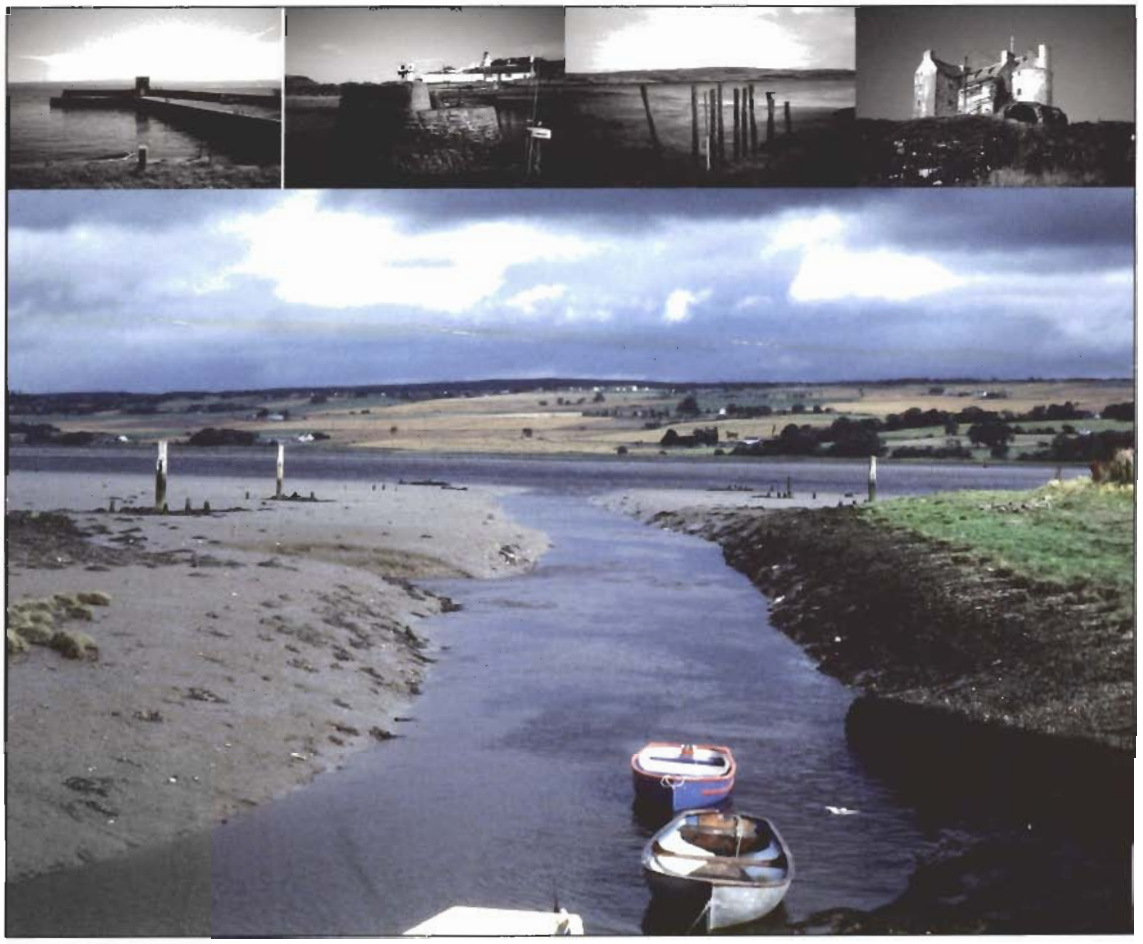
Coastal Assessment Survey
Inner Moray Firth

Inverness to Dingwall

September 1998

VOLUME 1

Map sets 1-18



a report for
HISTORIC SCOTLAND

by the
CENTRE *for* FIELD ARCHAEOLOGY

CENTRE *for* FIELD ARCHAEOLOGY

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MORAY, BEAULY AND CROMARTY FIRTH COASTAL ASSESSMENT 1998

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX 1 LIST OF PLATES

Volume 1- The central cover photograph is Dingwall Harbour
Volume 2 - The central cover photograph is the Tarbat Ness Light House

1 INTRODUCTION

Background

In August 1998 Historic Scotland invited tenders to conduct a coastal survey project to cover the coastal edge from Inverness to Tarbat Ness (National Grid Reference NH 650465 and NH 950 878 respectively). Following submission of its Project Design, the Centre for Field Archaeology was awarded the contract.

This project is part of a larger Historic Scotland review of archaeology and the coastal zone and is the thirteenth such survey to be completed. Surveys have already examined the Solway coast (Cressey and Toolis 1996), the north coast of the Forth estuary (Robertson 1996); the south coast of the Forth estuary (James 1996); a stretch of coast from Ullapool to Lochinver (Long 1996) and the coastline within the Firth of Forth and Tay Estuary Robertson *et.al.* (1997). Surveys have also been undertaken in Lewis (Burgess & Gilmour 1997), Orkney (Moore & Wilson 1997) and Shetland (Moore & Wilson 1997). In addition there have been excavations, site recording and focal studies such as the Solway Phase 2 study that examined the biostratigraphy of coastal sediments (Cressey *et. al.* 1998)

This programme of work has come out of the recognition of the importance of the coastal zone to Scottish archaeology and the need for information that will allow Historic Scotland to determine the nature of specific threats to archaeology and formulate solutions for specific sites (Ashmore 1994). Of particular relevance here was the recognition of the need to obtain standardised information and colour-coded mapped data for coastal areas. As a consequence, all the coastal surveys follow similar methodologies, based on Historic Scotland's *Archaeology Procedure Paper 4, Coastal Zone Survey* (1996), although there has been some evolution of the format.

In addition to the archaeological dimension, this survey has been conducted against a wider regional interest in the management of the Moray Firth. The Moray Firth Partnership (hereafter MFP) has generated a large corpus of information designed to promote management objectives for the area centred on a cultural and historical perspective. The MFP document *Living and Working* considers, amongst other topics, the landscape and cultural heritage, geology and geomorphology, marine and coastal environments, ecology, social and economic resources, recreation and tourism, harbours and shipping as well as coastal protection, planning and management. Archaeology, and the preservation of archaeological sites, clearly cross-cuts a number of these subjects. The present report contributes towards understanding the current status of the coastal archaeology and built heritage, which can be placed alongside the wider issues central to coastal zone management for the Moray Firth.

During this project, desk based work and report production were conducted by Andy Dunwell, Alex Hale and Dr Mike Cressey. Alex Hale supervised the fieldwork, with assistance from Alastair Rees, Bruce Glendinning, Ian Sudderby and George Mudy. Geomorphologic and erosion mapping was conducted by Mike Cressey. Dr Malcolm Murray assisted with aspects of the coastal geomorphology and computer-based map production. Dr Bill Finlayson managed the project for CFA and Patrick Ashmore for Historic Scotland.

Project Aims

The objectives for the Moray Firth Survey were set out in the Historic Scotland Project Outline as:

To gain factual information on, and an inventory of part of the coastal heritage to provide a basis for more work including:

- *detailed survey of important areas prior to protection, excavation or abandonment;*

- *Monitoring of sites and stretches of coastline by local organisations and people.*

In addition to agreeing to follow the Historic Scotland *Procedure Paper* to fulfil these objectives, CFA has undertaken to carryout certain additional elements of work to further the long-term objectives of the project.

Report Format

In this report we use the term *shoreline* to refer to the distinct boundary between land and sea that changes with the tides. A *coastal unit* defines the areas between individually numbered cut-off points that demarcate individual sections of coastline which may be classified according to its *eroding, stable* or *accreting* status. The *unit* is distinct from littoral "cells" or segments of coastline that normally include an entire cycle of sediment delivery to the coast by either rivers or coastal erosion.

This report contains the results of the rapid coastal assessment. These are presented sequentially for each coastal unit and follow a standard format. Elements include an introductory section, a section containing the coastal geology/morphology, coastal erosion and archaeological gazetteer and maps. Pertinent issues are highlighted through three case studies, which are followed by a section incorporating results and observations. This is followed by a list of references, contacts made whilst the project was in progress and persons to who's help we acknowledge. Appendix 1 includes histograms of the statistics in support of the results.

The Study Area

The study area as defined for this project comprises a wide variety of coastal land - forms, including the steep precipitous cliffs characterised by the North and South Sutors. Estuarine environments are predominant within the Beulay and Cromarty Firths where intertidal mud flats, macro-tidal river channels and saltmarsh are extensive. Relict shoreline features reflecting relative sea-level changes are also present within the study area. The coastline is dynamic and its configuration is changing albeit at different rates.

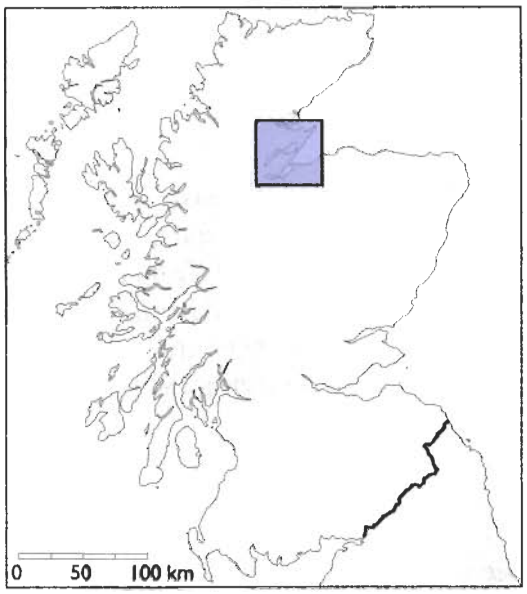
Geological Background

The geological structure of the Moray Firth has been comprehensively mapped and described by British Geological Survey in *The Northern Highlands of Scotland* 1989 publication. The distribution of basement and drift lithologies are shown in Figure 1. The dominant basement lithology consists of metamorphosed Moine sediment that is unconformably overlain by Old Red Sandstone of Devonian Age. The Old Red Sandstone is locally exposed along much of the coastal sections and is overlain by younger rocks of Permo-Triasic and Jurasic Age. These rock types are derived from mainly non-marine sources such as aeolian dune sand and freshwater/brackish marine alluvial sediment. Within the Moray Firth region, the Old Red Sandstone is sub-divided into Middle and Upper Old Red Sandstone. The latter series is predominant along the Black Isle shoreline and further south towards Inverness.

Quaternary/Holocene geomorphology and relative sea-level changes

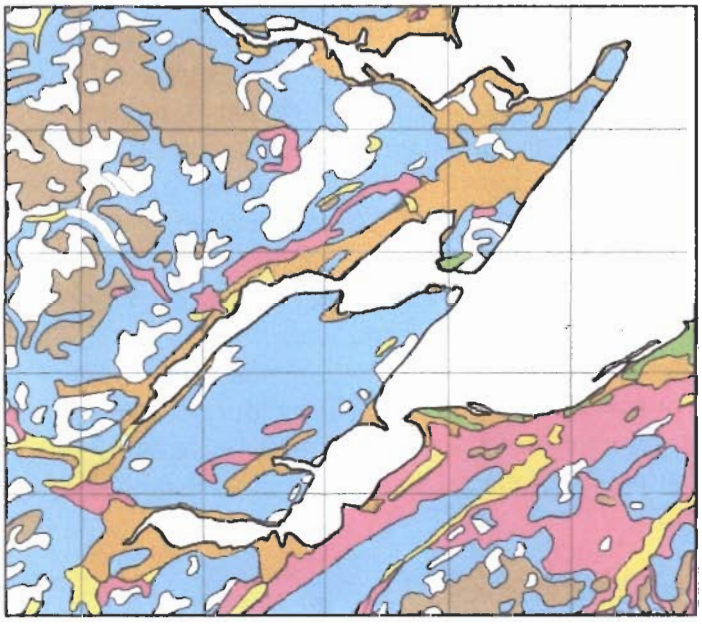
The climatic oscillations occurring within the Quaternary era (<1.6 million years BP) have given rise to a series of erosion and depositional events that have shaped the character of the present coastline. The Moray Firth experienced four major periods of glaciation during the Pleistocene epoch. The glacial maximum occurred ca 18000 years BP, during which time the ice sheet limit extended across the survey area beyond the present coastline and out into the dry bed of the North Sea (Jardine 1979). Deglaciation from ca. 13500 years BP onwards was marked by rapidly rising temperatures and rapid ice wastage, probably associated with high melt-rates, while unvegetated till-mantled slopes became exposed (Maizels and Aitken 1991). The wastage of the late Devensian Ice-Sheet (c.13000 BP) was instrumental in releasing large volumes of out-wash that was carried along much of the Inner Moray Firth at this period. The wastage of the Loch Lomond Advance (c.11.500-10500 years BP) is also attributed to the extensive re-distribution of glacial sands and gravel that mantle the basement facies already described.

During the Pleistocene, sea level rose and fell episodically as climate warmed and cooled and continental glaciers advanced and retreated. After the ice was removed, the continents rebounded. The rate of rebound was not a simple linear trend but rather a function of the isostatic/eustatic budget. Within our study area, the rebound has been on the order of several metres, and abandoned beaches and wave cut terraces lie several metres above current sea level.



LOCATION OF THE MORAY FIRTH SURVEY

LIMITS OF THE MORAY FIRTH SURVEY
Clachnarry to Tarbat Ness



DRIFT GEOLOGY
1: 625 000

Key:

- Blown sand
- Peat
- Alluvium (incl. River Terrace Deposits)
- Raised Beach and Marine Deposits
- Glacial Sand and Gravel
- Boulder Clay and Morainic Drift

Based on the 1977 *Quaternary Map of the United Kingdom* (First Edition), North Sheet.

FIGURE 1: LOCATION AND GEOLOGY MAPS

Based on the results of detailed stratigraphic investigations at the head of the Beauly Firth, Sissons (1981) proposed that extensive marine erosion occurred in the area during the Loch Lomond Stadial (Younger Dryas). He argued that the erosion produced distinctive abandoned clifflines that border much of the inner Moray Firth. Sissons (1981) suggested that the shoreline associated with this event stands at about 2 m above OD and it is equivalent to the Main Lateglacial Shoreline of the Forth Valley (Sissons 1969, 1974, 1976). Biostratigraphic analyses of the sediments deposited at the head of the Beauly Firth by Haggart (1986, 1987 and 1988) and Firth and Haggart (1989) have led to a greater understanding of sea-level movements and shoreline displacement. Haggart (1986) postulated that at 9600 BP, the estuarine flats (the so-called Barnyard Beds) lying at an altitude of 6m above OD, at the head of the Beauly Firth, were abandoned as relative sea-level fell. The limit of the regression is not known, but a rise in relative sea-level is recorded to 9m above OD at Béauly, and radiocarbon dated to between 7100 and 5775 years BP. This marine transgression is correlated with the Main Postglacial Shoreline of eastern Scotland (Sissons, 1989). The late Holocene has been characterised by falling relative sea-levels (Firth 1990). Minor transgressive events or stillstands are responsible for up to five late-Holocene shorelines (Firth and Haggart 1989).

The Tidal Environment of the Moray Firth

According to the MFP *Geomorphology and Coastal Defence Topic Paper* (p.17) there is a general lack of detailed scientific information on the movement of beach sediment or on the history of onshore wave height and direction. This is compounded by the fact that there are similar gaps in information on offshore wave height/period and direction. The MFP sees this as a serious obstacle in assessing the local effects of any global climate change. This report does however note (p.27) that at present the major tidal currents bypass the mouth of the Moray Firth and pass down the North Sea where the surge in water level can build up to 3m above the predicted level. This has allowed the Moray Firth coast to escape the worst effects of recent storm surges. The Shoreline Management Plan (SMP) 1996 Wallingford publication provides more information based on metrology and hydrographic information obtained from Admiralty records, the Met Office and offshore oil industry. The wave climate is suggested to be dominated by locally generated wind waves and episodic storm activity (see Lamb 1991). Short-fetch lengths are seen as a contributing factor in suppressing wave height (*ibid* p.7). Wind direction is critical in controling the tidal regimes at any given location. The Spring tidal range is quoted (*ibid* p.8) as increasing south-westward within the region; from 2.8/3.1m at Wick/Fraserburgh through 3.5m at Lossiemouth, Burghead and Cromarty, and through 3.6/3.7m at Nairn/Invergordon and 4.1m at Inverness. Overtopping events (breaches in sea defences) and the damage to coastal defence is usually associated with times of both large waves and high water levels. Within the survey area, the largest waves occur during storms from the north-westerly or north-easterly quadrants. There appears to be no known information on wave conditions within the Inverness Firth. Wave energy generated offshore of the Moray Firth will have limited effect on the coastline within the Beauly Firth due to the shelter provided by the forelands of Fort George and Channory.

Sites of Special Scientific Interest

Within the study area there are six sites designated as Sites of Special Scientific Interest and are important for specific habitats of plants and wildlfowl. The Rosemarkie to Shandwick coastline is important for its geology. All sites are associated with maritime and peri-marine environments. Table 1 below lists the sites by name and the reason for their designation.

No	Site Name	Conservation status and habitat	Principal Conservation Interest
1	Beauly Firth	SSSI, intertidal sand and mudflats; saltmarsh	Nationally important site for overwintering wadersand wildfowl; internationally important populations of seaduck.
2	Munlochy Bay	SSSI; intertidal sand and mudflats; saltmarsh	Important area for overwintering wildfowl
3	Conon Islands	SSSI; saltmarsh; fen woodland	Woodland; brackish fen vegetation; woodland and heathland birds; overwintering waders and wildfowl
4	Cromarty Firth	SSSI; intertidal sand and mudflats; saltmarsh; sand and shingle; Nigg & Udale Bays	Internationally and nationally important site for waders and wildfowl.
5	Rosemarkie to Shandwick Coastline	SSSI; slumped cliffs; rocky platform	Coastal cliff vegetation; seabirds; Cromarty and Rosemarkie inliers provide insight into the basement of the East Scotland Caledonides.
6	Tarbat Ness	SSSI; rocky platforms and low cliffs.	Maritime heath and salt spray communities

Table 1 Sites of Special Scientific Interest within the study area. The sites are shown in Figure 2 (Source: Moray Firth Review).

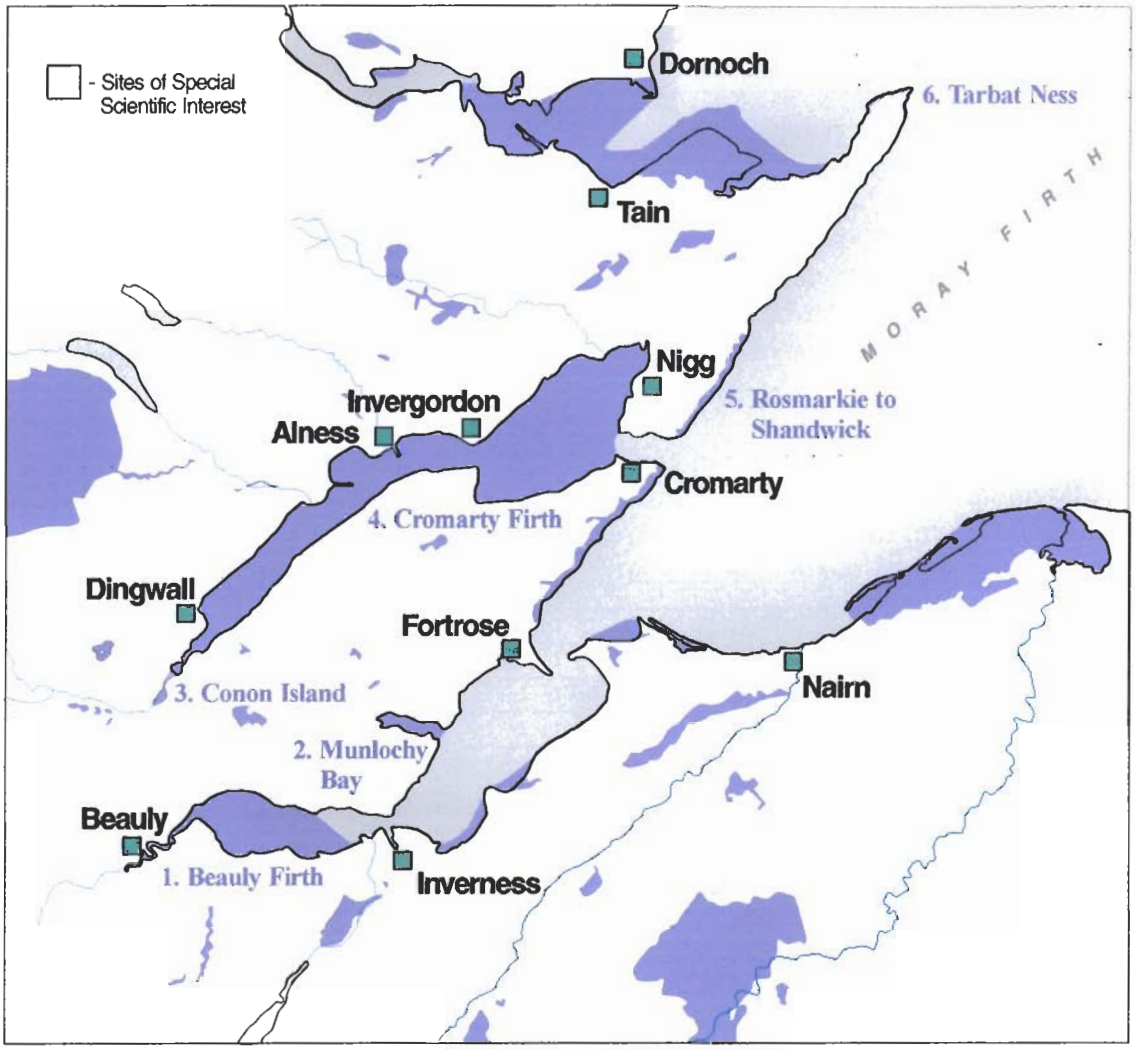


Figure 2. Distribution of Sites of Special Scientific Interest in the survey area.

2 METHODOLOGY

Methodology

The Project Outline requests information regarding the extent of our proposed survey within the total 200km coastal strip. To this end our Project Design proposed a four-phase strategy that would involve; desk-based survey, field survey, specific aerial photographic survey and reporting.

Phase 1 (preliminary work)

CFA conducted a rapid-scan desk-based survey for both archaeological and geomorphological aspects for the full length of the specified coastline from Inverness starting at Clachnaharry and finishing at Tarbat Ness, a distance of 166.8 km based on linear extrapolation. During the course of the rapid scan, CFA made initial contact with the relevant bodies listed in the Historic Scotland Procedure and Project Outline.

Phase 2 (desk based study)

CFA then carried out a full desk-based study, in accordance with Historic Scotland procedures. From this research we identified a series of zones of accretion, stability, or recession, which were subsequently ground truthed to verify the preliminary conclusions on their characteristics derived from the desk-based study. An important aspect of this work was an assessment of the reliability of geological and geomorphological mapping in the survey area.

CFA concurred with the Project Outline in considering that aerial photographic imagery would be of particular importance to the survey, especially in the study of intertidal mud and silt flats. This view was partially an outcome of safety considerations. Examination of accessible aerial photography was also important to ensure good spatial coverage within the constraints of available resources. In addition, however, we consider that the aerial photographic imagery is probably the best source of information for intertidal areas. Previous surveys of intertidal zones have shown that aerial photographic imagery is often the only source which reveals the patterns of large scale features.

There are several series of photographs relevant to the study, including runs from the immediately post war period, and surveys undertaken in the 1960s and' 70s taken for land use capability studies. More recent aerial surveys have been commissioned by SNH and these were scrutinised for additional information. These provide a series of images that can be used for comparative purposes over a considerable period, and when combined with ground inspection, provide evidence for almost 50 years of change. Although the Historic Scotland procedure notes that the examination of several series of photographs and map sources can be expensive, we consider that, especially given the importance we attach to aerial photographic analysis for the intertidal zone, the time employed on aerial photographic analysis and other documentary sources repaid the investment. In addition, it can be difficult in the field to determine whether a given stretch of foreshore is accreting, stable, or eroding, and the accumulated aerial photographic evidence makes this possible.

There have been a number of geomorphological studies made along the Inner Moray Coast, including work by Haggart (1987) and Peacock, Graham & Gregory (1980). Recent work conducted by Dr Andrew Haggart of London Guildhall University assessed the previous models of coastal change over the last ten thousand years and using multi-approach methods has proposed a remodelled sea-level change curve for the area (Haggart 1989). More recently collaboration between geomorphologists and archaeologists has led to the combination of using intertidal archaeological remains as specific sea-level indicators in the Beauly Firth (Haggart, Hale & Firth forthcoming). In many respects the paleoenvironmental data required for the purposes of the project has already been collected, and one of the chief aspects of the work required here is that of collation. Unfortunately, as much of this work has not been conducted with a specific archaeological/heritage interest and has occurred over the last 30 years, there are problems of compatibility of information and standards of research. However, recent commercial development, especially by the Cromarty Firth Partnership, has led to the production of a number of useful geological and geomorphological studies. The focus of most of the palaeoenvironmental research has been on Holocene deposits and the encouraging results indicate the potential for future palaeo-archaeological, multi-discipline research projects to develop in the North-East Firths region.

Phase 3 (fieldwork)

The archaeological survey undertaken required (as specified in the Historic Scotland procedure) to be systematic and to be conducted in all relevant land parcels (with the exception of unsafe intertidal areas). The northern shoreline of the Cromarty Firth has become heavily industrialised since the North Sea oil companies began to use the Firth as a deep water storage and repair base for off-shore oil rigs and the adjacent shorelines as supply depots and fabrication yards. This was considered likely to have had an impact on both the presence of archaeological remains and their visibility. No survey work was undertaken within the extensive petrochemical installations at Invergordon and further south at the Nigg Offshore Fabrication yards (see Map Sheet 25 below). However the desk-based assessment did take into account all the sites and monuments previously destroyed as a result of their construction. It was clear on the ground that industrial development had in fact been so intense to make inspection worthless in the immediate hinterland behind the artificial coasts created to protect them. Where access was available on the seaward side of the works, then the foreshore was examined according to normal procedures.

Based on the information obtained at the desk-based stage (both archaeological and geomorphological), we ensured that the field survey covered a representative sample of the various combinations of environmental settings and on the cultural side, periods/site types. There were no restrictions to access in regard sensitive wildlife areas including sites designated as SSSIs.

The desk study was completed before fieldwork commenced, allowing the field teams to be supplied with data assembled from a range of sources for checking. In essence, the fieldwork comprised standard archaeological fieldwalking survey, combined with the recording of the erosional status of sites, the assessment of vulnerable parts of the landscape, and ground truthing of geomorphological data. We used GPS to assist in the determination of the location of sites for mapping as required in the Historic

Scotland Procedure, where local mapped features did not provide an accurate fix. The survey was not done in a single sweep but was carried out at selected points along the coast in order to take into account the vagaries of local tidal variation. Separate field visits along key locations by the geomorphology team (Drs Cressey, Murray and Alex Hale) ensured that the observations made during the initial survey were as accurate as possible. Additional information was added to CFA's Rapid Coastal Assessment Sheets as required.

The initial survey was undertaken during September 1998, during which the full advantage of the equinoctal tides were taken and no time was lost to inclement weather. The only restriction imposed on the field team was access to beaches at the base of precipitous cliffs. These were encountered at the North and South Sutors, parts of which were not surveyed on the grounds of health and safety.

Phase 4 (report compilation)

We allowed a considerable time element for reporting, as we appreciated that a considerable volume of data is likely to be produced during the survey. The present Report has been constructed using digitised map-based data based on desk-based results and field data. The survey map sheets are shown from south to north forming a logical progression around this sinuous part of the Scottish coastline.