium umbellatum, Cynoglossum officinale, Euphorbia paralias, Euphorbia portlandica, Echium vulgare, Coincya monensis* subsp. *monensis, Phleum arenarium, Vulpia fasciculata, Rosa pimpinellifolia*, *Eryngium maritimum, Trifolium striatum, Koeleria macrantha, Ophrys apifera, Anacamptis pyramidalis* and *Blackstonia perfoliata*. In damper areas *Carex divisa, Centaurium pulchellum*, *Dactylorhiza praetermissa, Samolus valerandii* and recently *Pyrola rotundifolia* subsp. *maritima* has appeared at Red Rocks but it is doubtful if it will survive. *Cakile maritima, Salsola kali* and *Polygonum oxyspermum* subsp. *raii* are found on fore dunes.

Following the completion of the sea defence works in 1985 fronting the dunes at Leasowe and Meols *Medicago sativa* subsp. *sativa* was planted as part of dune restoration and this has become abundant.

Clay cliffs and cliff-top grasslands

Between Gayton and Caldy clay cliffs up to 15 m high border the Dee estuary. These are late Devensian glacial deposits with a sequence of sand and gravels interbedded between layers of till (clay). The cliffs provide an unstable habitat and vary between actively eroding and scrub-covered more or less stable cliffs. The totality of the cliffs is possibly in a form of balance between accretion below some cliffs providing stability and erosion providing open habitats. Above the cliffs are grasslands with a few marl pits (ponds) providing freshwater habitats. The whole complex forms the Dee Cliffs SSSI.

Where vegetation develops on unstable cliffs it forms a grassland vegetation referable to MC12 *Festuca arundinacea* grassland, an exclusively coastal plant community found on the south and west coasts of Britain. Coastal clay cliffs are particularly associated with this community. Other grasses found in the community include *Arrhenatherum elatius, Bromus sterilis, Briza media, Lolium perenne* and *Trisetum flavescens. Brachypodium sylvaticum* is also present heralding the development of scrub on more stable cliffs. In more open vegetation *Aira praecox* is present. The herb flora is rich with a range of neutral and calcicole species including *Blackstonia perfoliata, Centaurium erythraea, Picris hieracioides, Geranium sanguineum, Linum catharticum, Genista tinctoria, Jacobaea erucifolia, Dipsacus fullonum* and *Ononis repens. Centaurea nigra* and *Leucanthemum vulgare* are often abundant. Other local species that occur from time to time include the orchids *Ophrys apifera*, *Anacamptis pyramidalis* and *Dactylorhiza purpurella*.

The cliff-top grasslands at Thurstaston and Heswall Fields are MG5 *Cynosurus cristatus – Centaurea nigra* grasslands. They are species rich with few notable species but include *Dactylorhiza praetermissa, Picris hieracioides, Ononis repens, Genista tinctoria, Lotus corniculatus* and *Silaum silaus*. Grasses include *Holcus lanatus, Anthoxanthum odoratum, Dactylis glomerata, Trisetum flavescens, Agrostis stoloniferea* and *A. capillaris. Lolium perenne* occurs rarely.

The stabilised cliff vegetation is composed of W22 *Prunus spinosa – Rubus fruticosa* scrub with few other species present although *Hedera helix* is common. Occasional trees of *Acer pseudoplatanus*, *Crataegus monogyna, Sambucus nigra* and *Quercus* sp. may be found. On some cliffs *Salix cinerea* subsp. *oleifolia* becomes dominant. Cutting through the scrub covered cliffs small streams have formed steep sided ravines with a mixture of *Prunus spinosa* and *Salix cinerea* subsp. *oleifolia* scrub. Their banks are unstable and usually wet but support a number of ferns including *Asplenium scolopendrium* (abundant), *Polystichum setiferum, Dryopteris filix-mas, Dryopteris affinis* and, on dryer parts near the top of the ravine sides, *Dryopteris dilatata*. This assemblage suggests oceanic affinities.

Despite the inherent instability of the cliff habitats floristically there appears to be little change in their composition over the last 200 years.

Bidston Marsh

On the Mersey estuary side of the Wirral peninsula there were formerly three tidal inlets known as Brombrough, Tranmere and Wallasey Pools. It was on these inlets that small salt-marshes occurred with a flora typical of coasts in north west England. Although their flora was poorly documented in the Liverpool floras, species such as *Limonium vulgare* and *Artemisia maritima*, not known on the Dee marshes, were

present. By the middle of the 19th century industrialisation and the building of docks had destroyed much of the former botanical interest.

The largest of the Pools, Wallasey, extended inland from the Mersey estuary for nearly 4 km (three miles) ending in Bidston Marsh or Moss. Into the marsh flowed the River Birket draining Newton Carr (The Langfields), which joined the River Fender before meandering through the marsh to Wallasey Pool. The north side of the marsh was bordered by Wallasey Pastures forming a link between the marsh and the coastal sand dunes. Until the Enclosure Acts of 1809 and particularly 1814 the upper parts of Wallasey Pool, Bidston Marsh and surrounding areas were a wild area of largely natural vegetation and used for light common grazing. The Enclosure Acts initiated the first attempts at drainage but specifically mentioned the need to keep the sand dunes unenclosed as a barrier against flooding from the sea. The Acts also encouraged landowners to plant Starr Grass (*Ammophila arenaria*) to help stabilise the dunes.

Photographs taken in 1902 (Bidston tide mills, Patel, 2016; Fig. 8) show the site of Bidston tide mills, probably located at the junction of Bidston Marsh and Wallasey Pool. They show a tidal *Puccinellia maritima-Festuca rubra* marsh, a habitat favoured by *Cochlearia anglica* var *hortii,* the type locality for which is Wallasey Pool. In the foreground a species rich grassland is shown.

During the 19th century the Rivers Birket and Fender were canalised, railways were built and other activities disturbed the marsh. In particular part of the marsh was used as a municipal tip from 1936 to 1995 and in 1972 the M53/A5139 was built over the marsh on a viaduct. Nevertheless, even today Bidston Marsh has never been fully reclaimed. However, Wallasey Pasture was converted to farmland and later in the 19th century was converted to market gardens where the peaty/sandy soil and mild climate provided a suitable environment for growing salad crops.

During the 19th century and since, the Liverpool floras have documented the flora of Bidston Marsh but unfortunately there are no records for the linking habitat of Wallasey Pastures before enclosure. Since the 1990s and following reclamation of Bidston tip the whole area has been reclaimed as a recreational area with paths and cycle ways. In recognition of its natural history interest and the development of wild areas part of the area has been designated a Local Nature Reserve. In some parts former pastures have reverted to reed swamps. However, there is now sufficient data to attempt an analysis of the floristic changes that have taken place over 200 years.

Since 1994 botanical species lists have been compiled for various sites at Bidston Marsh. The main sites are the Local Nature Reserve (SJ285910), the green corridor behind a retail park (SJ289911), calcareous grassland under the M53/A5139 (SJ289914) and the abandoned dock railway and sidings formerly serving Bidston Dock. Bidston Dock at the inland or western end of Wallasey Pool was built in 1933 and was filled in by 2003. Once built, the uppermost part of Wallasey Pool was left as a much-modified lake, which remains ('fishing lake', Bidston Marsh, 2022, Fig. 9). In addition to these discrete areas the old river channels of the Rivers Birket and Fender remain as mostly reed filled ditches whilst the canalised rivers also become choked with vegetation from time to time. Although most of the area is open to public access, operational railways and much of the reed swamp are inaccessible. To date over 400 species have been recorded from an area of about 2 km^2 (200 ha). Of these 20% are neophytes and archaeophytes. As part of the reclamation works

approximately 7% of the species were planted, mostly native species. This leaves 80% of the flora consisting of native species.

Figure 8. Tidal pools at the junction of Wallasey Pool and Bidston Marsh taken by Mitford Abraham in 1902. The photograph shows a species rich grassland in the foreground with *Puccinellia maritima/Festuca rubra* salt-marsh beyond between the grassland and the pool. This is the likely type habitat for *Cochlearia anglica* var. *hortii* (Greenwood & McAllister, 2022). Image reproduced by courtesy of the Heswall Society.

From the local Floras a total of 59 more notable species was recorded from Bidston Marsh in the 19th century. These included salt-marsh species as presumably the marsh nearest Wallasey Pool was more often inundated by the tide than further inland which remained irrigated by fresh water.

Figure 9. Photograph of the 'fishing lake' Bidston Marsh looking towards the approximate location of the photo taken in 1902 (Figure 8) Image: B.D. Greenwood

Table 1 lists 31 species that were recorded from Bidston Marsh in the 19th century and that have been recorded since 1994. Table 2 records 28 species found in the 19th century but not since 1994 and are presumed lost. Fifteen (55%) of the 'lost' species show at least some tolerance to salt water and are characteristic of brackish or salt-marsh habitats, habitats that no longer exist at Bidston. It is also probably notable that 'lost' species generally favour more nutrient poor substrates than those that are still present. Most of the 'lost' species are typical of fresh water or wet grasslands but two, *Coincya monensis* and *Hordeum secalinum* are more typical of sandy ground. Both are still found nearby at Leasowe. Interestingly although no longer directly influenced by tidal inundation fourteen (45%) of the species still present at Bidston Marsh show some degree of salt tolerance. What is perhaps remarkable is that despite the massive changes over 50% of the former flora remains or has re-colonised the Marsh.

Notable taxa

Wirral is not generally noted nationally for its flora or vegetation, yet a number of notable taxa occur and amongst these some hybrids are especially noteworthy.

Elymus hybrids

On the Dee side of Wirral *E.* x *drucei* dominates extensive areas of salt-marsh. Similar marshes are found on the Lancashire coast and elsewhere but until recently they may have been mis-identified as being dominated by either *E. athericus* or *E. repens* from which the hybrids are not easily distinguished. Herbarium material shows that *E.* x *drucei* was widespread on Lancashire marshes by 1900 with an 1873 record from Waterloo on the Mersey estuary. Both parents are found on the Dee

marshes. *E. athericus* is only found occasionally at the top of marshes or on nearby sandy ground but *E. repens* often forms a distinct zone above the *E.* x *drucei* dominated marsh.

Table 1. Bidston Marsh 19th century plant records seen since 1994 D = De Tabley, 1899; G = Green, 1902. Plant attributes, Ellenberg values: N: Nitrogen, R: Reaction, S: Salt tolerance (Hill *et al.*, 2004)

Species	Record	N	R	S
Anthyllis vulneraria	D	2	7	0
Apium nodiflorum	D	7	7	0
Atriplex littoralis	D	6	7	4
Atriplex prostrata	D	7	7	2
Blackstonia perfoliata	G	2	8	0
Bolboschoenus maritimus	G	7	8	4
Butomus umbellatus	D	7	7	0
Carex riparia	D	7	7	0
Ceratophyllum demersum	G	7	7	1
Conium maculatum	D	8	7	0
Equisetum telmateia	G	6	7	0
Galium palustre	D	4	5	0
Hieracium umbellatum	G	-	-	-
Melilotus albus	D (dock)	4	7	1
Oenanthe crocata	G	7	6	0
Oenanthe fistulosa	G	6	7	0
Oenothera biennis	G	4	6	0
Oenothera glazioviana	G	5	6	0
Ophrys apifera	G	3	8	0
Phragmites australis	G	6	7	2
Pilosella officinarum	G	2	7	0
Puccinellia distans	D	7	7	4
Puccinellia maritima	D	6	7	5
Ranunculus sceleratus	D	8	8	2
Rorippa amphibia	D	8	7	0
Schoenoplectus tabernaemontani	D, G	7	8	3
Sparganium erectum	D	7	7	0
Spergularia marina	D G	7	8	5
Trifolium arvense	G	2	5	1
Trisetum flavescens	D	4	5	0
Zannichellia palustris	D, G	7	8	2
Mean		5.6	6.9	1.3

Table 2. Bidston Marsh 19th century records not seen since 1994 D = De Tabley, 1899; G = Green, 1902. Plant attributes, Ellenberg values: N: Nitrogen, R: Reaction, S: Salt tolerance (Hill *et al.*, 2004)

Species	Record	N	R	S
Apium graveolens	D	7	7	2
Baldellia ranunculoides	D	2	6	0
Carex distans	D	5	7	3
Cochlearia anglica var *hortii*	Boswell, 1875	-	-	*C. anglica* x *C. officinalis* derivative. Salt-marsh
Coincya monensis	G	3	6	0
Hippuris vulgaris	G	4	6	1
Hordeum secalinum	D	6	7	1
Hottonia palustris	D	5	7	0
Hydrochaeris morsus-ranae	D	7	7	0
Juncus gerardii	G	6	7	3
Lepidium coronopus	D	7	7	0
Lysimachia maritima	G	5	7	4
Menyanthes trifoliata	G	3	4	0
Oenanthe lachenalii	G	5	8	3
Ophioglossum vulgatum	D	3	7	0
Parapholis strigosa	D	5	7	5
Petasites hybridus	D	7	7	0
Plantago maritima	G	4	6	3
Rumex hydrolapathum	D	6	7	0
Ranunculus baudotii	D	6	7	4
Ranunculus circinatus	D	7	7	0
Ruppia maritima	G	8	8	4
Sagina nodosa	G	3	7	1
Samolus valerandii	D	5	8	2
Scutellaria galericulata	D	5	6	0
Thalictrum flavum	D	5	7	0
Trifolium fragiferum	D	6	7	2
Tripolium pannonicum	G	6	7	5
Mean		5.1	6.8	1.5

It is not known when *E.* x *drucei* first appeared on the Dee marshes, but it is interesting to speculate that it became prominent only after *Spartina anglica* started to colonise the estuary in 1930 (see above).

On the Dee side the *Elymus* hybrids of *E.* x *laxus* and *E.* x *acuta* also occur. They do not dominate the marsh vegetation to the same extent as *Elymus* x *drucei* but can form significant clumps. They are similarly difficult to identify and are probably under recorded. The parents of both hybrids are found on the Wirral.

Atriplex x *hulmeana*

Dr Barbara Hulme of Liverpool Botanic Garden, Ness, carried out pioneer research on *Atriplex* species (Hulme, 1957). This was developed by Pierre Taschereau who published a series of papers on *Atriplex* hybrids. Amongst these he described *A.* x *hulmeana* named after her (Taschereau, 1989). Although he named the type from a Norfolk specimen, the Dee has a large population of this hybrid. *Atriplex* taxa form significant zones of vegetation in the upper regions of the Dee salt-marshes. The taxa involved are *A.* x *hulmeana* and its parents *A. prostrata* and *A. litorallis. A.* x *hulmeana* is thought to be fertile, which accounts for its frequency in the *Atriplex* zone. Although there are a few records of *A.* x *hulmeana* from Europe it has not been certainly identified from outside of Britain and Ireland (Stace *et al*., 2015). It is suggested by Wilcox (2022) that the hybrid back crosses with both parents.

Salix x *friesiana* (*S. repens x viminalis*)

According to the BSBI database this hybrid was first found at Wallasey in 1982. Despite a large colony surviving a fire in 2018 the hybrid continues to flourish on a number of mature Wallasey dunes. Elsewhere in Britain and Ireland it grows in small quantity at a few sites, especially on sand dunes on the west coast of England (Stace *et al*., 2015). It is particularly abundant on the Sefton coast where it is one of a number of rare hybrids (Smith, 2009, 2021).

Apart from the Sefton coast and Wallasey *S.* x *friesiana* is only found in small quantities, often as single bushes. This is surprising as the hybrid is fertile but plants grown from seed are much more variable than the literature suggests, e.g. Stace *et al*., 2015. It is widespread in temperate Europe.

Equisetum x *meridionale*

Barker (1979) reported what was thought then to be *Equisetum* x *trachyodon* at Red Rocks, as new to the English flora. Jepson *et al*. (2013) demonstrated that the plants at Red Rocks were another hybrid, *Equisetum* x *meridionale* (*Equisetum ramosissimum* x *E. variegatum*). *Equisetum variegatum* has been recorded from the sand dunes between New Brighton and Leasowe since it was reported by Hall (1839). Because some forms of *E. variegatum* and *E.* x *meridionale* are very similar all records and vouchers need checking. Evidence from a survey of specimens at the Natural History Museum, London suggests that records for *E. variegatum* are identification errors. *E. ramosissimum* has not been recorded from Wirral but there is a 19th century record from 'Nr Liverpool' (Rumsey & Spencer, 2012). Early Floras for Liverpool suggest that the authors were aware of at least two forms of '*Equisetum variegatum'*. From their comments one fits the description of *E. variegatum s.s*. According to Hall (1839) Mr Murray of the Botanic Gardens also knew of plants at New Brighton near the 'Rock Fort' that were between three and four feet in length.

Could these have been *E. ramosissimum* or *E.* x *meridionale*? Today E. x *meridionale* occurs at intervals from New Brighton to West Kirby, mostly on sand dunes where it is found on both dry, fixed dunes, where it is difficult to distinguish from *Equisetum variegatum,* and in wet areas or dune slacks. It also occurs in a few urban habitats, formerly sand dunes, close to the shore. Elsewhere in Britain it is recorded from Anglesey and there are voucher specimens for 19th century records from the Sefton coast. Thus, in Wirral it is found, possibly in the absence of both parents, raising issues of its origin.

X*Festulpia hubbardii* (*Festuca rubra x Vulpia fasciculata*)
This intergeneric hybrid was first described in 1974 (Stace and Cotton, 1974) and appears to be endemic to Britain and Ireland. Its distribution is centred along the Irish Sea and English Channel coasts. It has also been found in Scotland. It is a sterile, short-lived perennial but probably spreads vegetatively by pseudovivipary. It was first recorded in Wirral in 1999 at Leasowe and at Red Rocks, West Kirby end, in 2008 (BSBI database). It has not been seen recently, probably because no one has searched for it.

Cochlearia hybrid
The 19th century botanists realised that plants identified in Wirral as *Cochlearia anglica* were different to *C. anglica* plants in southern England. These were named as *C. anglica* var. *hortii* with the type described from plants in Wallasey Pool. Recent work (Greenwood & McAllister, 2022) showed that plants variously named as *C. anglica* or *C. officinalis* were of hybrid origin (*C.* x *hollandica*). *C anglica* has not been found in Wirral and *C. officinalis* only very rarely, possibly only as a casual as there are no old records for *C. officinalis*. The hybrid derivative is morphologically variable but always shows characteristics from both putative parents, *C. anglica* and *C. officinalis*. In particular at least some basal leaves seen in early spring have truncate lamina bases.

Cyperus longus
Cyperus longus (Galingale) was first recorded from the uppermost zone of the Parkgate salt-marsh near the Boathouse in 1997 (BSBI database). Since then it has spread into a large patch. Originally it was thought it might have arrived as a garden escape but there are few garden throw outs in the marsh. Stace (2019) regards it as native to coastal localities in southern England and western Wales but it is widely introduced to inland localities. Often it is impossible to distinguish between native and introduced coastal populations. Its claim to be a native species of the Dee estuary is supported by John Lightfoot's record in the marshes near Harding [Hawarden] in Flintshire on his way to Chester in 1773. The New Cut had been opened in 1733 so that at the time of Lightfoot's visit the marshes between the New Cut and the old shore line were more or less reclaimed for farming but were crossed by drainage ditches. At that time, it is unlikely that *Cyperus longus* had escaped from gardens, although still possible. The implications of the record are discussed further by Wynne (1993).

As a native plant it is scarce and Pearman (1994) suggested it had gone from many coastal sites. More recently presumed native populations are spreading (Preston *et al*., 2002) and it was recorded from the River Conway estuary in

northern Wales in 1946 (BSBI database). It has spread further in Wales since then. It is thought to be largely sterile reproducing through vigorous rhizomatous spread. Its status at Parkgate is therefore uncertain; it could be a garden throw-out or it could have spread from presumed native populations in Wales.

Catabrosa aquatica

A small form of *Catabrosa aquatica* is well-known from freshwater irrigated, gently sloping beaches from north-western England, western and northern Scotland and Ireland. It is distinguished from other forms of *C. aquatica* by having shorter culms, leaves and panicles and one flowered spikelets. It was described by Perring & Sell (1967) based on a specimen, the lectotype, collected by Rev. Thomas Gisborne (1758 – 1846) on 24 August 1804 from sand of the sea shore, Hoylake (**CGE**). Today the plant is named *C. aquatica* var. *uniflora* Gray (Stace, 2019). Its distribution was mapped by Perring (1968) and has been updated on-line on the BSBI database. It is not known outside Britain and Ireland. The Liverpool floras recorded var. *uniflora* at Hoylake, Leasowe and Parkgate (De Tabley, 1899) and on the Lancashire shore at Bootle (Hall, 1839). A recent paper on its occurrence at nearby Hightown was published by Smith (2022).

Catabrosa aquatica flourishes today at Hoylake at spring lines close to the promenade and on the gently sloping freshwater irrigated beach. However, there seemed to be considerable morphological variation and four plants with contrasting morphologies were selected for further examination in July 2022 (Table 3).

Table 3. Morphological variation of Hoylake *Catabrosa aquatica* plants collected July 2022

Character	Plant 1	Plant 2	Plant 3	Plant 4
Leaf length cm	5 – 6	14	4.0	6.0
Panicle length cm	7.0	1.5	3.5	4.5
No of florets	1	2 - 3	1 - 3	1

Plant No 2 was a robust, procumbent to erect plant with two to three florets and would appear to *C. aquatica* s.s. but it seemed to link via intermediates to those on the beach which themselves were variable. The other plants were also procumbent to erect but plant 1 and perhaps 4 equate to var. *uniflora*, whilst plant No 3 was intermediate especially in the number of florets.

In 2020 plants were collected from the beach. These were all small plants and measurements shown in Table 4 suggest all are *C. aquatica* var. *uniflora.*

Table 4. Morphology of *Catabrosa aquatica* plants from Hoylake Beach collected 9 July 2020

Character	Plant 1	Plant 2	Plant 3
Leaf length cm	4.0	6.0	7.0
Panicle length cm	6.6	8.5	7.0
No. of florets	1	1 - 2	1

It is remarkable that this colony of *C. aquatica* has survived despite the establishment of the town of Hoylake on the former sand dunes and the building of the promenade and sea wall. Historically inland of the dunes there was a low-lying area of fen known as Newton Carr or the Langfields, now more or less drained but it was the source of the R. Birket that flowed into Wallasey Pool via Bidston Marsh. The Langfields was a locality for *C. aquatica* s.s. (Green, 1902).

To what extent *C. aquatica* var. *uniflora* is genetically distinct is perhaps questionable; a hesitancy possibly expressed by Cope & Gray (2009). In its typical form and in isolation var. *uniflora* is distinct but given the measurements in Table 3 for Hoylake plants it is suggested that the unusual environmental conditions of freshwater irrigated, gently sloping, sandy beach influences the morphology of this variable species.

Puccinellia rupestris

This is a plant of open habitats on bare mud and clay at the highest parts of salt-marshes and on and behind sea walls. It is found mostly on southern and eastern coasts of England but there is a cluster of old records on the Mersey estuary. It appears that in the second half of the 19th century as the later Liverpool and Birkenhead docks were being built (dates for when individual docks were built are given in Collard, 2022) *P. rupestris* became abundant on recently excavated mud (De Tabley, 1899 and captions to voucher specimens in several herbaria). The records date from about 1860 to 1912. Perhaps more significantly it was found at Leasowe on the north-west coast of Wirral in July 1885, probably in the brackish marsh then located behind the sand dunes (H. Searle, Natural History Museum, London). Few suitable habitats remain and as it is an inconspicuous species, small populations can be easily missed. One suitable habitat remains on Rock Promenade, Rock Ferry where *P. distans* is abundant in cracks on the sea wall. A small number of what is believed to be *P. rupestris* was found in amongst plants of *P. distans* in 2022 (Fig. 10). Rock Promenade and jetty were built in 1836 and are less than a mile from the former Tranmere Pool that was being converted to docks at that time. Although not recorded from Tranmere Pool the habitat available then was similar to that at Wallasey Pool where it was abundant a few years later. The promenade at Rock Ferry has remained more or less unaltered apart from minor repairs from time to time. A species favouring similar habitat, *Bupleurum tenuissimum*, was found at Brombrough Pool in 1903 and Ness in 1910 but it has not been seen since.

Cotula coronopifolia

This species is believed to have been introduced to the gardens at Leasowe Castle by Lady Cust whose family acquired the property in 1821. (Sir Edward Cust, 1st Baronet, 1794 – 1872). It had escaped into nearby marshes and ditches by 1885 (De Tabley, 1899) and today it has spread to several brackish localities in the north-west of Wirral. It forms a conspicuous feature and in places dominates the mid-marsh zones of the freshwater irrigated beach at Hoylake (Fig. 6). It occurs in scattered localities in England with an apparent centre of distribution on either side of the Mersey estuary.

Pyrola rotundifolia subsp. *maritima*

This is a well-known species of sand dune slacks in western Britain from Devon to southern Cumbria. Its occurrence in North Wales has been patchy and was apparently absent for many years (Wynne, 1993). It is a patch-forming, clonal perennial and entirely dependent on mycorrhizal associations yet in recent years it has spread into new sites and sometimes into inland Open Mosaic Habitats. However, at any one site it is often ephemeral disappearing after a few years. It was first recorded at Red Rocks in 2017 but it remains to be seen how long it persists.

Figure 10. *Puccinellia rupestris* gathered in Birkenhead in 1872 by Robert Brown (photo; copyright Natural History Museum, London) (left), and by the author at Rock Promenade, Rock Ferry in 2022 (right). Key characters for the Rock Promenade plant: Inflorescence more or less one sided, short panicle branches remaining erect, Lemma 3 mm, upper leaf margin minutely scabrid, leaves 2 -3 veins on either side of mid-rib

Rumex crispus

Rumex crispus subsp. *crispus* is a ubiquitous and common taxon of ruderal habitats in Britain and Ireland (Akeroyd, 2014). *R. crispus* subsp. *littoreus* is also a common taxon found on shores around the coast of Britain and Ireland and is particularly frequent on strand-lines at the top of beaches and salt-marshes.

In contrast, *R. crispus* subsp. *uliginosus* is a rare taxon of tidal muds and river creeks in southern England, Wales and Ireland. It was recorded on the coast of

northern Wales at Abergele in 2000 (BSBI database) and from tall herb communities at the top of the Parkgate marsh in 2021. Also, in 2021 similar plants were found in wet areas close to the promenade and sea wall at Hoylake beach. These were confirmed as this taxon in 2022 and were growing with *R. crispus* subsp. *crispus*.

These records of *R. crispus* subsp. *uliginosus* are a significant extension of its range northwards, possibly originating from plants in North Wales. Elsewhere it is only known in southern Brittany. Despite its large size and distinctive features, it may well be overlooked and under recorded.

Rumex rupestris

Rumex rupestris (Shore Dock) is one of the rarest dock species being confined to north-western Europe including Britain and Ireland (Ackroyd, 2014). It occupies specialised coastal habitats irrigated by fresh water yet subject to occasional tidal inundation or salt spray (King *et al*., 1999). It therefore shares the same habitat requirements as *Catabrosa aquatica* var. *uniflora*. Its discovery at Hoylake beach in 2021 joins *Catabrosa* in enhancing the interest of this site on the Wirral coast. Its England threat status is vulnerable but its habit of being somewhat ephemeral makes it difficult to safeguard its future at any one site. Its history in Britain is chequered with sites lost to coastal developments or it has disappeared without known reason. Nevertheless, it also appears in new sites, as at Hoylake. However, the nearest known site to Wirral is at Newborough, Anglesey and it is difficult to see how this site could be the source of the Hoylake plants.

Floristic changes

Increasing abundance

Wirral plant records date back to the late 18th century and were published in the first flora of Liverpool (Hall, 1839). These and records published in subsequent floras of Liverpool were summarised in the *Flora of Cheshire* (De Tabley, 1899), which also recorded the coastal flora in sections. Most of De Tabley's work was completed in the 1870s when the Liverpool Naturalists' Field Club started to gather records for the *Flora of Liverpool District* (Green, 1902) with a second edition in 1933 (Green, 1933). Using these and more recent Floras (Newton, 1971, 1990), together with information in the BSBI Distribution database it has been possible to make some assessment of the changes to the coastal flora.

Comparing the records and distribution noted by De Tabley (1899) with present day records the following species have considerably expanded their distribution around the Wirral coast but especially on the Dee estuary: *Atriplex glabriuscula, A. laciniata, A. littoralis, A. portulacoides, A. prostrata, Bolboschoenus maritimus, Cochlearia* hybrid derivative (see above), *Juncus gerardii, Juncus maritimus, Plantago maritima, Ranunculus sceleratus, Spergularia marina, Spergularia media* and *Triglochin maritima.*

In addition to salt-marsh taxa a few other taxa have extended their range. *Allium vineale* is common on Wirral coasts yet the first record, from Hoylake *c.*1850, was doubted by De Tabley (1899) although by 1902 it was recorded by Green (1902) from eight localities. It may have been overlooked but it seems it was more likely a 19th century introduction. *Hippophae rhamnoides* was recorded as a garden escape in the 19th century on both the Mersey and Dee sides of the peninsula (De Tabley, 1899; Green 1902) but it has spread only slowly around the coast. *Leymus*

arenarius was planted at Hoylake from where it has spread along the coast on sandy ground. It is an important early coloniser of mobile dunes at Heswall. *Lycium barbarum* planted at West Kirby has spread slowly in coastal localities. Both these latter two species were recorded by the Liverpool Naturalists' Field Club (1872). *Oenothera biennis* was first recorded from sand dunes at New Brighton (Dickinson, 1851) but only in recent years has it spread more widely, possibly from recent garden escapes. Although *Beta vulgaris* subsp. *maritimus* was first recorded from Brombrough Pool in 1894 it remained rare until recently. It is now common in coastal localities but reasons for its spread are unexplained.

There is some doubt over the status of *Artemisia absinthium* and *Lepidium draba*. Both are introduced species, probably escaped from gardens. There are few records from the 19th century for either species but for *L. draba* there is a definite record from West Kirby in 1883. Today *A. absinthium* is especially abundant at Burton and occurs occasionally elsewhere along the coast. *Lepidium draba* occurs in many coastal localities but is especially abundant on the Dee shore sand dunes between Heswall and Caldy.

Lost Species

Table 5 lists those species that are believed to have been lost to the coastal flora. Most are characteristic species of sand dunes, sandy ground and grasslands near the coast; habitats that have been lost or greatly altered. *Menyanthes trifoliata* was only recorded from a pond amongst railways at Bidston marsh and could have been introduced. The locality is still present but inaccessible.

Table 5. Species considered as lost from the Wirral coastal flora. Plant status: LC: least concern, NT: near threatened, VU: vulnerable, EN: endangered (Stroh *et al.*, 2014). Plant attributes: N: nitrogen, R: reaction (Hill *et al.*, 2004)

Species	Status	N	R	Last record & Comment
Arabis hirsuta	NT	3	8	1987 Wallasey & Leasowe. (Kay, 2015)
Artemisia maritima	NT	6	8	1981 (SJ29)
Botrychium lunaria	VU	2	6	1865 (SJ29)
Bupleurum tenuissimum	VU	4	8	1903 Brombrough Pool (**BM**); Ness 1910 (Green, 1933)
Calystegia soldanella	VU	4	7	*c.*1875 (SJ 28, 29)
Carlina vulgaris	NT	2	7	*c.*1875 Sand dunes
Centaurium littorale	LC	3	8	*c.*1875
Cerastium arvense	NT	3	5	1866 (SJ28)
Dactylorhiza incarnata	LC	2	6	1983 Red Rocks (Kay, 2015)
Eleocharis quinqueflora	LC	2	7	2015? Leasowe Site dominated by coarse vegetation
Eleocharis uniglumis	LC	4	7	3.7.1979 Leasowe Common
Epipactis palustris	NT	3	7	*c.*Wallasey - Leasowe
Equisetum hyemale	LC	6	7	1867 Heswall shore

Equisetum variegatum	LC	3	8	2011 (SJ28) Check re confusion with *E. x meridionale*
Gentianella campestris	EN	3	6	*c.*1875 Sand dunes
Hippuris vulgaris	LC	4	6	1997 (SJ29)
Hottonia palustris	VU	5	7	1861 Bidston Moss (Ecroyd-Smith, 1861)
Hypochaeris glabra	VU	2	4	1837
Lysimachia tenella	LC	3	5	1995 Leasowe
Menyanthes trifoliata	LC	3	4	1933 Bidston Moss
Neottia ovata	LC	5	7	1933 Sand dunes
Parentucellia viscosus	LC	5	7	*c.*1839 Hoylake
Parnassia palustris	VU	3	7	1933 Leasowe
Platanthera bifolia	EN	2	6	1874 (SJ28)
Puccinellia rupestris		5	7	1897 Wallasey (**YRK**); 1898 Leasowe (**BHDL**; Green, 1933). First recorded from Seacombe 1870 (**BIRM**), Birkenhead 1878 (**K**). It was first found on the Lancashire side of the estuary at Bootle in 1860 (**K**)
Ranunculus baudotii	LC	6	7	19.5.1960 Hoylake
Ranunculus circinatus	LC	7	7	1992 Leasowe
Ruppia maritima		8	8	1971 Burton (Kay 2015)
Ruppia spiralis		5	7	Bidston (Hall 1839). Recorded as *R. maritima* but Web thinks it is *R. spiralis* (De Tabley 1899)
Sagina nodosa	VU	3	7	*c.*1875 Several localities
Selaginella selaginoides	LC	2	6	*c.*1875 (SJ29)
Spiranthes spiralis	NT	3	6	1851 Red Noses, New Brighton; *c.*1875 Wallasey – Leasowe?
Trifolium subterraneum	LC	2	4	By 1933, West Kirby, SJ217857 approx. (Green, 1933). See also De Tabley, 1899).
Trifolium suffocatum		2	4	1849 Parkgate (**LIV**) Formerly recorded as T. subteraneum (Kay, 2015)
Viola tricolor dune ecotype	NT	4	6	1924 New Brighton (Kay, 2015) Formerly thought to be *V. curtisii* (Rich & McVeigh, 2019)
Zostera marina	VU	6	8	1851 Hoylake
Mean		3.7	6.5	

Equisetum variegatum was recorded regularly from the sand dunes from New Brighton to West Kirby with the last record in 2011. It is now thought *E. variegatum* records may be errors for the recently discovered *E.* x *meridionale* (see above). More herbarium material needs to be checked. Of the 36 species that appear to have been lost only ten were apparently lost since the 1930s. However, if it is accepted that *Puccinellia rupestris* has been re-found and records for *Equisetum variegatum* are errors for *Equisetum* x *meridionale* then only 34 species have been lost of which nine were lost since the 1930s. In view of the enormous changes to the Wirral coast this seems a remarkably small number. Other studies (Amphlett, 2013; Preston, 2000; Walker, 2003) note that the loss of species in the 20th century was greater than in the 19th and Greenwood (2015) suggested that the loss was accelerating. This study of changes in the Wirral coastal flora suggests the reverse is true for this localised area.

It is also noteworthy that of the lost species approximately half are regarded today as to some degree threatened in England. Presumably they were more sensitive to loss than other species.

New species

Since the publication of De Tabley's Flora (1899) and Green's Floras (1802, 1933) at least 23 taxa have become established in Wirral coastal localities (Table 6). Of these only five are neophytes. *Malva arborea* was planted at Dawpool or Gayton Cottage, Thurstaston (Green, 1903) and it has spread to many localities on the peninsula but mostly on the Dee estuary. *Oenothera glazioviana* was first recorded for the 10 km square SJ29 in 1905 (voucher at the Natural History Museum, London) whilst *Rosa rugosa* was not recorded until 1993 but was surely present before then. It now forms thickets on the Heswall shore and occasionally elsewhere, *e.g*. Leasowe. *Menyanthes trifoliata* was only recorded at Bidston (see above). Of the remaining species *Eleocharis quinqueflora* (first recorded in 1971, now lost) and *Carex divisa* first recorded in 2006 and *Koeleria macrantha* first recorded in 2021 were probably overlooked. There could also have been confusion in recording marsh orchids and it is possible *Dactylorhiza praetermissa* was present before 1933.

All the remaining species probably spread to Wirral by natural means although there is some suggestion that *Crithmum maritimum,* first recorded in 1994 was introduced. For some, e.g. *Raphanus raphanistrum* subsp. *maritimus* first recorded at West Kirby in 1985, now abundant on sandy shores, there is no explanation for its spread (Rees, 2022).

In addition to *Raphanus raphnistrum* subsp. *maritimus,* which was a rare coastal plant in 1900, although it was known to be spreading into the region (Greenwood, 2012), four other notable taxa have spread recently on to Wirral coasts. The first to arrive was *Cyperus longus* in 1997 followed by *Pyrola rotundifolia* subsp. *maritima* in 2017 and the docks *Rumex crispus* subsp. *uliginosus* and *R. rupestris* in 2021. All five species have similar geographical affinities with western Mediterranean and Atlantic coast distributions. Reasons for their spread are not known and it is difficult to speculate on their origin. It is tempting to suggest climate change may be involved but *Cyperus longus* was recorded from the Dee marshes in the 18th century and *Raphanus raphanistrum* subsp. *maritimus* was spreading northwards long before climate change was an issue.

Table 6. Wirral coastal flora: First records post 1900 (* = neophyte). Plant status: LC: least concern, NT: near threatened, VU: vulnerable, EN: endangered (Stroh *et al.*, 2014). Plant attributes: N: nitrogen, R: reaction (Hill *et al.*, 2004).

Species	Status	N	R	Date & Comment
Anthriscus caucalis	LC	5	6	
**Artemisia absinthium*	LC	9	7	1933 Wallasey to Burton
Beta vulgaris subsp. *maritima*	LC	8	7	1894 Brombrough Pool; 1927 Hoylake
Ceratophyllum demersum	LC	7	7	1933 Bidston Moss
Crithmum maritimum	LC	5	7	4.6.1994 Red Rocks – Introduced?
Cyperus longus	LC	5	7	1997 Parkgate
Dactylorhiza praetermissa	LC	3	7	1933 Leasowe (Green, 1933)
Dactylorhiza purpurella	LC	2	7	2015 Lingham, Leasowe
Eleocharis quinqueflora	LC	2	7	1995 Leasowe Probable earlier records but confused with *E. acicularis*
Euphorbia portlandica	LC	3	7	1933 Hoylake
Koeleria macrantha	LC	2	7	2021 Inland dunes, Meols
**Lepidium draba*	-	6	8	1883 (SJ28); 1933 Dawpool
**Lycium barbarum*	-	4	7	1993 West Kirby
Malva arborea	LC	8	7	1933 Dawpool Cottage (=Shore cottage, Thurstaston). Planted?
Menyanthes trifoliata	LC	3	4	1933 Bidston Moss. Only record
**Oenothera glazioviana*	-	5	6	1933 Sand dunes
Pyrola rotundifolia subsp. *maritima*	LC	3	7	4.8.2017 Red Rocks
Raphanus raphanistrum subsp. *maritimus*	LC	5	7	1989 (SJ28)
**Rosa rugosa*	-	3	6	1992 (SJ28)
Rumex crispus subsp. *uliginosus*	-	-	-	2021 (Parkgate & Hoylake)
Senecio erucifolius	LC	5	7	By 1962
Spartina anglica	LC	6	8	1945 Parkgate (McMillan, 1945) or earlier (Green, 1933) & 1931 Stanlow Point or possibly earlier c. 1900 (Massey, 1937)
Spergularia rupicola	LC	5	6	1945 (SJ27)
Mean		4.7	6.8	

It is possible that *Cyperus longus* and the docks have spread from populations in North Wales with rhizome fragments and seed borne on currents flowing from Wales to Wirral and the Merseyside coasts (Brew & Gardiner, 2022). Although, current populations in Wales of these species may or may not be introduced historical records show that the Dee estuary was within the probable former native range of all of them. *Pyrola rotundifolia* subsp. *maritima* has probably spread by wind borne seed from Welsh populations. Although rare and sporadic in occurrence in Wales the prevailing south westerly winds are the most likely vector; similarly, frequent north westerly winds come off the open sea rather than the Sefton coast where *Pyrola* is relatively frequent.

To what extent these newly arrived taxa will become established is doubtful. *Pyrola* and *Rumex rupestris* in particular are notable ephemerals. In contrast to other new species both *Rumex rupestris* (VU) and *Cyperus longus* (NT) are nationally endangered.

Discussion

Wirral coastal habitats comprising salt-marshes, sand dunes, clay cliffs and engineered structures of sea walls, promenades and docks provide a wide variety of habitats for plants. Coastal habitats are unstable and are constantly changing and in Wirral are adjacent to or intermixed with Open Mosaic Habitats on previously developed land formerly known as Post Industrial Habitats, e.g. parts of Bidston Marsh, which are also constantly changing. (Open Mosaic Habitats on previously developed land were added to the UK Biodiversity Action Plan (UK BAP) as a priority habitat listed on Section 41 of the Natural Environment and Rural Communities Act 2006 and revised by Natural England in 2020). Landscapes and habitats in these situations provide an environment for increased biodiversity and richness. Conversely, more stable habitats tend to have less biodiversity and richness unless of ancient origin. Crawford (2008) discussed these ideas with specific reference to northern and arctic floras, where climate warming is producing major changes. Similarly, Bradshaw (1999) discussed the processes and opportunities for plants in urban wastelands and Open Mosaic Habitats of the Mersey Basin.

Whilst many of the landscape changes are either directly or indirectly anthropogenic in origin, there are also more underlying natural factors involved. The changes in vegetation in north-west England during the Flandrian stage are described by Tooley (1978) and more specifically for the Mersey Basin by Plater *et al*. (1999). Still, before large-scale human intervention the Mourholme Local History Society (1998) citing Marshall (1967) reported William Stout's account of erosion and accretion of salt-marshes in Morecambe Bay in the 17th century.

These constant changes to the coast cause both destruction and opportunities for plants. As Crawford (2008) pointed out, plants have evolved a dynamic relationship with disturbance both by physical forces and herbivory and therefore it should not be surprising that a lack of disturbance can lead to a reduced species richness.

On the Wirral coast the opportunities for new species to appear as the salt-marshes and sand dunes developed has been reflected in the appearance of taxa new to the area, e.g. *Elymus* x *drucei* or *Rumex crispus* subsp. *uliginosus,* notwithstanding the acceleration of vegetation development following the planting of

Spartina anglica. Nevertheless, such changes could not have taken place if there had not been an ongoing tendency for sediment accretion on most, but not all, parts of the coast. These opportunities were given further impetus by the development of new Open Mosaic Habitats. Here, a few alien plants have taken the opportunity to become established, e.g the spectacular *Dipsacus laciniatus* (Fig. 11).

Figure 11. *Dipsacus laciniatus*. The author recording one of the more spectacular recent arrivals at Bidston Marsh. Image: B.D. Greenwood

In some places, habitat destruction has been total. The more nutrient poor sand dunes and pastures were destroyed before 1900 and it is species of these habitats that have been lost, accounting for most losses over the last 200 years. It is perhaps the resilience of the native flora despite the changes that is more remarkable with 80% of the native flora of Bidston Marsh surviving or re-appearing again after possibly having been lost for a period in the intervening years. Plants can be opportunists and the history of *Puccinellia rupestris* illustrates this. Historically it was mostly found in a 50-year period coinciding with the development of the docks on both sides of the Mersey Estuary. Its habitat was often found on the drying mud extracted from the estuary as the docks were formed. In this habitat it often became

abundant. It is easily overlooked so perhaps it was not recognised before 1870 or after 1911 when its preferred habitat of drying estuarine mud and disturbed areas on or behind sea walls became rare or were lost. It was probably always rare but its possible survival at Rock Promenade, Rock Ferry is remarkable.

Both the coastal and Open Mosaic Habitats provide the conditions for the mixing of taxa and the creation of hybrids facilitating gene flow (Crawford, 2008). The abundance of hybrids on the Sefton coast has been known for many years and Smith (2008) pointed out that 111 hybrids had been recorded for the sand dune system. A number of these were rare and/or well established. Similarly, on the Wirral coast there are a number of important hybrids and hybrid derivatives. Perhaps the best known is *Spartina anglica*, an allopolyploid derived from *Spartina* x *townsendii*, the hybrid between the native *Spartina maritima* and the introduced North American *Spartina alterniflora*, which arose in Southampton Water after the latter's introduction (Stace *et al*., 2015). By a similar process *Centaurium intermedium*, first described in 1897 but not recognised as a distinct species until 1976 (Rich & McVeigh, 2019), was found at Bidston in 2000. It is derived from the hybrid between *C. erythraea* and *C. littorale* and so far, is only known from the Sefton, Lancashire and Wirral coasts. Both parents are native species so what factors have been involved in the apparent recent creation of this new species? And what agencies were involved in *C. intermedium* colonizing a Wirral railway only abandoned about 1989 (Maund, 2009)?

More remarkable is the presence of *Equisetum* x *meridionale*, only known in Britain from North Wales and the Sefton coast apart from Wirral, yet it is widespread in Europe. Neither parent has been confirmed from Wirral (old records for *E. variegatum* have so far proved to be the hybrid). Is this an ancient hybrid or is it of more recent origin in Wirral?

Amongst the fertile hybrids behaving as species are *Salix* x *friesiana* and the *Cochlearia* x *hollandica* derivative. Both are fertile but apart from Wirral and one or two other localities *Salix* x *friesiana* is confined in the UK to the Sefton coast. It was first found in 1939 but it is widespread in temperate Europe (Stace *et al*., 2015), so why is it more frequent in Sefton and to a lesser extent in Wirral than elsewhere in Britain? On the other hand, the *Cochlearia* x *hollandica* derivative is probably widespread in north-western Europe (Greenwood & McAllister, 2022).

The sterile hybrid *Elymus* x *drucei* is remarkable for its abundance on the coasts of north-western England. Although known from early in the 20th century it was not correctly named until 2001 (Stace, 2001). Today it occurs around many coasts of Britain and western Europe and occasionally inland.

The instability of coastal and Open Mosaic Habitats gives opportunities for new plants to migrate and colonize open habitats and for mixing of species. It allows for constant change and diversity but they are marginal habitats and subject to sudden or catastrophic change and destruction by natural or anthropogenic causes that might cause local extinctions. It is not known if any local extinctions were caused by natural events in Wirral but the loss of many sand dunes plants can be attributed to urbanisation and associated works. Elsewhere the loss of *Corallorhiza trifida* at Tentsmuir National Nature Reserve (Crawford, 2008) by storms is well documented. However, many plant taxa are more resilient than is perhaps generally appreciated and are able to adapt to change and ensure their survival. All these are features demonstrated in this study of Wirral's changing coastal flora.

Acknowledgements
My thanks are due to Prof. Rob Marrs and Barbara Greenwood for help and advice in preparing this paper. I am also grateful to Dr Hilary Ash for information on the landscaping works at Bidston Marsh and for plant records. Also, to members of Wirral Wildlife, Josh Styles and Robert Freeth for plant records. I also thank the curators of herbaria for access to their collections, especially World Museum, Liverpool and the Natural History Museum, London. Herbaria@home (http://herbariaunited.org/atHome/) provided invaluable data on-line of voucher specimens available in herbaria across the country.

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ISSN: 2632-4970

https://doi.org/10.33928/bib.2023.05.030