Introduction

During the months of June, July and August 1996, a team from the Department of Archaeology at the University of Edinburgh undertook an assessment of the erosion of the archaeology and built heritage within the coastal zone of the west, north-west and north-east of Lewis. The results of this 441-km linear survey detail 1825 individual cultural heritage sites, 15 palaeo-environmental sites and 319 geomorphic and erosion cells. Historic Scotland and the Department of Archaeology, University of Edinburgh, sponsored the study.

Aims

The primary aims of the project were to fulfil the requirements of the ongoing programme of coastal erosion assessment defined in Historic Scotland’s Archaeology Procedure Paper 4: Coastal Zone Assessment Survey (1996). In addition, the results also contributed to ongoing research interests of the wider Calanais Archaeological Research Programme (CARP; Harding 2000). These included:

- the development of computer-aided survey using the software package PenMap (Strata 1996), initiated during previous research projects in Lewis
- provision of a linear survey control along the coasts for the various area survey projects undertaken within the study area
- examination of the coastal strip for potential sites for rescue excavation and selective sampling

The Study Area

This survey comprised the intertidal zone and a 50–200 m strip inland from the Mean High Water Spring (where possible). The survey was executed along a linear transect running from Aird Drollageo in the south-west via the Butt of Lewis to Ranish in the south-east of the study area (Figure 7.1). A wide diversity of coastal forms was covered by this transect, including high cliffs and low rock platform, stretches of raised beach, areas of extended sand dunes and machair, intertidal saltings and isolated areas where alluvial deposition is prevalent.

Lewis is the largest land body in the bow-shaped chain of islands which makes up the Western Isles. The almost exclusive coverage of basement rock of hard metamorphic Lewisian Gneiss is amongst the oldest in Britain, with some formations dating back to 2800 million years. However, the Butt of Lewis and an area north and east of Stornoway are underlain by softer Metasediments and Triassic sediments that affect the long-term erosion of their respective coastlines in relation to the rest of Lewis.

The present Holocene landscape can be broadly separated into two main areas: the ‘blacklands’ and the coastal strip. The ‘blacklands’ cover most of the island interior and consist of a treeless subdued topography covered in blanket peat, dotted with hundreds of lochs of varying size and bare outcrops of Lewisian Gneiss. Stretches of the coastal strip consist of land that is agriculturally more viable and on which most of the island’s settlement is concentrated. Its form is a function of the development of machair through natural processes (Ritchie 1979; 1985) and anthropogenic intervention (Pankhurst & Mullin 1994; Boyd & Boyd 1990). Pollen diagrams within the survey area indicate that tree cover was greatly reduced by the 1st millennium BC (Bohncke 1988; Birks 1994; Lomax & Edwards 2000).

During the second half of the Holocene the increasingly marginal and forbidding interior has concentrated settlement within the coastal zone. The resulting archaeological remains cover all periods from Neolithic ceremonial remains, through Bronze Age landscapes in both machair and blanket peat, the monumental drystone architecture of later prehistory, medieval ecclesiastical complexes and expanses of abandoned post-medieval settlement. The concentration of this varied and diverse settlement within the coastal zone, coupled with the unique preservation systems of peat and machair and limited intensive agriculture, has created an archaeological resource of great importance.

Previous Work

More than 20 excavations of archaeological sites have taken place within the survey area. These are outlined by Burgess and Church (1997, 29–31). There has also been important research into Quaternary environments and geomorphology, concentrating on Uig Sands and a stretch of relic coastline in the north-west (Sutherland 1993).
Figure 7.1. Location map showing the area of survey and places mentioned in the text.
Prior to 1985 the main projects were the RCAHMS survey published in 1928 and the coastal erosion assessment undertaken by the National Museums of Scotland (Cowie 1994). The latter involved a detailed survey and site description of selected strips of coastline rich in prehistoric remains.

The initial research of CARP, following the acquisition of Calanais Farm in 1985 (Harding 2000) concentrated on the later prehistoric settlement on the Bhaltos Peninsula. Field survey (Armit 1994) was followed by the excavation of a wheelhouse and cellular complex at Cnip (Harding & Armit 1990), an island dun at Loch Bharabhat (Harding & Dixon 2000), and a broch at Loch na Beirgh (Harding & Gilmour 2000). The island dun and broch have now both been classified as complex Atlantic roundhouses.

In 1993 the West of Lewis Landscape Project (WLLP) started a programme of field survey concentrated around the Loch Roag complex in the west of Lewis (Burgess 2001). Initial work concentrated on the chronology and nature of human settlement from the Neolithic to the post-medieval within an area 4 km by 10 km, stretching from Calanais on the coast into the ‘blackland’ interior (Coles & Burgess 1995). Further fieldwork within the survey area, investigating the remains of early prehistoric field systems under the peat near the Calanais stones, has been completed recently (Flitcroft et al 2000).

The Garenin Landscape Survey (GLS) was set up in 1994 to investigate the late medieval and post-medieval settlement of Garenin through intensive field survey and limited excavation. This led to the trial excavations of features of all periods including blackhouses, illicit stills, a corn kiln, and a promontory enclosure (Burgess & Gilmour 1996; Burgess & Johnson 1999).

The Uig Landscape Survey (ULS) was initiated to investigate the human settlement of Aird Uig, the headland adjacent to the Bhaltos Peninsula. This area was chosen to provide a western comparison for the study of the Loch Roag complex (Burgess 2001). An intensive field survey in the initial season (Burgess & Church 1996a) was followed by selective excavation of certain settlement types in the following seasons (eg Church & Gilmour 1999; Bronk Ramsey et al 2000). A component of the initial field survey was a coastal erosion assessment of the archaeology in the 50 m strip around Uig sands (Burgess & Church 1996b) and a reassessment of the coastal erosion sites examined by Armit in the Bhaltos Peninsula (1994).

The survey of the Loch Roag area was completed in 1996 with the detailed survey of the Islands of Great and Little Bernera. Covering an area of more than 900 ha, these two islands lie at the centre of the Loch Roag complex between East and West Loch Roag. The opportunity to study these islands provided a perfect opportunity for linking the surveys on the east (GLS and WLLP) and the west sides (ULS) of the Loch Roag complex (Burgess 2001). Sites of all periods were examined at the same time as the detailed excavation of the late prehistoric and Norse settlement at Bostadh Beach (Neighbour & Burgess 1997).

Methods

Phase 1: Desk-based assessment
Archaeological, geological and geomorphic material was consulted from the following sources:

- Ordnance Survey record cards, map sheets and the National Monuments Record of Scotland (NMRS) database through the Artemis GIS system – the Artemis data was generated on the basis of a search set to note all sites within 500 m of a centre line path based on the Ordnance Survey 1:25000 survey of the coastline of Lewis
- a selected sample of aerial photographs from the Aerial Photographic Unit at the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS)
- the Historic Scotland Map Room for all relevant Scheduled Ancient Monuments
- the National Map Library for copies of the First Edition 6” Ordnance Survey

Phase 2: Fieldwork
Three field teams, each comprising two people, examined stretches of the coastline divided into arbitrary administrative parcels. Each team covered 5–10 km per day. Each team was equipped with a pen-based portable computer (Compaq Concerto 486SL 33 MHz, 12 Mb RAM) into which details of all cultural heritage, palaeo-environment features and erosion and geomorphology were recorded. PenMap software was used to record the data onto scaled background maps using a GIS system to manage the data. Record forms were programmed for the project by the authors and altered and refined on the basis of the first week’s experience in the field. Sites were located to an accuracy of 20 m (a radius of 10 m) by means of either compass resection or hand-held navigational GPS.

The coverage by linear transect included the intertidal zone (where it was deemed safe to examine it) and a
50–200 m strip inland from the Mean High Water Spring. Extensions to the survey strip were made when areas subject to erosion processes directly related to the coastal erosion regime were noted, e.g. Barvas machair, NGR NB 346 514. Only offshore islands safe to reach by foot were visited, for example Holm Island, NGR NB 450 304. Some stretches of coast were inaccessible due to the presence of crofts running to the foreshore.

**Phase 3: Reporting**

The use of computers in the field greatly increased the efficiency of transfer, manipulation and analysis of the survey data. A 440-page archive report was lodged with the NMRS (Burgess & Church 1997) and a summary note published in *Discovery and Excavation in Scotland* (Burgess et al 1997).

**Analysis**

**Archaeological sites**

One thousand eight hundred and twenty-five sites were recorded with a monument density of (on average) more than four sites per kilometre (Table 7.1 and Figure 7.2). This density varies spatially, with areas such as Great Bernera having a high density, and, conversely, some of the more inaccessible cliffs, such as the stretch in the north-east of the survey, having a much lower density. The density from this survey is greater than those of the other surveys completed to date under the wider national strategy being implemented by Historic Scotland. However, rather than simply signifying a higher density of archaeological sites, this may be due to the chronological range of this survey, which included a vast number of post-medieval sites. Also, this may be due to the identification of single ‘site elements’ in addition to the ‘settlement complexes’ that are commonly recorded in the other surveys.

<table>
<thead>
<tr>
<th>Period (field recording)</th>
<th>General period</th>
<th>Number of sites</th>
<th>Percentage of total sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prehistoric</td>
<td>Prehistoric</td>
<td>178</td>
<td>9.75</td>
</tr>
<tr>
<td>Neolithic</td>
<td>Prehistoric</td>
<td>8</td>
<td>0.44</td>
</tr>
<tr>
<td>Bronze Age</td>
<td>Prehistoric</td>
<td>7</td>
<td>0.38</td>
</tr>
<tr>
<td>Iron Age</td>
<td>Prehistoric</td>
<td>17</td>
<td>0.93</td>
</tr>
<tr>
<td>Pictish</td>
<td>Prehistoric</td>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td>Norse</td>
<td>Norse/Medieval</td>
<td>4</td>
<td>0.22</td>
</tr>
<tr>
<td>Medieval</td>
<td>Norse/Medieval</td>
<td>31</td>
<td>1.70</td>
</tr>
<tr>
<td>Pre-clearance</td>
<td>Norse/Medieval</td>
<td>211</td>
<td>11.56</td>
</tr>
<tr>
<td>Post-medieval</td>
<td>Post-medieval/Modern</td>
<td>592</td>
<td>32.44</td>
</tr>
<tr>
<td>Crofting</td>
<td>Post-medieval/Modern</td>
<td>101</td>
<td>5.53</td>
</tr>
<tr>
<td>Modern</td>
<td>Post-medieval/Modern</td>
<td>133</td>
<td>7.29</td>
</tr>
<tr>
<td>Multi-period</td>
<td>Prehistoric</td>
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<td>0.05</td>
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<tr>
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<td>Unknown</td>
<td>541</td>
<td>29.64</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>1825</td>
<td>100.00</td>
</tr>
</tbody>
</table>

*Table 7.1. Breakdown of sites by period.*

It must be stressed that though some sites can be attributed with confidence to a period, for example complex Atlantic roundhouses are thought to be exclusively Iron Age, many of the period identifications for the sites should be interpreted as ‘possible’ rather than ‘probable’ dates. This is
especially true of the Norse/Medieval bracket which may include many post-medieval buildings and field systems which were identified in the field as earlier due to variations in the overall form of the rectilinear structures and rigging. Also, many sites, for example Galson (see below), cover more than one period. Past research has shown the dangers of constructing chronologies by survey alone (cf Armit 1996), especially as many Lewisian sites appear as piles of stones obscured by peat and turf. Five hundred and forty-one of the sites (approximately 30 per cent of the total) have therefore been assigned to the ‘Unknown’ category.

Vulnerable sites

The erosion status of sites by period can be seen in Figure 7.3. This shows that almost 50 per cent of the prehistoric sites are definitely eroding, with a further 15 per cent eroding/stable and only 36 per cent stable. Conversely, the later sites are predominantly stable (66 per cent for Norse/Medieval and 77 per cent for Post-medieval/Modern) and the ‘Unknown’ sites are subject to slightly more erosion. Clearly, the prehistoric sites are much more likely to be eroding than any other period grouping, primarily as a result of their location and their archaeological visibility within the machair and sand zones. This again has implications for the monitoring and management of the machair zone as many of these sites are considered to be important site types within the Western Isles and beyond.

Erosion cells and geomorphology

The results below were obtained through analysis of the 319 erosion cells, the total length approximately 441 km. The results are presented in three basic groups of data:

- the overall survey (Figure 7.4)
- comparison of the east and west coast data sets (Figure 7.5)
• inspection of the erosion cells within the coastline of sand and machair in more detail (Figure 7.6)

Figure 7.4 shows that the overall regime is characterised by erosion of the coastline, with approximately 29 per cent of the coastline actively eroding and a further 36 per cent of the coast showing some signs of erosion. Only 34 per cent of the coastline was stable and less than 1 per cent of its length displayed a predominantly depositing regime.

Comparison of erosion to the east and west coasts

The hypothesis that the west coast was undergoing more erosion than the east coast was formulated during fieldwork. This was thought to be because the west coast is in the direct line of the severe storms and marine action from the Atlantic whereas the east coast that faces on to The Minch is relatively sheltered. This was an important distinction as approximately 78 per cent of the archaeological sites were located on the west coast. However, when the two data sets are compared (Figure 7.5), it can be seen that the east coast was experiencing the greater erosion, with over 39 per cent of the coast definitely eroding and a further 26 per cent eroding/stable compared to the west coast where 23 per cent was definitely eroding and 38 per cent was eroding/stable.

This apparent negation of the initial hypothesis can be explained through more detailed examination of the geomorphic profiles of the two coasts. For example, though there are large stretches of generally stable high cliff on the east coast, there are also long stretches of eroding sand beaches and machair that are different in character to the generally smaller pocket beaches of the west coast. Also, on the east coast there are long stretches of softer New Red Sandstone cliffs to the north and east of Stornoway. These were generally showing signs of active erosion. Conversely, most of the underlying geology of the west coast is harder Lewisian Gneiss, a sizeable proportion of which consists of stable low rock platforms and cliff within the more sheltered sea lochs of East, West and Little Loch Roag.

Erosion within sand and machair zones

During the fieldwork it was obvious that many of the sand and machair systems encountered were more dynamic in their erosion regimes than the other systems observed. Also, the machair areas have acted as a focus for human settlement from prehistory to the modern day, resulting in numerous rich archaeological sites being recorded. Many of these have been shown through excavation to be unrivalled for their preservation of structural remains, bone and shell, for example Cnip wheelhouse complex (Harding & Armit 1990; Armit 1996) and Bostadh Beach (Neighbour & Burgess 1997).

Previous archaeological and environmental surveys (Ritchie & Mather 1970; Cowie 1994; Ramsay & Brampton 1995; Burgess & Church 1996b) have been biased towards these areas though none has presented comparative data to justify this concentration of research and assessment. All the erosion cells from sandy beaches and machair (approximately 33 km) are presented in Figure 7.6. Fifty per cent was definitely eroding, 26 per cent was eroding/stable and only 4 per cent was stable. This shows that within the wider framework of the generally eroding regime, the sand and machair coastlines act as erosion foci. The low level of stability was particularly marked when compared to the overall stable proportion of the entire study area (approximately 34 per cent). Sand and machair systems also act as deposition foci, with almost 7 per cent depositing and a further 13 per cent showing signs of erosion and deposition.
The threat to the archaeology within the machair zone is twofold: predominantly from erosion of the archaeological remains but also from the changing ‘archaeological visibility’ that occurs within the system. For example, the potentially unique Mesolithic stone artefact scatter located by Lacaille at Traigh na Berie (Lacaille 1937) has never been relocated following sand accretion and so has been lost to archaeological research up to this point. The eroding middens within the same zone will also soon be lost forever.

The ease of transport by water and wind action, coupled with the inherent high levels of erodibility of the matrix (Summerfield 1991), mean that machair systems are extremely dynamic, suggesting that the observed results may change from season to season. The results presented here only relate to the erosion regime occurring at the time of fieldwork. Therefore, medium- to long-term predictions for a particular area can only be gained through comparison with further periodic surveys, using a similar methodology. It is obvious, highlighted by all previous surveys and assessments, that the machair should be one of the priority areas for any coordinated and regular monitoring scheme in the future.

Discussion and Recommendations

A more detailed discussion on the types of sites comprising the study is provided in the full archive report (Burgess & Church 1997). The large number of sites and their wide diversity in form and date make it impossible to discuss the archaeological results in any depth within this paper. However, the main threats and erosion foci for the archaeology can be summarised into three general classes which apply for both the west and east coasts within the study area:

- erosion of sites (such as promontory enclosures) located on incised cliffs
- sites of various types and ages within the dynamic erosion/deposition system of machair
- a small number of sites threatened within alluvial systems

Sites on incised cliffs

Sites of this class are typified by promontory enclosures, of which over 60 individual examples have been identified (Burgess 2000). These promontory enclosures are almost exclusively located on incised cliff lines and stacks, and include Gob Eier (Figure 7.7; Church et al 1999). The cliffs are eroding through continuous small-scale slumping and erosion of the soil matrix coupled with low-frequency, high-magnitude cliff slip events which could destroy large portions of a promontory enclosure. Some of these events have reduced many promontory sites to little more than stacks of less than a few metres across.
The actual rate of erosion seems to vary depending on the underlying geology and the depth of substrate on which a site sits. Sites located on the cliffs of Lewisian Gneiss, for example, are generally stable; the threat of erosion increases when sites are situated on deep soft substrates such as glacially-derived sands and gravel. Conversely, sites on the ‘till cliffs’ overlying Metasediments around north-west Lewis and the conglomerate cliffs of New Red Sandstone on the east coast are at a much greater risk as these areas are experiencing much higher rates of erosion of the relatively soft underlying geology.

Sites within machair zones

Sand and machair zones are experiencing severe erosion and rapid deposition that impacts on the archaeological sites within these dynamic systems. The erosion mechanisms stem from marine, aeolian, livestock and human activity. Marine erosion results in wave undercutting of the sand sections. This can vary in size from the small-scale, as seen in the eroding middens on Cnip headland, to the large continuous eroding sections of up to 5 m in height at Galson. Marine erosion is particularly marked at high spring tides and during high-magnitude, low-frequency storm events such as the storm which revealed archaeological remains at Bostadh during the winter of 1993/4 (Neighbour & Burgess 1997).

Aeolian erosion results in blow-outs and erosion scars which are sometimes very extensive, as at Barvas machair. These basic erosion mechanisms and resulting geomorphic features are exacerbated by animal and livestock grazing. Animals cause direct erosion through their tracks, especially up dune sides, and through extensive burrowing (eg at Mealista, Traigh na Berie and Barvas). Animal activity also impacts on the ability of the machair system to resist erosion by thinning or removing the vegetation that binds the unstable matrix together. Human activity further destabilises the delicate balance between the erosion faces and the erodibility of the machair. This can be the direct impact of human exploitation of the zone, for example through sand extraction and cultivation at Barvas machair, or the more widespread impact of recreational activity. All these erosion mechanisms create material that is consequently deposited further inland by aeolian activity, unless constrained by topography.

Both the erosion and deposition within these zones can be very local and the general regime of an erosion cell may hide the fact that an important site is being eroded or covered up. Also, the dynamic erosion regime that exists in many of these zones can switch from erosion to deposition in a season. Therefore, the high concentration of important prehistoric sites within this zone needs a rigorous monitoring and management scheme.

Sites affected by alluvial action

This class is limited to the points along the coastline where rivers and streams enter the sea or within wider areas of alluvial erosion and deposition, for example at Broad Bay. Generally, the erosion is not too severe because most of the bodies of water are not of the size to cause extensive damage. Along certain stretches of incised coastline, streams are providing a further erosive mechanism at points of weakness that may directly impact upon sites located there. Alluvial action is also one of the few observed mechanisms for deposition within the coastal zone. This is particularly marked at Broad Bay where a number of sites, including a probable Norse settlement, are being both eroded and covered over by sand and mud.

Project evaluation

Further fieldwork, under the wider CARP, has been undertaken on a selection of coastal erosion sites highlighted by the survey. These include a hearth complex of presumed Late Neolithic/Bronze Age date under 1.5 m of eroding peat near Aird Calanais (Figure 7.8; Flitcroft & Heald 1998); a more detailed assessment of the promontory enclosures identified during the coastal erosion assessment of Lewis (Burgess 2000); and work on the multi-period later prehistoric/early historic settlement and cist complex at Galson (Neighbour & Church 2000).

Figure 7.8. Eroding section at Aird Calanais. The hearth complex is eroding from the basal layers of the section and the site is representative of those sites eroding on the low rock platforms of the sea lochs.

At Galson (Figure 7.9), the machair edge has been eroding for decades and has revealed a succession of archaeological remains. These can be broken down into two main groups associated with two major levels in the eroding section. The lower group consists of a number of Iron Age burial cists from an old ground...
surface that sporadically appear approximately halfway up the section. These were revealed by the progressive erosion of the section (Stevenson 1954; Ponting & Bruce 1990; Neighbour et al in press) and form part of an Iron Age cemetery, with the grave goods and radiocarbon dates pointing to the period of burial within a single horizon or old ground surface relating to the first half of the 1st millennium AD. The higher group consists of domestic dwellings with associated palaeosols and middens. This level is less easy to define chronologically, with many finds of Late Iron Age, Norse and medieval date reputedly recovered from the upper horizons. Early excavations (Edwards 1924; Baden-Powell & Elton 1937) identified this upper level as one continuous midden, with the implicit assumption of single-period deposition. However, it is clear from the range of structural forms and artefacts recovered from this layer, which is up to 4 m thick in some areas, that it represents hundreds of years of accumulation.

The Iron Age cemetery is very important archaeologically, not only because of the alkaline properties of the machair that allow excellent preservation of skeletal material, but also due to the rarity of Iron Age burials within Atlantic Scotland and beyond. The archaeological remains within the upper level are also very important as they contain the transitional period from the relatively well-represented Late Iron Age to the Norse and early medieval periods about which very little is known archaeologically within Lewis.

A programme of monitoring has been underway since 1997 (Church & Neighbour 1998; Neighbour & Church forthcoming). Photographic composites for computer rectification and detailed drawings of the eroding section have been produced at regular intervals. Baseline EDM surveys of the eroding edge have been complemented by geophysical survey in the area immediately behind the erosion face. This has revealed a range of high-resistance anomalies, probably reflecting the presence of buried walls up to 30 m beyond the eroding face. The shapes of the anomalies confirm the presence of both Iron Age cellular structures and Norse or medieval buildings. This research has led to the establishment of a stratigraphic relationship of at least six structures for the upper level, at the time of recording. From initial observation of the pottery, these range in date from Iron Age polycellular forms to rectilinear Norse and medieval structures. Detailed sampling for palaeo-economic data and radiocarbon dating has also been undertaken, establishing the taphonomic pathways for the carbonised material to be used in the dating programme (Peters et al 2000). The various classes of environmental remains (plant macrofossils, marine and terrestrial bones and shell) have been incorporated into ongoing PhD research by researchers at the University of Edinburgh.

The initial results of this monitoring have shown that a strip at least 1 m wide has eroded at certain points of the site since 1997. Hence, detailed recording of this type provides a snapshot of the archaeological profile that can change radically over one season, with the concomitant development in interpretation that may occur from the evolving identification of the structural forms of the site. It is hoped that the analysis of the data from the survey and sampling will allow insights into the transitional period between the Late Iron Age and Norse periods. However, it has been argued in the past that a full appreciation of this and other important aspects of such sites is only possible through extensive excavation, as the recording of successive eroding sections can be misleading (Owen pers comm).

The threat that coastal erosion poses to the archaeological resource in the study area has only been summarised briefly in the space available. The archaeology within the Western Isles in general is of international importance, with a significant proportion of the sites concentrated within the 1 km coastal strip. Many of these sites, especially the prehistoric remains, are actively eroding and some are likely to be lost within the next 10 years.

The three erosion foci outlined above should form the starting point for any monitoring scheme to be developed in the future. Schemes such as Shorewatch, utilising local enthusiasm that is apparent across Lewis,
would be the obvious first step. This could be complemented by establishing baseline surveys and detailed and regular monitoring by professionals of especially complex areas such as Galson. Survey and monitoring can be made more effective by backing them up with targeted excavation of sites identified as being of particular importance that would otherwise be lost, unrecorded, to the sea.

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