HURST CASTLE SPIT

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Introduction

Hurst Castle Spit extends the shingle fringing beaches at the eastern end of Christchurch Bay across the western arm of the Solent (see Figure 6.2 for general location). Its seaward end is marked by Hurst Castle, constructed in the mid-16th century, and threatened from time to time by erosion since the mid-19th century. The spit protects Keyhaven Marshes (see separate GCR site report in Chapter 10 of the present volume).

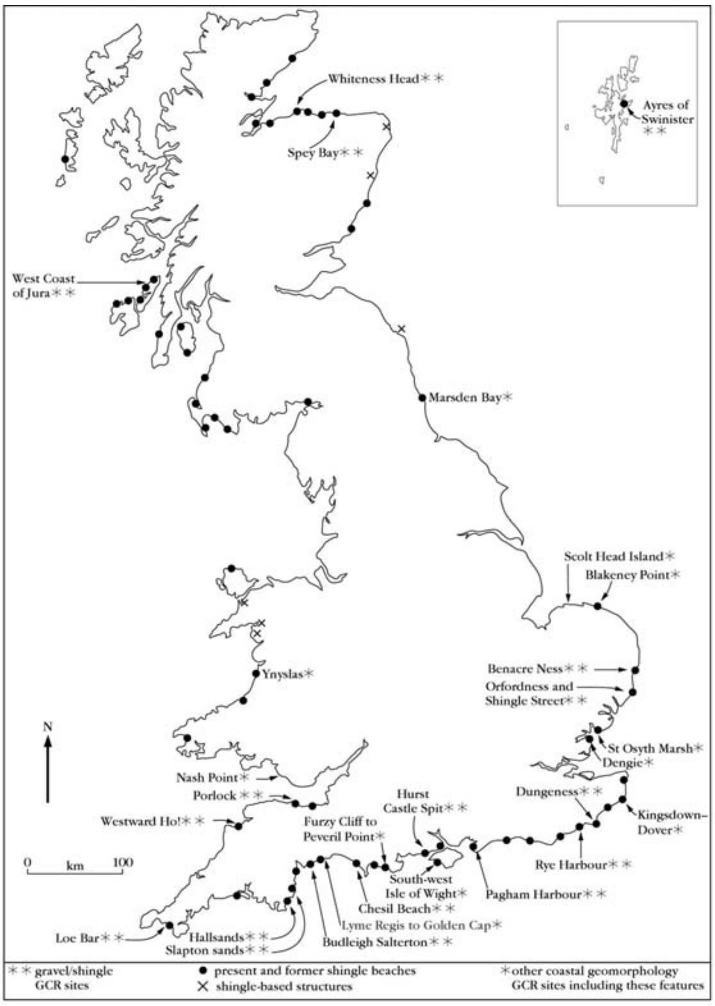

Figure 6.2: Coastal shingle and gravel structures around Britain, showing the location of the sites selected for the GCR specifically for gravel/shingle coast features, and some of the other larger gravel structures.

Following the seminal paper of Lewis (1931) in which he argued that beaches align themselves at right angles to the direction of approach of dominant waves, Hurst Castle Spit is often used as an example of a multi-recurved spit (Johnson, 1919; Wooldridge and Morgan, 1937; Steers, 1946a; Sparks, 1960; Bird, 1968; King, 1972b; Komar, 1976; Bird and Schwartz, 1985). King and McCullagh (1971) used Hurst Castle Spit as the basis for an early computer model – 'Spitsim'). More recently, Clark and Small (1967), Clark (1974), Nicholls (1984, 1985) and Nicholls and Webber (1987a–c, 1989) re-examined its features. Nicholls and Webber suggest that this is not a complex recurved spit, but owes its detailed form to variations in local sediment supply and to changes in sea level that had not been considered in previous work.

During the winter of 1989–1990 the whole ridge was overtopped and moved inland by up to 80 m. The risk to the recently completed coast protection works at Keyhaven and Lymington, the ecologically important saltmarsh behind the ridge and low-lying residential areas from flooding was judged to be so severe that major coast protection works were put in place during the late summer and autumn of 1996. 120 000 tonnes of imported Norwegian rock (with boulders up to 1.5 m across) were placed along a 550 m-long section of the proximal end of the spit. 500 000 tonnes of shingle dredged from the Shingles Bank were placed along the remaining length of the barrier beach to double its width and raise it to a height of 7 m (see Figure6.21). A rock revetment 100 m in length was constructed to protect the western wing of Hurst Castle and regrettably shingle was excavated from the most recent distal recurves to be placed along the remainder of the frontage of the castle. As a result, despite the recognition of the importance of this GCR site, much of its natural interest has been removed. Although much weakened at its proximal end by erosion combined with a reduction in the littoral supply of shingle as a result of coast protection works, the spit nevertheless retains its characteristic form.

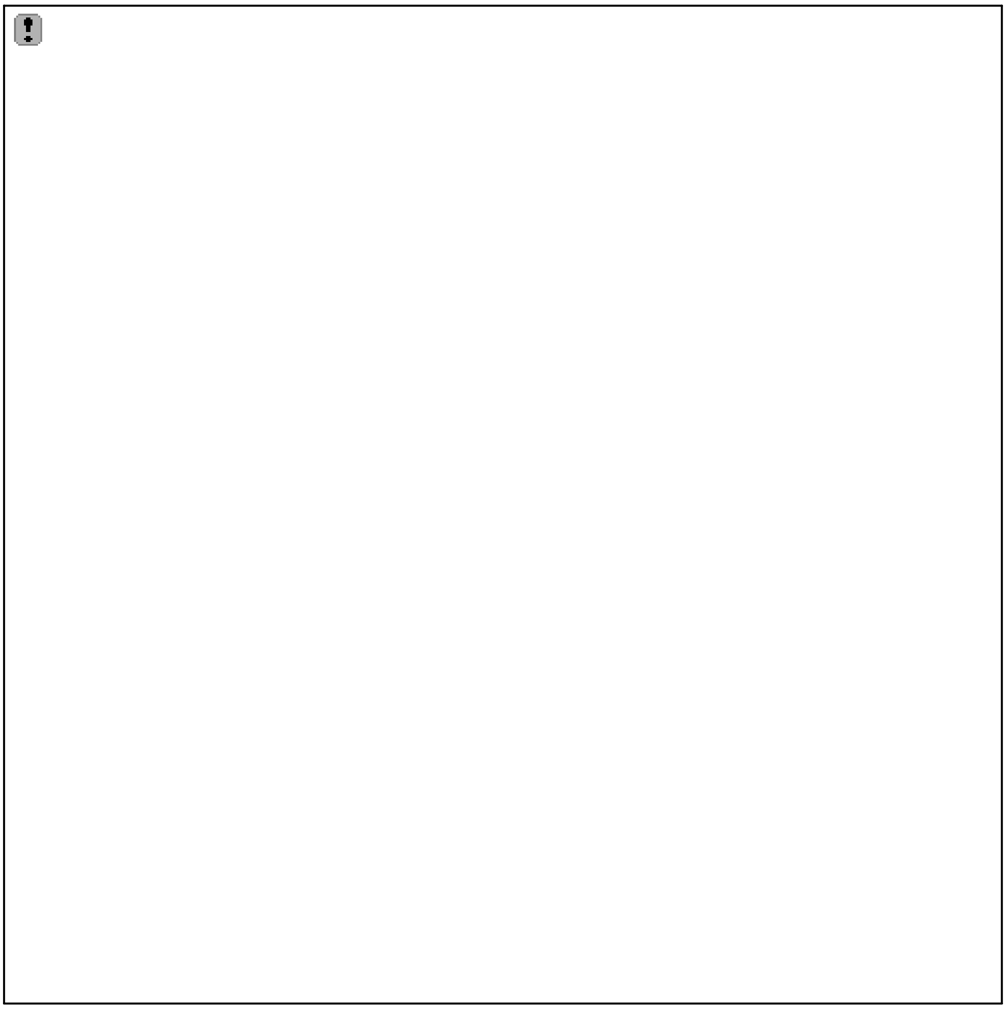

Figure 6.21: (a) Changes in the profile of Hurst Castle Spit. (After Nicholls and Webber, 1987a.) (b) 1996 coast protection works at Hurst Castle Spit. The pecked line in (b) delimits the saltmarsh edge.

Description

The natural spit had two main parts (Figure 6.20):

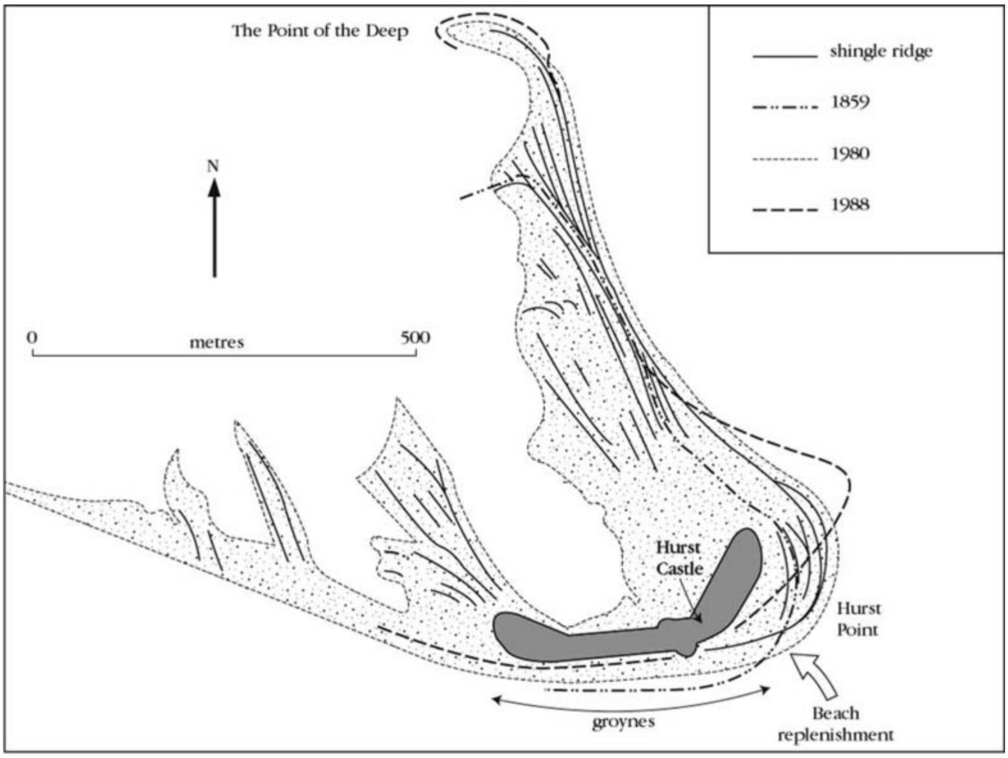

Figure 6.20: Distal recurves at Hurst Castle Spit – the history of geomorphological development. (After Nicholls and Webber, 1987a.)

1. Hurst Beach, a single transgressive shingle ridge orientated towards the dominant south-westerly waves of Christchurch Bay. Along much of its inner length, the shingle rests upon saltmarsh and earlier gravels which are occasionally exposed on the foreshore. Its maximum height varies between 3 m and 5 m OD. The direction and energy distribution of the waves approaching the beach is affected by both the Isle of Wight and a shallow offshore shingle shoal, known as the 'Shingles Bank'.

2. An active recurve, behind which are three groups of preserved recurves, which may pre-date the construction of Hurst Castle (AD 1541–1544). The recurves are aligned towards the dominant north-easterly waves of the western Solent.

The beach is formed mainly of subangular to subrounded flint pebbles with subsidiary fine- to medium-grained sand, derived from the erosion of Pleistocene sandy gravels farther to the west. Net littoral drift is towards the east, although much of the sand is lost offshore.Nicholls and Webber (1987a) reported a littoral sediment transport sub-cell boundary at Hordle Cliff to the west. This, they believed, means that the spit is much more dependent upon local sources of sediment than earlier writers had supposed. At Hurst Point, much of the shingle is lost offshore into Christchurch Bay or the western Solent. The nearshore slope is steep and tidal energy in the western Solent is high, the tidal streams between Hurst Point and the Isle of Wight attaining 2.3 m s^{-1} at spring tides and so capable of moving small shingle.Dyer (1970) reported that much of the material forming the Shingles Bank is similar in composition to that forming Hurst Beach and most writers agree that it is likely that much of the sediment lost from Hurst Point reaches the Shingles Bank.

The shingle ridges forming the recurves are generally about 1 m lower in altitude than the transgressive Hurst Beach and the present active recurve, except over the last 100 m at its distal end. Within the main area of shingle north of Hurst Castle it is still possible to identify two strongly recurved distal ridges, which suggest that this area includes at least three ridge groups. The innermost of these must pre-date the construction of the castle, and the second may pre-date the extension of the castle between 1861 and 1873. The second group of ridges are not continuous, having been removed in their central section by erosion. At present the active recurve appears to be marked by zones of accretion at Hurst Point and its distal end with a zone of erosion between them (Figures 6.20 and 6.21).

The landward end of the spit was most recently armoured by boulders in 1996 and both beach replenishment and reshaping of the ridge have been adopted as measures to prevent breaching of the ridge. The beach fronting the castle has been subject to considerable erosion and the foundations of the outer works of the castle have been undermined. A series of groynes had been in place for several decades, but these had decayed badly and were renewed by English Heritage during the late 1980s together with a programme of beach replenishment using shingle from the zone of accretion at Hurst Point. Further replenishment was needed by 1996.

The natural spit was affected by several processes. Hurst Beach is transgressive (Figure6.21), moving over the saltmarsh and Pleistocene gravels, which were reworked, providing a local source of shingle. The transgressive ridge is affected by overwashing and seepages, both of which can lower the ridge crest. Some shingle is moved along the spit with littoral drift increasing towards Hurst Point where it attains a maximum of 15 000 $m^3 a^{-1}$ for the shingle fraction alone (Bray *et al.*, 1992). Shingle is moved seawards from Hurst Point onto the Shingles Bank, which, as it changes shape and height, affects the wave energy distribution along Hurst Beach (Nicholls and Webber, 1989). North of Hurst Point, the active recurve continues to grow towards the Point of the Deep, but this appears to be at the expense of the central part of the active recurve.

The spit protects a large area of saltmarshes, known as 'Keyhaven Marshes' (see separate GCR site report in Chapter 10 of the present volume) which are drained by an intricate pattern of creeks dominated by three major creeks: Mount Lake, alongside the spit, Keyhaven Lake and Hawkers Lake. The first two merge and drain into the Solent after being diverted by the modern recurves of the spit. Active marsh-edge beaches (cheniers) are formed mainly of shells and shingle with a low sand content. Much of the saltmarsh edge is being eroded rapidly, resulting in patches of unvegetated mud. The surface of the marshes is characterized by a high proportion of eroded marsh, pans, and broad channels. There are only small areas of higher-level, species-rich saltmarsh, located mainly close to the spit and on its older recurves. Sea purslane *Atriplex portulacoides*, common sea-lavender *Limonium vulgare*, sea plantain *Plantago maritima*, sea meadowgrass *Puccinellia maritima*, annual sea-blite *Suaeda maritima*, samphire *Salicornia* spp., and sea aster *Aster tripolium* are common throughout these higher marshes. In contrast, the lower more extensive marshes are species-poor and dominated by common cord-grass *Spartina anglica*. The intertidal area close to the spit is often a stony mud (see GCR site report for Keyhaven Marsh in Chapter 10).

Before the late 19th century, much of this marsh lay as much as 1 m lower and was dominated by eel grass *Zostera*. Colonization by *Spartina anglica* following its hybridization from the native *Spartina maritima* and the introduced *Spartina alterniflora* in Southampton Water led to a rapid build-up of the saltmarsh surface. The area of *Spartina*-dominated saltmarsh reached a maximum about 1930, after which the area declined. As the recurves of the modern spit have extended into the westernmost creek, they have increased local accretion of mudflats.

Interpretation

Ward commented (1922, p. 114) that 'for many centuries, the spit has in size and position suffered no substantial permanent change, so that accretions of fresh shingle must, now that the period of growth is over, be balanced by wastage from the spit... '. Both the history and the future development of Hurst Castle Spit depend upon the balance of sediment supply and loss. Lewis (1931, 1938) showed that the main ridge was aligned at right angles to the direction from which storm waves approach along the English Channel with a fetch extending across the Atlantic Ocean from where the strongest winds and waves also come. The recurves face the waves from the north-east along the Solent. Lewis suggested that the spit grew towards the south-east as shingle was moved by oblique waves alongshore from the eroding coastline of Christchurch Bay. Large waves from the direction of maximum fetch would build up the main part of the ridge. Constructive waves would build the beach up to high tide level and storm waves would deposit shingle onto the crest of the ridge, building it above the reach of normal waves. Storm waves would also comb shingle down onto the lower beach. Constructive waves following the storm would push shingle up the beach. The result of this combined wave action would be a gradually consolidated spit probably moving slowly towards the north-east. Lewis considered that, as the spit curved more towards the east and the angle of waves to the beach changed, the rate of drift would increase. Shingle would move rapidly around Hurst Point, but travel more slowly along the recurves. As water depth increased, more shingle would have been required to extend the spit. Refracted waves would move some shingle along the recurves, while north-east waves in the Solent with their longer fetch could build up the ridges. The distinctive sharp angle at Hurst Point (Figure 6.22) is the result of the main ridge-building waves being restricted by the shelter of the Isle of Wight to two main directions, the south-west and the north-east.

Figure 6.22: Aerial photo of Hurst Castle spit. 1. Distal end of modern beach; 2. Groynes protecting Henrician (16th century) castle; 3. and 4. earlier recurves; 5. saltmarsh – the seaward edge of saltmarsh is undergoing retreat; 6. Spartina anglica-dominated saltmarsh, declining in area; 7. coastal defences at Keyhaven; 8. most commonly overtopped and artificially rebuilt section of beach ridge; 9. waves approaching from south-west. For discussion of the saltmarsh features, see GCR site report in Chapter 10 for Keyhaven Marsh. (Photo: courtesy Cambridge University Collection of Aerial Photographs, Crown Copyright, Great Scotland Yard.)

The role of tidal streams was thought by Lewis 1931 to be very small, though affecting wave height and the angle of wave approach to the beach. He concluded that the tidal role in the growth of the spit was negligible. This was contradicted byWilliams (1960) who claimed that the effect of east–west tidal streams in Christchurch Bay could explain the eastward growth of the spit. Clark and Small (1967) concluded from a drifter study in Christchurch Bay that seabed movements of shingle could occur in depths as great as 20 m both directly onto the spit and across the floor of the bay towards Mudeford, from where they could move alongshore back towards Hurst Castle. King (1968b) and King and McCullagh (1971) followed Lewis' (1931, 1938) hypothesis for the growth and shape of the spit in their development of a computer model to simulate the effects of different wave directions, refraction and increases in the depth of water. Clark (1974) questioned whether the spit was either a complex recurved spit, as had been commonly accepted, or merely a storm beach resting on the edge of one of the partially submerged former terraces of the Solent River (Everard, 1954). Nicholls (1984, 1985) and Nicholls and Webber (1987a–c, 1989) reviewed the history and present development of Hurst Castle Spit arguing that previous models of its evolution emphasized longshore growth at the expense of other factors, especially changes of sea level. The submergence of a Pleistocene valley system along the line of the present-day western Solent brought about a major transformation of Christchurch Bay from a low to a high tidal energy environment. The Shingles Bank was particularly important because, in refracting waves crossing it, it influenced wave energy along Hurst Beach. However, the date of its formation remains unclear. If it acts as a sink for shingle from the spit then it may be relatively recent. Substantial local supplies of sediment were also available from Pleistocene sandy gravels, which lie both in the cliffs at Milford and beneath the root of the spit.

Nicholls and Webber (1987b) suggested that the second youngest recurve formed during a possible period of sea-level still-stand between about 4500 years BP to 3000 years BP (West, 1980; Devoy, 1982; Nicholls and Clark, 1986). Nicholls and Webber (1989) acknowledge that sub-shingle sediment compaction may be important in affecting ridge height and follow Lewis (1931, 1938), Lewis and Balchin (1940: at Dungeness) and Carr (1970: at Orfordness) in their interpretation of increasing height with decreasing age of ridges as indications of a rising sea level.

On Hurst Beach, there are two types of overwashing: crest-maintaining overwashing and throat-confined overwashing (Nicholls and Webber, 1989). The backslope of the beach ridge is affected by collapse features associated with seepage, but this does not appear to affect the development of washover throats as has been reported elsewhere (Eddison, 1983b; Carter *et al.*, 1984). Nevertheless, the washover throats are significant forms. The landward movement of shingle during a single storm was estimated by Nicholls and Webber (1989) as twenty-five times greater in throat-overwashing than in crest-maintaining overwashing. Washover throats have been observed to have a preferred longshore spacing, and wave run-up has exhibited regularly-spaced maxima along the shore, implying edge waves or some similar effect.

The present-day processes described by Nicholls and Webber at Hurst Castle Spit suggest that much of the spit should be regarded as a barrier beach rather than as a spit in the traditional sense, because it has not arisen simply as a result of longshore transport. Nevertheless, the alignment of the transgressive beach and the recurves depend upon the two different sets of dominant waves from the south-west and the north-east, as described by Lewis. Sediment was derived from erosion of the shore to the west. The present-day reduction in littoral drift is partly a result of the protection of the coastline at Milford and the construction of groynes. Longshore input of sediment has now been reduced and some beach replenishment has been undertaken. Beach nourishment will have to be repeated in the future, as the decision to protect Hurst Castle itself requires stabilization of that part of the beach. Much of the surface of the shingle has been disturbed and the recurves have been damaged by vehicles. Parts have been affected by the various phases of castle and lighthouse construction. The interpretation of the history of the spit during the Holocene Epoch will depend upon investigation of the recurves, and considerable care will need to be taken to avoid further damage. The main ridge is now almost entirely managed, but provides an interesting situation for case-studies of the effects of diminished littoral transport, and barrier management by beach replenishment and rock armouring.

Conclusions

Although Hurst Castle Spit is commonly regarded as a classic example of a complex recurved spit, recent work suggests that it was initiated in response to a combination of processes, among which a rise in sea level appears to have been most important. It may thus be better interpreted as a form of barrier beach. It is nevertheless a very important site because of its seminal role in coastal studies and its simplicity of form when compared to other shingle beach sites such as Orfordness and Dungeness. Its place in coastal studies rests upon the classic studies of Lewis (1931, 1938). The revised model of Nicholls and Webber is a development of earlier work and offers a basis for understanding of other shingle beaches. Studies of the detailed forms and processes on Hurst Beach have brought about a better understanding of shingle beach development. Hurst Castle Spit, Orfordness and Dungeness each display different aspects of shingle spit and barrier beach development, but the similarities of ridge patterns and their relationships to sea-level variations make them a unique suite of sites in Europe. The spit provides shelter for the intricate system of creeks in the very important Keyhaven saltmarshes where *Zostera*-dominated marshes have been colonized by *Spartina anglica*. The site forms part of a Ramsar site and both an SAC and an SPA.

The spit's present-day largely artificial form provides an opportunity to analyse changes from a natural feature to a mainly anthropogenically influenced landform, and research into its re-establishment of equilibrium conditions will be of significant interest, particularly when compared with the formerly managed Porlock GCR site.

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