# GOSWICK - HOLY ISLAND - BUDLE BAY

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## Introduction

The Holy Island GCR site (see Figure 10.1 for general location) includes one of the largest sandy beaches on the coastline of England and Wales. About 25% of the coastline between Edinburgh and Whitby is formed by predominantly sandy beaches (European Commission, 1998). To the north of Holy Island, the coast is predominantly cliffed, whereas to the south, hard-rock cliffs alternate with small sand beaches backed by narrow lines of dunes. The largest of these beaches is at Druridge Bay, but it lacks any substantial geomorphological interest, other than the effects of the removal of sand from its foreshore between 1960 and 1996.

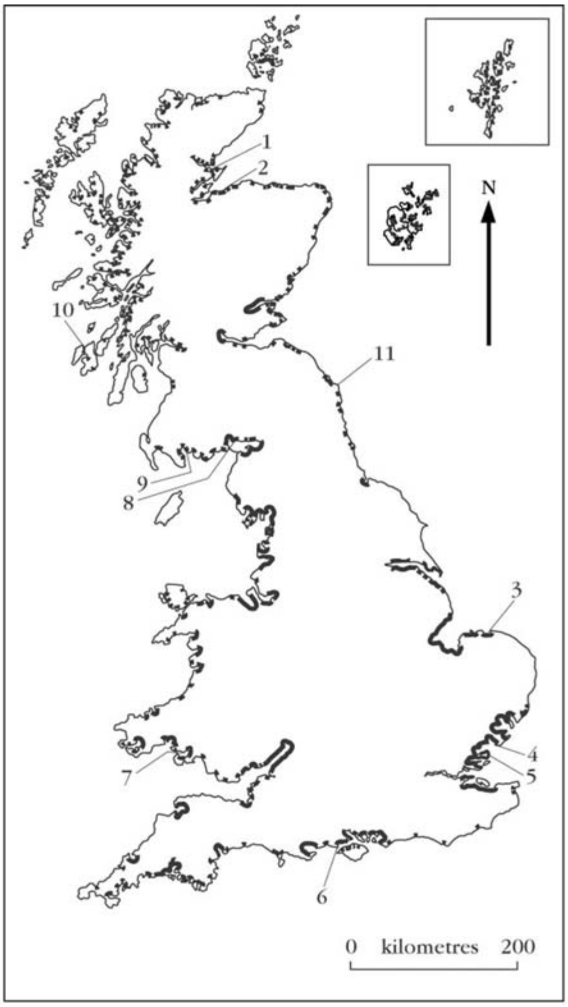


*Figure 10.1: The generalized distribution of active saltmarshes in Great Britain. Key to GCR sites described in the present chapter or Chapter 11 (coastal assemblage GCR sites): 1. Morrich More; 2. Culbin; 3. North Norfolk Coast; 4. St Osyth Marsh; 5. Dengie Marsh; 6. Keyhaven Marsh, Hurst Castle; 7. Burry Inlet, Carmarthen Bay; 8. Solway Firth, North and South shores; 9. Solway Firth, Cree Estuary; 10. Loch Gruinart, Islay, 11. Holy Island. (After Pye and French, 1993.)*

Holy Island forms part of a suite of large sandy beach and dune systems along the British east coast that include the north Norfolk coast, Gibraltar Point, Lincolnshire, and the Sands of Forvie, and Rattray Head in Scotland. Similar to other English beaches, it is relatively narrow in comparison to larger Scottish dune systems such as the Sands of Forvie and the much more extensive beach–dune systems of the west coast. Unlike all except Rattray Head, its outline is controlled by the presence of major rocky outcrops that act as hinge points for sediment deposition and beach development. It lacks large amounts of gravel, although parts of the dunes lie upon a gravel base. It is dominated by progradation and there has been no interference with coastal processes by protection works and its relative remoteness has restricted pressures from recreation.

Geomorphological interest in the site has been comparatively limited, although Steers (1946a) drew attention to its considerable potential for research, and Carruthers *et al*. (1927) described the main features of the site. More recently, Robertson (1955) described the main ecological features of part of the site at Ross Links; Farquhar (1967) identified it as a key locality for tied island development; and King (1976) outlined its main geomorphological features. None of these later workers considered the site as a unit, though this is how Steers (1946a) described it. The description and discussion that follow regard the site as a single complex entity.

## Description

A key area for coastal geomorphology, the Holy Island GCR site comprises three main units (Figure 11.23):

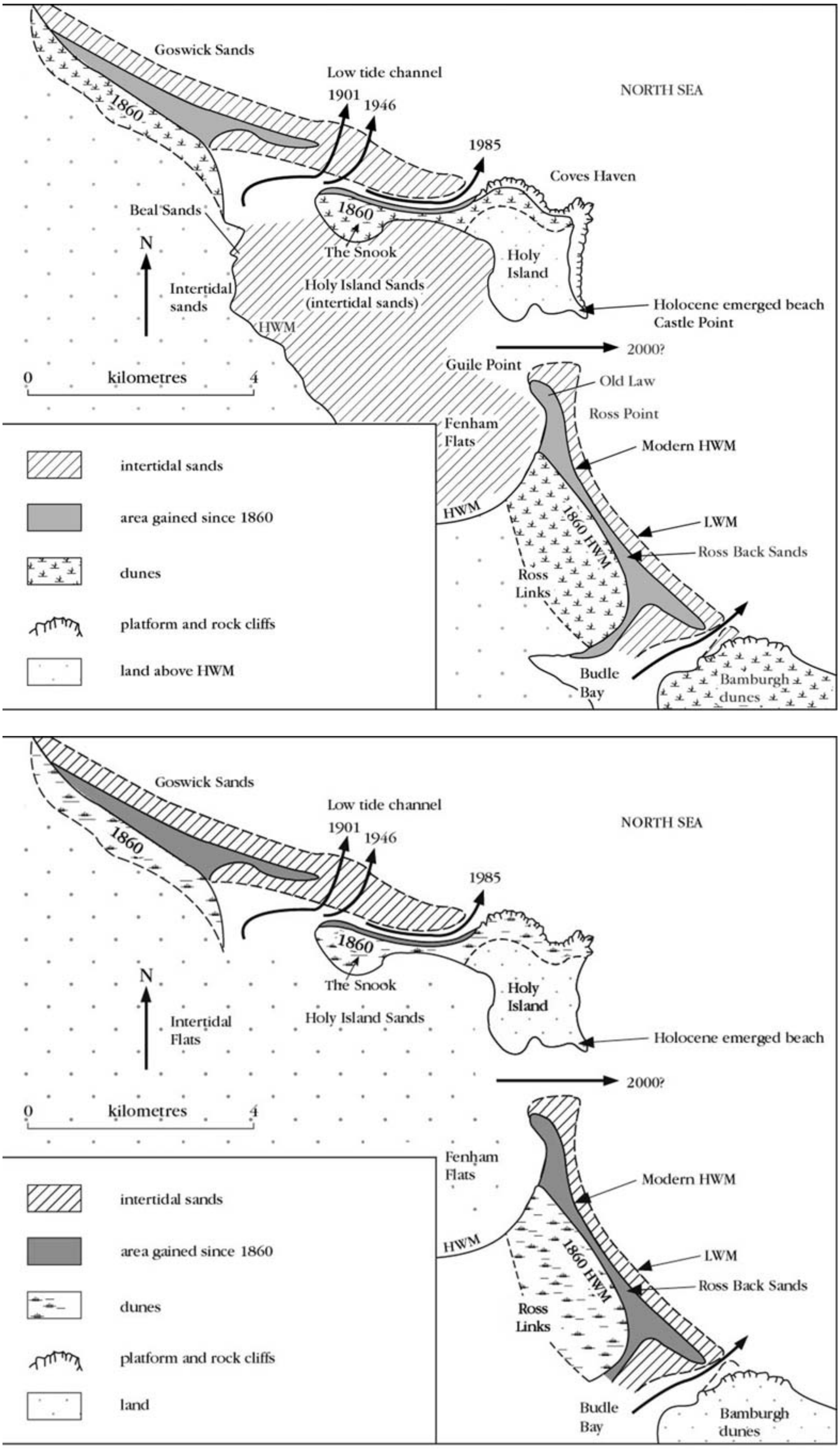


*Figure 11.23: Sketch map of the key geomorphological and historical changes to Holy Island. Bold arrows show the dates of the main channels draining estuaries.*

1. the dunes and the barrier beaches of Cheswick and Goswick Sands,

2. the dunes of the Snook and the cliff-top dunes and cliff–beach system on the north coast of Holy Island, and

3. the dunes and sandy beaches of Ross Links and Budle Bay.

In addition, there are hard-rock cliffs, an emerged (‘raised') Holocene beach, saltmarsh and intertidal sandflats and mudflats. The site extends for about 20 km from Far Skerr in the north (NU 035 481) to Bamburgh in the south (NU 171 362). In the north, a predominantly sandy beach and dunes extend south-eastwards across Cheswick and Goswick Sands diverting eastwards the northern channel of the intertidal flats that lie between Holy Island and the mainland. The central part of the site is dominated by Holy Island whose eastern cliffs, cut into limestone and shales, provide the only erosion-resistant feature in the central part of this large site. Holy Island extends westwards in a large dune area known as ‘the Snook'. South of Holy Island the main tidal inlet divides the rocky southern shore of the island from the northern sandy beaches of Ross Links. The plan form of Ross Links results from the wave refraction and energy distribution between Holy Island and Bamburgh. A prograding sandy shoreline extends southwards as a low sandy spit across the mouth of Budle Bay, a small tidal inlet floored mainly by sandy sediments. Its southern shore is formed by dunes banked against a hard-rock cliffline, whose easternmost extremity is formed by the Whin Sill.

Despite the limitations of cartographic evidence, Ordnance Survey maps and plans of the area from the mid-19th century onwards show that there has been considerable accretion at both Goswick Sands and Ross Links (Figure 11.23). Steers commented (1946a, p. 452) that ‘Unfortunately the physiography and ecology of the coast between Black Rocks and Budle Point have not been fully investigated. They should afford many interesting problems for research purposes.' There appears to have been no comprehensive examination of the coastal geomorphology of the whole site. Bird (1985) suggested that, similarly to the northern side of Rattray Head, the Sands of Forvie and the north Norfolk coast, the sand accumulation here may be derived from the seabed.

At its northern end at Cheswick and Goswick the site is bounded by low rock-cliffs formed in Lower Carboniferous shales. Rather more resistant limestone beds (Lowdean or Sandbanks Limestone) form small headlands and a number of reefs that extend seawards from the cliffs. About 250 m of reefs are exposed between high and low tides, acting as low groynes. No other exposures of bedrock occur for some 9 km to the south, until Holy Island itself.

Between Cheswick–Goswick and Holy Island, the shoreline is formed in sand. There are four main zones:

1. The landward side of the site is formed by dunes that were in place by the middle of the 19th century. Their maximum height reaches about 18 m at their northern end, where they rest on bedrock, but they decline in height towards the south-east. Over most of this area the dunes rarely exceed 8 m OD.

2. Seaward of this zone, there are several narrow lines of active dunes and an intermittent line of low vegetated embryo dunes.

3. This line is continued south-eastwards in Goswick Sands as a barrier beach extending towards Holy Island.

4. The final zone is an active intertidal beach that appears to be dominated by progradation. The sand that stands above high-water mark has gradually increased in area from the mid-19th century and extended towards Holy Island. It lacks any evidence of recurves and appears to have extended not as a result of longshore transport, but as a result of a gradual onshore accretion.

Over the same time period, the channel draining the northern part of the Beal Sands has been diverted eastwards and its dimensions have decreased (Figure 11.23). The shoreline alignment is strongly dominated by a swash-related curve between its two rocky extremities at Cheswick and Holy Island.

Holy Island itself was described by Farquhar (1967) as a situation where sand spits and sand-bars were prevented from joining the island to the mainland by tidal streams. He also referred to 'the breached bars connecting Holy Island to the Northumberland coast' (p. 120).Steers (1946a) and King (1976) noted that shingle beaches have joined what were originally three or more separate islets to form the present-day Holy Island. Galliers (1970) suggested that the outline of Holy Island and its westward projection at the Snook have changed little between the publication of a map in 1610 and the present day.

The eastern part of Holy Island is formed mainly by Lower Carboniferous shales and thin, limestone strata, including the Lowdean or Sandbanks Limestone. Much of its surface is also covered by till and emerged beach sediments. On the northern side of the island, these are covered by dunes. In bays such as Coves Haven (Figure 11.26), where the dunes are aligned from north-west to south-east, and around Emmanuel Head, the shoreline is formed in part by vertical bedrock cliffs up to 18 m in height and by dunes banked against the underlying rock surfaces. The eastern shoreline is marked by several benches and rocky outcrops. The intertidal area is formed by boulder fields and some rocky platforms. At Castle Point, cobble ridges occur at both low-water mark and high-water mark, the higher ridge including several small recurves. King (1976) described a low gravel terrace of sub-rounded to rounded gravel at 3.6 m OD rising landwards to unweathered gravels at 5.5 m OD. This site has been identified as the only known emerged beach of Holocene age on the east coast of England (see GCR site report in Huddart and Glasser, 2002), and is an important reference site as an isostatic marker. King (1976) described the Snook as underlain by gravel ridges up to +3.6 m OD (a similar level to the Holocene beach) overlain by dunes that reach about 15 m OD. The dunes form both low ridges about 10 m in height roughly parallel to the shoreline (i.e. east–west) and crescentic-shaped mounds that vary in height between 10 m and 12 m. Absent from the earliest maps of the area, the Snook appears on 18th and early 19th century maps as a series of separated ridges. At Snipe Point, the dunes are aligned south-west–north-east.King (1976) suggested that the Snook dunes receive sand from the ridges to the north and north-west, that is Goswick Sands, and from the Holy Island Sands to the south. According to King, the symmetry of the dunes may reflect these two sources. The underlying gravels are exposed only in hollows, these forming most commonly where recreational access has produced local deflation.

*Figure 11.26: Coves Haven, on the northern coast of Holy Island. The underlying Carboniferous Limestone is covered by till and emerged beach sediments, which are covered by dunes aligned from north-west to south-east. (Photo copyright English Nature.)*

South of Holy Island, the shallow lagoon between Holy Island and Ross Links drains the intertidal flats that are almost enclosed by the Snook and Goswick Sands to the north. Although there is some saltmarsh, much of this area is formed by extensive sandy and muddy areas crossed by very well-developed dendritic channel patterns. The more elevated sections of sandflat, where tidal inundation is of lower frequency and duration, are colonized by saltmarsh vegetation and in the west, dense stands of common cord-grass *Spartina* exist. Guile Point is the northernmost part of Ross Links, but the dunes that cover it are broken at Ross Point. There are several small rocky outcrops close to low-water mark seaward of Guile Point. Most of Ross Links is underlain by till, generally at about +3.8 m OD, which is exposed between Guile Point and Ross Point. The relative resistance to erosion of this material has played a part in the recent development of Ross Links since it has fixed the northern end of the sand shoreline curve. Robertson (1955) divided the dunes of Ross Links into four zones from west to east:

1. The oldest part of Ross Links, wind-blown sand is underlain by glacial sand, regarded by Robertson as late-Glacial. The $CaCO_3$ content of this sand is very low. Blowthroughs expose buried podzols throughout this zone, the upper one having Bronze Age pottery in its A1 horizon. Brewis and Buckley (1928) suggested this surface could as a result be dated at about 3600 years BP.

2. Robertson's (1955) ‘ancient beach' in which the sand is ‘distinctly calcareous'. This has similar blowthroughs to the previous zone and is separated from the next zone by a single almost continuous dune ridge. Long Bog represented this feature best in Robertson's view because farther north it had been covered by dunes and was directly observable only in the blowthroughs.

3. The main area of Ross Links formed by linear dunes that rise from about +7 m OD at the landward boundary of the site to over +18 m OD. From a single ridge about 18 m high at Ross Point this zone widens from about 30 m to over 600 m in the south. There are between 7 and 16 sub-parallel sand dune ridges, each of which marks a period of dune-building (Figures 11.24 and 11.25). At the time of Robertson's 1955 survey the southern part of this zone was about 550 m wide and there were only 14 ridges.

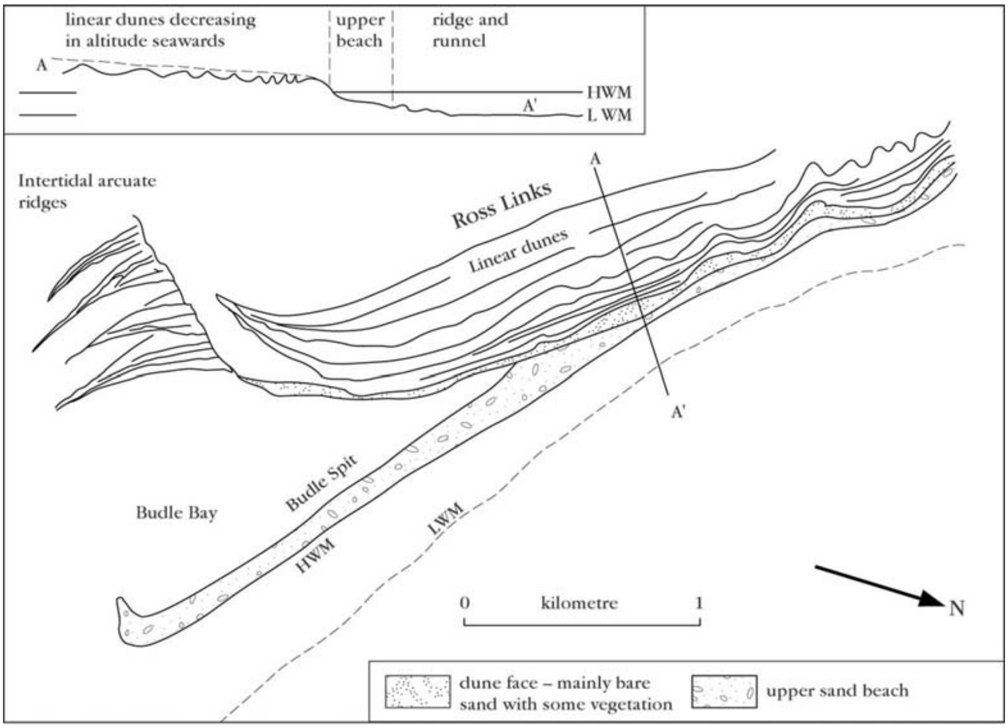


*Figure 11.24: Cross-section and profile of the main geomorphological features of Budle Bay and Ross Links. (based in part on interpretation of aerial photographs, see Figure 11.25.)*

*Figure 11.25: Aerial photograph mosaic showing the main features of Ross Links and Budle Bay. 1, cliff-foot dunes; 2, sand-waves in Budle Bay; 3, intertidal sandflats and mudflats; 4, Budle spit; 5, prevailing wave direction; 6, saltmarsh and intertidal mudflats; 7, possible former beach ridges; 8, dunes of Ross Links; 9, linear shore-parallel dunes decreasing in altitude towards shoreline. (Photo courtesy Cambridge University Collection of Aerial Photographs, Crown Copyright, Great Scotland Yard.)*

4. The beach, Ross Back Sands and the sand-bar across Budle Bay. Robertson believed that this bar had built up following the 1953 storm surge, but it is an identifiable feature on 19th century maps.

King (1976) suggested that the curve of Ross Links shore results from the pattern of refracted swell. The refraction patterns would tend to move sand to north and south, and this accounts for the development of spits in both directions. The shoreline appears to have advanced as much as 250 m during the last 100 years (2.5 m $a^{-1}$ is among the more rapid rates nationally). There has been much greater accretion across Budle Bay where a sand ridge narrows the mouth of this estuary to under 300 m at high-water mark. Evidence that this is the result of longshore transport is sketchy, and the detailed surface forms suggest that this beach may be the result of gradual seaward building of the shoreline. The low-water mark has always had an outline that has been tied strongly to the more resistant features of Guile Point and Bamburgh. It appears that during the last few decades sufficient sand has accumulated to sustain this beach and build it across the estuary.

Budle Bay and its southern shoreline show considerable evidence of sand movement by currents on parts of the intertidal estuary floor, and wave and wind action where sand has been banked up against the rocky outcrops (Figure 11.25). Here, as elsewhere on the site, the sand appears to have been derived from offshore, since there are no large inland or longshore sources.

## Interpretation

Holy Island has been given surprisingly little attention by coastal geomorphologists, yet it is one of a small number of sites where accretion appears to dominate. On the coastline of Great Britain, fewer than 25% of all beaches are accreting. Sites in which progradation occurs throughout the site are thus very rare, for many are characterized by both erosion and accretion (e.g. see site reports for North Norfolk Coast, Dungeness, South Haven and Morfa Harlech). Growth in the distal parts of these beaches usually takes place at the expense of their landward parts. This is not the case in the Holy Island site (although sediment arriving here has been eroded from elsewhere). Barrier beaches are also rare on the British coast. In this site, the beaches at Cheswick and Goswick have many of the characteristics of such barrier beaches, i.e. narrow strips of low-lying land formed entirely of beach sediments and frequently overwashed by waves. However, the Holy Island barriers are more properly described as bay barriers since they enclose embayments north and south of the island, unlike true barrier islands that lie separately from the land mass. The most important feature of the Holy Island barriers is the lack of significant longshore sediment feed to them. They appear to have grown primarily as a result of the addition of sand to the seaward face. Lengthening alongshore, which characterizes the Goswick Sands, is a function of beach growth in gradually deepening water rather than of spit extension. However, Hansom (pers. comm.) suggests that there is a southerly feed into these beaches.

The origins of the plentiful sand both offshore and nearshore have not been investigated in detail. One possible source is the reworking of glacial sediments filling depressions in the Carboniferous seabed rock surface, such sediments having a high ratio of glacial sand and gravel to till (Clayton, pers. comm.). There are only very limited fluvial sources.Robertson (1955) drew a distinction between the non-calcareous shell-free sand of the inner part of Ross Links and the calcareous sand containing marine shells, which formed his ‘ancient beach' that developed in the British post-Mesolithic era (*c*. 8000 years BP). Since Mesolithic times, relative sea-level change along the Northumberland coast has been only about 2.6 m (Plater and Shennan, 1992). Plater and Shennan identified a transgressive phase up to 7630–7970 years BP, but consider that low rates of relative sea-level change (<1 mm $a^{-1}$) combined with local variations in sediment supply have been the most important processes here.

Holy Island differs from other large progradational sites in lacking extensive development of saltmarsh behind the beaches. Human activity along the beaches has been minimal. There has been no coast protection and there is little evidence that land-claim has been a significant process. There is saltmarsh in both the ineer Budle Bay and along the western shore of the National Nature Reserve (NNR). Parts of the dunes at Ross Links bear the scars of past use as a bombing range. Nonetheless, the site has some of the most pristine features anywhere on the English coast. The site's similarities to the features of Rattray Head on the Scottish coastline make for interesting comparison because Holy Island appears to represent along its northern side conditions comparable to an earlier stage of the development of Rattray Head and Strathbeg (see Chapter 8).

The southern extension of the sand ridge at Budle Bay poses a question as to its origins. It appears to result from gradual accumulation of sand across the bay as an extension of the shoreline curve to the north. There is, however, one piece of evidence that conflicts with this hypothesis. The Geological Survey Memoir (Carruthers *et al*., 1927) describes an area in a similar location to the sand ridge as ‘raised beach', althoughSteers (1946a) was unconvinced by the account in the Memoir. If such materials were exposed in the past there is now no surface evidence of them. However, they would provide a base for the development of the present-day sand ridge. Further investigation of this location is needed to elucidate its history.

Both the cartographic evidence and the progradation of the dunes and beach throughout their length argue against any significant re-distribution of sand alongshore. Although the development of the sand ridges, at both Ross Links and Goswick Sands, could be seen as resulting from longshore transport, both sediment cells are dominated by overall accretion. If longshore transport is occurring, there must be substantial inputs of sand to the beaches at Cheswick in the case of Goswick Sands and at Old Law in the case of Ross Links. There is some erosion from Far Skerr northwards towards Berwick, but it appears too limited to provide the volumes needed for the growth of the Goswick system. At Ross Links, the older dune ridges all have a predominantly linear sub-parallel form and there is no evidence of old recurves within the dunes. Robertson (1955) argued that on the basis of cartographic, soil and archaeological evidence that these ridges had formed between the beginning of the 16th century and the middle of the 18th century. The whole system is dominated by progressive movement seawards. Even considerable surface damage to the dunes as a result of bombing has not initiated shoreline retreat. There are, however, blowthroughs throughout the dunes mostly with an alignment SSE–NNW. The dune and beach system appears to have a strongly positive sediment balance.

Farquhar's (1967) suggestion that this site has been affected by breaching of beaches thus separating the islands from the mainland is not supported by either the cartographic or the field evidence. The only point at which there appears to have been an erosional break in an otherwise symmetrical shoreline is at Ross Point. Here the mid-19th century high tides appear to have passed between Ross Point and Old Law. Such a cut in the coast occurred in the underlying till and not in the beach. Robertson (1955) used cartographic evidence to suggest that although Old Law first appeared on Armstrong's map of 1769, it had been separated from the mainland by the time of Fryer's 1820 map. There is now sufficient accumulation of sand to ensure that the shoreline is a continuous one. There is no other evidence of breaching.

There is evidence in the cobble beaches of Holy Island itself of higher relative sea levels, but the general reduction in altitude of the dune ridges on Ross Links may be indicative of a falling relative sea level. However, such a hypothesis requires a fuller investigation of the site.

In summary, four issues needing further research are raised by the features of the Holy Island site, i.e.

1. the relationship of the dunes and beaches to any underlying till,

2. the development of the tied islands by beach growth or breaching,

3. the sources of sand for the substantial progradation at this site, and

4. their relationship to changes in sea level and wave climate.

## Conclusions

Sand spits and barrier-type beaches characterize this predominantly prograding site. Holy Island is unusual in Britain in combining tied islands with barrier-beach development. The positive sediment budget for the site cannot be explained by longshore sediment transport alone and so an offshore source has to be postulated. The early development of Rattray Head in Scotland appears to have followed a similar pattern.

The significance of Holy Island lies, first, in the extensive progradation of sandy beaches, a rarity not only worldwide, but also on the coastline of Britain. Second, it illustrates well the role of different wave energy distributions through its contrasting beach forms and processes to the north and south of Holy Island. Third, the total assemblage and variety of contemporary and older coastal features makes it unusual. Fourth, it is a rare example of tied islands, in which several rocky islands have been joined by beaches. This is a very unusual form in England and Wales, although it is more common in Scotland. Finally, this site is one of only three locations in England and Wales where barrier-type beaches occur and is the only one that co-incides with conditions of coastal emergence.

The site is also of national and international importance as a National Nature Reserve, Special Area of Conservation (SAC) and Special Protection Area (SPA) under the Habitats and Birds Directives, a Ramsar site and a site of great archaeological and historical importance.

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