The Role of Sea Affordance and Monument Orientation in the Landscape Contexts of the Long Cairns of Scotland

A Phenomenological and GIS-Based 'Hybrid' Approach

Ruwangi Griffiths

April 2021

A thesis submitted for the degree of
Doctor of Philosophy
of The Australian National University.

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of any educational institution.

Ruwangi Griffiths

02 – 02 – 2021

Word count: 93,989

Acknowledgements

I owe many thanks to many people for their assistance and guidance while I undertook this work. First and foremost, to my supervisors: I have received considerable tuition, at different times, from Catherine Frieman, Thomas Whitley, Gail Higginbottom and Ian Farrington. All played crucial roles in educating me in the practise of landscape archaeology and in offering me the support I needed to see this through to completion.

When I started my studies at ANU, my focus was drawn to the specific area of archeoastronomy, within landscape archaeology. I am indebted to Gail for introducing me to that field, to the British Neolithic, alignment studies, and to Scotland (during my visit in 2012). Her enthusiasm for these subjects was and remains infectious, and has been a genuine source of strength. I am so grateful for the time I had at ANU under her guidance, and for her support since then. I am also indebted to Ian, for instructing me in the study of ethnoarchaeology and archeoastronomy, before his retirement.

After deciding to use GIS-based techniques to study the landscapes that surround Scotland's Neolithic monuments, I required specialist instruction in that area. After making painfully slow progress for some months, I found and contacted Thomas Whitley. Tom agreed to offer me supervision as I tackled some technical issues using GIS software. I had no idea of the extent to which he would attend to my concerns and would be prepared to guide me in learning to use the various techniques, and to combine them in novel ways. I never had a question too dull, or too ambitious for him to answer it definitively, usually with a number of different solutions, each of which would have satisfied me. I remain thankful beyond belief for his level of input and engagement, not to mention for guiding me through that minefield of technical issues!

By the time Catherine Frieman agreed to be my principal supervisor in 2013 (after Ian's retirement), I had a rough outline of the methodology and rationale for this work and had completed several steps involving both fieldwork and data analysis. However, I did not yet feel that I had sufficient mastery of the theoretical background to the direction that my work was heading that would show where and how it could take relevance in the archaeological literature. Cate's guidance has been invaluable is several ways since that time. Not only did she ensure that I had a more rigorous appreciation for the wider literature, but she also closely engaged with my work and systematically offered constructive criticism that would lift the standard of both my thought on the subject and my written expression. Cate's input has seen me grow as an archaeologist and my work transform and evolve in ways beyond what I had hoped for. I am very pleased to be able to thank her for that, as well as for her enduring patience and unfailing support.

I am also grateful for several meetings with Kenneth Brophy as well as Dave Cowley and Angela Gannon (from RCHMS) for helping guide me as I considered which monuments to study. I am further thankful for Dave and Angela for some GIS training and for their assistance accessing the relevant records. I am grateful to Gail to have the pleasure to meet Roderick McCullagh, an especially enthusiastic, senior archaeologist who welcomed me to Scotland and offered me some practical advice before I undertook my fieldwork there.

It was wonderful that so many archaeologists were able to meet me and discuss their perspectives on my prospective research in 2012. Those meetings were all very meaningful to me and I owe a special thanks to each of them for taking the time and for giving me their thoughtful consideration: Colin Richards, Clive Ruggles, David Field, Martin Barber, Joshua Pollard, Timothy Darvill, and Richard Bradley. I am especially grateful to Richard Bradley for engaging with problems I was having while considering an alignment study of henge monuments, and for his suggestion that the long cairns of Scotland may be a more suitable class of monuments to use for my purposes.

Andrew Smith provided me with ongoing support, over a period of years, while I used his software, Horizon. I am very thankful to him for that, and for his guidance.

I received vital research material through correspondence I had, respectively, with Vicky Cummings, Richard Tipping, and Steward Eve. I am very grateful to them each for sharing with me their work and for their encouragement.

I am also thankful to British Geological Survey for allowing me access to their databases.

And, of course, to my husband, Paul. As a trained philosopher, he was always keen to hear my different ideas, offer his perspectives, and read through my work. I am extremely grateful for the conversations we shared, not to mention for his company and his assistance in visiting and surveying nearly a hundred monuments scattered across Scotland! I am also grateful for ongoing meetings with his supervisor, the late Tom Campbell, for his support and good humour, and for providing us with accommodation at Oxford University while we visited monuments in south England.

My family has also been instrumental in providing me encouragement and giving me the strength to persist through the various challenges we have faced together and to see this through to completion. Both of my parents have been constant sources of strength. I am grateful to them, and I am also grateful to my two young children, Sasanka and Sakula (of four and two years), for their patience.

Abstract

Many have argued that the landscape setting of prehistoric monuments played a significant role in shaping the experience of places and have thus sought to understand the relationships between monuments and their surrounding landscapes. One such claim is that sea views may have played a role in the placement of megalithic monuments, yet there has been a lack of substantial empirical data to support this. In adopting currently available GIS techniques and the concepts of 'affordance' and monument orientation, this thesis seeks to interrogate this interpretation using the long cairns of the coastal regions of Scotland, dating to the Neolithic. Several trends are found in the data that support this interpretation. Namely, the long cairns considered seem to be placed preferentially in their landscapes to afford sea views. In large numbers, these cairns are also found to be placed to reveal sea views to observers as they approach the sites from a seaward direction, creating potentially auspicious effects that arguably reference the sea. In addition, it is found that these monuments are often oriented in way that suggests a reference to the sea. There is some variability in these trends and in their prevalence in the different regions of Scotland investigated, which may be attributable to other factors also determining monument placement and to variability in the landscape types between those different regions. This investigation provides an illustration of how digital technology can be adapted to further explore and support insights gained through phenomenological narratives and examine the validity of the conclusions drawn in the field. Additionally, it is hoped that the predictive models created using this GIS-based analysis can, in turn, be tested and informed by future experiential-based field observations. This thesis thereby aims to contribute to ongoing discussions on the development of a hybrid approach that combines both phenomenological and GIS-based analysis, highlighting the dual potential of such an approach.

Contents

Acknowledgements 3

Abstract 5

Chapter 1: Introduction 11

1.1 Aims 13

1.2 Chapter Outline 14

Chapter 2: Approaches to Landscape Archaeology 177

2.1 Experiential-based Approaches to Landscape Archaeology and their Critiques 18

Phenomenological Theory and Methodology 19

Critiques of Phenomenological Analysis 20

The Use of Metaphorical Possibilities in Phenomenological Studies 23

Phenomenological Reconstructions of Past Experiences as Incomplete 24

2.2 GIS and its Limitations in Phenomenologically Orientated Studies 25

Cartesian Perspectivalism 26

Primacy of the visual 28

2.3 The Potential Benefits of a 'Hybrid Approach' to Landscape Archaeology 30

Benefits of GIS Techniques for Phenomenological Approaches to Archaeology 32

2.4 Monuments as Referencing the Sea 36

Chapter 3: The Long Cairns of Scotland 39

3.1 The Prehistoric Context of the Long Cairns of Scotland 39

The Beginning of the European Neolithic 39

Long Barrows in Europe 40

Long Cairns and the British Neolithic 42

3.2 Classification and Morphology 45

Façades and forecourts 48

Chambers and Cairn Cores 49

Regional Diversity of the Long Cairns of Scotland 50

3.3 Long Cairns as Multi-Period Constructions 52

3.4 How Long Cairns were Used 53

3.5 The Landscape Sitting of Long Cairns 55

3.5 Summary 58

Chapter 4: Methodology 59

4.1 Preliminary Bibliographical and Database Research 60

4.2 Field Visitation and Recording 61
4.3 Sea Affordance Analysis 77
Assumptions and Limitations from Computer Processing 78
A Limitation of a Sea Affordance Viewshed: The Problem of the 'Shadow Effect' 82
Correcting for the Shadow Effect 86
4.4 Quantitative and Qualitative Analysis of Surrounding Landscapes 88
4.5 Testing for Revelatory Views: Cost Corridor Analyses and Sea Affordance Profiles 89
Cost Corridors and Considerations for Cost Surfaces 90
Generating Friction Surfaces and Modelling Cost Corridors 92
Assessing Pathways for Revelatory Views 94
4.6 Alignments of Long Cairns' Axes, Sea Views and Pathways 97
4.7 Summary 100
Chapter 5: Analysis of the Long Cairn of Dumfries and Galloway 101
5.1 Sea Affordance Surfaces and Statistical Considerations 101
Sea Affordance Analysis and Verification of Results 103
Statistical Considerations 106
5.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones 111
Analysis of Site Locations and Alternative Locations using Horizon Panoramas 115
Considering the Effect of Atmospheric Conditions 119
5.3 Testing for Revelatory Views 121
The Presence of Sea Previews along Pathways 122
Comparison of Site Locations and Preview Locations using Horizon Panoramas 126
Considering the Effect of Atmospheric Conditions 130
5.4 Alignments of Long Cairn Axes, Sea Views and Pathways 134
Orientation of Cairns Relative to Sea Views 134
Orientation of Pathways Relative to Sea Views and Monuments 134
5.5 Summary 140
Chapter 6: Analysis of the Long Cairns of Argyll and Bute 142
6.1 Sea Affordance Surfaces and Statistical Considerations 142
6.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones 148
Investigation of Cairns' Surrounding Landscapes and the Presence of 'Alternative Locations' 15251

Investigation of Alternative Locations using Horizon Panoramas 15857

Considering the Effect of Atmospheric Conditions..15958

6.3 Testing for Revelatory Views..16361

Analysis of Sea Affordance Profiles and Preview Locations..17271

Comparison of Site Locations and Preview Locations with Horizon Panoramas................17473

Considering the Effect of Atmospheric Conditions on Preview Locations 1776

6.4 Alignments of Long Cairn Axes, Sea Views and Pathways 18079

Orientation of Cairns Relative to Sea Views 18079

Orientation of Pathways Relative to Sea Views and Monuments 18483

6.5 Summary...1876

Chapter 7: Analysis of the Long Cairns of the Highlands..18988

7.1 Sea Affordance Surfaces and Statistical Considerations 18988

Sea Affordance Analysis and Verification of Results..19695

Statistical Considerations.. 200

7.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones...............................210

Investigation of Alternative Locations using Horizon Panoramas 216

Considering the Effect of Atmospheric Conditions.. 221

7.3 Testing for Revelatory Views..22625

Varieties of Revelatory Views.. 229

Investigation of Revelatory Views and Previews with Horizon Panoramas 24140

Comparison of Site Locations and Preview Locations with Horizon Panoramas.................25251

Considering the Effect of Atmospheric Conditions on Revelatory Views 26059

Considering the Effect of Atmospheric Conditions on Sea Views from Preview Locations....26867

7.4 Alignments of Long Cairn Axes, Sea Views and Pathways 27372

Orientation of Cairns Relative to Sea Views 27372

Orientation of Pathways Relative to Sea Views and Monuments 27574

7.5 Summary...28079

Chapter 8: Analysis of the Long Cairns of Aberdeenshire...28281

8.1 Sea Affordance Surfaces and Statistical Considerations 28281

Consideration of Sites and Verification of Sea Affordance Analysis...................................28685

Statistical Considerations.. 296

8.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones 2998
Initial Analysis of Sites with Horizon Panoramas 3009
Effects of Atmospheric Conditions on Sea Views from Cairn Sites 303
Investigation of Alternative Locations that offer Higher Sea Affordance Values 306
Investigation of Alternative Locations using Horizon Panoramas 311
Considering the Effect of Atmospheric Conditions 314
8.3 Testing for Revelatory Views 317
Investigation of Previews with Horizon Panoramas 32322
Considering the Effect of Atmospheric Conditions on Sea Previews 32524
8.4 Alignments of Long Cairns' Axes, Sea Views and Pathways 32827
Orientation of Cairns Relative to Sea Views 32827
Orientation of Pathways Relative to Sea Views and Monuments 3298
8.5 Summary 332
Chapter 9: Analysis of the Long Cairns of the Isle of Arran 33433
9.1 Sea Affordance Surfaces and Statistical Considerations 33433
Consideration of Sites and Verification of Sea Affordance Analysis 3365
Statistical Considerations 33938
9.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones 34443
Investigation of Alternative Locations that Offer Higher Sea Affordance Values 35049
Investigation of Alternative Locations using Horizon Panoramas 35453
Considering the Effect of Atmospheric Conditions 35958
9.3 Testing for Revelatory Views 36362
Investigation of Previews with Horizon Panoramas 37170
Considering the Effect of Atmospheric Conditions on Revelatory Views and Previews 376
9.4 Alignments of Long Cairns' Axes, Sea Views and Pathways 38180
Orientation of Cairns Relative to Sea Views 38180
Orientation of Pathways Relative to Sea Views and Monuments 38382
9.5 Summary 3887
Chapter 10: Discussion of Results 39089
10.1 Consideration of Sea Affordance Values and the Sea Views at Cairn Sites 39089
10.2 Study of Alternative Locations 3998

10.3 Investigation of the Idea of a Revelatory View of the Sea.......400
The Significance of Previews 401
On the Noticeability of Sea Views and 'Revelatory' Views 405
10.4 Investigation of Long Cairn Orientations and Potential Alignments with the Sea 409
Alignments Toward Sea Views 409
Axis Alignments Towards 'Narrower' Sea Views 412
The Prevalence of Sightlines 412
Axial Sightlines in Isolation.......416
Arrival Locations of Seaward Pathways 417
10.5 Overview and Discussion of the Four Steps of the Investigation.......418
Chapter 11: Conclusion.......422
11.1 The Long Cairns of Scotland as Referencing the Sea.......42625
11.2 Wider Implications of this Study 43130
11.3 The Inclusion of Further Factors Relevant to Location Choice 43231
References 434
Appendix 446

Chapter 1: Introduction

A scarcity of preserved remains from which to draw inferences about the past is a problem often faced in prehistoric archaeology, and for that reason landscape archaeology can be especially useful in the study of the Neolithic period. Landscape archaeology concerns the areas beyond as well as within the immediate space that defines a given archaeological site and brings into focus the significance of its surrounding environment, how that environment was used and how it was affected and altered in such use. In phenomenological approaches to landscape archaeology, the perception of space is considered to be influenced by an individual's engagement with a given landscape, as mediated by their senses. These approaches involve the investigation of the qualitative attributes of a landscape's natural features, including topography and vegetation, and how those features might have been perceived to interact with or accentuate the features of an archaeological site during the time of its use. A claim that is taken seriously in such investigations is that 'certain locations embodied specific visual (and spatial) relationships with elements of the wider world that themselves encoded strong social and cosmological significance…and in turn these propitious places were marked through the construction of monuments' (Gillings 2009, p. 342). An example of one such way that monuments may mark the features of their surroundings is by referencing the sea, which is of a particular interest due to the ability of the sea and water more generally to symbolize a range of concepts and themes, including death and transition, purity, the wider cosmos, and the origin of a people's ancestors (Rudhardt 1987, pp. 350-58).

Phenomenological approaches present a fertile source from which to speculate about the past and a means of increasing our understanding of the range of the possible ways that archaeological sites and their landscapes may have been experienced during their use, and the kinds of meanings that may have been attributed to them. However, a persistent problem that these approaches have faced results from the subjective epistemology from which they often draw. Phenomenological claims are criticised for their lack of verifiability and because they are often unchallengeable (see Barrett and Ko 2009; Fleming 1999; 2005; 2006; Liddiard and Williamson 2008; Shennan 2002). Their ability to further knowledge about the past is to that extent limited.

Purely phenomenological approaches to landscape archaeology can be contrasted with approaches that implement GIS techniques in landscape analysis, which provide a method for the scientific representation of data and a replicable means of drawing inferences about the past. There has been a tendency for proponents of these two approaches to landscape archaeology to remain separate and even to reject interpretations and methodologies belonging to the other (Barrett and Ko 2009; Fleming 1999; 2005; 2006; Johnson 2006). However, rather than being mutually exclusive, there is wide scope for the concepts and techniques used in these approaches to inform and enhance one another. This thesis demonstrates not only that there is a broad area of compatibility between phenomenological and GIS-based approaches to landscape archaeology, but also that using each approach in tandem with the other—in a 'hybrid approach' to landscape—allows for an interplay and cross-fertilization of methods, data, and theories that both guide and result from ongoing investigation.

The long cairns of Scotland are used as a case study to investigate a claim made in phenomenological studies of landscape, alluded to above, which is that the sea is often referenced through monument placement and that such a reference signifies an important aspect of a Neolithic culture. Similar Neolithic chambered tombs are found scattered across the British Isles. Built as communal burial places by the earliest farming communities, composed of trapezoidal or rectangular mounds of stone, long cairns are amongst the oldest surviving and most permanent of archaeological structures in the landscape. To date, approximately 615 chambered cairns have been identified in the British Isles and of those about 213 are long in design, and thus known as 'long cairns'. Over the years, the long cairns of Scotland have been frequently overlooked: of the known sites, about 32 have been excavated but only a handful have been excavated to modern scientific standards. Since the information that is available regarding the long cairns of Scotland is derived from the few individual sites that have been thoroughly investigated, only relatively superficial generalizations are made about this group of monuments in its entirety. Nevertheless, many have argued that the landscape settings of such prehistoric monuments were significant (Cummings and Whittle 2004; Cummings 2008; Millican 2012; Tilley 1994). There is, therefore, a rich source of speculation made in phenomenological approaches to landscape that holds direct bearing on the long cairns of Scotland. Yet, this group of monuments and the contexts in which they lie also present a rich source of data that lends itself easily to investigation via GIS-based techniques of landscape analysis. This presents an ideal opportunity to further the capacity to gain insights into the past, through the development of a hybrid approach to the study of landscape that incorporates the methods and imaginations used in both disciplines; of phenomenological approaches to landscape, and of the scientific rigor of GIS-based techniques and assessments.

1.1 Aims

The thesis has three complementary aims, each of which are situated at different levels of generality. First, at the most general level, the thesis aims to make a methodological contribution to the practice of archaeology, by presenting an example of a hybrid approach to the study of landscape. It is argued here that such an approach holds a 'dual potential'. On the one hand, GIS has the capacity to provide an evidential base to support experiential-based, or phenomenologically inspired, interpretations, overcoming criticism levelled at phenomenologically orientated studies. This thesis, thus, seeks to provide an illustration of how digital technology can be adapted to further explore, support or reject ideas discovered and presented in phenomenological narratives. On the other hand, interpretations and conclusions drawn from GIS-based analysis may both be informed and verified by experiential-based field observations. Thus, insights and data gained from either approach may be used to test the other, in turn leading to a more complete and a more coherent picture of the past. It is hoped that the dual potential for such a hybrid approach to landscape archaeology will contribute to current dialogue and demonstrate a decisive way forward in improving extant methodology.

The second aim of this thesis is to test the claim made in phenomenological studies of landscape that sea views played an important role in monument placement, such that prehistoric builders often deliberately chose locations or constructed their monuments to reference the sea. There are many reasons why the sea, and water more generally, may have played important roles in the lives of prehistoric people, and thus why the sea may have been referenced in the construction of their monuments. Yet, empirical evidence in support of this claim has arguably not been provided on a scale sufficiently large to take this claim beyond the realm of speculation, however well informed it may be. Therefore, this thesis will investigate ways in which this claim may either be supported or rejected on an empirical basis.

These two, general aims will be pursued via the third and most specific aim of this thesis, which is to test the claim that the long cairns of Scotland's coastal regions were deliberately positioned and constructed in such a way so as to reference the sea, through what is known as an 'orientation study' of this monument type (Hoskin, 2001). Long cairns were chosen for two main reasons that became apparent to the researcher after an attempt to conduct a similar investigation, in the earlier phases of this study, using 'henges'; a different monument type of a roughly though not identically contemporaneous period in British prehistory. Due to their likely ceremonial significance for prehistoric peoples, henges – causewayed earthwork enclosures comprising an external bank and internal ditch – present an interesting example of a monument type that could be studied for their possible orientations toward and associations with bodies of water, amongst other features of their surroundings, such as astronomical phenomena. However, a study using this monument type was determined to be less fruitful and pose greater problems than the monument type ultimately chosen. As detailed in Ru Griffiths (2020), this was due mainly to: first, difficulties in distinguishing henges from other prehistoric constructions, such as round houses, which may leave similar footprints in the landscape (see also Bradley 2011); and relatedly, second, the vastly fewer numbers of confirmed henges in comparison to the number of long cairns found in the same regions of Britain. The trends discoverable from an orientation-study of henges were, therefore, deemed not to be capable of being held with a same level of confidence, by an order of magnitude, than the trends that might be discovered regarding the long cairns of Scotland, on the basis of a similarly designed study.

It is supposed that there are a number of ways that the long cairns of Scotland's coastal regions could have been deliberately positioned and constructed in such a way so as to reference the sea. First, long cairns might be placed preferentially in locations that afforded either sufficient sea views or the greatest sea views in a given area. Second, cairns may be oriented so as to reference the sea with their features, and this may have been achieved with a monument's long axis, or other aspects of its structure such as chambers and forecourts, being aligned towards the sea. Third, a monument may have been positioned deliberately so that a person approaching the monument would be unaware of the visual backdrop of the seascape until they reach the structure (Cummings 2002a; Scarre 2002, pp. 84-102; Tilley and Bennett 2001, pp. 335–362). Topographic features such as ridges, for instance, may mask a person's view of the sea on their approach from lower ground until they reach the structure placed at higher ground where the seascape would suddenly be revealed (Scarre 2002, pp. 84-102). Such locations are referred to as having 'revelatory views' of the sea. Several theorists have suggested that locations with revelatory views were chosen intentionally to 'choreograph visual exposure' (Cummings 2004, p. 33; Cummings and Fowler 2004, p. 3), perhaps to create a sense of anticipation and awe (Harding 2003).

Confirmation that monuments' affordance of sea views and revelatory views were intended by prehistoric builders would shed light on aspects of their belief systems that would be of interest in archaeology. However, as foreshadowed above, theorists have not provided empirical support for their claim that such views were deliberate. By investigating these claims, this thesis addresses this shortcoming.

The aforementioned aims are restated here in the form of research questions.

1) To what extent, and in what specific ways, may a hybrid combination of phenomenology and GIS based approaches to landscape archaeology be used to inform our understanding of past peoples and the landscapes they inhabited?

2) Can phenomenological studies of landscape be confirmed to be correct in supposing that sea views played an important role in monument placement, such that prehistoric builders often deliberately chose locations or constructed their monuments to reference the sea?

3) Were the long cairns of Scotland's coastal regions deliberately positioned and constructed so as to reference the sea in any of the following ways?
    a. Were these long cairns placed preferentially in locations that afforded either sufficient sea views or the greatest sea views in a given area?
    b. Are these long cairns oriented so as to reference the sea with their structural features or other features relating to the way in which they were used, such as burial chambers or the sites of ceremonies, such as forecourts?
    c. Were these monuments positioned deliberately so that a person approaching the monument would be unaware of the visual backdrop of the seascape until they reach the structure, perhaps to create a sense of anticipation and awe?

1.2 Chapter Outline

Chapter 2 describes the two dominant approaches to landscape archaeology, those that primarily use either phenomenological- or GIS-based methods. The critiques of both approaches are examined and the chapter concludes by noting that there exists wide areas of compatibility between them. It is also demonstrated that there are sound grounds for supposing, with phenomenologists, that prehistoric monuments such as the long cairns of Scotland may hold some associations with bodies of water, and that such associations may be effectively investigated through the use of GIS technologies. Chapter 3 provides background information on the long cairns of Scotland, as a group of monuments and as partaking in the larger class of 'long barrows' that belongs to the European Neolithic. The cultural origins of the monuments are described together with their morphology, the chronology of their construction and use and their environmental settings. Chapter 4 details the methodology that is used to investigate the monuments and the claim that they reference the sea. Chapters 5 to 9 respectively describe the results of the analysis of the 5 regions under investigation: Dumfries and Galloway, Argyll and Bute, the Highlands, Aberdeenshire, and the Isle of Arran. Chapter 10 discusses the results of those regions considered together, before the conclusions of the thesis are presented in Chapter 11.

Chapter 2: Approaches to Landscape Archaeology

GIS and the Inhabited Landscape

There are two dominant approaches to landscape archaeology. These are, first, the traditional and processualist methods that are commonly used in GIS-based analysis, and second, phenomenological or experiential-based forms of investigation. Both approaches have been subjected to wide-ranging criticisms and there was once a subsequent tendency for researchers not to use both approaches in tandem. Nevertheless, debates over the last decade have demonstrated the merits of integrating GIS methods within phenomenological frameworks, such as the method employed in the present research (see Graves 2012, pp. 526-547; Graves and Millican 2012; Johnson 2012, pp. 279-280; Millican 2012a, pp. 548-563).

This chapter describes the theoretical underpinnings for those approaches and the potential benefits of a 'hybrid' approach that incorporates concepts and techniques from both. First, phenomenological forms of investigation of landscape are considered, alongside critiques of that approach. Second, the traditional processualist methods of landscape archaeology used in GIS-based analysis and critiques of those methods are considered. The third section of this chapter describes the wide scope for these different approaches to inform and enhance each other in principle, and how GIS-based mapping methods and predictive techniques, among other digital technologies, may provide an evidential base that augments experiential-based approaches. It is further supposed that the amalgamation of these qualitative and quantitative techniques in a 'hybrid' approach is likely to lead to more meaningful interpretations and thus to a better understanding of past societies. Finally, the fourth section of the chapter addresses the claim made in phenomenological studies of landscape, which is investigated in this thesis, that water may have played an integral role in the placement of megalithic structures.

2.1 Experiential-based Approaches to Landscape Archaeology and their Critiques

Landscape archaeology concerns the area beyond the immediate space that defines a given archaeological site, so as to bring into focus the significance of the surrounding environment, how it was used and how it was affected and altered in such use. This field of archaeology affords a range of insights into the way that space was engaged with by actors in the past. However, until the late twentieth century, studies in landscape archaeology used a processualist framework that largely focused on the investigation of economic, subsistence and settlement patterns while ignoring other aspects of human behaviour, such as religious beliefs and the place of aesthetics. A need for a different theoretical framework sprang from dissatisfaction with the way that space was conceptualized under traditional archaeological methods. Post-processual archaeologists began exploring 'human subjectivity' and integrating phenomenological concepts into the discipline of landscape archaeology (Cosgrove 1978; 1985; Gosden 1996; Tilley 1994). This new wave of landscape analysis originated in Britain and was pioneered by archaeologists such as Christopher Tilley (1994), Julian Thomas (1996), Barbra Bender (1993), and Mark Edmonds (1999). Over the years, it gained considerable momentum in archaeological work concentrating on north-west Europe (see Bender et al, 1998; Edmonds 1999; 2004; Tilley 1994; 2004b).

Explicit in the original, processualist framework for landscape archaeology was the assumption that archaeology should be conducted scientifically. In a quest for objectivity and scientific verification, human subjectivity was discounted as factor that might be worthy of consideration, while landscape was seen purely as a 'backdrop against which archaeological remains were plotted' (Knapp and Ashmore 1999, p. 1). As Tilley (1994, p. 9) observes, processualists considered space to be 'an abstract dimension or container in which human activities and events took place'. Such positivist viewpoints inadequately take stock of the influence the individual's engagement with landscape may have had on the meanings and construction of places (Bell 1994, p. 277).

The main issue raised regarding processualist enquiries stems from their empirically driven nature. In order to review and offer statements about the past, these enquiries rely heavily on two-dimensional representations of landscapes such as maps, texts, aerial photographs as well as statistical analyses and simulations (Thomas 2001, pp. 163-186; Tilley 2012). Persistently ignored in this dominant theoretical practice is the explanatory power of human cognizance and its potential in underpinning and bringing about cultural transformation (Thomas 2001, Tilley 2012).

Consequently, post-processualists argue that the traditional approach is capable of providing 'only a relatively superficial and abstracted knowledge' about the past (Tilley 2012, p. 26). Due to this perceived failing, post-processualists have offered a novel conceptual framework based on the notion that landscapes are culturally constructed and imbued with meaning (see Cosgrove 1984; Renfrew and Bahn 2005, pp. 157-58). In this shift towards understanding individual human experience, such theorists urge us to re-examine the meanings and values that may have emerged as a result of the intricate relationships between humans and the physical environments that they inhabited.

Phenomenological Theory and Methodology

Phenomenology is a branch of philosophy that is based on the idea that perceptions and experiences arise from an inseparable relationship between human bodies and the physical worlds in which they find themselves (Heidegger 1927; Merleau-Ponty 1945). The main implication of this idea is that one's views and experiences are mediated through the physical engagement of the body with the material world (Brück 2005, pp. 45-72). In Tilley's germinal text, *A Phenomenology of Landscape*, he notes that all human beings, past and present, share an identical element: the body. It follows, then, that by recording and describing the embodied experiences of the researcher, insights may be gained into the experiences and interpretations of those who inhabited the same physical landscape during prehistoric times (see Cummings 2002; Tilley 1994; 2004, pp. 201-22; 2012).

Experiential-based approaches propose a sensuous examination of the past through the body. These studies require the phenomenologist to be fully immersed within a three-dimensional landscape and to explore the roles all senses play in determining how space is perceived and how the multisensory composition of experience may have shaped and structured prehistoric peoples' understanding of the world. As detailed below, it is supposed that phenomenological perspectives may enrich our understanding of how archaeological landscapes were engaged with and perceived by prehistoric people, enhancing the interpretive possibilities of the past in ways that surpass those that are afforded by the conventional techniques that are used in archaeology.

From a methodological point of view, experiential-based approaches involve 'participant observation', drawing information from being 'inside' a given landscape (Cosgrove 1984; Tilley 2012). For instance, in an attempt to investigate how acoustic properties may have orchestrated people's encounters with monuments, Watson and Keating (1999, pp. 325-336) performed acoustic tests in the presence of an audience at the site of Camster Round, a Neolithic passage-grave. Their tests revealed how the sound produced from a beating drum could reverberate off the stone walls of the main chamber, amplifying the volume within and creating unusual sensory effects on individuals, such as changes in heart rate and breathing patterns. Tilley (2012), among others, argues that such insights can only be derived by being directly 'inside' the landscapes being studied, from an emit perspective, as opposed to from 'outside' experiences of a landscape, or from etic perspectives.

To illustrate this point further, consider gazing out of the window of an aeroplane or a moving vehicle. Such perspectives provide a merely visual experience of the surrounds. Being detached from the physical land itself, the extent of the experience is diminished as it is deprived of input from other sensory modalities such as smell, sound, taste and texture. Similarly, in the case of an investigator examining aerial photographs or digitally created landscapes, sensorial experiences are limited to the visual modality alone: the researcher, the 'non-participating observer', is detached spatially from reality (Cosgrove 1984; Haciguzeller 2012, pp. 245-263). To be sure, such traditional methods of analysis may reveal visual characteristics and spatial properties that enhance our understanding of a given landscape. However, many believe that resulting reconstructions of prehistory are unsatisfactory, as past peoples would not have perceived and experienced space in such a disembodied, or as some maintain, 'inhuman' way (Thomas 1993; Tilley 1994; 2012). Hence, some post-processualists have rejected many available quantitative methods, arguing that the kind of knowledge gained through those approaches is partial or distanciated and 'will never succeed in producing the understanding of the past which we require' (Thomas 1996, pp. 88-89; Tilley 2012).

Critiques of Phenomenological Analysis

Although its proponents consider the phenomenological analysis of landscape as a better alternative to traditional methods, and an innovative means of accessing and interpreting past landscapes, a key flaw in phenomenological research results from practitioners not making their methodologies explicit other than offering relatively small sets of guidelines. Existing guidelines include: Tilley's (2008; 2010) 'phenomenological walk', which consists of journeying through the landscape and observing and providing 'thick' descriptions of 'the ways monuments and topography relate'; Cummings et al.'s (2002) implementation of 360º panoramic sketches and photographs taken from a set point at the centre of a monument, which are made available to allow other researchers to reproduce the observations made; Hamilton and Whitehouse's (2006) development of Cummings et al.'s (2002) method; and, Cummings and Whittle's (2004) use of viewshed maps to represent on-site observations.

The scant reliable methodologies for 'capturing, communicating and interrogating the results' (Gillings 2011) has, then, led opponents to criticize intensely phenomenologically inspired studies (see Barrett and Ko 2009; Fleming 1999; 2005; 2006; Johnson 2006). Many commenters conclude that such studies persistently fail to offer robust methodologies for carrying out fieldwork (Hamilton and Whitehouse 2006; Llobera, 2012). Phenomenological analysis has, thus, ignited much discussion within the discipline and has been widely criticized for being 'subjective' and 'unscientific' (see Barrett and Ko 2009; Fleming 1999; 2005; 2006; Liddiard and Williamson 2008; Shennan 2002). This section presents the grounds for such criticisms.

A central problem with phenomenological narratives of prehistory results from their highly speculative nature, which introduces concerns regarding the validity of their evidential criteria and the often impossibility of verifying their subjective claims. As Fleming (2006) comments, some of these works are 'imaginative' and 'hyper-interpretive' with 'overtly emotive' or 'poetic' writing styles. Thus, without relevant supporting evidence, phenomenologically inspired studies often lack the required scientific rigor (Boado and V´azquez 2000; Chadwick 2004a, p. 21; Fleming 1999; Llobera 2001; 1005).

The following two examples demonstrate the speculative nature of these studies. Cummings and Whittle (2003, pp. 255-266) attempt to account for the experience and engagement of Neolithic people living in wooded settings by drawing on their own field observations and on an analogy from the Yolngu tribe of Arnhem Land, Australia, where tree trunks are associated with bones and leaves with flesh. Using this anthropological insight and taking into account the seasonality of the annual woodland cycle, Cummings and Whittle (2003, p. 262) argue that trees may have been 'an integral part of the experience and use of early Neolithic monuments'. They explain that the deceased's body would have been placed to decompose during summer months when trees are full of leaves, which draws a connection between leaves and flesh. Furthermore, Cummings and Whittle also suggest that foliage would have partially obscured the view of these sites from the wider community, as such places may have been identified as a source of pollution due to the decomposition and putrefaction of corpses. These associations stand in contrast with the winter months, when tree trunks are left bare and monuments become more visible through the landscape. Therefore, in observing the association between tree trunks and skeletal remains, Cummings and Whittle suggest that the winter months may have been a time for the deposition of de-fleshed bones. In this way, Cummings and Whittle (2003, p. 262) provide what they acknowledge to be a deliberately speculative account of how Neolithic tombs may have been 'actually used and perceived'. A second example of the speculative nature of phenomenologically inspired studies is seen in Cummings' (2003) work on the chambered tombs of western Britain. Cummings suggests that monuments were placed on hillsides deliberately in order to restrict the view in one direction with the immediate hill slope. Additionally, she argues that this is found to be the case 'at virtually every site in western Britain and beyond' (Cummings 2003, p. 29). Consequently, she accepts that such a 'restricted view' was somehow significant, a key factor in determining the choice of location for the construction of chambered tombs.

The speculation used in both of these examples lends itself easily to overgeneralization and a methodological neglect of alternative hypotheses. For instance, the first example relies on an analogy between Indigenous Australian culture and the British Neolithic, yet there are a multitude of other available associations that could be drawn from ethnographical accounts. That narrative is but one possible interpretation of the past. Moreover, regarding the second of the above examples, there are many possible factors that may have led prehistoric peoples to build on hillsides. A point that Cummings and Whittle (2004) acknowledge in a later work is that such a choice of location may have resulted merely from reasons of practicality that arose from living in a landscape that was naturally hilly. Builders may have often preferred to avoid a perhaps treacherous climb to a summit, and that may have meant building on hillsides as opposed to summits. Such a choice would mean that views are consistently restricted in one direction by immediate hill slopes, but that need not imply that those were chosen in virtue of that characteristic. Other plausible scenarios where practicality dictates location choice include the intentional avoidance of low-lying flat areas that may have been prone to flooding, and builders' wanting to find locations that provide some form of shielding from strong wind conditions. Any one of these explanations, if accurate, imply that the placement of monuments on the sides of hills did not result from intentional acts imbued with 'special meaning'. This point is not, of course, made to deny that analogy might be used to gain important insights into how landscapes were perceived and engaged with in the past, only that such perspectives must be seen in context of a broad range of possibilities as well as what is sometimes described as the multivocality of the ways that a given landscape may have been engaged with (Fewster 2013). Analogies do offer more richly informed ways of apprehending the past than the near exclusive consideration of factors identifiable from an economic rationalistic perspective that characterises the processualist approach. However, so as to ensure that such methods are successful in concerning the past as it may have been and not mere fantasy, they must also be considered critically with the wider range of possibilities in mind.

The Use of Metaphorical Possibilities in Phenomenological Studies

A notion often invoked in phenomenological studies is that landscapes are rich with metaphorical possibilities, as is seen in the first of the two above examples, where an association is drawn between leaves and trunks with flesh and bones. Such a notion is also implicit in the claim that the locational choice for the placement of Neolithic monuments may have been deliberate and influenced by metaphorical associations, which is taken seriously and investigated in this thesis. For instance, some (e.g. Cummings and Whittle 2004; Tilley 1994) believe that subjectively observing landscapes and identifying landscape metaphors may provide 'a clue as to the motivations for the construction of these monuments' (Barrett and Ko 2009, p. 283). Examples of such a contention are seen in Cummings' (2002a), Fowler and Cummings' (2003, pp. 1-20) and Scarre's (2002, pp. 84-102) works on identifying monument–landscape relationships.

These writers suggest that megalithic chambered tombs were framed against the sea and that views of the sea were effectively masked until prehistoric people approached forecourt and chamber areas (Fowler and Cummings 2003, p. 3; Scarre 2002, p. 86). It is held that the careful orchestration of the approach to a monument, in such a way, may have been deliberate and that setting the monument against the dramatic backdrop of the sea may have had a profound impact on the experience of such places. Moreover, such an impact that would have been further emphasized by a masking of sea views until prehistoric people reached forecourt areas, which may have created a sense of anticipation as they navigated across the landscape.

Cummings and Whittle (2004, p. 82) draw on ethnographic accounts to illustrate the significance such landscape choices may have held. They refer to the well-established metaphorical associations of water and stone with practices of 'transformation', such as death, to suggest that the close proximity of chambered tombs to bodies of water may have held similar metaphorical associations during the Neolithic. In another instance, in examining megaliths in Wales, Cummings and Whittle (2004, p. 33) observe that, despite 72% of sites having a view of the sea, many such sites only offer a restricted or a 'narrow' view of the sea. This has led these theorists to suggest that, 'although it may have been desirable to build a monument from which the sea was visible, this view should not be too expansive' (2004, p. 33). Later, in the same work, Cummings and Whittle (2004, p. 82) query whether the 'monument may be referencing the importance of the sea as a resource', in offering only a view of smaller areas of the sea, 'could this refer in some way to the diminishing role of coastal resources in the diets of Neolithic people…?'.

Fleming (2005, p. 930) describes these types of phenomenological works as presenting 'a version of "landscape archaeology" which is much more dependent on rhetoric, speculation, argument by assertion and observations not always replicable when checked.' Hence, the notion that such landscape metaphors may have somehow determined the location of monuments has been widely criticized. As Fleming (2006, p. 273) questions, if another researcher were to walk along the same landscape and deliver different insights on observed landscape metaphors, could anyone determine 'on the basis of the "evidence" which of us has produced the better account of the prehistoric past?'

Phenomenological Reconstructions of Past Experiences as Incomplete

Phenomenological approaches use the human body as a 'universal medium' through which legitimate insights into the past can be gained (Brück 2005, p. 55; Hamilton and Whitehouse 2006, p. 34; Tilley 1994). Tilley's methodology, 'the phenomenological walk', thus invokes this notion but faces some fundamental difficulties that arise due to the considerable variability in physical attributes between persons (e.g. young/old, male/female, able-bodied/infirm), which undoubtedly affect their perception and experience of places. A further point of contention is seen in the idea that, in the modern age, one can encounter the 'same physical landscape' as those who inhabited those spaces thousands of years ago. Tilley has postulated that the 'bones', 'lines' and 'forms' of the land, and its ridges and combes have remained virtually unchanged over the years. Yet, his claim is not always applicable due to the impact on landscapes of modern-day interference and land clearing and enclosure from agricultural and construction work, not to mention vegetation changes through the millennia, erosion and sedimentation. Hence, the phenomenologist cannot properly use either the human body or the landscape to replicate completely the experiences of prehistoric people as they were. Of course, this does not mean that phenomenology cannot be useful, only that—as with GIS-based analysis—it too offers an incomplete representation of prehistoric people's experiences.

A further point that both supports and underscores the significance of this conclusion is that prehistoric people did not encounter and experience cultural landscapes in a vacuum. There were other factors that affected their perceptions, such as strangers, neighbours, animals and even objects of significance (Brück 2005). Often archaeologists cannot with any certainty account for the particular mindset people experienced when they were at a particular place and taking part in activities. For instance, prehistoric people might have travelled to a monument to meet with neighbours near or far, for large social gatherings involving rituals and ceremonies, or simply to exchange goods. Any of those purposes would have played a role in the way prehistoric people perceived and experienced their immediate surroundings. In addition, our own personal attitudes, the weather, or the time of the day of a site visit can all contribute to our experiences and interpretations of these places. Some have argued that such factors detract from the authenticity of the constructed narrative (Brück 2005). Archaeologists may, thus, simply be unable to recreate the social and cultural atmosphere in which past events took place, and it may be impossible to offer a complete account of how and in what way such factors shaped prehistoric peoples' engagement with and experience of places.

Given the complexity of the issues involved, the phenomenological approach to landscape archaeology is considered to be inherently flawed by many of its critics. Such critics (e.g. Barrett 2004; Brück 1998; Boado and Vazquez 2000) maintain that the interpretations of the past provided by phenomenological narratives are incomplete at best, owing to the fact that those narratives are produced in the absence of factors that may have played a significant role in determining how prehistoric peoples may have actually perceived and experienced places. Thus, many question the degree to which past and present experiences can actually match. Furthermore, due to these speculative narratives' reliance on unverifiable metaphorical associations, they are inconclusive and only produce partial and questionable reconstructions of the past.

2.2 GIS and its Limitations in Phenomenologically Orientated Studies

Despite the aforementioned criticisms, phenomenological theoreticians believe that interpretations of the past should be derived solely from our own embodied experiences of archaeological landscapes (Thomas 1991; 1996; 1999; Tilley 1994; 2004; 2008). Hence, there has been a strong tendency for phenomenological analyses of landscape to dismiss the relevance of GIS-based mapping methods and predictive techniques. For instance, Tilley (2004b, p. 218) argues that the use of digital technology is the worst means of achieving knowledge about the past:

> Ancient stones in landscapes . . . cannot be known or understood simply from publications, from maps, diagrams, photographs and descriptions, because these are only representations. As representations they necessarily fail in conveying a bodily understanding of prehistoric remains.

> Statistical analysis, Geographical Information Systems and simulations are, if anything, far worse. There can be no substitute for the human experience of place – of being there . . .

Such a critique rests largely on two aspects. First, the Cartesian rationality of modern cartography is seen as a historically specific way of representing the world, a modern western construct inadequate for the purpose of conceiving of the world as it is viewed by other cultures. Second, GIS-based techniques and other digital tools 'artificially "privilege" the visual over other senses' (Wheatley, 2014).

Cartesian Perspectivalism

Cartesian rationalism views the subject as a detached, gender-neutral, thinking entity, capable of logically and objectively perceiving the world from an 'uncontaminated' viewpoint. This philosophy has been adopted in many areas of research, perhaps most obviously in the disciplines of geography and cartography. Consequently, geographic representations created using GIS, aerial photographs or satellite imagery were believed to be a significant advancement in science, enabling spatial relationships to be wholly recognized and analysed (Haraway 1991, p. 678)—'GIS', or Geographic Information Systems, here referring to systems that create, manage, analyze and map data specifically relating to geographical contexts. Examples in the use of GIS in archaeological contexts include but are not limited to: projecting likely settlement patterns, based on resource availability, such as fresh water and arable land suitable for farming based on soil or pollen samples (e.g. Tipping 1994); inter-site visibility and visibility from given locations in a landscape (e.g. Jerpåsen 2009); and the identification of pathways the may likely have been used to traverse a landscape, based on the caloric expenditure required for using different routeways (e.g. Verhagen 2010).

Godlewska (1995, p. 5), accordingly, claims that such techniques were 'the most powerful tools of spatial analysis ever developed'. The distancing of the observer from the observed object, in the way afforded by Cartesian representation, was considered fundamental to scientific research at two basic levels. First, it would prevent an investigator's hidden and unconscious biases being imposed on the object under examination, thus, increasing the quality of objectivity. Second, such technological advances facilitated new ways of seeing the world. For example, through satellites, telescopes and binoculars, human vision could be extended far beyond its natural limitations. The presumption made is, thus, that technological advances enhance our 'primitive vision', allowing us to see everything and contribute to the process of knowledge making, by allowing us to assume true objectivity. Furthermore, such devices would enable researchers to rigorously and continually examine and experiment, in the hope that their work would eventually lead to 'new and more enlightening mode[s] of description[s]' that can be scientifically verified (Godlewska 1995, p. 11).

Yet, some writers argue that the detached method of mapping the world in this way can only produce abstracted, disembodied representations from somewhere above the Earth's surface, using what Haraway (1991, p. 189) calls the 'god trick of seeing everything from nowhere'. Although Haraway acknowledges the enrichment of the scientific field that results from technological advancements, she argues that the problem with such a worldview is that it ignores human limitations and tricks the human brain into believing that we can, in actuality, see everything and be truly objective. As Thomas (1993, p. 25) reasons, the knowledge gained through aerial photographs, satellite images, and GIS 'all present a picture of past landscapes which the inhabitants would hardly recognize'. Thus, such representations are considered to be mere simulations, far removed from reality. This notion raises the question of whether such a top-down view of the world can provide an accurate representation of how the people of the past engaged with and perceived the world.

Such a question is related to an observation made by feminist theorists who maintain that these conventional methods originated from the male-dominated, western European scientific tradition. Dodge et al. (2011) argue that this tradition has led to a 'particularly masculin[e] way of thinking and representing the world' (Dodge et al. 2011). The criticism is not, however, that there could be a gender neutral method of representation that would ameliorate any problematic outcomes of masculine forms of representation; rather, the feminist contention is that it is impossible neutrally and objectively to capture and know the world, as has been suggested by Cartesian perspectivalism (Dodge et al. 2011; Hamilton and Whitehouse 2006, p. 152). Hence, despite claiming to be objective, Cartesian perspectivalism incorporates its own biases.

Post-processual theorists, such as Stephanie Meece (2006), similarly argue that cartographic concepts are a historically-specific way of imaging space, and that archaeologists should refrain from imposing on to the past such a 'map culture' and the biases it carries. However, this view has led to some controversy, as is illustrated in the following example. In 1963, James Mellaart discovered a mural on the wall at the Neolithic site of Çatalhöyük in Turkey which later came to be known as the oldest known 'plan map' in the world. Dating to approximately 6600 BC, the upper register of the mural depicts an exploding volcano while the lower register shows a plan of the settlement with approximately 80 houses (Mellaart 1967). However, Meece (2006, p. 3) argues that this mural is 'unlikely to be a map of Catalhoyuk, but rather depicts a leopard skin in the upper register, and the lower section is one of the very typical geometric patterns commonly found at the site'. Her view rests on the supposition that 'as a pre-literate, small scale society, Neolithic Çatalhöyük would be an extremely unlikely place to expect to find the first cartographic map' (Meece, 2006, p. 20), a point she argues is further supported by the lack of evidence of map-like thinking in other Neolithic cultures. Even though Meece admits that 'the cognitive ability to transfer spatial consciousness to a two-dimensional surface would have been a development of intelligent behaviour attained very early in the evolution of humanity' (2006, p. 17) she believes that map-making was beyond the cognitive capabilities of Çatalhöyük residents (Clarke 2013, pp. 136-143). Such reasoning has prompted some to question the spatial-cognitive abilities of pre-modern societies (Meece 2006, pp. 17-20; see also Wood and Krygier 2009, pp. 1-10).

Yet, a new study of geological and geochronological evidence has cast doubt on Meece's interpretation (Schmitt et al. 2014). This study reveals that residents of Çatalhöyük may have indeed witnessed the explosive eruption of Mount Hasan, and that that eruption closely overlaps with the time when the painting was created, thus lending credibility to the Mellaart's (1967) hypothesis. Moreover, Wheatley (2014) has revisited the claim that it may not be implausible to imagine prehistorical mapping traditions with cognitive abilities capable of comprehending a 'top-down' view of the world. For example, the Nazca lines in Peru are massive geoglyphs that appear as arbitrary and indistinguishable lines from the ground but begin to take shape and form when viewed from the summits of the surrounding hills, indicating that the idea of a top-down view is not entirely alien among non-western cultures (Wheatley 2014). On this basis, Wheatley argues that representations and knowledge gained using GIS-based mapping methods and predictive techniques, satellite imagery and aerial photographs should not be easily dismissed. In addition, he points out that there are genuine hazards in denying other cultures' abilities based solely on the notion that 'non-western, non-modern cultures cannot or could not engage in this kind of spatial abstraction' (Wheatley 2014, p. 120). In the past, for instance, such fallacious reasoning has led some to ascribe great achievements of ancient cultures to alien intervention (cf. Däniken 1968).

Primacy of the visual

The second objection to GIS-based analysis concerns the hegemony of vision that it involves. The concern here is the status of 'vision' which has long been considered as a higher-order sense in western thought and culture (Crary 1995; Duncan 1993; Ingold 2000; Synnott 1991). Over the years, many writers have challenged the notion that vision is the 'master sense of the modern era' claiming that the embodied experience of the self is not merely perceived through vision but is also composed of the different sensory elements of smell, hearing, touch, and taste (Cummings and Whittle 2004; Curry 1998; Frieman and Gillings 2007; Ingold 2000, pp. 286-287; Jay 1988, p. 3; McLuhan 1962; Mlekuz 2004; Pink 2009). For instance, Frieman and Gillings (2007, pp. 4-16) argue that, as space is perceived through the engagement of all senses, researchers should consider the sensorium as a complex whole rather than focusing on individual modalities. The multisensoriality of human experience is further supported by a wealth of ethnographic knowledge (see Ingold 2000; Gell 1995; Rodaway 1994). For instance, Gell's (1995) work on the inhabitants of the dense jungles of Papua New Guinea reveals that the Umeda people's hunting skills depend significantly on their sense of hearing. Their skills involve listening for the presence of animals, as dense vegetational cover greatly impaired visibility. Although vision remains an important component of their lives, it appears that the everyday activities of the forest-dwellers of Papua New Guinea are governed, perhaps predominantly, by the sense of hearing rather than vision. Such notions are further supported by recent work in the field of sensory archaeology, which has convincingly demonstrated the potential roles that textures, smells, sounds and tastes may have played in determining some of the choices made by past societies (For examples, see Cummings 2002b; Saunders 2001; Scarre and Lawson 2006; Watson and Keating 1999; Waller 2006; 2012). The wealth of knowledge gained through the study of sensory anthropology and archaeology, therefore, highlights the need for recognition that everyday experience is a multi-sensorial engagement with the material world and that investigation of such experience must reach beyond mere visual representation.

While GIS-related analyses of landscapes have been predominantly vision-orientated, in recent years, some researchers have attempted to bridge the gap and gain a more holistic understanding of the sensory engagement of past societies by incorporating other senses into their analyses (see Dawson et al. 2007; Gillings 2007, pp. 31-46; Mlekuz 2004). This is evident in Mlekuz's (2004) analysis of the soundscapes of late medieval Slovenia. Although the Slovenian terrain is mountainous and would have considerably reduced people's visibility of neighbouring communities, Mlekuz demonstrates that the sounds from various church bells would have permeated and dominated the late medieval landscape. He argues that this may have assured Christian communities in close proximity to each other of their respective presence, thus linking those communities together through sound despite being visually isolated from each other. For a similar study, see Alain Corbin's (1998) work on bells. Corbin examines documents and church archives to present an account of the once forgotten auditory landscape that played a significant role in various activities of village life in the French canton of Brienne.

Notwithstanding the promise of GIS-based soundscapes, such as those provided by Mlekuz, the investigation of the soundscapes of the modern era, where there is a rich record of documentation and material evidence, is a much easier feat than the reproduction of the 'sensescape' of prehistory, particularly regarding sounds and smells which 'have long since melted into air' (Thompson 2002, p. 12). One might be able to reproduce the sounds of nature, the sound of waves crashing on the shore for instance, and such sounds may be of relevance as they would have provided a constant aural backdrop for the activities that may have taken place in and around monuments situated near the ocean. Nevertheless, most other soundscapes and smellscapes of prehistory are 'generally difficult to retrieve without a large degree of speculation' (Llobera 2007, pp. 52-53). Moreover, even where such sensescapes are retrievable, there are further problems in identifying and interpreting the level of significance, if any, that may have been associated with particular smells and sounds: sensory engagement with place can be either unique to individual life histories or culturally constructed. As Hamilakis (2011, p. 1) argues, 'sensory and sensuous experience is socially and historically specific, and our bodies and sensory modalities too are the products of our own historical moment, thus rendering attempts at sensory empathy with past people problematic'.

Such difficulties in interpreting meaning may also be present when considering visual sensory data. However, there is at least a certain permanency attached to visually perceptible objects that may be absent when considering data relevant to the non-visual senses that are no longer observable or accessible. This point has prompted Llobera (2012) to suggest that, even though multi-sensorial investigations of past landscapes are undoubtedly of significance, the examination of visual and visibility patterns should, nevertheless, remain a vital component of landscape studies.

2.3 The Potential Benefits of a 'Hybrid Approach' to Landscape Archaeology

As described above, the post-processual critique maintains that GIS-based mapping methods and predictive techniques as well as other quantitative methodologies lack the ability to provide a sufficiently complete sensory appreciation of prehistoric landscapes, which many phenomenological theoreticians believe can only be achieved through a corporal engagement with the world. Therefore, despite the capabilities of GIS techniques, phenomenologists often see them as maladapted to the study of landscape archaeology, holding that interpretations of past societies should be derived solely through the 'direct physical and sensory involvement in, and around, the land' (Gillings 2011, p. 53). GIS-based methods are, on this view, an unfortunate by-product of Enlightenment thinking that is driven by a desire for unattainable objectivity. Such Cartesian approaches produce spatial abstractions and representations that 'inadequately' substitute reality by creating false images, considered by many as a disembodied, partial and masculinist way of knowing the past (Cosgrove and Daniels 1988; Haraway 1991; Rose 1992, pp. 8-18; Sui 1994, pp. 258-278). Along such lines, Thomas (2004, p. 200) argues that GIS representations are 'divorced from any context of human involvement' and are therefore ill-equipped, a problem rather than a solution, for furthering our understanding of past perceptions and experiences (Tilley 2004b, p. 218; 2008, p. 266; Thomas 2004, pp. 198-201).

Hence, there is a 'strong rejection of GIS' in landscape archaeology, stemming from the notion that the knowledge produced via digital technologies inadequately represents reality, as constituted by disembodied and unreal spaces (Haciguzeller 2012, pp. 245-263). Yet, critiques of phenomenological studies maintain that the insights gained from a corporal engagement with the world will also be incomplete. As Haciguzeller (2012, p. 257) observes, 'it is important to realize that we are recreating the worlds of past people *in the present* whether that is with our bodies, GIS or something else' (emphasis added). Haciguzeller's comment suggests that we may never be able to provide a highly 'authentic' account of the past, not even through embodied practice as advocated by Tilley and his followers. This notion is particularly true for prehistory, where there are no written records and all that remains are physical objects to guide us in considering how the people of the past may have perceived and experienced places (Brück 2005, pp. 45-72).

Llobera (2012, pp. 495-509) makes a similar response to the critique of GIS-based methods when he says that there may be no significant difference between observations made in the field on the 'bones' of the land and observations made using high resolution Digital Terrain Models. GIS practitioners have, thus, cautioned against the view that past landscapes can only be accessed and interpreted through direct embodiment, maintaining that field observations taken during the 'phenomenological walk' may not be all that different from the observations made via digital technologies. Archaeologists may even draw more informed observations using digital technologies for the reason that the inclusion of appropriate environmental data in visualizations may afford more accurate representations of the environments in which these monuments were built. This is particularly important for the many reasons outlined earlier that mean that it may not always be possible to make observations in the field. For instance, GIS techniques can be used to create a visualscape of a landscape as it may have been thousands of years ago, by more or less accurately approximating the vegetational cover using pollen records and eliminating dense plantations and buildings, which may otherwise obstruct a monument's surrounds in the present.

Serious problems may always be apparent when trying to understand prehistoric mindsets with modern minds, and such areas will always remain murky to a certain degree. No matter which framework is chosen to model and interpret the past, the nature of the knowledge gained will be partial. Neither approach to the study of landscape is, then, capable of presenting both undistorted and authentic representations of the past. This is not to say, however, that neither approach is useful. For such reasons, many GIS practitioners consider the post-processual rejection of their methodologies to be premature.

The trend has, accordingly, shifted in recent years, with theorists suggesting that 'hybrid' or 'middle-ground' approaches, which combine concepts and methods from both fields, can contribute to the further development of extant quantitative and qualitative methods, leading to 'new interpretations of archaeological sites' (Graves and Millican 2012, p. 493). A hybrid approach may complement and enhance current methods in the study of landscape archaeology, in particular, giving us better insights into the past (Gillings 2009, pp. 336-356; Haciguzeller 2012, pp. 245-263; Hamilton and Whitehouse 2006; Llobera 2005, pp. 171-194; 2012, pp. 495-509; Sturt 2006). This section describes and discusses potential benefits of one such approach, and the response to critiques of GIS techniques in landscape archaeology.

Benefits of GIS Techniques for Phenomenological Approaches to Archaeology

As discussed earlier, phenomenologists commonly believe that for an examination of landscape to be satisfactory it must ultimately involve an analysis of the embodied experience of the researcher. However, such a view cannot consistently discount the notion that there are other valid ways to think about, access, and interpret past landscapes. This is because the theory underpinning phenomenology maintains that there are myriad intentional structures that define the way that humans perceive and experience the world (Moran 2000). Thus, the theory implies that, in addition to the traditional form of examination that is accepted by phenomenologists, there are myriad valid ways to perceive those landscapes. It is fitting, then, that GIS practitioners have urged the scientific community to reconsider the role of GIS techniques in landscape analysis by highlighting its potential benefits in the fields of visualization, spatial analysis and modelling (see Llobera 2007; 2012; Llobera et al. 2011, pp. 843-851; Roughley and Shell 2004; Verhagen and Whitley 2012, pp. 49-100; Winterbottom and Long 2006).

GIS software offers versatile tools that allow researchers to analyse and recognize spatial relationships and identify features around which cultural landscapes were created (Gillings et al. 1999; Johnson and North 1997; Wheatley et al. 2002). Those tools present a resource for landscape theorists to use in investigating how the particular elements of a monument's landscape context may have influenced either its shape or sitting within that landscape (for examples, see Harding et al. 2006, pp. 28-53; Mithen and Lake 1998; Lake et al. 1998; Winterbottom and Long 2006). A distinct advantage of investigation with GIS techniques is that it is able to perform large-scale regional analyses that can create environmentally deterministic predictive models. The works of various researchers have demonstrated that such models can effectively predict past places of land use, settlements, places of burial, and artefact deposition (Hudak et al. 2002; Mehrer and Wescott 2005; Verhagen 2007; Verhagen and Whitley 2012; Wescott and Brandon 2000, for objections to environmentally deterministic models see Gaffney and Leusen 1995, pp. 367-382; Wheatley 2004). However, despite the promise of this means of investigation, it is relatively uncommon that studies combine phenomenological and GIS methodologies (see Fitzjohn 2007, pp. 36-50; Graves 2012, pp. 526-547; Jerpåsen 2009, pp. 123-145; Rennell 2012, pp. 510-525; Sims 2009, pp. 386-408; Trick 2004).

Phenomenological investigations of landscape can be aided with GIS techniques in numerous ways. One major benefit stems from the fact that, due to economic costs and time constraints, it is often not practical, if at all possible, for a researcher or research team to visit all sites of interest individually—as is sometimes advocated by theoreticians of embodied practice and experience. In such circumstances, it is possible for researchers to use the variety of tools GIS offers, to investigate with relative ease the landscape context of a large number of sites over wide areas. While large scale analyses of this type are not commonly used in phenomenological research, they provide a decisive and non-trivial benefit. Such analyses enable the researcher to assess the relevance and significance of observations made at sites that have been visited in person. Spatial statistics tools, for instance, can be implemented to explore the data and identify any statistically significant trends and patterns—hotspots, spatial clusters, and anomalies or outliers (see Baxter 2009, pp. 1035-1054; Benwell et al. 2002, pp. 1-11; Bevana and Conolly 2009, pp. 956-964; Jerpåsen 2009, p. 137; Pugh 2003, pp. 941-953; Sims 2009, p. 387). An examination of a large sample of sites can, thus, assist in eliminating and ruling out chance occurrences, and confirm the intentionality of the observed associations. Such analyses, then, enable researchers to evaluate the credibility of the interpretive claims made in phenomenological accounts of landscape and to draw well-sustained arguments with more convincing conclusions (see also, Graves 2012, pp. 526-547; Rennell 2012, pp. 510-525)

GIS techniques are also valuable in studying landscapes that are unavailable for on-site visitation in a way that affords effective phenomenological investigation, which involves envisaging a site's experiential properties. Landscapes have often been radically altered since prehistoric times, with many sites being either denuded or partially destroyed as a result of cultivation, looting, road construction, mining and industrial land use (Rennell 2012, p. 521). Visibility can be affected urban developments and other constructions. Moreover, even where sites are well-preserved, their surrounding landscapes are sometimes lost in dense forest plantations, or are simply inaccessible due to forestry restrictions (Foley et al. 1991; English Heritage 2003; Johnson 1998). Such factors place strains on conducting field observations, and make it difficult to identify visual features on-site (Ch'ng 2009, p. 460; Roughly and Shell 2004).

An illustration of such a problem is found in Roughley and Shell's (2004) work on the ruined Neolithic monuments of the Carnac region, southern Brittany. Roughley and Shell (2004) explain that, on investigation, monuments located on convex promontories were obscured from view when approached from the river. However, since those same monuments originally stood to a height of approximately 4m during prehistoric times, they would have been visible on approach. Hence, those monuments' current states do not provide the phenomenologist with genuine on-site opportunities to create narratives about how 'people engaged with monuments as they moved within and through the landscape', as is required by phenomenological methods such as Tilley's (2008; 2010) 'phenomenological walk'. Tilley's and others' phenomenological methods of on-site investigation are, therefore, insufficient to afford researchers opportunities to investigate all relevant sites and assess or appreciate the experiential qualities of the sites' respective landscape settings.

These problems, regarding the present state and accessibility of monuments and their surrounding landscapes, are effectively transcended in important ways with the aid of GIS techniques. Archaeologists are able to reconstruct monuments digitally to their original heights, which is essential for a proper appreciation of their forms, and for investigation of how monument visibility a may have varied with distance and was affected by topographical features (Harding et al. 2006, pp. 28-53; Rennell 2012, pp. 521-522; Roughley and Shell 2004). Furthermore, these techniques can factor in changes in vegetation cover, sea-level, erosion and sedimentation, while also eliminating modern-day buildings and forestry plantations among other visual distractions. Hence, GIS can be used to create better representations of prehistoric landscapes, thus allowing archaeologists to gain a more accurate sense of the environments in which these monuments were built (see Ch'ng 2009, pp. 458-470; Ch'ng, Stone and Arvanitis 2005; Ch'ng and Stone 2006; Grün, Sauerbier and Lambers 2003; Winterbottom and Long 2006, pp. 1356-1367).

In addition to reconstructing environments as they were in the past, GIS techniques also afford archaeologists with opportunities to represent and explore the different experiences of those environments in four distinct ways. First, there are temporal changes affecting monuments and their surrounds, including seasonal conditions, weather, and changes in lighting conditions based on time of day. Second, there are the numerous topographical and visual properties of a landscape that may reveal whether monuments either occupied or referenced prominent features such as mountains, rocky outcrops, ocean, seas, rivers and lochs (see Gao et al. 2009, pp. 333-340; Siart et al. 2008, pp. 2918-2926). Some if not all of these features may be discoverable for phenomenological investigators during on-site visitation, but a third way that GIS techniques may aid such investigations is to reveal features of a landscape that may not always be obvious to phenomenological investigators, at least not until they have spent considerable time in a landscape. One such feature is the directionality of approaches to a monument that prehistoric peoples would likely have taken. Through 'least cost path' or 'travel corridor' analyses—as used in this thesis—GIS can identify possible routes from which a monument was approached, revealing the way that a monument was likely to have been experienced during prehistoric times, including the visual background to a monument on approach and aspects of the journey taken to get there. Finally, GIS modelling is not confined to a top-down form of representation. Such techniques can be used to explore different experiences in a fourth way, by constructing powerful 3D visualizations of alternative spatial realities by (see Agugiaroa et al. 2011; Ch'ng et al. 2011, pp. 40-46; Teichmann 2009, pp. 101-125). Thus, it is possible to recreate and examine the visual fields of those walking in and around monuments and to consider both their immediate and wider visual settings.

It may be supposed that the aforementioned considerations amply demonstrate that phenomenological and GIS-based methods of landscape archaeology can profitably work together. What this thesis aims to do, beyond demonstrating the mere possibility of a fruitful hybrid approach incorporating these methods, is to demonstrate the potential for cross-fertilization between these methodologies, at a general level, as well as provide a specific example for how GIS might be used to model and test the experiential qualities of the landscapes once inhabited by prehistoric peoples.

2.4 Monuments as Referencing the Sea

The claim considered and investigated in this thesis is that prehistoric monuments, such as the long cairns of Scotland, were often placed so as to reference the sea. As discussed above (in Section 2.1), this notion is one among many metaphorical possibilities that have been suggested by archaeologists who use the phenomenological approach to landscape archaeology. As also discussed earlier, a criticism that might be levelled against such narratives of the past is that they are offered as mere speculation and would appear to be unverifiable, thus, posing limited use and perhaps distracting from more fruitful lines of enquiry and methods of investigation.

There are, however, two reasons as to why such a criticism is undue. First, as illustrated above, there are a plethora of GIS techniques that are able to be used to substantiate or help to reject such interpretations of archaeological monuments, and as is detailed in Chapter 4, several of these are implemented and further developed in the present study. Second, the notion that bodies of water, such as the sea, may have held significance is not simply one among a multitude of metaphorical possibilities. Carl Jung (2014, p. 18) describes water as the 'commonest symbol for the unconscious', and ethnographic studies reveal that water is a vital component in many non-Western cultures (Rudhardt 1987, pp. 350-58). Water is intertwined throughout many mythical narratives about how the world was created and is identified with life-bearing forces in sustaining plant, animal and human life (Pollard 2012, p. 94; Rudhardt 1987, pp. 350-58). Bodies of water are known to establish boundaries between dichotomies such as purity and pollution, the living and the dead (for examples see Richards 1996a, p. 203, 1996b, p. 317; Rudhardt 1987, pp. 350-58). There is also evidence to suggest that, during prehistoric times, certain rituals and religious practices involved votive deposition in wet places such as rivers, springs and bogs, thus indicating the symbolic significance water may have held (Bradley 2011).

Martin Smith and Megan Brickley (2009, p. 42), for instance, illustrate the association of water with practices of excarnation, in which a corpse would be defleshed and 'transformed'. Such practices have been used by various cultures in history and prehistory and, in addition to being symbolic, are also thought to allow for remains to be made suitable for ceremonial purposes as well as managed more easily prior to and for deposition in final resting places (Smith and Brickley 2009, p. 55). There is evidence for excarnation being achieved through the deliberate removal of flesh from bone with flint tools, and even by leaving corpses exposed to scavengers. However, Smith and Brickley describe how, during the time when long cairns and barrows were used, excarnation was likely often achieved through exposure via deposition in water, as indicated by collections of human (and animal) bones at the edge of a channel of the River Nene (Harding and

Healy 2007, p. 10, cited in Smith and Brickley 2009, p. 42) and waterlogged deposits at Preston Docks:

> [T]he implication [of such findings] is that some quantity of human remains were ultimately disposed of in water, which may partly account for the low overall quantity of skeletal remains that survives from the period.

Such practices suggest a strong association between water with death, and by extension, between mortuary monuments and the sea, as is considered in the present study.

References of a similar kind are meticulously detailed by Fowler and Cummings' (2003) study of the repeated invocation of water at the sites of Neolithic structures in Ireland and across the Irish Sea, to Britain's west, including long cairn sites analysed in the present study (Crarae and Glecknabae, in Argyll and Bute, as well as High Gillespie and Cairnholy I, in Dumfries and Galloway). These authors describe masses of seashells and bones from sea creatures being deposited in and around monuments' chambers and forecourt blockings, and 'the chambered tomb of Glecknabae in Bute was actually built over a shell midden' (Pollard 2000, cited in Fowler and Cummings 2003, p. 6). Moreover, in addition to large quantities of water-rounded pebbles placed in and around sites, significantly sized water-worn stones are sometimes perspicuously used in these monuments' constructions, such that the 'monuments literally combined water and stone in megalithic form' (Fowler and Cummings 2003, p. 5).

References to water persist through to later periods in prehistory, as seen in discoveries of precious metalwork and polished stone axes in lakes and in rivers, which demonstrate the regard held for acts of deposition in water, as Chris Scarre observes, 'rivers . . . appear to have held a special, possibly sacred significance' (Scarre, p. 154-5). Furthermore, monuments other than cairns, such as henges, have been found close to and orientated towards bodies of water (Bradley 1998, p. 121, 2011; Bradley and Lamdin-Whymark 2008; Woodham 1955, p. 78). Drawing on the well-documented finding of metalwork deposition in water, Richard Bradley (2011, pp. 179-80) notes the alignments of henge monuments and associated structures towards nearby rivers:

> The orientation of [the timber structure outside the south entrance of the Broomend of Crichie] . . . introduced a new alignment towards the nearby river. That may be no coincidence, for the small earthworks classified as henges in northern and north-eastern Scotland illustrate a similar concern. Some, like Pullyhour and Wormy Hillock, are directed towards nearby rivers or streams, while other sites, such as those at Migdale or Shiel Bridge, are aligned on lochs. This connection with water happens sufficiently often to suggest a new emphasis on an environment in which metalwork might be deposited.

These associations not only warrant further investigation into the potential connections of long cairns and the sea, but they also establish that water is not merely one among many perhaps trivial metaphorical possibilities, it is likely a central motif of significance the connections with which must be considered before a more complete understanding of these monuments and their builders can be attained.

Chapter 3: The Long Cairns of Scotland

Prehistoric Context, Use and Morphology, and Environmental and Landscape Sitting

This thesis investigates the long cairns of Scotland to test the notion that prehistoric monuments are positioned and structured so as to reference the sea or other bodies of water. This chapter provides background information on these monuments, the pronounced significance of which are revealed by their sometimes massive size, elaborate design, prolonged usage and the sheer number of long cairn sites spread out across the Scottish countryside. Long cairns and long barrows, their counterparts as found in England and continental Europe, were among the first monuments to be constructed after the advent of agriculture and the Neolithic period in those regions. Hence, for a more complete appreciation of the significance of these structures, it is necessary to see them in their context in prehistory. Some of the main developments in the transition from the European Mesolithic to Neolithic will be described here, before the use of long cairns, their morphology as a monument-type, and their environmental contexts are considered.

3.1 The Prehistoric Context of the Long Cairns of Scotland

The Beginning of the European Neolithic

The warmer and wetter conditions that emerged towards the end of the Last Glacial Maximum led to the development and flourishing of new ecosystems, particularly in the Near East Levant, that made a wide variety of plants and animals to become available for human exploitation. It has previously been thought (see, for example, Malone 2001) that such a change made new and different subsistence strategies possible in that region, to contrast with an earlier reliance on mammal meat. This change supported a massive population growth, leading the settlement in the Levant to face a different situation during the climatic episode known as the Younger Dryas. Lasting for only 200–300 years, the Younger Dryas saw a temporary return to the colder drier conditions that characterised the Last Glacial Maximum and thus the contraction of the formerly productive ecosystems. Subsequently, pressure for food production coupled with the availability of the wider variety of plants and animals led to the beginnings of cultivation and husbandry.

This explanation supposes the emergence of a distinct culture that was largely different in kind from that of the Mesolithic and Palaeolithic due to its use of the wider variety of plants for subsistence, as opposed to a reliance on meat. However, evidence has been found that many of the self-same plants that were available in the warmer conditions towards the end the Last Glacial Maximum had also been available previously, during the colder and drier conditions (Bar-Yosef 2014, p. 11). What may, then, be the most likely explanation for the adoption of agriculture follows from the observation that the prehistoric people of the Levant were inclined both to manage their food sources and hunt and gather opportunistically (Finlayson 2013, p. 3). After the population boom towards the end of the Last Glacial Maximum and the onset of the Younger Dryas, food sources that were not managed by the population were simply used up. More or less organised management and farming of plants and animals, therefore, became a necessary means of subsistence.

Organised labour became a defining characteristic of the way of life that became necessary for the prehistoric people of the Levant and for the ensuing Neolithic period. The era saw several developments. Rectangular housing and communal structures were built, presumably to accommodate larger numbers of people than the pre-existing circular houses. The people of the Levant also began to use pottery, which facilitated the production and consumption of agricultural products in the storage of grains and in the use of dairy and making yogurt and cheese (Cummings and Harris 2014, p. 10). These developments spread first to Greece, by 6500 BC, and then to the rest of Europe in different stages (Fowler, Harding and Hofmann 2014, p. 3). Evidence from aDNA samples now show that the mechanism by which this happened was largely by the emigration of Anatolian farmers (Brace et al. 2018). However, in different regions, Mesolithic populations were not replaced by those of Anatolian descent, but retained their cultures and ethnicities to differing degrees as well as their hunter-gathering subsistence strategies, creating what is described as a patchwork of varied Neolithic cultures (Thorpe 2014, p. 12).

Long Barrows in Europe

One such culture of prehistoric peoples is responsible for the long barrows of western Europe, some of which have been dated to the early and mid-fifth millennium BC (Cummings, Midgley and Scarre 2014, p. 2). These monumental burial practices seem to stem from the combination of two distinct influences, one from the former Mesolithic practices of the inhabitants of the area, and another from the Neolithic practices and way of life brought from Anatolian immigrants. First, the people of late Mesolithic Brittany had practiced multiple-burials in the form of stone-lined pits, some of which were covered in cairns of stone (Thorpe 2014, p. 8). Hence, the prehistoric population in the area had a long standing tradition of burial practice. A second influence that may have led to the development of monumental burial practices is the Neolithic way of life's heavy emphasis on not just communities of individuals working together, but on *exclusive* communities of people engaged in a common enterprise of both food production and storage. In contrast, hunter-gathers had a way of life that could involve 'sharing, mutual support, and extensive, relatively fluid webs of social relationships', which could lead neighbours to demanding that an otherwise potentially successful farming community share out their seed corn or breeding stock for immediate consumption (Thomas 2014, p. 9). The transition to a Neolithic way of life, therefore, may have required that such ties or at least such relationships with local neighbouring communities were either cut or transformed. Notions of ownership, and especially land-ownership, and territoriality would have emerged as a consequence of the long and arduous processes of clearing forest-covered land for farming, digging and tilling the soil, planting and protecting crops from animals and birds, and finally harvesting and storage (Malone 2001, p. 18). The monumental structures of long barrows and cairns may, thus, have served to stand as markers of territories, which is an aspect that largely explains their distribution in many areas. Caroline Malone makes an observation to this effect regarding the long cairns of Scotland:

> The distributions of tombs on some Scottish islands have shown…a pattern closely mirroring the modern land division of farms and crofts…Tombs may represent family areas…each tomb is in a location that has access to a variety of soil types. In Arran they are spread out almost equally in the island. (Malone, 2001, p. 107)

These two influences—the pre-existing burial traditions of the people of Neolithic western Europe, in combination with a given community's need to demarcate in an obvious and visible way their territory—may provide some explanation for the emergence of the distinctly *monumental* burial tombs that they began building in the fifth millennium BC. However, these elements of the culture do not account for the particular way in which long barrows and long cairns were typically constructed. A widely held view is that the rectangular design of these monuments is attributable to the design used in Neolithic houses and community structures such as halls. Such prehistoric buildings were largely ephemeral, temporary structures that would need to be replaced relatively frequently, and would stand for no more than 50 years at a time (Brophy 2013, p. 13). Moreover, there is evidence for many halls being cremated at the end of their period of use as well as evidence for such buildings being used as burial sites. A compelling explanation for the emergence of long barrows in western Europe during the Neolithic is, therefore, that rectangular community halls were used as a site of burial, to be covered in cairn material of earth, stone or both (Brophy 2018, p. 13). The resulting structures are likely, then, to have been replicated overtime, leading to the trend of the particular kind of monument construction seen in long barrows and cairns.

Long Cairns and the British Neolithic

The tradition of long barrow and cairn building seems to have travelled to Britain directly from western Europe. Collard et al (2010) report a sharp increase in Britain's population after 4000 cal BC, which is a date that coincides roughly with the appearance of Neolithic culture in the Thames estuary (Cummings and Harris 2014, p. 11). These developments follow an 'amelioration' of a period of relative cooling in the northern hemisphere, in 4100 cal BC, which had lasted around four hundred years (ScARF 2012). It is plausible that the stable and warmer temperatures, and the longer growing seasons they would have facilitated, led to increases in continental Neolithic populations. Subsequent dates, after 4000 cal BC, have been found for Neolithic material from elsewhere in Britain and Ireland that present a picture of the culture practised in western Europe spreading from that time. Evidence from aDNA samples reveals that the population of the ensuing Neolithic Britain was dominated by individuals with the same genetic markers as those of western Europe (Brace et al. 2018), and several other pieces of evidence indicate that there were distinct changes in culture, practices and demographics from what was seen in the former period, the British Mesolithic: there was a sudden change in the diet away from marine resources; and, an advanced use of pottery appears immediately in the archaeological record, without signs of development (Cummings and Harris 2014, p. 10). Moreover, a large number of houses appear in Ireland, and some in Britain, at the beginning of the fourth millennium cal BC, which have been interpreted as the 'footprint of colonizers arriving from abroad' (Cummings and Harris 2014, p. 6). There is, therefore, compelling evidence of an influx of people to Britain and Ireland travelling from western Europe at around and after 4000 BC.

However, there is also evidence of continuity of the practices of the formerly Mesolithic inhabitants of the region. There is an absence of remains of housing in the archaeological record, which may be due to the temporary structures used in the Mesolithic methods of housing going largely unchanged. There is no evidence of the kind of widespread practice of cereal farming that would support whole communities, which indicates that Mesolithic hunter-gathering was likely still used to a significant extent, such as through the persistent gathering of hazelnuts, which has been found in certain areas (Cummings and Harris 2014, p. 9). Furthermore, Neolithic settlements track the same locations as those of Mesolithic settlements, indicating that the communities of the former subsumed and acculturated the later, or were at least combined in some way.

Nevertheless, despite the prevalence of Mesolithic practices in Britain and Ireland, certain Neolithic developments, such as the construction of long cairns, are clear. There is also evidence of the beginnings of the kind of large and community oriented Neolithic cultures that emerged in the continent. At the advent of the Neolithic in Scotland, a small number of large and rectangular timber halls are built, measuring between 22–27m long and 8–12m wide (Brophy 2013, p. 6). These buildings are similar to those that are seen in western as well as central Europe and bear close associations with the long barrows also seen there. Hence, there is a sufficient basis from which to infer that the long cairns of Scotland are inextricably linked to the Neolithic population influx and cultural developments occurring at the beginning of the fourth millennium cal BC.

The particular culture that would emerge in the British and Irish Neolithic was different to those from the patchwork of cultures of Neolithic Europe. Some of the typical practices adhered to in the continent were not adopted and maintained over time by the people of Neolithic Britain, such as more permanent housing structures and dependence on cereal. Some have also argued that after cereal cultivation was introduced to Britain at the beginning of the Neolithic, around 3800 cal BC, the practice saw a decline as subsistence became more centred on pastoralism around 3400 cal BC (Stevens and Fuller 2012). That time-period coincides with the building of most if not all long cairns, with the exception of the later re-use of some such structures (see Figure 3.1; Cummings, Midgley and Scarre 2014, p. 12). Hence, the notion that cereal cultivation declined at 3400 cal BC would seem to indicate that the beginnings of the Neolithic period in Britain were marked by the influx of immigrants from western Europe who carried with them certain cultural norms, such as cairn and barrow building, and that those norms waned with time along with the associated practice of cereal cultivation. However, that interpretation of the data on cereal pollen records has since been shown to be questionable (Bishop 2015). The cultural norms marking the beginnings of the British and Irish Neolithic may indeed have waned overtime, but it is also just as likely that they were simply transformed, as values and relations within and between communities evolved. A further, critical factor that should be taken into account in considering these changing trends is that the period of warmer and stable temperatures, which began in 4100 cal BC, ended in 3700 cal BC when temperatures (detected in northern Scandanavia) dropped, before a further and sharper drop in 3650 cal BC. This likely contributed to the changes in subsistence patterns, as the colder and wetter conditions in Britain may have had a deleterious impact on cereal cultivation.

Site Name	Council Area	Lab no.	Context	Material	Uncalibrated date Before Present (BP)	Calibrated radiocarbon date BC/AD	References
Port Charlotte	ARGYLL AND BUTE	HAR-2084 HAR-2405 HAR-2406 HAR-2836 HAR-3486 HAR-3487		Charcoal Charcoal Charcoal Charcoal and charred hazel nut shell (mixed) Charred hazel nut shell (Corylus avellana) Charred hazel nut shell (Corylus avellana)	4540 BP +/-70 1860 BP +/-70 4710 BP +/-70 4660 BP +/-90 4940 BP +/-70 5020 BP +/-90	3550 to 2900 cal BC 20 cal BC to cal AD 340 3640 to 3360 cal BC 3650 to 3100 cal BC 3950 to 3630 cal BC 3980 to 3640 cal BC	Canmore
Glenvoidean	ARGYLL AND BUTE	I-5974		Charcoal	4860 BP +/-115	4050 to 3100 cal BC	Canmore
Crarae	ARGYLL AND BUTE	OxA–7662 OxA–7880		Bone, human (*homo sapiens*) Shell	4735±40 (Date BP±err) 5230±55 (Date BP±err)		Discovery & Excavation 2000, p. 123
Mid Gleniron I	DUMFRIES AND GALLOWAY	GrA-21692		Bone, human (*homo sapiens*)	3470 BP +/-60	1940 to 1620 cal BC	Canmore
Lochhill	DUMFRIES AND GALLOWAY	I-6409		Wood	5070 BP +/-105	4250 to 3500 cal BC	Canmore; Discovery & Excavation 1973, p. 32
Camster Long	HIGHLAND	GU-1706 GU-1707 GU-1708 GU-1709	On the ground, S forecourt Buried soil under S part of cairn Buried soil under S part of cairn Buried soil under S part of cairn	Charcoal Charcoal Charcoal Charcoal	4780 BP +/-170 4950 BP +/-80 4915 BP +/-60 4920 BP +/-125	4000 to 3050 cal BC 3960 to 3630 cal BC 3940 to 3530 cal BC 4000 to 3350 cal BC	Canmore; Henshall and Davidson 1991, p. 83
Tulach an t'Sionnach	HIGHLAND	GrA-28611 GU-1330 GU-1331 GU-1334	N/A Filling of chamber Filling of chamber On chamber floor	Bone, human (homo sapiens) Bone, animal (red deer?) Bone, animal (red deer?) Bone, human (homo sapiens)	3705 BP +/-35 4210 BP +/-60 4055 BP +/-70 4685 BP +/-60	2140 to 1970 cal BC 3100 to 2450 cal BC 2900 to 2300 cal BC 3700 to 3050 cal BC	Canmore; Henshall and Davidson 1991, p. 83
Clachaig	NORTH AYRSHIRE	UB-6898 UB-6897	From the Clyde cairn From the Clyde cairn	Unburnt human bone (cranium) Unburnt human bone (cranium)	4708 BP ±37 3949 BP ±363	3630–3370 (at 1?) / 3640–3370 (at 2?) 2570–2340 (at 1?) / 2570–2300 (at 2?)	The National Museums Scotland Radiocarbon Dating Programmes: results obtained during 2005/6. Sheridan, Alison.
Torlin	NORTH AYRSHIRE	GrA-25644 GrA-25646		Bone, human (homo sapiens) Bone, human (homo sapiens)	4775 BP +/-40 4770 BP +/-40	3650 to 3380 Cal BC 3650 to 3380 Cal BC	Canmore
Monamore, Meallach's Grave	NORTH AYRSHIRE	Q-675 Q-676	1) Charcoal from a hearth in the forecourt under the blocking of a chambered cairn 2) Charcoal from the top of a thick layer of deposits in the forecourt of a chambered cairn	Charcoal Charcoal	5111 BP +/-110 4190 BP +/-110	4351 to 3500 cal BC 3400 to 2300 cal76	Canmore
Margaret's Law, Haco's Tomb, Haylie	NORTH AYRSHIRE	GrA-25643		Bone, human (*homo sapiens*)	4665 BP +/-50	3630 to 3350 Cal BC	Canmore

Figure 3.1: Radiocarbon dates for material found at some long cairn sites in the regions examined.

3.2 Classification and Morphology

As it is used in this thesis, and elsewhere (e.g. Henshall 1963, p. 43), the term 'long cairn' describes monuments that are composed of stones, timber or earth, or a mixture of these materials. This may seem to conflict with an intuitive usage of the term, as cairns are generally understood to be composed of stones alone, or at least primarily of stones. There are two main reasons why the term 'long cairn' is used here in this way, that is, so as also to be inclusive of similarly shaped monuments built from other materials (earth or timber).

First, without excavation, it is not usually possible to determine whether a mound that appears to be made of earth does not also incorporate significant amounts of stone. Hence, monuments that appear to be wholly earthwork and possibly timber, to be 'barrows' so-defined, may actually be long cairns in the sense that they are also constructed out of stone. Second, in Scotland, the vast majority of monuments fitting the description of long cairns, as I have used this term, are composed of stone. In the relatively few cases where 'long cairns' (or 'long barrows') appear to be made from earth (and wood) and not stone, the purpose for which they were built is likely to be either identical, or very closely related, to their stone-constructed counterparts. Hence, the long barrows present in the regions studied are a subject of interest for the self-same reasons as are long cairns, under a more stringent definition of that term.

Long cairns are differentiated from other cairn monuments in virtue of having a defined long axis that, as discussed here, may be emphasised to greater or lesser extents. It is this feature of the long cairn, its long axis, that makes it ideal as a monument type for the study conducted in this thesis, which investigates the extent to which their structures may be oriented in relation to the sea or other bodies of water.

By the aforementioned rationale, bank barrows might also have been included in the study, as a monument type with a salient long axis, along with other longitudinal monuments, such as cursuses. However, these other varieties of prehistoric constructions were not included in the present study in order to balance the competing considerations of having a sufficiently large corpus of monuments to investigate, a manageable number of monuments to investigate, as well as having monuments with a reasonable degree of uniformity in purpose.

The term 'long cairn' refers to cairns that are both chambered and unchambered (Davidson and Henshall 1991, p. 3). The use of this term for both monument types is necessary to avoid both error and the associated difficulty of determining whether or not a cairn once contained chambers. Such difficulties arise for two reasons. First, rather than being exposed, chambers can sometimes be hidden beneath a stony or turf-covered long cairn, giving the false impression that the cairn is unchambered. Second, some chambers were constructed from wood, a material that is prone to decay. Since wood remains generally vanish quickly over time, a wood-constructed chamber may leave no indication of its existence, other than perhaps a cave-in. However, apparent cave-ins may also have other causes, as hollows in a cairn may be due to the salvaging of stones for more recent constructions such as boundary walls and sheep pens. Therefore, for cairns that do not contain exposed and readily observable chambers, the presence or absence of a chamber must be confirmed by further investigation, such as excavation or geo-physical survey. For these reasons, there are also difficulties in determining whether a site contains a burial chamber. Therefore, the term 'long cairn' continues to be used somewhat superficially to describe sites that are substantially long, with or without an exposed burial chamber.

Long cairns exhibit great variation in their length, width, height, and overall shape. The majority of the 213 sites in Scotland range between 30 and 70m. The shortest long cairns are less than 20m. Examples are Glenviodean, on the Isle of Bute, at 13m, and Ballie Hill, in the Highlands, at 18m. The longest cairns are 80m or more, as seen at Knappety Hillock, in Aberdeenshire, which stretches to 86m, and Greens Moor, in South Lanarkshire, where the visible extent of cairn ruins reach 80m (see Figure 3.2). Auchenlaich, in Stirling, is an outlier in this regard and measures to several times this length, to 322m on its long axis. Long cairns generally taper to become narrower at one end, where their width is reduced by half (see Figure 3.3). Long cairns' widest ends are usually between 1/4 and 1/2 the cairn's length, although some of the longer cairns are narrower, with a width of around 1/6 their length, or less as in the case of Auchenlaich. Long cairns are often taller depending on their size, with ruins frequently standing at less than 1m but sometimes reaching to over 4m, as seen as Knowe of Lairo, in Orkney, which stands at 4.8m, and Longman Hill, in Argyll, which stands at 4.3m.

Figure 3.2: Site plans of Glenviodean, in Bute (bottom), and Greens Moor, in South Lancashire (top), showing variation in size.

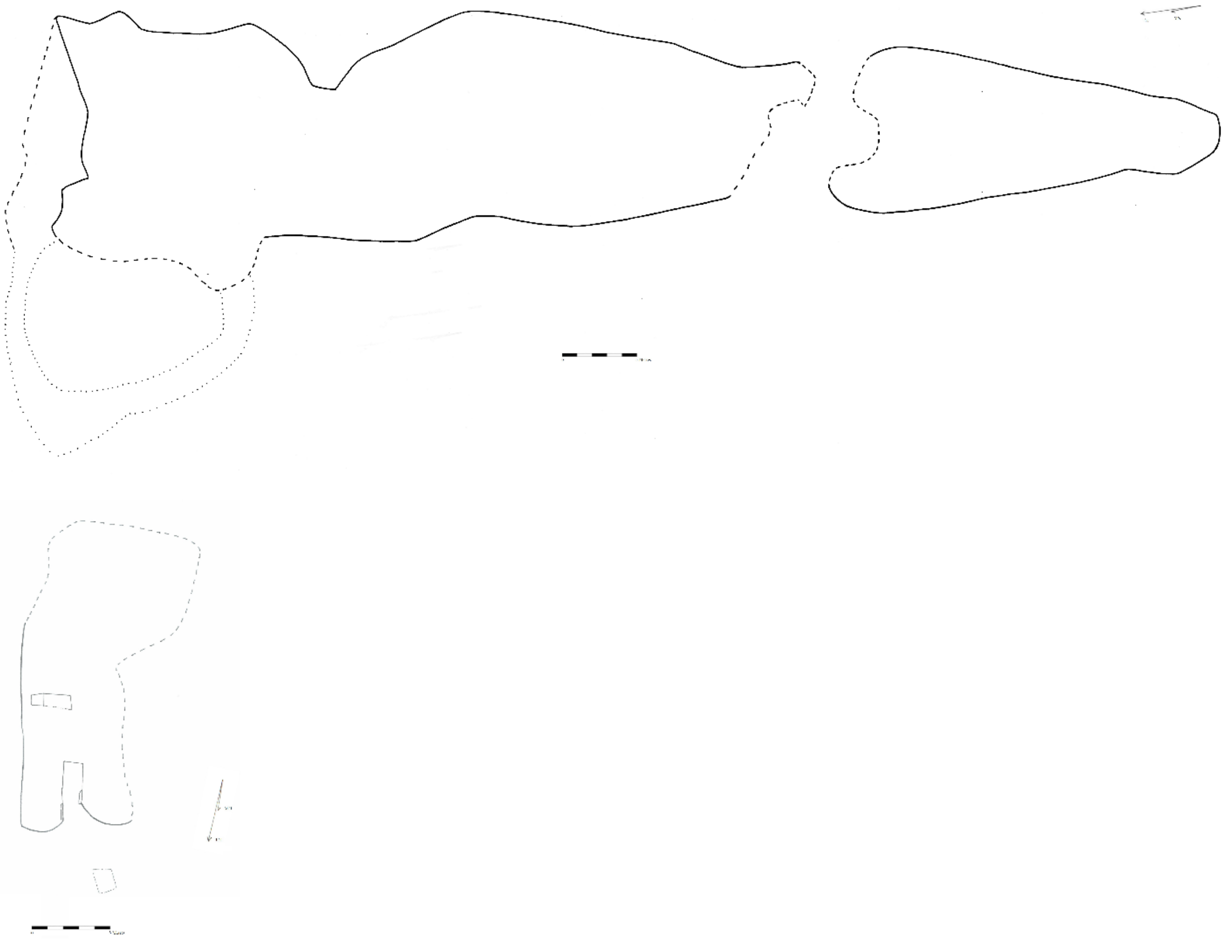


Figure 3.3: Photograph of South Yarrows South, in the Highlands, showing an example of a larger monument's scale and dimensions.

Façades and forecourts

An arc of 'orthostats' (upright stones) is seen at some sites. These orthostats may have been linked by panels of walling to form a semi-circular façade, and a lack of evidence of any such panelling could be explained by their being constructed from non-surviving building materials. Such wall-faces may, then, have been susceptible to weathering and human interference, eventually disappearing from the archaeological record.

A facade is usually located at a cairn's entrance at its proximal or distal end(s). A key feature of a cairn façade is that it is tallest at the centre, progressively reducing in height approaching the ends of the façade's arc. At South Yarrows South, the wall-face at the entrance stands to a height of roughly 1.5m, which gradually diminishes to a height of roughly 0.6m at the ends of the arc (Henshall and Ritchie 2001, p. 55). Facades comprise stone-built or earthen projections that protrude from the cairn, known as 'horns' (see Figures 3.4 and 3.5). Horns formed roofless forecourts at the entrance to a burial chamber, and created either deep or shallow concave façades, similar to small amphitheatres. Horned long cairns can have forecourts with horns at both of its ends or a single forecourt with horns at its proximal or distal end. Tulach an t'Sionnaich, for instance, has only one forecourt with horns, which is located at its proximal end. Na Tri Sithean and South Yarrows South are examples of cairns with horned forecourts at both ends of the structure. Horns are also sometimes present at sites that do not have entrances at the cairn's proximal or distal ends. For example, at Camster Long, the entrances to the northern and southern chambers were approached from the long side of the cairn (from the east) rather than from its forecourts, which were constructed at both its proximal and distal ends. Such instances notwithstanding, impressive façades and forecourts around the entrances at many sites have led to the suggestion that the entranceway into the burial chamber was of great significance to builders.[1] Horned forecourts may, accordingly, indicate a shift towards the development of ritualistic behaviour outside these cairns (Henshall and Ritchie 2001, p. 67, p. 108).

[1] An example of the pronounced importance of side chambers is seen at the site of Arthur's Stone, a Neolithic burial chamber in the hills above Herefordshire's Golden Valley.

Figure 3.4: Photograph of the horned forecourt at Glen Lussa, in Argyll.

Figure 3.5: Photograph of a horned forecourt at South Yarrows South, in the Highlands.

The forecourt is on the far side, on the right.

Chambers and Cairn Cores

Audrey Henshall and J. L. Davidson (1991, p. 21) argue that fully excavated chambers could be used to provide a typological framework that may be used to further our knowledge of the unexcavated and poorly reported chambers. However, it should be noted that there is some question as to how useful any such typological framework might be, due to the presence of aberrant chamber plans. Moreover, and relatedly, the known chamber plans to be used in the development of such a typological framework may not be representative of the large percentage of sites that remain unexcavated and which may contain unexposed chambers that possess hidden features. On this possibility, there may as yet be insufficient data to describe accurately the range of different chamber-types made by prehistoric builders. Nevertheless, Henshall uses the following key features to define a chamber and its characteristics, and to classify different types of chambers (1991, p. 21; Henshall and Ritchie 2001, p. 36):

- Chamber: a complete structure beyond a passage, which contains one or more compartments.
- Compartment: an area within a chamber, between pair of divisional slabs.
- Divisional slab(s): pair of upright slabs in a chamber, or alternatively a slab that sub-divides a chamber without reaching its roof.
- Main chamber: the part of the chamber covered by the high vault.
- Ante-chamber: a low-roofed area between the passage and main chamber.
- Cell: a low-roofed area accessible from the main chamber.

Chambers were immediately enclosed by a densely-built cairn core, a stable structure constructed from densely-packed horizontal slabs, gradually corbelled in until the opening at the top of the vault was spanned by either a capstone or a lintel. The cairn core was a vital part of the chamber itself as it supported the chamber walls and roof. Since the stability of the chamber was contingent on the cairn core, both structures were built as a unit. Therefore, the shape of cores were round, oval or rectangular depending on the chamber plan and were typically protected by an exterior layer of looser cairn rubble, which was confined by a wall face. The only proper investigation of a cairn core was at Point of Cott (ORK 41) in Orkney, a long cairn excavated by Barber in 1997 (Henshall and Ritchie 2001, pp. 56-5 8, pp. 98-99).

Regional Diversity of the Long Cairns of Scotland

A number of distinct regional groupings of long cairn types can be identified in Scotland, however, a significant amount of sites cannot be classified into any one group as they lack adequate features that are necessary for classification. In the northern region, which includes the Outer Hebrides, Skye, and the Northern Isles, almost all chambered cairns belong to the passage-grave tradition of tomb building—defined as round or rectangular mounds that encompass one or more chambers. The distinctive feature of the passage-grave tradition is that chambers are not directly accessible from the outside but are, instead, approached via a passage (Henshall and Ritchie 2001, p. 5). Passage-grave tombs tend to vary widely in size and design, which is likely due to their long history of construction and use, described below (in section 3.3), and due to factors relating to the vast geographical area that they cover. Practical issues relating to the construction of these monuments, such as the availability of raw materials, may have contributed to their diversity. Prehistoric communities may also have adopted ideas that suited their specific needs, while discarding others.

Architecturally, the majority of these monuments belong to what Henshall describes as the 'Orkney-Cromarty group' (Henshall 1963).

Of the 213 long cairn sites discovered in Scotland thus far, 51 sites situated in northern Scotland can be identified as belonging to the Orkney-Cromarty group. These sites bear close similarity with the Balnagowan group, which comprises 11 sites. These cairns are predominately found in Aberdeenshire, in the east, and are distinguished from the Orkney-Cromarty group by two characteristics. Balnagowan cairns are often although not always earthen as opposed to stone structures, and, they have no apparent chambers (Henshall 1963 vol. I, pp. 40-44). However, as noted above, these cairns might simply conceal chambers in such a way that does not make them apparent. Balnagaown cairns may also encompass chambers that have since decayed, as it is possible that they were constructed from decomposable materials such as wood.

The 'Clyde' or 'Clyde-Carlingford' architectural design defines another distinctive group, which is widespread in the south-west region of Scotland. Belonging to the gallery-grave tradition of tomb building, the main feature that differentiates these 68 cairns from the Orkney-Cromarty group is that their chambers do not have a separate 'formal' entrance passageway. Clyde-type chambered cairns are found in the counties of Dumfries and Galloway, North Ayrshire (Arran), and Argyll and Bute, with a few outliers in nearby provinces. Cairns belonging to this group are known to differ from each other significantly in size and complexity (Henshall 1972; Malone 2001, pp. 137-138). A distinguishing feature of Clyde-type long cairns is seen in their forecourts. They are frequently edged by magnificent façades of upright stones, which can form either a deep crescentic shape or a much shallower concave design. These forecourts have centrally placed axial chambers, however, some sites also have lateral chambers in the sides of the cairn or chambers at the distal end. Some scholars consider Clyde cairns to be the first chambered cairns ever to be built in Scotland (Noble 2006, pp. 104-05). There is, however, evidence of some degree of hybridization. Some cairns discovered in and around these regions appear to have incorporated elements from both of the main traditions, Clyde and Orkney-Cromarty, suggesting a diffusion of ideas.

3.3 Long Cairns as Multi-Period Constructions

Henshall (1972) argues that multi-phase constructions could explain much of the architectural diversity witnessed in chamber types and cairn forms. Under this theory, all burial chambers were once covered by round cairns, which were modified at a later stage to produce other cairn forms. The addition of a straight façade or a crescentic forecourt to a round cairn would, respectively, create a heel-shaped or short-horned cairn. Alternatively, a rectangular extension, with or without a crescentic forecourt, resulted in a long cairn. Such additions, then, came about as a result of prehistoric builders enlarging or elaborating the external appearances of these monuments.

At two sites, Camster Long (CAT 12) and Tulach an t'Sionnaich (CAT 58), partial examination of the long cairns revealed that both monuments' structures amalgamated pre-existing chambered cairns (Davidson and Henshall 1991, pp. 47-59). At Tulach an t'Sionnaich, a rectangular cairn had been added to a heel-shaped chambered cairn (Corcoran 1966). Investigations have revealed that the rectangular cairn at that site was not built against the heel-shaped cairn, thus leaving a small gap between the two structures. Henshall and Ritchie (2001, p. 106) argue that that gap was filled in at a later date, clearly marking two distinct phases of construction. However, a different scenario seems apparent at Point of Cott (ORK 41), where Barber (1997) demonstrated that the long-horned cairn enclosed both the rectangular cairn and the core without a gap between the two components. This, Barber argues, forms a unitary design even though clearly built in three distinct phases (Barber 1997; Henshall and Ritchie 2001, p. 107). The three distinct phases included: the construction of a rectangular core that encompassed a stalled chamber; a rectangular cairn that was added to the core at its rear; and, finally, the construction of the long-horned cairn that enclosed the two earlier structures.

Excavations at Camster Long have, similarly, confirmed that the long cairn was built in at least three phases. Phases 1 and 2 saw the construction of two chambers that had been enclosed by respective round cairns. The southern round cairn incorporated a Camster-type tripartite chamber, more complex than the single compartment chamber in the north. This difference in chamber design led Henshall and Ritchie (2001, p. 108, p. 110) to suggest that the northern chamber and its round cairn likely predated the round cairn in the south. Their contention is, therefore, that these prehistoric constructions began with a basic design, simple in concept but later became more elaborate (Henshall and Ritchie 2001, p. 108, 110). Thus, the two chambers were unlikely to be contemporary. The final phase of this multi-period monument was the construction of the long cairn, which was built to enclose the two pre-existing round cairns (Davidson and Henshall 1991, p. 58; Masters 1997).

Henshall (1972), therefore, argues that there is substantial evidence to suggest that many long cairns began as simple round and oval cairns that were enlarged and elaborated at a later time. She notes also that many of the complexities observed in long cairns can be explained by the theory that they are multi-period constructions, even if such a theory may not apply for long cairns. The side entrances at Camster Long One is an example of such a complexity, as they are not obviously features that were intended by their original builders. The range of differences in chambers and long cairn axes present in the long cairns across Scotland may also be, at least partly, explained by this theory, which has largely been accepted (Corcoran 1966, 1972; Henshall 1972; Masters 1997).

Nevertheless, there is tension between the notion that long cairns were constructed as a result of an amalgamation of two round cairns, and the notion that they emerged as a result of the cremation and burial of rectangular community halls, the resulting structures of which may have been replicated over time, as discussed earlier above (in Section 3.1). However, taken together, both of these theories may be helpful in explaining the regional diversity of long cairns. The Balnagowan group of Aberdeenshire in particular includes some cairn structures, such as Knaperty Hillock, that appear to be decisively rectangular and not to hold deviations in their shapes in a way that would suggest that they are amalgamations of two pre-existing cairns. Nevertheless, despite such differences in the styles of long cairn building, it remains a subject of interest in all cases whether or not their long axes are oriented in relation to the sea or other bodies of water. This is because, regardless of their design, they remain to be monumental feats of human effort with salient orientations. Hence, for the purposes of this thesis, the term 'long cairn', as the subject of the study, is taken to include all such monuments despite their differences.

3.4 How Long Cairns were Used

In addition to being repositories for the dead, the elaborate nature of long cairns' magnificent façades and forecourts has led scholars to suggest that these tombs were also foci for ceremony and ritual. In the late nineteenth century, Joseph Anderson excavated several cairns in Caithness. His investigations revealed large quantities of charcoal within tombs, providing evidence of such ceremony and ritual. These discoveries led Anderson to infer that the people who built these monuments 'kindled great and long-continued fires within cairns' (M.A.S.L. vol. III 1867–9, p. 220). In a similar vein, Henshall notes:

> . . . there were long and elaborate ceremonies at the tombs and the structures themselves are much more than functional burial vaults. Their frequently astonishing size and elaboration indicate a powerful belief in a life after death . . . (1963, vol. I, p. 4)

Henshall's comment notwithstanding, support for her claim is scarce as few excavations have revealed evidence of burning outside the entrances.

Some theorists have suggested that these monuments were more than just vaults for the dead. Such a view is supported by the fact that while these are massive and impressive structures, it appears as though only a small percentage of a cairn's total area was actually used for entombing the dead (Smith and Brickley 2009, p. 11). Moreover, some cairns, such as South Street Barrow, have revealed no evidence of burial after excavation (Ashbee 1970). This may be explained by long cairns playing other important roles, such as serving as cenotaphs (Ashbee 1970), or, as described earlier, as territorial markers to establish their builders' authority over the surrounding landscape.

The outer and inner ends of cairn passages were blocked by stacks of slabs that denied entry into chambers. Although slabs securely closed entry points, prehistoric people could gain access to chambers by removing the slabs. The passage could once again be resealed after new interments were made. Evidence of such processes suggests that chambered long cairns were reused over centuries. There are indications that the final phase of long cairns involved a more permanent closure that was achieved in a number of ways. The most basic style of permanent closure was a partial or complete infilling of the passages and chambers with loose stones and soil. Sometimes the permanent closure involved blocking the ends of the passageways. An example is seen at Shean Stemster, where an upright slab was placed at the inner end of the passage, closing the entry point into the chamber. Further but contrasting examples of cairns' permanent closures are seen at Camster long and Tulach an t'Sionnaich, where the outer ends of passages were blocked by carefully placed stacks of slabs. In addition, at Tulach an t'Sionnaich, Corcoran identified a deliberate layer of deposits which included burnt animal bones, charcoal, burnt earth, land snails and limpet shells. These deposits were carefully laid out and packed tightly, forming a deliberate infilling of about 0.7m thick. A similar treatment can be found at the small northern chamber at Camster Long, where Anderson's excavations revealed a deliberate infilling of stones reaching almost to the roof of the chamber. In the same way, the roofed cell at South Yarrows South was found to be packed with small stones, with the entry point closed off by an upright slab. It is also common to find evidence of external blocking, outside a cairn's passage entrances and forecourt. At Camster Long, excavations have unravelled extensive blocking that filled the forecourts. Any blocking that may have existed outside the passage entrances had been removed during nineteenth century excavations.

3.5 The Landscape Sitting of Long Cairns

Some speculation has been made regarding the landscape sitting of the long cairns of Scotland and the considerations that may have led to their builders' location choices (See Henshall 1972 and Phillips 2002). As a preliminary to such considerations, it will be of benefit to first have an account of the nature of the wider environment of Scotland, as it was in and around the period when long cairns are known to have been constructed.

Much of present day Scotland comprises vast wastelands of wild moor and peat blanket largely inhospitable to human occupation let alone prehistoric settlement. This was not, however, the case during the Neolithic. Although it is unlikely that much if any vegetation survived the Loch Lomond Stadial (c 9000–8300 BC), the last glaciation that affected Scotland, the next one to two millennia to follow saw the migration of trees from southern Britain and the continent until most if not all of Scotland, including the isles to its north, was covered in both closed and open woodlands, and grassy plains (Tipping 1994). While peat mosses first appeared at roughly the same time, at c 7600 BC (Tipping 1994, p. 15), moorland and peatbogs had not yet taken hold at that time. As that era in Scotland was also characterised by a slightly milder climate, the area was unrecognisably more hospitable and welcoming for human settlement than it is today. The Scottish landscape would not undergo significant deforestation until 2000 BC, long after the construction of the long cairns considered in this thesis. While there is disagreement as to what caused the drastic change in the landscape into what it has become today, there is a consensus that climate change to colder and wetter conditions in addition to the spread of the peat mosses were major contributors to the retreat of the woodlands and the present condition. The impact of land-clearing for cultivation may also have contributed to this change, although the extent to which it did has been debated and it is probable that it would have happened in the absence of human settlement (Tipping 1994, p. 15).

Pollen analysis reveals that there is some variation between the different regions of Scotland under investigation in terms of the vegetation that grew during the Neolithic. Pollen analysis of a number of locations south of the Forth–Clyde line indicate that woods of birch, hazel and oak were present in Dumfries and Galloway (Tipping 1994, p. 31). The regions of Argyll and Bute, the Isle of Arran, and Aberdeenshire are all revealed to have contained woods of pine, and pine and birch. The long cairns of the Highlands that were investigated in this study are situated in either of three topographical zones, some of which contained different types of woodland: the Straths and the Firthlands both held woodlands of birch hazel and oak, while Caithness held open woodlands of birch and hazel (Phillips 2002, p. 55, Tipping 1994, Fig. 3). It should be noted that while certain pollen types may be discoverable through coring, others are poorly preserved and are, therefore, underrepresented. Such species that may also have been present in these regions include: poplar, rowan, willow, ash, hawthorn, holly, juniper, and bird cherry (Tipping 1994, p. 11).

Several factors of these aspects of Scotland's prehistoric landscape are relevant for the purposes of this study. First, woodlands were ubiquitous for the inhabitants of prehistoric Scotland, and this would have both affected their experience of the landscape and allowed for the availability of wood for fuel and for construction. While this will be a consideration that plays a role in assessing visibility from cairn sites, it should be noted that little can be determined conclusively about how thick such woodland grew, as 'it is currently not possible to reconstruct tree density' (ScARF 2012). Interpretations range between, on the one hand, scenarios in which rivers may have been an essential means of travel through dense riparian woods and, on the other, where woodlands were substantially cleared for farming before seeing regeneration in the mid-Neolithic, due to 'agricultural failure' at that time (ScARF 2012).

One theory supposes that slash-and-burn techniques were used to rejuvenate soils for farming. This theory would, then, account for charcoal deposits in sedimentation that disappear as conditions became wetter following the drop in air temperature roughly four hundred years after the beginning of the British Neolithic, after 3650 cal BC (ScARF 2012). However, as compelling as this theory may seem, others (Tipping and Milburn 2000, as cited in ScARF 2012) have argued that 'such fires were natural and ceased with the change to a wetter climate', so that there is no unambiguous evidence for land use in these ways.

The second factor that should and has been taken into consideration is the significance of the present-day locations of peat bogs and what that can tell us about the areas of Scotland that were once the most and least hospitable. Henshall (1972) comments that while peat did not cover the landscape as completely as it does now, its spread, or rather the areas where it has not spread to, do give some indication as to the best land for cultivation and the best-draining land. She supposes that it is likely that this explains why cairns were often placed in and around areas of arable land that are used for cultivation today, and which also resisted the spread of peat mosses—

a point also made by Tipping (1994). Hence, there are complementary reasons that account for why the cairns of Scotland occur largely in areas that are used in present-day farming, and may have been used for farming in the Neolithic. These same reasons also account for why clusters of cairns often occur within and not across present-day municipalities which have been defined in ways that correspond to areas of land adjacent to a given river or body of water.

Henshall observes that cairns are not situated in particularly prominent areas, but rather seem to have been placed intentionally on sloped ground on hill-side perhaps to ensure effective drainage (1972). Tim Phillips presents a different view to Henshall, although he draws on the same set of factors. Phillips observes that cairns are placed on the outer limits of arable land, and he supposes that an intention of prehistoric builders may have been to mark the boundaries of the landscapes used by the living, that is, for farming and settlement, and the landscapes that were used for burial, thus the title of his volume, *Landscapes of the Living Landscapes of the Dead* (2002).

Another noteworthy observation made by Phillips is that in the Highlands at least, the area he investigated, cairn structure varies somewhat predictably according to the kind of environment in which a cairn is situated (2002). Phillips' assessment of pollen data alongside cairn distribution reveals that round cairns are more frequently built in densely wooded areas, dominated by pine and birch or birch, hazel and oak, whereas long cairns are found more often in open woodlands, of birch and hazel where there are greater ranges of visibility over distance (2002, p. 56). Hence, there is a strong association between visibility and cairn structures having distinct long axes, which suggests that long cairns may be oriented in particular directions in virtue of what is visible from their locations.

These interpretations notwithstanding, both Henshall (1972) and Phillips (2002) acknowledge that a major limitation in assessing the extant distribution of cairn sites in Scotland is the differential survival of sites: it is probable that a great number of cairns once stood in places that have been occupied since prehistoric times, and that cairn material was subsequently used for building other structures, such as sheep pens and walls, or destroyed so that there is no trace of the lost monuments. Therefore, any interpretation of the extant distribution of cairn sites must be considered alongside the fact that the perceived trends may be misrepresentative of cairns as they once stood.

3.6 Summary

The long cairns of Scotland vary widely in their design and characteristics. They vary markedly in size and length as well as their overall shape. Depending on their region, long cairns generally have differing chambers, and some appear to have held no chambers at all. Similarly, some such cairns have forecourts, some of which are grand and elaborate, while others have none. Nevertheless, the long cairns of Scotland hold several features in common. Regardless of which region they belong to, they were usually used as tombs. Furthermore, while there is the association between long cairns and large rectangular community halls, long cairn structures seem also to have at least sometimes originated as round cairns, which were later elongated by prehistoric peoples in a particular direction. This thesis brings to focus these particular features of the long cairns of Scotland, as a varied but unified monument type, and seeks to further knowledge regarding their original significance, and how that may have related both to ritual and to the directionality of their long axes.

Chapter 4: Methodology

This thesis investigates the specific claim that the long cairns of Scotland often referenced the sea in a way that is indicative of meaningful aspects of past belief systems. Several ideas were considered and several steps conducted in order to test this claim. This chapter describes the methodology used to carry out these steps and to investigate the associated ideas.

A preliminary task, which is described in Section 1, was to define the types of sites being investigated to ensure that they fit a pattern of similarity and that they are unlikely to represent substantially different purposes. Following this task, there were five main steps to the research undertaken here. The first two steps involved determining the two aspects of long cairn positioning of: whether they are placed in locations that afford sea views; and, whether their long axes, chambers or facades are oriented to reference the sea. The means of investigating these aspects of cairn positioning are described in the Section 2. The third step involved determining whether long cairns' sea views are unique or typical in comparison to their respective surroundings. As described in Section 3, this involved the generation and analysis of 'affordance viewsheds', maps that depict the extent of sea views in a given area. Section 4 describes the quantitative and qualitative techniques implemented to examine the affordance viewsheds in determining how typical or unique such sea views are at cairn sites. Section 5 describes a further way that affordance viewsheds are used in this thesis: in determining whether, in addition to sea views, long cairn sites also afford 'revelatory views'. Defined as views that are obscured during approach and are suddenly revealed to persons upon their arrival at a site, revelatory views, if and when present, are a striking and effective way to reference the sea, and are thus a subject of particular interest. The final step of assessing the extent that the long cairns of Scotland seem to reference the sea is detailed in Section 6. This involved compiling the information gained from the previous steps in regard to the alignments of long cairns' (long) axes, sea views and the pathways likely used to approach them, to present the evidence to suppose that the cairns studied here reference the sea or other bodies of water.

4.1 Preliminary Bibliographical and Database Research

Due to the large number of long cairns in Scotland, the directionality of their long axes and their frequent proximity to water, they were considered to be a particularly good example of a monument type that could be used to assess the claim that some prehistoric monuments were deliberately placed to reference the sea. Therefore, a preliminary stage in this study was to identify cairns or mounds that are 'long' in design, and likely to be Neolithic funerary monuments. This was sometimes a difficult task given that such structures have been described in a variety of ways, such as 'long barrow', 'long cairn', 'chambered cairn' or 'chambered long cairn', depending on a monument's mound construction and associated features, which can differ considerably in type and complexity. Nevertheless, these structures share a set of key morphological characteristics: as described in Chapter 3, they are rectangular or trapezoidal mounds composed of either stones or earth, or in some cases a combination of both, and which may or may not contain passages and burial chambers. Given the similarities among such sites, it was decided that a general class of 'long cairns' could be identified and, subsequently, intensive bibliographical and database research was undertaken to that end.

The (former) Royal Commission on Ancient and Historical Monuments of Scotland (RCAHMS) 'Canmore' database was the most useful research tool in compiling the list of sites that fit the chosen criteria. This database holds regional and period inventories, and provides access to valuable information, including details regarding site locations, descriptions of sites and site plans, photographs and aerial imagery where available. Sites from most regions of Scotland are also catalogued online under Site and Monuments Records (SMR) and Historic Environment Records (HER). Initial search results were cross-referenced with these local authority inventories. A further resource that was consulted was *Discovery and Excavation in Scotland* (DES), which provided access to archaeological reports, unpublished fieldwork reports and theses from 1947 onwards. The resulting corpus of long cairn sites (see Appendix) was further supplemented by catalogues obtained directly from the councils of the regions studied, as well as other archives and publications, including excavation reports, journal articles, and book-length texts. Audrey S. Henshall's *The Chambered Tombs of Scotland*, volumes I and II, published respectively in 1963 and 1972, were of great value, so too were her revised publications on the chambered cairns of the counties of Orkney, Sutherland, Caithness and Central Highlands (Davidson and Henshall 1989, 1991; Henshall and Ritchie 1995, 2001). These texts offered a range of information, including descriptions, measurements, orientations, scaled plans, and details regarding the landscape and environmental contexts in which the monuments are situated, such as the local geology, soils and climate. This first phase of research led to the compilation of a sufficiently large and reliable corpus for the proposed study, and the construction of a database that provided a detailed and comprehensive description of long cairn sites (see Appendices A and B).

This investigation led to the initial database comprising 213 long cairn sites, 22 more long cairn sites than Canmore's database currently holds. However, a number of these sites lacked sufficient information, especially in regard to shape, dimension and orientation, despite being cited as belonging to this class of monuments by previous site surveys and visitations. Many of these monuments no longer exist due to their current landscapes being affected severely by both natural and anthropogenic factors, such as arable ploughing and the heavy robbing of cairn material for the construction of sheep pens or walls (Henshall 1972). Consequently, as it is impossible to define and classify all such sites with confidence, of the 213 sites that were initially recorded only 149 were retained for the current study (see Appendix A).

4.2 Field Visitation and Recording

The resulting dataset of long cairns was then investigated to determine whether the sites appear to reference the sea, with respect to being placed in locations that afford sea views or being oriented to reference the sea (see Figure 4.1). Visiting as many of the sites as possible in person not only provided insights into the various topographic locations chosen and transformed by prehistoric human activity, but also facilitated the comparison of field observations with the results from the GIS analyses described below. Of the 149 long cairns identified, 76 sites were able to be visited with available resources and inside the given timeframe for fieldwork, in 2012. As long cairn orientations were considered a subject of particular interest, 63 of those sites were re-surveyed to ensure accuracy. The remaining 13 sites of the 76 that were visited were unable to be surveyed for various reasons, including insufficient remains of cairn material and significant areas of sites being obscured by blankets of bracken. These sites are shown in the following site distribution maps (Figures 4.1–4.9). All long cairn sites in Scotland are shown in yellow, in Figure 4.1. In Figures 4.2–9, sites visited and surveyed are shown in red, sites visited but not surveyed are shown in yellow, and sites analysed without visitation are shown in white.

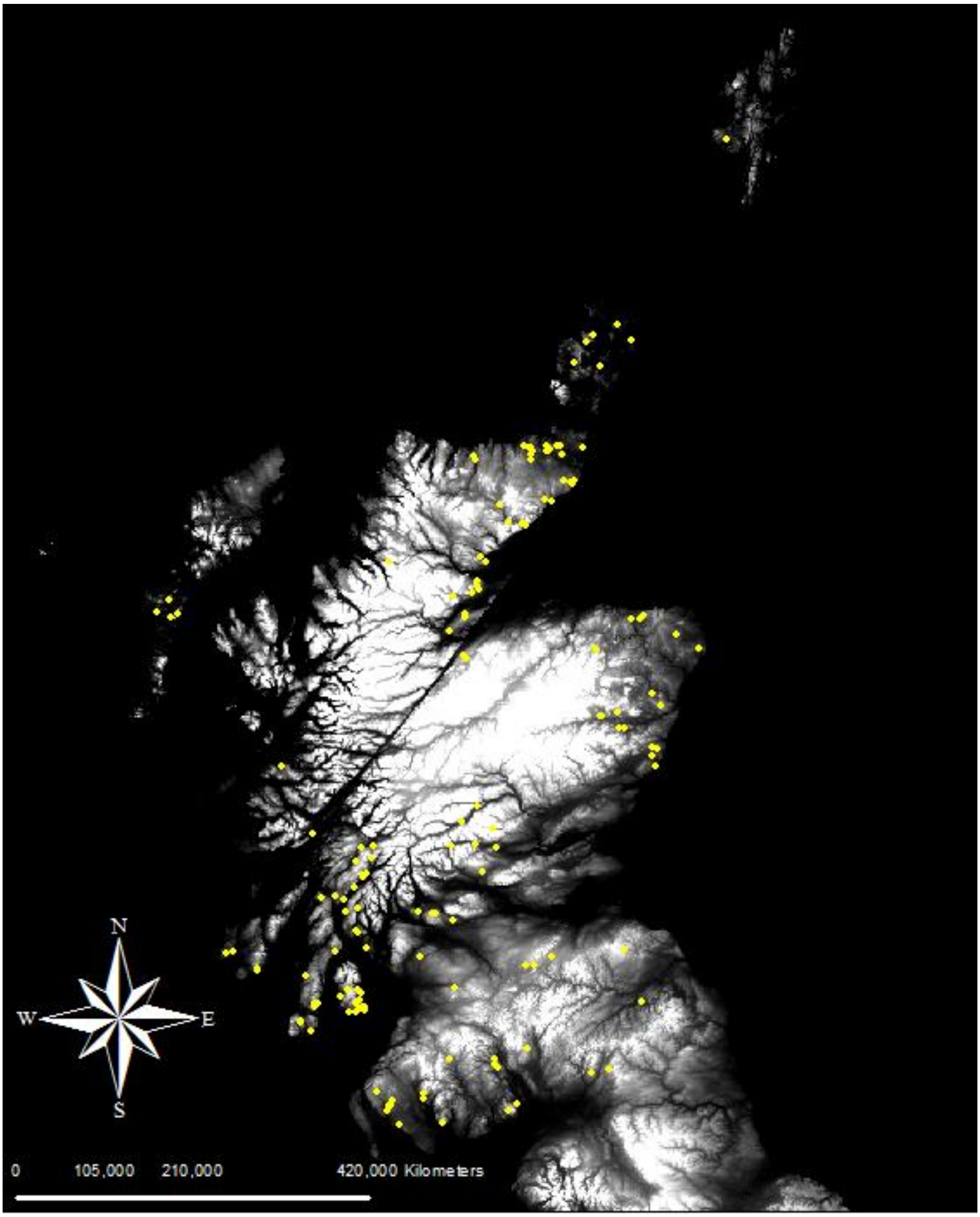


Figure 4.1: All Long Cairn Sites in Scotland (in yellow).

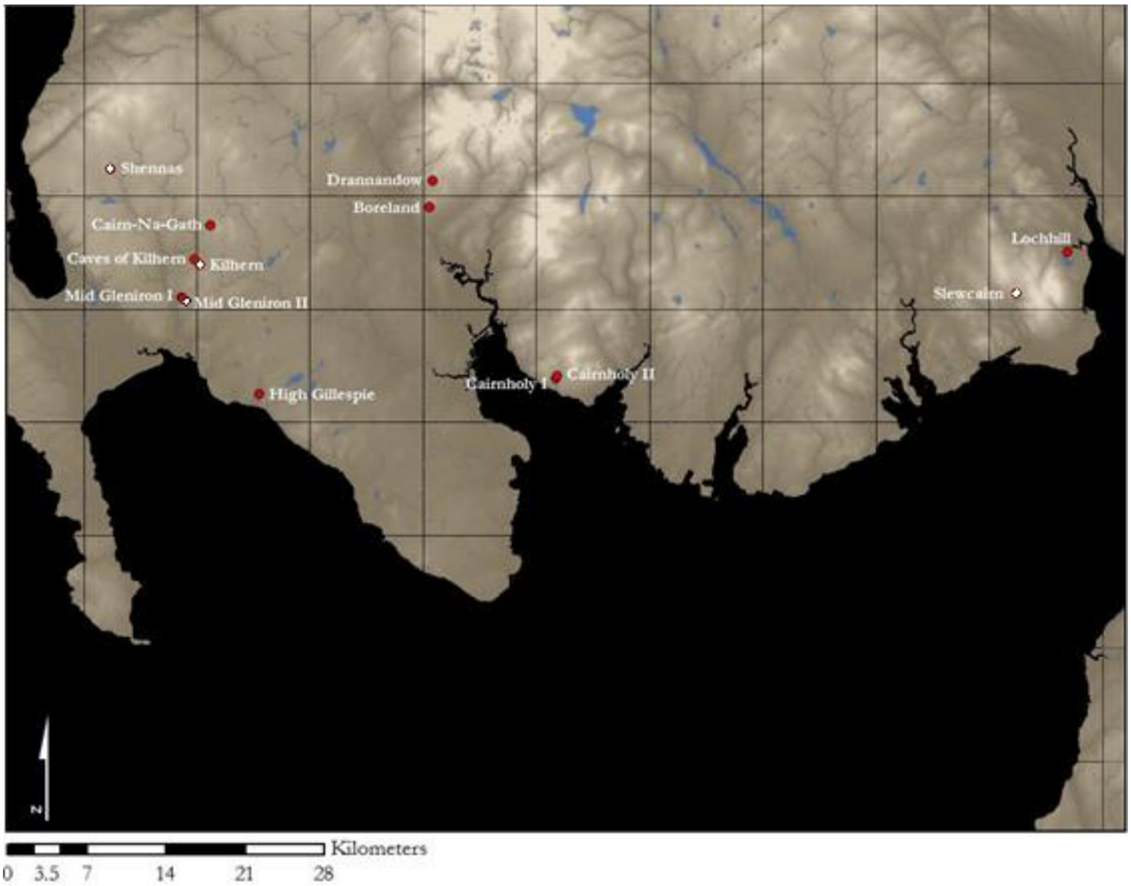


Figure 4.2: Long Cairns Analysed in Dumfries and Galloway

Sites visited and surveyed are shown in red. Sites analysed without visitation are shown in white.

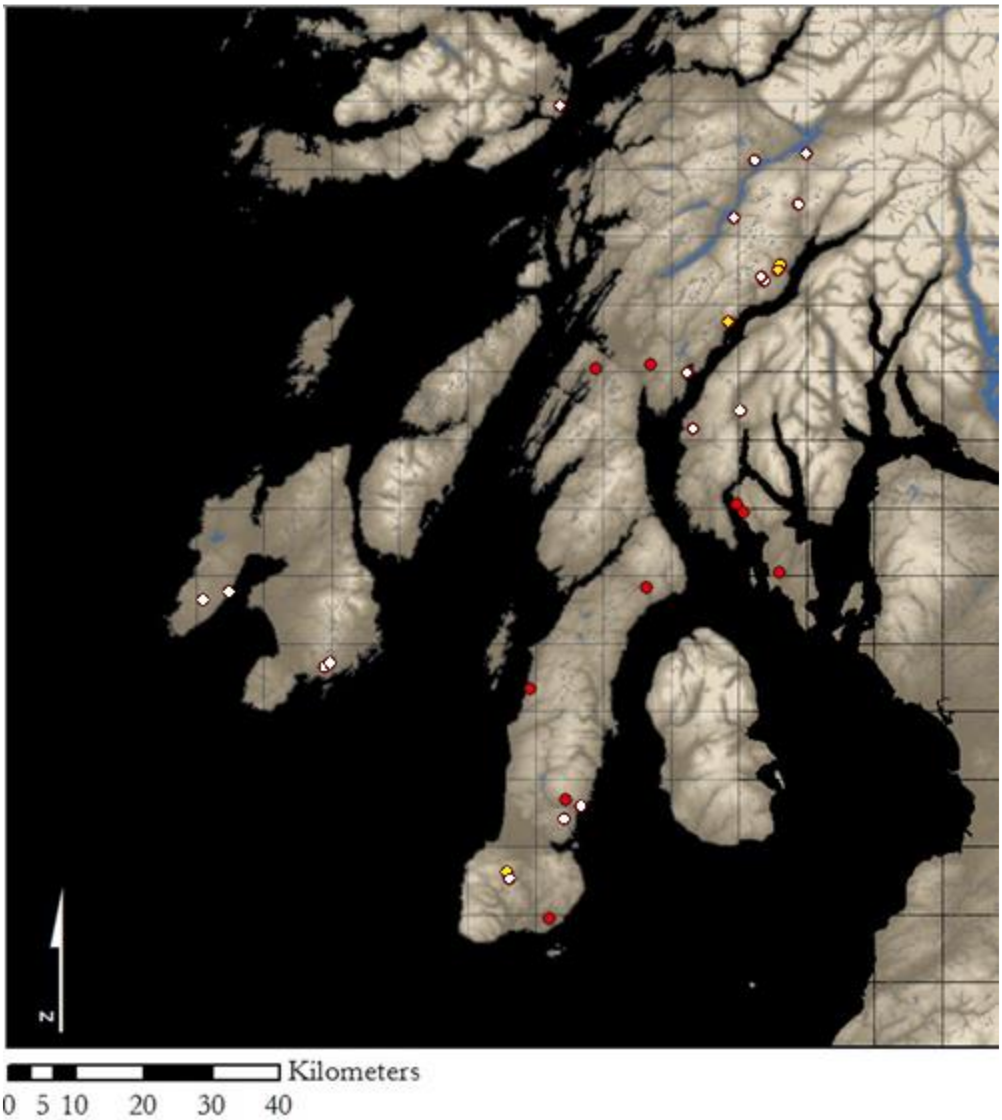


Figure 4.3: Long Cairns Analysed in Argyll and Bute

Sites visited and surveyed are shown in red. Sites visited but not surveyed are shown in yellow. Sites analysed without visitation are shown in white.

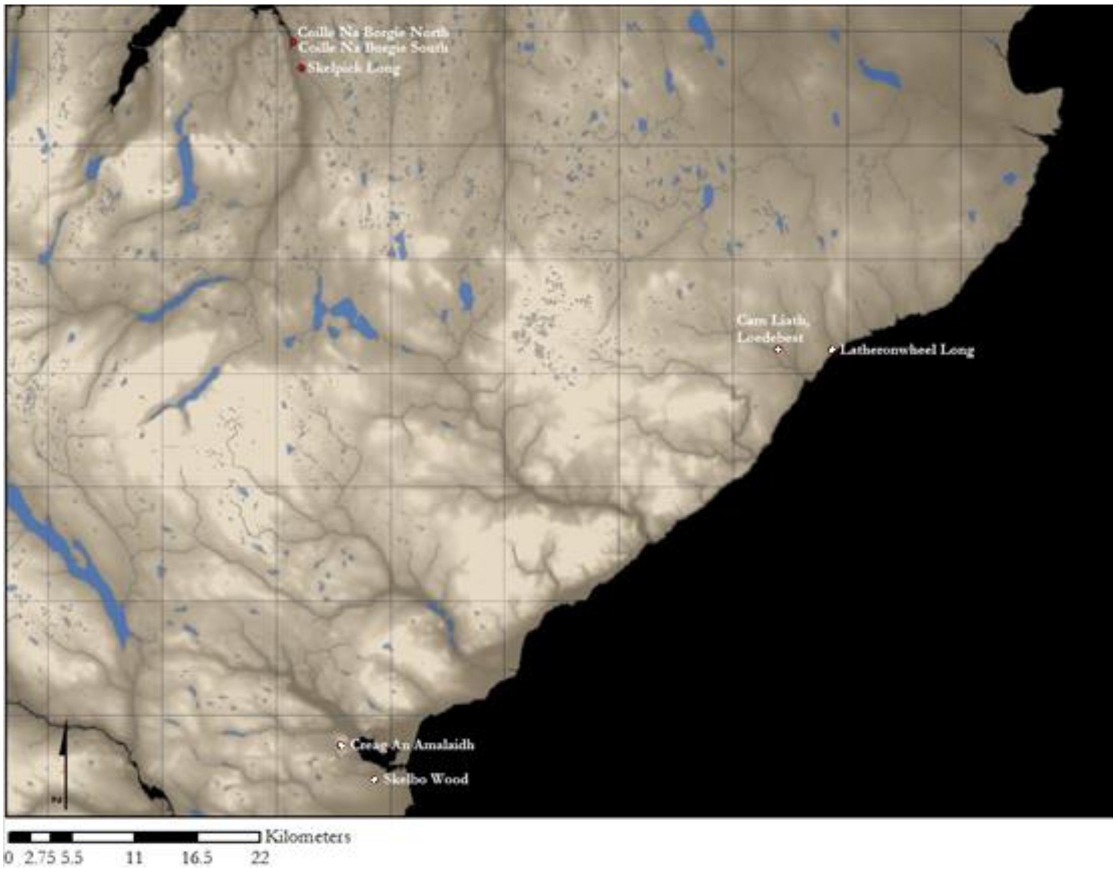


Figure 4.4: Figure 4.4: Long Cairns Analysed in the 'Straths Zone' of the Highlands (except for sites along the Strath of Kildonan).

Sites visited and surveyed are shown in red. Sites analysed without visitation are shown in white.

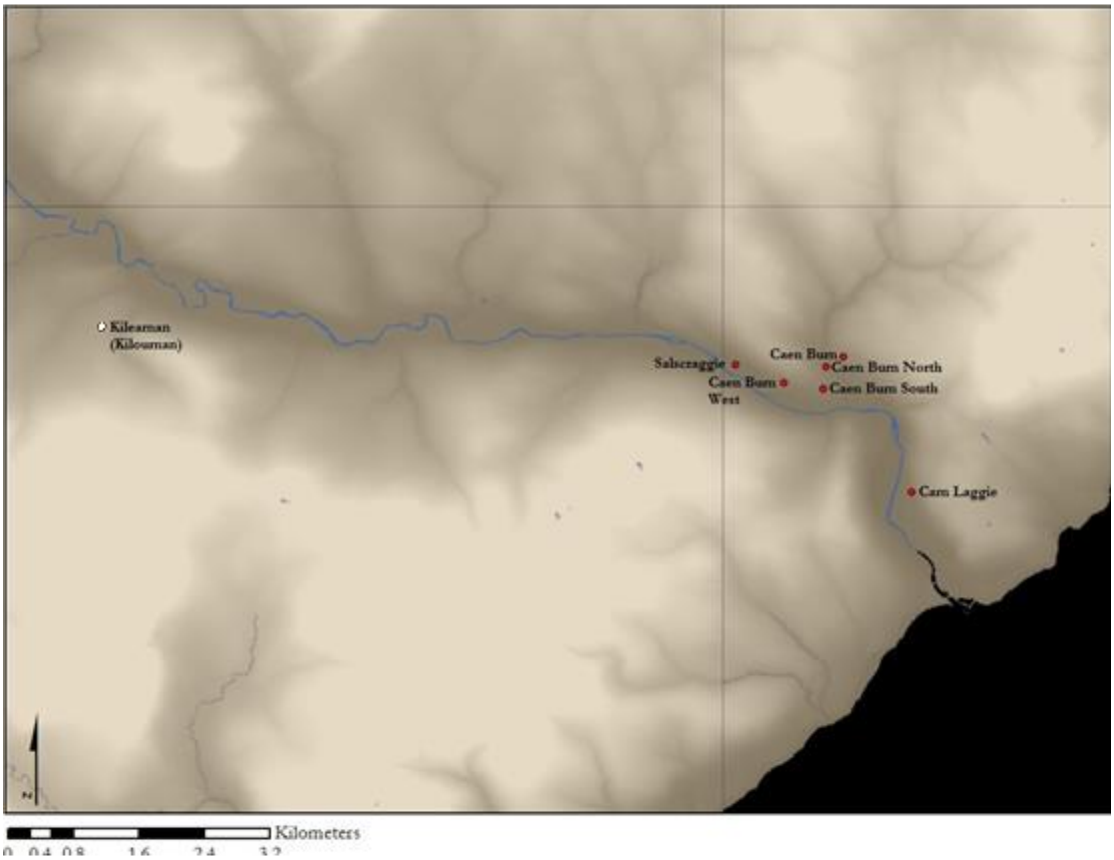


Figure 4.2: Long Cairns Analysed in the 'Straths Zone', in the Highlands (only those sites found along the Strath of Kildonan).

Sites visited and surveyed are shown in red. Sites analysed without visitation are shown in white.

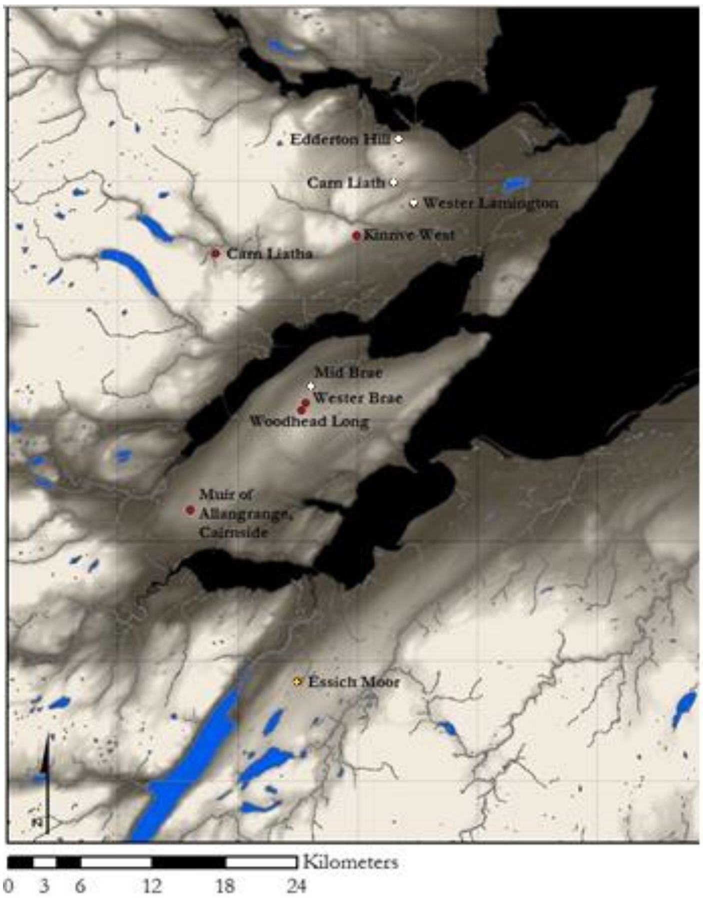


Figure 4.6: Long Cairns Analysed in the Firthlands, in the Highlands

Sites visited and surveyed are shown in red. Sites visited but not surveyed are shown in yellow. Sites analysed without visitation are shown in white.

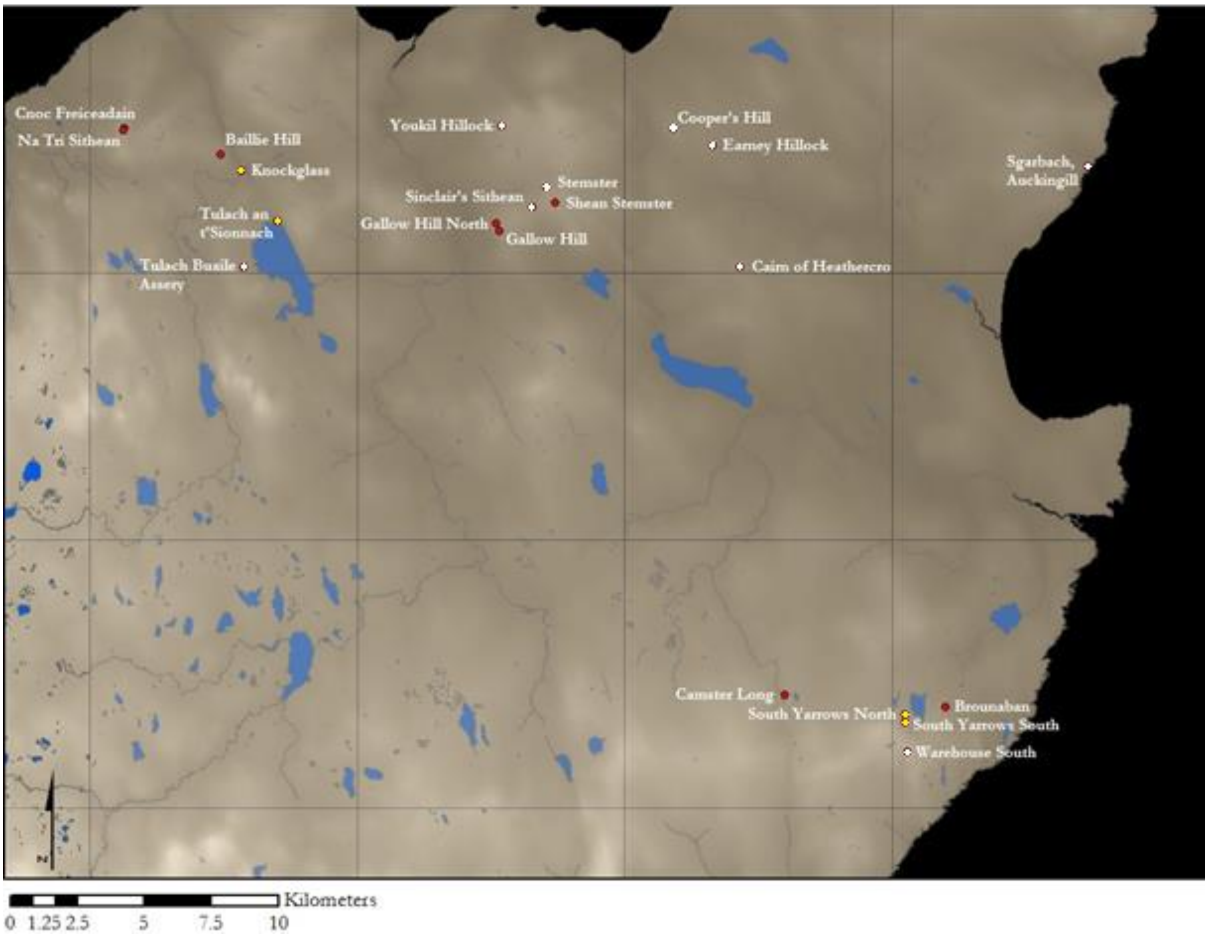


Figure 4.7: Long Cairns Analysed in Caithness, in the Highlands.

Sites visited and surveyed are shown in red. Sites visited but not surveyed are shown in yellow. Sites analysed without visitation are shown in white.

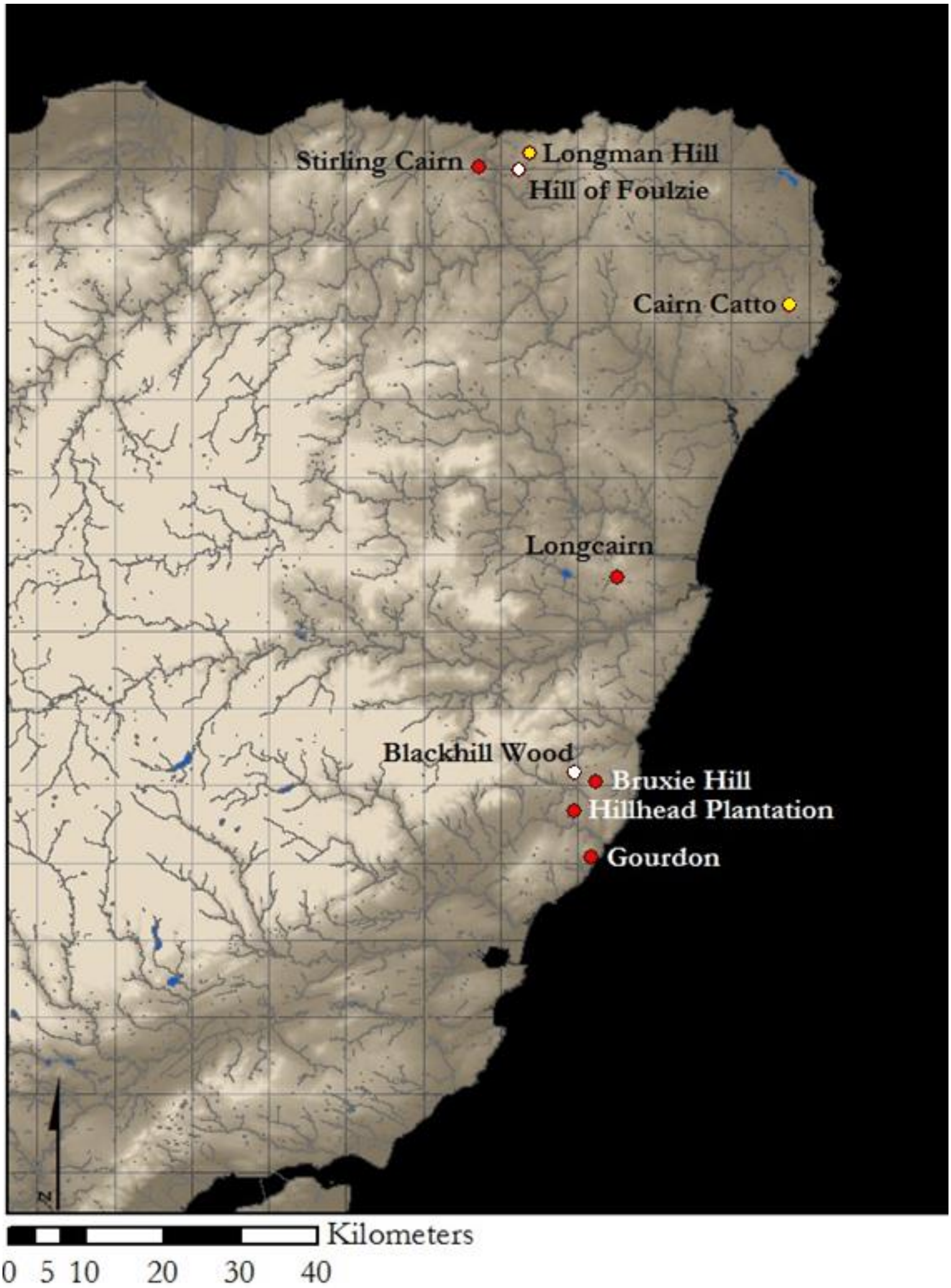


Figure 4.8: Long Cairns Analysed in Aberdeenshire.

Sites visited and surveyed are shown in red. Sites visited but not surveyed are shown in yellow. Sites analysed without visitation are shown in white.

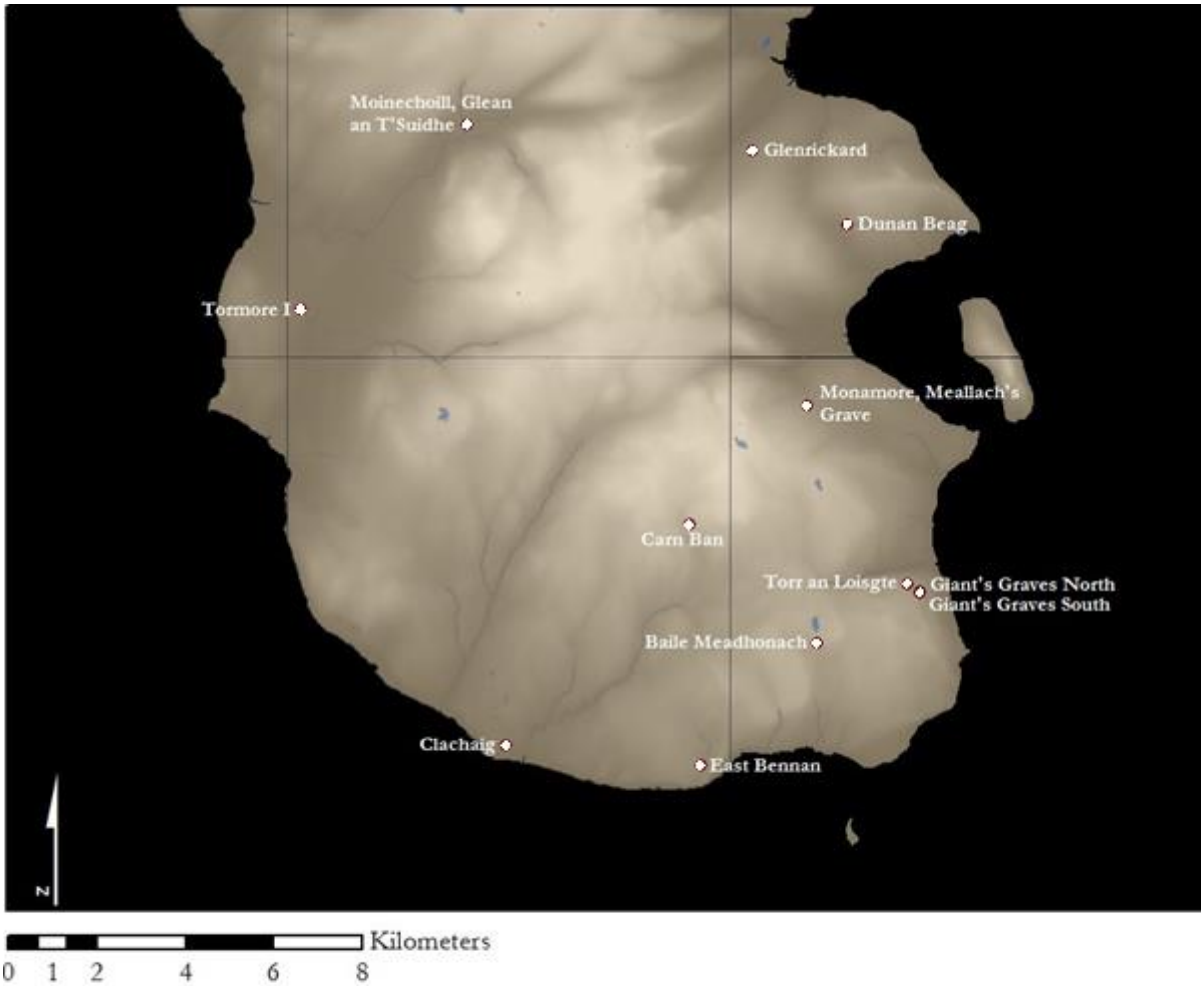


Figure 4.9: Long Cairns Analysed in the Isle of Arran, North Ayrshire

All sites were analysed without visitation. These are shown in white.

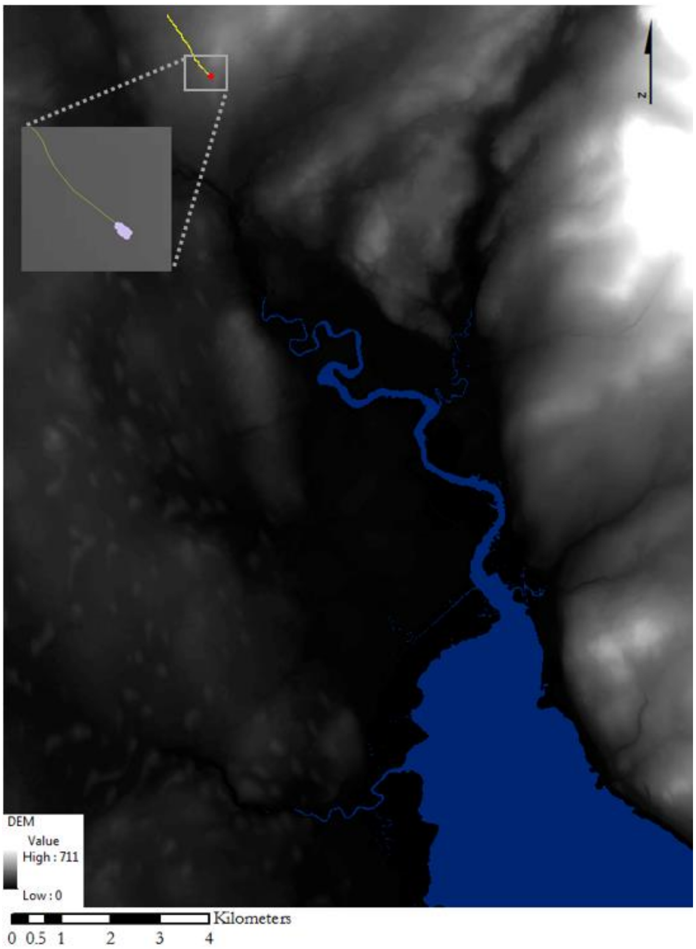


Figure 4.10: The long cairn site Boreland, in Dumfries and Galloway, is oriented toward the sea.
As discussed in Chapter 5, Section 4, sea views are unlikely to be reliably noticeable from the particular location of this cairn, however, it remains of interest that the cairn structure should have this orientation.

The following details were recorded for each site visited: easting, northing, and elevation measurements were taken using a handheld GPS;[2] the shape of the cairn; the shape of the ends of the cairn, including the shape of façades where present; clinometer readings of horizons; monument length and width, including width at broader and narrower ends, and the mid-way point of the cairn. The time of day of site visits were recorded, so too were weather and lighting conditions. Each site was thoroughly photographed and panoramic shots were taken of surrounding landscapes and horizons (see Figures 4.11 and 4.12). Notes were taken on what was visible from the cairn sites, and how the monuments were situated in relation to their surrounding landscapes (for extracts, see Figures 4.13–5).

[2] A Garmin GPS device was used, with an accuracy of ±3m.

Figure 4.11: Photograph of the long cairn site Glen Lussa, in Argyll and Bute.

Figure 4.12: Panoramic photograph from the long cairn site Glen Lussa, in Argyll and Bute.

Saturday
28/07/12 Knapperty Hill

11.32am Destination Knapperty Hill!
Spoke to the lady who owns the house, where we parked. She was happy for us to park in her driveway and use the back gate. Apparently there is also a stone circle and a standing stone. Need to go past this, jump a few fences and keep going up the hill to get to the knapperty hill cairn. Nice lady. looks like she had injured a her leg.

12.25pm Arrived at the actual site.
The actual extent of the cairn is hard to tell because it is now overgrown with tall weeds.
Both ends appear to relatively high. Forecourt may be visible, side A appear to have a big cave in or is it the forecourt? But looking at the 'B' end it too appear to have a forecourt, because of the monoliths lying around. I am not sure which end has the forecourt. Need to check old drawings and photographs. Also when I draw up the site plan it will become clearer.
Commanding views from the 'B' end. The A side in general looks in the direction of the Stone circle and the Standing Stone. (Stone)
The site is covered in earth, grass weeds and cairn rubble
Weather: blanket cloud-cover. gentle cool breeze.

Pictures for this site start from 3599
red quart 3 (?)

→ Pan Shots taken from wp 146; N57°32.579'; W002°05.534; elev 126m; acc 3m → pic 3599-3602
→ Pan Shots 3603-04 taken from wp 147; elev 127; acc 3m; N 57°32.574'; W002°05.490

Figure 4.13: Notes on survey of Knapperty Hill (Knapperty Hillock), in Aberdeenshire, page 1 of 3.

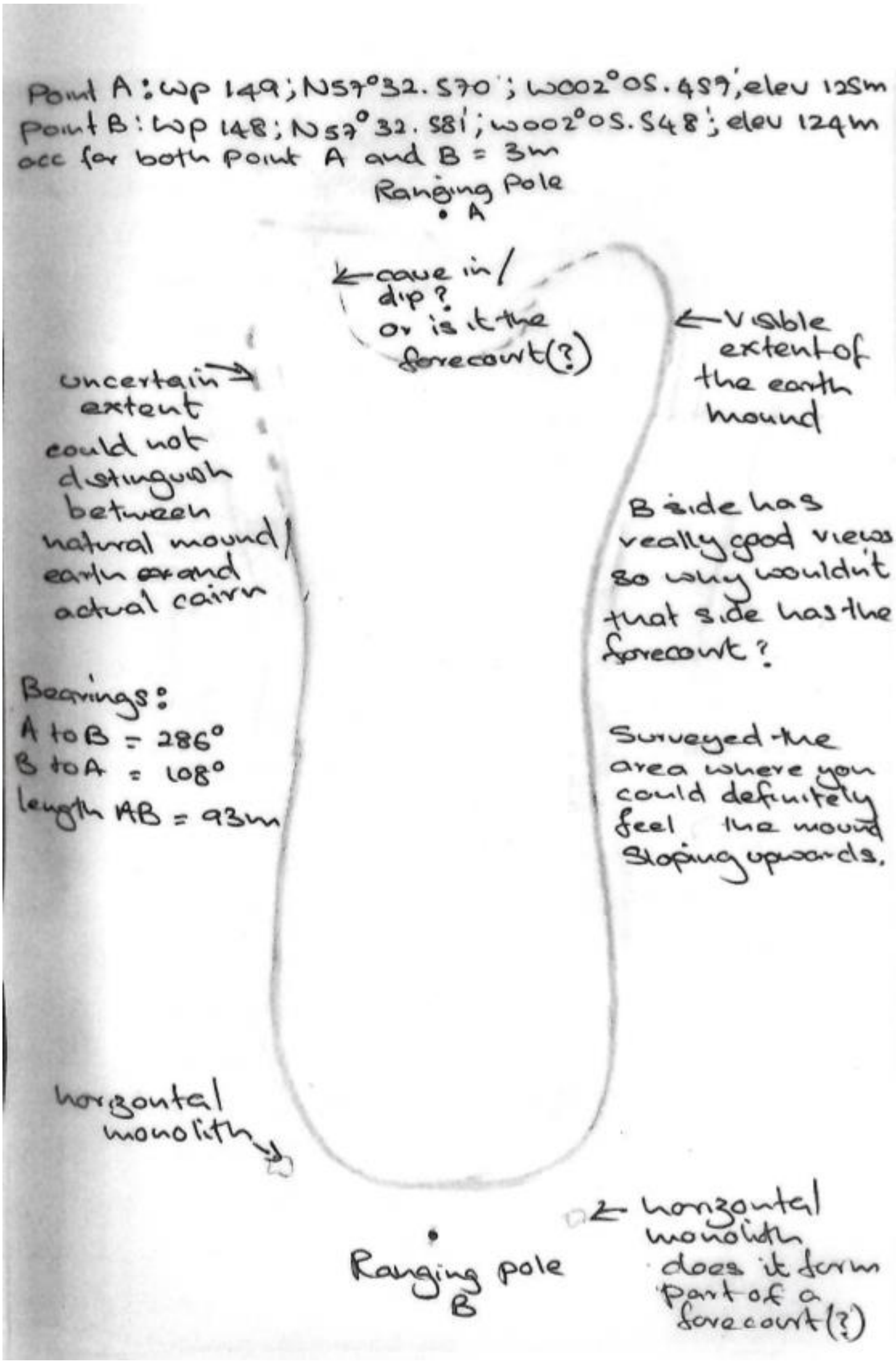
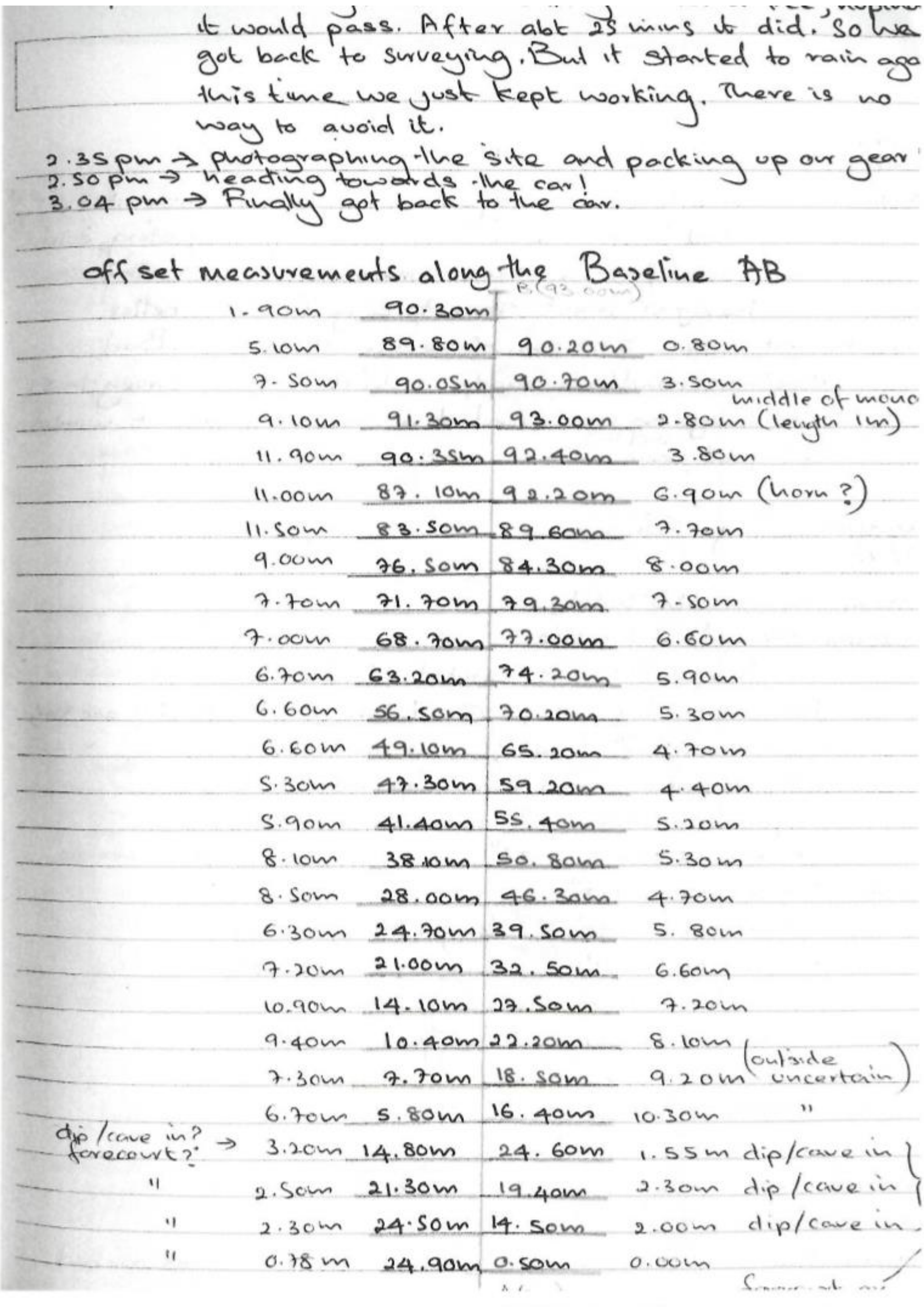


Figure 4.13: Notes on survey of Knapperty Hill (Knapperty Hillock), in Aberdeenshire, page 2 of 3.



it would pass. After abt 25 mins it did. So we got back to surveying. But it started to rain ago this time we just kept working. There is no way to avoid it.

2.35 pm → photographing the site and packing up our gear
2.50 pm → heading towards the car!
3.04 pm → Finally got back to the car.

off set measurements along the Baseline AB

B (93.00m)

	1.90m	90.30m			
	5.10m	89.80m	90.20m	0.80m	
	7.50m	90.05m	90.70m	3.50m	
	9.10m	91.30m	93.00m	2.80m	middle of mound (length 1m)
	11.90m	90.35m	92.40m	3.80m	
	11.00m	87.10m	92.20m	6.90m	(horn?)
	11.50m	83.50m	89.60m	7.70m	
	9.00m	76.50m	84.30m	8.00m	
	7.70m	71.70m	79.30m	7.50m	
	7.00m	68.70m	77.00m	6.60m	
	6.70m	63.20m	74.20m	5.90m	
	6.60m	56.50m	70.20m	5.30m	
	6.60m	49.10m	65.20m	4.70m	
	5.30m	47.30m	59.20m	4.40m	
	5.90m	41.40m	55.40m	5.20m	
	8.10m	38.10m	50.80m	5.30m	
	8.50m	28.00m	46.30m	4.70m	
	6.30m	24.70m	39.50m	5.80m	
	7.20m	21.00m	32.50m	6.60m	
	10.90m	14.10m	27.50m	7.20m	
	9.40m	10.40m	22.20m	8.10m	(outside uncertain)
	7.30m	7.70m	18.50m	9.20m	
	6.70m	5.80m	16.40m	10.30m	"
dip / cave in? forecourt? →	3.20m	14.80m	24.60m	1.55m	dip/cave in
"	2.50m	21.30m	19.40m	2.30m	dip/cave in
"	2.30m	24.50m	14.50m	2.00m	dip/cave in
"	0.78m	24.90m	0.50m	0.00m	

Figure 4.14: Notes on survey of Knapperty Hill (Knapperty Hillock), in Aberdeenshire, page 3 of 3.

From the information gathered in the field, survey plans were drawn up and digitised for further investigation (See Appendix). Cairn axis azimuths (degrees from True North) were measured from those plans. For further verification, those orientation measurements were compared with Henshall's plans and, when monuments were clearly visible from above, with images taken from Google Earth (2013). These sources also made it possible to gain verified information on sites not visited in person.

A comparison of the newly created survey plans with existing survey plans from Henshall's (1963, 1972) work revealed that some of Henshall's site plans from the southwest region of Scotland are inaccurate. Henshall's measurements occasionally deviated by as much as 10º (Griffiths 2012, unpublished). These discrepancies are attributable to the variation between Magnetic North and True North at the time of Henshall's measurements, which correspond directly to the same extent of deviation in each particular case. Caution is, therefore, advised against uncritically accepting Henshall's (1963, 1972) measurements in this regard.

Site plans were assessed to determine if cairns are oriented towards sea views, either through their long axes or other structural elements such as chambers or facades. Any sea views available from each site location were examined both from photographs taken on site, including panoramic shots, and through digital reconstruction using DEM data from the Ordnance Survey's LandForm PROFILE dataset (2013–4), and the programs, ArcGIS 10.2 and Horizon (discussed below, in Section 4.4). Representations drawn through such GIS techniques were compared against field photographs to establish their reliability, so that those techniques could be used with some degree of confidence for sites that could not be visited in person. Sea views could be represented either through a first-person viewpoint, as produced by Horizon (see Figure 4.15), or through top-down map images, as depicted in a standard viewshed (Figure 4.16). With site surveys both new and old, and images taken from Google Earth, it was possible to determine long cairn orientations to high degrees of certainty for most sites in the corpus. This information was then compared against the direction of sea views to determine whether cairn long axes are oriented towards the sea.

Figure 4.15: Horizon panorama depicting the horizon as it appears from Shennas, a long cairn site that does not offer sea views.

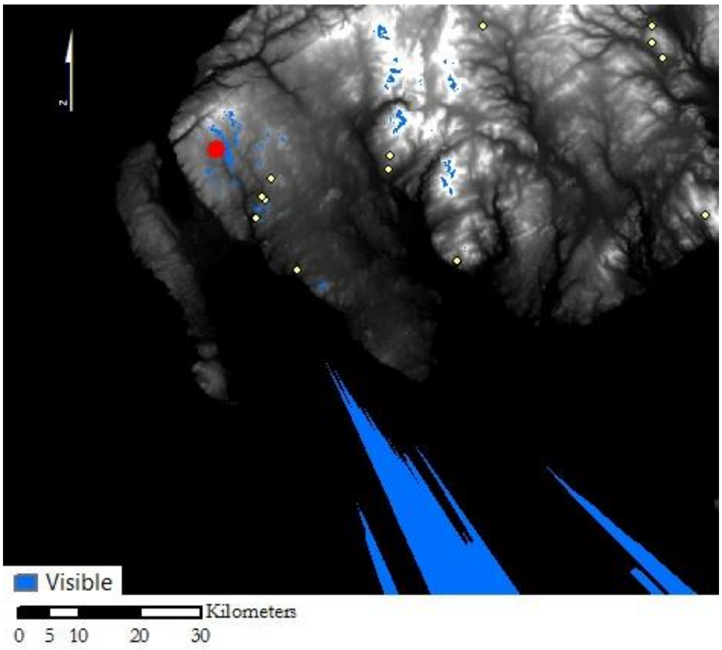


Figure 4.16: Standard viewshed from the long cairn Shennas, depicting visible from the site location.

As is discussed in Section 5, a further factor taken to be relevant to the investigation was the direction from which sites were likely to have been approached by prehistoric peoples. Some information regarding this factor was gleaned from field visitation and examination of site locations with Google Earth (using GPS readings). However, the GIS generated 'cost corridor' analyses, described further below (in Section 5), enabled a more comprehensive assessment of sites and their surrounding landscapes for this purpose. On some occasions where sites were unable to be visited, there was uncertainty regarding the exact location of the monument due an ambiguity in whether previous GPS readings were taken from a forecourt, the middle of a cairn or from some other location at the site. This meant that it was not always possible to determine precisely from which direction a monument was most likely to have been approached.

4.3 Sea Affordance Analysis

'Sea affordance maps' were generated for cairn sites and their surrounding landscapes to determine how typical or unique the sea views are at cairn sites in comparison to their surrounding areas. These maps were also used to test the hypothesis that monuments are often or sometimes placed so as to achieve a revelatory view of the sea, which is discussed further below, in Section 5. The generation of sea affordance maps implemented a 'cumulative viewshed' technique. A 'standard viewshed' displays the views that are available from a given location. A cumulative viewshed, in contrast, displays simultaneously how much total visibility is afforded from multiple locations on a map. The type of cumulative viewshed used here was developed by Gillings (2009) and is known as a 'sea affordance viewshed'. This test displays visibility of the areas of sea that are encompassed by a map, so that cells or pixels display how much of the sea is visible from each location on land. In the present study, an achromatic colour ramp was used. Low visibility was represented by darker shades, with 0 visibility as black, and high visibility by lighter shades. This sea affordance technique, thereby, quantifies and provides a representation of the nature of the sea views that are afforded in a given area, and allows determinations to be made regarding whether or not specific locations offer better than average sea views as compared to their surrounds (Gillings 2009, pp. 344-345).

Assumptions and Limitations from Computer Processing

Gillings' (2009) study concerned an island landscape, roughly 5.5km from end to end and 2km wide. To define the area of sea he would use to test visibility, he invoked the 'limit of human recognition acuity for a 1m wide object' (Ogburn 2006, cited in Gillings 2009, p. 344), which holds that, at a distance of greater than 6.88km, a 1m wide object is not recognisable. Gillings, thus, used a buffer of sea area, extending for 6.88km from the coast of the landscape he examined, to achieve a representation of how much sea visibility would be afforded by a given location of the map he examined.

However, in different landscape contexts, sea affordance viewsheds (hereafter 'affordance viewsheds') face certain limitations that arise due to limited computer processing capabilities. This type of test requires large numbers of points to be tested simultaneously and can place an exponential strain on computer processing as compared to a standard viewshed, which tests only one point at a time together with how that point is related to its surrounding landscape. Given the large area encompassed by Scotland (approximately 78,387 km^2) and limitations in computer processing as well as the time-intensive nature of the affordance analyses carried out, it was necessary to reduce burdens on processing as well as processing time where possible. Therefore, on a relatively standard PC platform in 2014 (specs: Intel Quad Core i7 Gen 3, 3.60 GHz, 8GB RAM), only a limited area of sea and a limited map size or area of landscape was able to be analysed in each test. This led to the adoption of different measures and assumptions than were used by Gilling (2009).

Therefore, while 149 sites were compiled for the final dataset, it was not practical to test all such sites for affordance. In selecting from these 149 sites, it was observed that the following regions appear to contain sufficiently large corpuses of coastal sites: Dumfries and Galloway, Argyll and Bute, Aberdeenshire, Highland, and North Ayrshire. Only those regions were selected for affordance analysis. Furthermore, monuments were not tested for sea affordance if they were placed in areas that are too far inland to offer opportunities for prehistoric people to achieve sea views at the sites of their constructions. After a preliminary survey of the extent of sea visibility using both standard viewsheds as well as affordance viewsheds for the aforementioned regions, it was found that the upper limit of sea visibility was 10km inland, except for a small number of sites located on rarer landscapes that offered far-reaching sea views, which were placed no more than 13.5km from the nearest coastline. The ArcGIS 'Near' tool was used to calculate the distance of each site to the nearest coastline or waterbody, where the 'Input Feature' was the site coordinates shapefile and the 'Near Feature' was the coastline shapefile which was obtained from OS Vector Map data.[3] This criterion reduced the sample size of long cairn sites to 92.

As opposed to being located on a small island, as in Gillings' (2009) study, these 92 sites could be found adjacent to long stretches of coastline. Test areas, therefore, needed to be defined. A 5km expanse on either side of each site, up and down the adjacent coastline, as well as 5km inland, was used in order to provide sufficient area of land surrounding each site; the purpose being to generate an accurate representation of sea visibility at each site as well as a 1.5km radius around it, which required a significant buffer beyond the 1.5km radius.

Moreover, while Gilling (2009) was able to use a buffer of 6.88km of sea from the coastline of the sites he examined, the same extent of sea area was not able to be tested in the present study, due to the aforementioned limitations in computer processing. This was, in part, due to the larger size of the test areas (of land) used here, which extended for at least 10km of coastline—5km on either side of a site, up and down the coastline. The test areas used here also extended for at least 5km inland of a site, in the case that a site was placed on the immediate coast, and it was not uncommon for this distance to be as great as 15km in an inland direction, in the case that a site is placed 10km inland—as the test required an additional 5km of buffer further inland.

A further limitation on processing, beyond what was experienced by Gillings (2009), was also introduced by the higher resolution of the data used to generate the DEM. Gillings used a

[3] Alternatively, one could use the 'Spatial Join' tool to accomplish the same results, where the 'Target Features' is the site coordinates, the 'Join Features' is the coastline shapefile and the 'Match Option' is the 'CLOSEST'. This alternative method was used to test the accuracy of the results obtained.

bespoke scripting method to generate his DEM, from a contour map drawn in 1911 (2009, p. 344), with the resolution for his DEM set at 30m. However, it was determined that a far superior representation of sea affordance could be produced with elevation data available for Scotland from the Ordnance Survey's LandForm PROFILE dataset (in 2013), which used a 10m resolution. This required much more processing power. Hence, although a more powerful PC platform was used in the present study, than what was available to Gillings (2009), a balance needed to be sought between: the extent of sea views able to be tested, the resolution of the DEM, and land area used to define the test areas.

After much experimentation, it was found that there was a limit to how much sea area could be included in an affordance map, before the program's (ArcGIS) task would result in overloading the PC—an additional complication was that it would take one to two weeks to determine that the PC was overloaded and that a map of a given size could not be generated, and that the test would need to be aborted. This problem was not, however, so severe as to hamper the utility of the affordance viewshed technique used here. This is because the closer an area of sea is to an observer, the more space it will occupy in their visual field. At a certain point, areas of sea that are further from the coast represent an increasingly smaller portion of the vertical visual range, such that sea 'views' are infinitesimal. From this we can assume that the more distant a pixel of sea in the GIS data is, the more it loses individual significance. Thus, to be effective, it is unlikely that an affordance viewshed must represent the visibility of particularly distant areas of sea. To illustrate this, consider an expanse of sea that extends 1km out from the coast and 0.5 km either side of point 'a', on a (straight) shoreline at sea level, encompassing 1km^2 of area on a map. For an observer who is standing on point 'a', that area of sea occupies nearly 60% of their visual field below the horizon (which is approximately 75° vertically, by 120° horizontally). However, that same amount of area (i.e. 1km^2), if located 3–4 km out to sea instead of 0–1 km out to sea, would occupy less than 0.1% of the same observer's visual field. The area of distant sea, then, occupies an exponentially smaller area than what is occupied by the near sea, suggesting its significance can often justifiably be considered as either irrelevant to the analysis, or at the very least exponentially less relevant.

Distant sea areas may, for the above reasons, be of diminished significance particularly in the case of landscapes where sea views are more common. Of course, such speculation holds inherent challenges, as there may be a number of factors that may make a given sea view significant. For instance, a sea view, however narrow or slight, might have held significance to prehistoric builders in virtue of marking the location or direction of an island from which they or their descendants originated. Such a possibility may not be able to be excluded or accounted for by an affordance viewshed that cannot include all areas of distant sea. However, the affordance viewshed technique can to some extent account for sea views that appear as greater or more salient to an observer and which are in that sense more significant. For the purpose of the analysis, then, for a sea view to be identified as unique or of interest in such landscapes, it may be supposed that it must be more expansive or occupy a larger portion of an observer's visual field in comparison to the kinds of sea views that are available in the landscape. Views of distant areas of sea can, then, confidently be considered as holding a diminished level of significance, provided that views of nearer areas of sea are available in a landscape. The opposite may also hold true in landscapes where sea views are uncommon: distant areas of sea may hold some significance where sea views are rare. Nevertheless, in either case, whether views of near or distant areas of sea are rare or common, the affordance viewshed displays how much sea is visible from each pixel of land as compared to other pixels of land in the same landscape. Therefore, the affordance viewshed technique generally provides an effective representation of whether a sea view might be of significance for observers in a given landscape. Moreover, it is also generally reasonable to assume distant areas of sea hold an overwhelmingly reduced level of significance.

The diminished significance of distant areas of sea, thus, offsets the practical constraints of computer processing mentioned above. Although computing limitations mean that expansive areas of sea, extending out from and along the coast, are unable to be tested in their entirety, effective affordance viewsheds may, nevertheless, be performed because visibility of the most significant areas of sea is able to be represented, and including more distant areas adds increasingly smaller increments of benefit to a cumulative viewshed. As demonstrated by the example described above, under most situations, an effective affordance viewshed is attainable when the tested area extends for at least a 1km buffer out to sea. Nevertheless, to guard against inaccurate results and to aim to encompass as much potentially significant sea area as possible, within the constraints of computer processing, the affordance viewsheds conducted in this thesis tested sea areas that extended 3km out from the coast.

An exception to the diminished significance of distant sea occurs when an observer is located on areas of high elevation. In such instances, the angle made between the area of sea and the observer's vantage point is changed, resulting in sea areas taking up more space in an observer's visual field. This means that where sites or their surrounds are at a high elevation, to be effective, an affordance viewshed must test an area of sea that extends further out from the coast than in the instance that a site and its surrounds were placed at a low elevation. However, since the sea areas tested in this thesis already extend further out from the coast than is necessary, as described above, this consideration was not deemed to detract from the reliability of the analyses.

In a small number of instances, the only observable sea views from site locations and their surrounds comprised distant areas of sea. As was observable from standard viewsheds and occasionally onsite investigation, this occurred where sites were situated on inland plateaus, which although far from the coast still afforded sea views. Even though such views of distant sea occupy a very small portion of an observer's visual field, it was considered as a possibility that those views might be of significance, particularly because, in those landscapes, it might be rare to have sea views in general. Therefore, in these small number of instances, the buffer of sea area tested was extended from the standard 3km to 5.5km out to sea, so that the affordance viewshed would represent visibility of distant sea. This was a strain on computer processing and was not an option that could be taken for all sites generally; however, in these few instances the affordance viewsheds were successfully completed and successfully represented affordance of distant sea.

A Limitation of the Sea Affordance Viewshed: The Problem of the 'Shadow Effect'

When conducting affordance analyses one peculiar result was consistently displayed on certain occasions. Some site locations appeared to possess what Gillings (2009) describes as a 'revelatory view', which, as described further below, was also tested for in this study. A revelatory view occurs when sea views are obscured from an observer until they arrive at a site location. Such views are of interest since their presence in a given instance may suggest prehistoric builders' intentions to choreograph visual exposure, and achieve with their construction a particularly salient and effective referencing of the sea (Fowler and Cummings 2003). However, after closer examination, it was revealed that there were inconsistencies between the affordance results for those locations and with what is known about the views from those locations.

Take, for instance, the preliminary affordance viewshed for Giant's Graves North in the Isle of Arran, North Ayrshire which indicates 0% sea visibility. The same pattern was observed at three other sites in Arran: East Bennan, Dippen, and Sannox. Yet, site descriptions from previous surveys indicate that, contrary to those results, they are situated in locations that would offer sea-views. For instance, Giant's Graves North is placed on a hillside that slopes down towards the coast and, disregarding the impact of vegetation on visibility, there are no physical barriers such as other hills blocking sea views from that location. Sea views available from Giant's Graves North and other such sites were confirmed further with standard viewsheds and with 'Horizon panoramas'—Horizon is a GIS tool, similar to the standard viewshed that also displays visibility from a given point in the landscape, but does so in terms of first-person panoramic scenes of the horizon instead of using a top-down view (as in a standard viewshed).[4] Further examination of these site locations indicated that the observed anomaly occurs on broad areas of uniform flatness, such as on level plateaus on the top of ridgelines or terraces. This characteristic of the anomaly was instructive. An examination of the nature of such landscapes led to further consideration of Gillings' (2009) method for the affordance viewshed, and to the identification of the source of the observed errors, which is detailed here.

It became evident that the problem emerged as a result of the particular way that the affordance viewshed technique works to represent visibility. It works in a way that is reverse to how one might expect it to: instead of directly modelling visibility of the sea from each pixel of land and then adding together readouts, affordance viewsheds model the visibility of pixels of land from the point of view of pixels of sea, to represent the areas of landscape that are visible from the sea. If sufficient points of sea area are able to be tested for, the display will show the areas of the landscape that are jointly visible from the sea. Importantly, such a display also represents visibility of the sea *from land*, which is the purpose of the test, because line-of-sight will be the same in both cases, from sea and from land. However, a complication arises when observers' heights are included in the calculation. To display more accurately visibility of the sea, not from the land itself but for *a person standing on the land*, an offset is provided. Therefore, an affordance viewshed tests, in the first instance, visibility from the sea of points that are 1.7m higher than the points of land—where a (Neolithic) person's eye-level might be. Yet, an unintended consequence of the 1.7m offset is that, effectively, the landscape is as though it were raised uniformly by 1.7 m. The algorithm used then displays visibility from the sea of that raised landscape. Line-of-sight of the sea from 1.7m above land, and vice versa, is represented and the test is able to illustrate the nature of the sea views that are afforded in the landscape, with one important exception. The raised landscape casts what might be described as a 'shadow', which is not present in a standard viewshed. Visibility of the sea from an observer standing on an inland plateau, say, may be obscured by the edge or ridge of that plateau facing the sea, which the affordance technique must raise artificially by 1.7m in order to represent also the visibility of an observer standing on that point on the ridge. This effect is similar to having observers' eye-levels placed on the ground, with that ground raised by 1.7m.

[4] 'Horizon' is a software created by Andrew Smith, of the University of Adelaide.

Another way to think of this is that, in placing the 1.7m offset to represent the height of an observer, the GIS algorithm performs a function that has the same effect as placing a 1.7m tall person on each pixel of land. However, on analogy with the algorithm placing a 1.7 tall person on each pixel of land, each such person also has a width of one pixel, which in the case of this study is represented as 10m wide. Someone standing behind that (10m wide) person at the same elevation would not, then, be able to see any sea located on the other side of that person: the 10m wide and 1.7m high observers cast shadows in affordance, creating what is called here the 'shadow effect'.

The shadow effect means that affordance values will be consistently lower for locations that have their views of the sea partly obscured by land, as at those locations such land masses will be even more prominent—1.7m higher—and obscure even more sea views than previously. This has two important implications for the present study. First, although affordance values are reduced, they are reduced in a consistent way across the landscape. Therefore, in considering affordance values in a landscape as relative to each other, the affordance test is, nevertheless, able to provide effective representations. The nature of affordance in a given area can still be displayed, despite the shadow effect, and it can still be determined with this test whether sites are placed in unique locations in terms of their sea views.

A noteworthy caveat in this regard is that, where a site is placed in a location unaffected by the shadow effect, affordance values for that location will artificially appear to be higher than those values found in surrounding areas that are affected by the shadow effect. This means that the test may be biased in favour of supporting the conclusion that sites are placed in unique locations. The test may also be biased in the opposite direction, under the circumstance that a site's affordance values are diminished by the shadow effect and affordance values from the surrounding landscape are not diminished in such a way. However, as both kinds of bias together with the geographical circumstances that produce them are able to be accounted for, it is held here that, despite the shadow effect, the affordance test is able to provide sufficiently accurate representations of sea views available in a given landscape.

The second implication of the shadow effect concerns the test for revelatory views. As is detailed below in Section 5, this involves, first, determining the paths that may have been used by prehistoric people to approach sites, and second, considering affordance values along those paths. As the shadow effect can sometimes impact on affordance values such that they are reduced to zero, this effect can sometimes make it appear as though the sea views afforded at a site are particularly 'revelatory'. That is, in considering affordance displays, the shadow effect may make it appear as though views of the sea are obscured to an observer until they reach the site, at which time the view is revealed, so that it appears to be a ‘revelatory view’. However, as described above, the shadow effect may account partially and perhaps significantly for any such obscuring of the sea view for an approaching observer. Another possibility is that in locations where sea views are prevalent, by representing such sea views as obscured, the shadow effect may make it appear as though a site was placed so as to avoid sea views. Hence, to be valid, any conclusion that a site’s location is unique must first mitigate and correct for the shadow effect.

To illustrate this phenomenon, consider the hypothetical example of site ‘X’, situated on flat ground on the top of a ridge (see Figure 4.15).

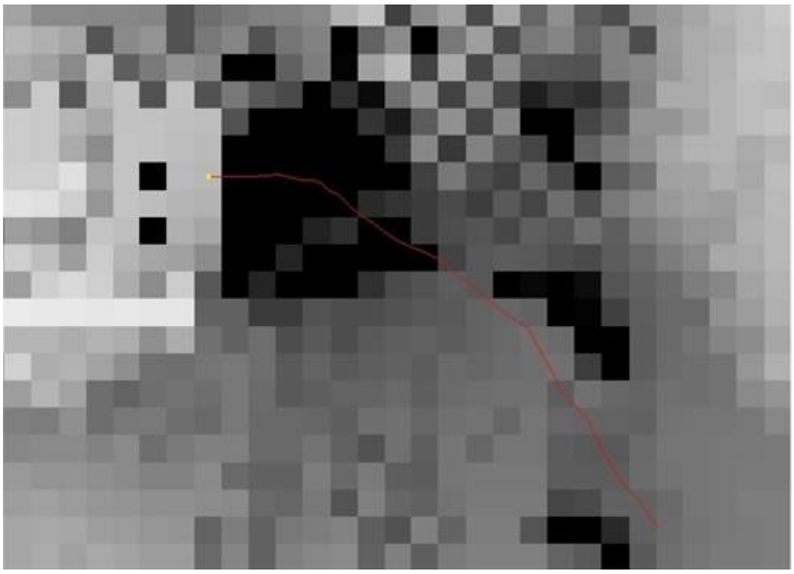


Figure 4.17: (Top) Sea affordance map in which lighter shades indicate higher sea affordance values. A false shadow of affordance is cast by ‘shadow effect’ (black) to the right of site X (in yellow) in the sense that sea views appear to be obscured by a ridge to the west of the site.

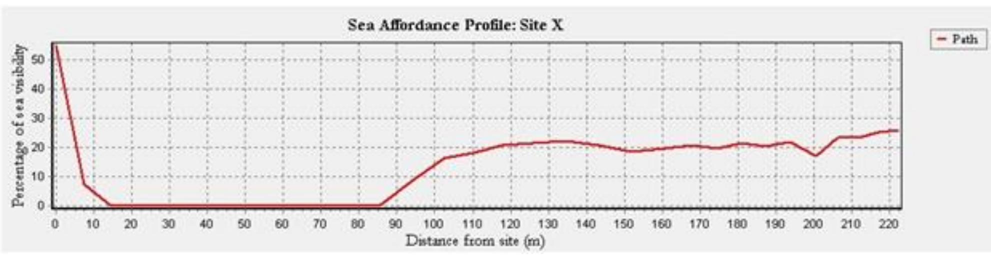


Figure 4.18: Affordance profile of site X, showing where views of the sea appear along the path and how rapidly those views change.

A plausible path for approaching the site from the northwest is drawn in and it is apparent that, for an observer approaching on that path, their view of the sea is effectively masked until they reach the site. Figure 4.18 represents this data with a profile graph. The graph shows that from 220 to 105m there is relatively consistent affordance of around 20%.5 However, at 85m there is a dive in the profile, with affordance dropping to zero and staying there for 70m. Then, at 13m from the site location, there is a sudden uptick in affordance percentages, reaching as high as 55% at the site (0m). This may be inaccurately interpreted as indicative of a dramatic final reveal of sea views upon approach, but in fact it is an outcome of the shadow effect described above.6

Correcting for the Shadow Effect

The shadow effect just described creates 'sinks' in affordance displays: locations where affordance values are zero. In order to determine whether and where such errors were occurring, affordance viewshed and slope surfaces were queried together to create 'SINK' surfaces that identified all possible sinks in the dataset. This was achieved by multiplying the slope and affordance rasters together. The shadow effect can only occur where both affordance is zero and slope is zero – i.e. the analysis cannot 'see' the sea, yet there should be nothing obscuring the view. Any location in which affordance is zero while slope is greater than zero is assumed to be the slope on the back side of sea-obscuring terrain. The resulting output was then reclassified with 1's for all the 0's, and 0's for every other value. This produced a surface where all locations with possible sinks were indicated by 1's.

To compensate for errors, a decision was made to create an 'estimated' or 'approximated' surface using interpolation methods. The SINK surfaces were, first, reclassified so that all 1's (sinks) in the raster were changed to -999, leaving the 0's unchanged. This reclassified surface was then added to the standardized affordance viewshed, creating a raster which had a value of -999 at all sink locations and the correct affordance values for all other pixels. The raster was then converted to a point surface using ArcGIS Conversion tools and since all the sinks had an

[5] This path was created using cost corridor analysis, as described below, and is, therefore, a plausible route that may have been taken to this site.
[6] This critical problem was not addressed in Gillings' (2009) methodology and it would, therefore, be of interest to verify his analysis, which displays similarly apparent revelatory views but which may also be erroneous due to the shadow effect described here.

affordance value of -999 it was possible to select these (with relative ease) and delete them from the record. Thus, the resulting surface would be lacking point data where the sinks were originally, but it would also retain accurate affordances for every other location. The resulting surface was then used to generate a new 'estimated' surface that interpolated affordance values for missing data points based on the adjacent cell values.

Different interpolation techniques use different approaches to determine and calculate the cell values of the missing data points. To determine the best method, three new affordance surfaces were modelled for each micro-region, respectively, using Spline, Inverse Distance Weight (IDW) and Kriging tools. A comparison of the new affordance surfaces demonstrated that IDW modelling was the most suited for correcting the shadow effect (see Figure 4.19). For further analyses, IDW surfaces were, therefore, used as a substitute for the standard affordance viewsheds.[7]

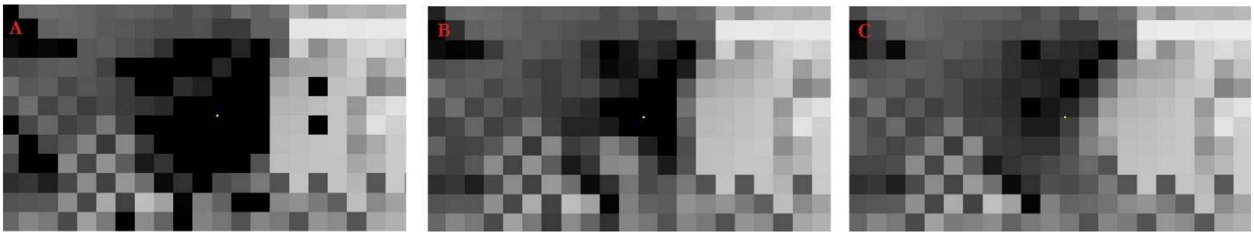


Figure 4.19: A comparison of the original affordance viewshed with interpolated surfaces. A) original affordance viewshed of site 'X', B) affordance surface generated using the Spline tool, and C) affordance surface generated using the IDW tool. Although the spline surface considerably eliminates the 'shadow' effect the site is still located in the false shadow area. IDW, therefore, achieves the optimal result.

The corrected readout was tested for and verified using standard viewsheds, Horizon outputs, and comparisons with photographs taken during on-site visitations. It was then found that many previously apparent revelatory views were no longer present. Once reliable results were obtained from corrected affordance viewsheds, that is, using the IDW when necessary, those results were compiled, analysed and tested for statistical significance with a chi-square significance test.

[7] While the discovery of the 'shadow effect' was an interesting development in the study, the issue has since been identified by ESRI (creators of ArcGIS, which is the program used here). ESRI have since designed a different method of generating cumulative viewsheds, such as the affordance viewshed, which is incorporated in the latest versions of the software.

4.4 Quantitative and Qualitative Analysis of Surrounding Landscapes

The affordance viewsheds of cairn sites and their surrounding landscapes provide a representation of the availability of sea views in a given area. These landscapes were, first, analysed quantitatively with statistical modelling to determine how typical or unique the sea views from a given cairn site are in comparison to its surrounding landscape. The affordance viewsheds also provided a means of analysing these landscapes qualitatively to assess the kinds of areas that cairn sites are placed in, and whether in fact cairns are placed in optimal locations for sea views in consideration of a wider set of factors.

Sites and their surrounds were examined on the assumption that prehistoric builders held a preference for incorporating sea views. Sea affordance surfaces provided an opportunity to identify locations with high sea affordance values, and which might offer sea views of interest, so that their suitability in terms of site placement could be assessed. It is determined on the basis of elevation and proximity to cairn sites whether those locations may have been viable alternatives and, therefore whether cairn sites were the best available for monument placement, in terms of sea views and such practical considerations. Absent independent means of verifying the precise locations where the prehistoric builders of Scotland's long cairns dwelt and, thus, where they may have travelled from, the method used here involved taking existing long cairn sites as an indication of the areas and elevations where they were prepared to place monuments. Alternative locations were, therefore, only considered suitable when they were also in areas and elevations that are not too far away from nor too far higher in elevation than corresponding long cairn sites. Alongside those factors, the alternative locations are also compared against cairn site locations to establish whether or not cairns are placed optimally in terms of sea views. These assessments of sea views were achieved through the use of photographs (of the sea views at cairn sites) when available and with the generation of '3D Horizon panoramas', hereafter referred to as 'Horizon panoramas'.[8]

As mentioned above, Horizon is a landscape visualisation tool that uses mapping data to project what is visible from a given location from a first-person viewpoint, as opposed to a top-

[8] This is part of the software developed by Andrew Smith, of the University of Adelaide.

down perspective as displayed in a standard viewshed. The data used to create a Horizon image are identical to a standard viewshed. However, as a tool for representation it was determined to be much more suitable and capable of producing much more meaningful renditions of landscapes that could help model or approximate as they were experienced by prehistoric people. The aim in this regard was not to determine how much of the surrounding area of sea was visible, but to determine how prominent the sea was in an observer's visual field; the former is represented by a standard viewshed, whereas the latter is represented by Horizon.

Processing time to complete Horizon panoramas ranged between 15 to 20 minutes in each case. These comparisons also involved examining the effects of atmospheric conditions in visibility, which were also modelled in the Horizon panoramas, so as to render a more accurate representation of the sea views that were likely to have been available from a given location. These steps provide grounds to determine whether monument sites could be described as exhibiting unique or at least above average sea views for their respective areas, and thus to substantiate or reject the claim that monuments may have been placed intentionally to afford such sea views.

4.5 Testing for Revelatory Views: Cost Corridor Analyses and Sea Affordance Profiles

One theory as to how prehistoric monuments, such as long cairns, might reference and, furthermore, dramatize the presence of the sea invokes the notion of a 'revelatory view' (Fowler and Cummings 2003, p. 3; Scarre 2002, p. 86). Under this scenario, it is supposed that prehistoric people used specific pathways to access their monuments and that those pathways choreographed their movement through the landscape and the visual exposure of the monument's features. This choreographed visual exposure may have had the effect of obscuring sea views along the pathway before revealing them at or around a person's arrival at the site, which is termed a 'revelatory view'. An approach to a monument that incorporates the sight of its imposing structure while framed against the striking backdrop of the sea in this way would have greatly added to the heightened emotions evoked in prehistoric people's experiences. The presence of a revelatory view at a cairn site, thus, accentuates the place of the sea, and may indicate that it was regarded as having some importance.

The presence of revelatory views was tested by considering two criteria. First, as already identified in the earlier steps discussed above, it was considered whether a site offers noticeable views of the sea. The second criterion was the extent that sea views either increased or decreased for observers as they approached a site, and whether those views were obscured and then revealed on arrival. Taken in isolation, aaffordance viewshed displays may be assessed to provide some indication of the extent to which a given site offers revelatory views. For example, Gillings (2009) considers the directions that the monuments he studies may have been approached and comments that those ways of accessing sites offer revelatory views. However, such attributions are largely uncertain and indeterminate for the reason that they rely on loose speculation on how a site might have been approached. To remedy this shortcoming, cost corridor analyses were implemented in the present study to correct for such uncertainty and to provide a representation of the possible and likely pathways that could have been used to approach sites. Those pathways, in particular, were analysed in combination with affordance displays. Thus, for each pathway that could potentially hold revelatory views, 'sea affordance profiles' were generated to examine consistently the degree to which a given site's sea views were revelatory, as in the extent that affordance increases for an observer upon their approaching the site from a given pathway. The results of these analyses were then compiled to determine, region by region, whether there are discernible trends towards sites having revelatory views and, therefore, whether there is evidence that confirms that such views were intentional and an outcome of prehistoric belief systems. This section details the steps taken and rationales underpinning the cost corridor analyses used here to identify paths to sites, together with the considerations taken in analysing sea affordance profiles.

Cost Corridors and Considerations for Cost Surfaces

Cost corridor analyses model how a given point in a landscape may be reached with the least cost, usually in terms of energy or time. This type of analysis differs from the generation of 'least cost paths', which determine the single least costly way of travelling from one specific point to another (Verhagen 2010). Rather, cost corridor analyses identify broad areas of lower difficulty or 'resistance' in travelling between points. There are several varieties of cost distance or path analysis. One way this technique is used is in identifying paths that model the least costly way to traverse a given landscape, in any direction, with numerous starting and ending points outside of that landscape, usually spread out across the entire perimeter of the area. This method, thus, defines every main pathway through the landscape. Although the nature of such paths would certainly be of interest, consideration of such large geographical areas is beyond the scope of the specific purposes of the present analyses. Hence, in the cost corridor analyses implemented here, it may be assumed that a long cairn site is a specific end-point, or at least one known point in a longer path. In considering the area surrounding long cairns, within a 1.5 km radius, these analyses identify the paths that could have been used to approach the monuments. As depicted in Figure 4.20, several such paths could be identified in each instance, with each path starting from a different direction relative to its respective site and terminating at the site.

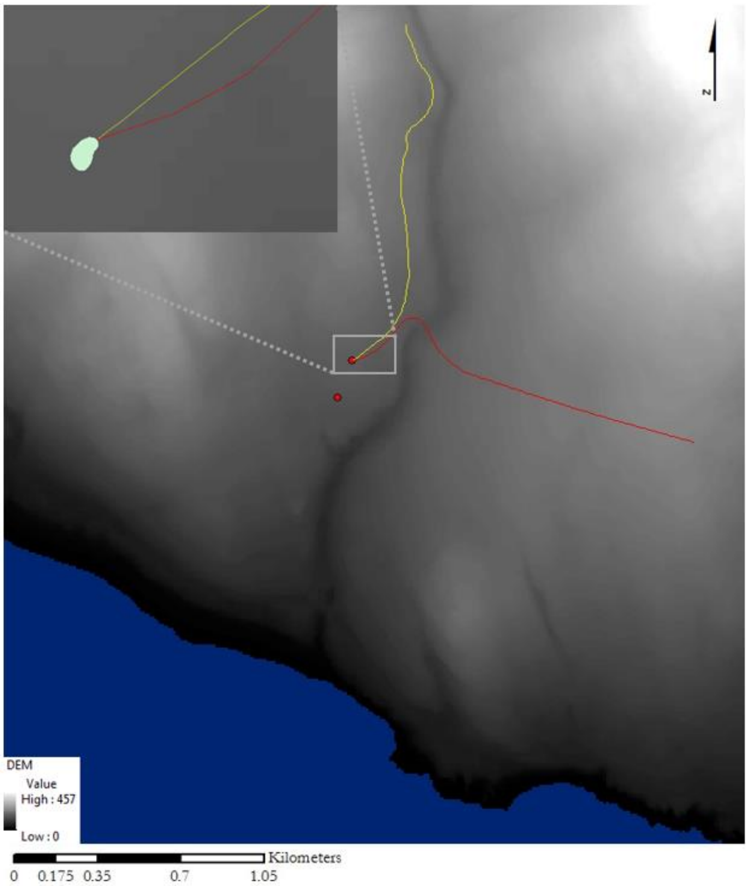


Figure 4.20: There are two seaward pathways that the long cairn site Cairnholy II may have been approached from.

To determine the costs of traversing different areas of a terrain, cost corridor analyses require the generation of cost or 'friction' surfaces, which provide a measurement of cost to distance travelled, given certain assumptions. These assumptions include: travellers' body types (height, weight and gender), what they might have carried with them, and their mode of transportation (by foot or by other means). Friction surfaces can plausibly incorporate a range of factors, including vegetation density, difficultly in wading across wetlands, geological formations, soil conditions, and river and stream widths. Site inter-visibility and proximity can also assist travellers in providing a sense of direction as monuments may act as way-points or meeting places prompting travellers to follow paths that connect sites. However, some of these factors are mutable. Vegetation cover, for instance, is liable to change with time. Moreover, without sufficient dating evidence there are difficulties in determining whether other sites were contemporary.

Therefore, due to both limited data and to the large number of sites considered, it was not practical to attempt to model effectively all such factors. Nevertheless, three factors were taken as decisive and to be able to provide a sufficiently detailed rendering of the paths taken to approach monuments. These factors were, primarily, slope and proximity to water, and, additionally, an avoidance of walking through water and waterlogged terrain.

Walking speed and energetic expenditure (calories expended), as depending on terrain slope, are the most commonly used measurements for generating friction surfaces and, thus, for reconstructing human mobility and determining the costs of travel (Verhagen 2010). However, the analyses implemented here used energy expenditure as its primary criterion for generating friction surfaces, as it was considered both more consistent and more relevant than walking speed; the ability to walk faster on a given terrain does not, for example, necessarily equate to saving energy. In addition, particularly due to Scotland's rugged terrain, it was considered as a plausible assumption that slope may have posed a major challenge to overland travel there, prompting prehistoric people to follow paths of least topographic resistance and to preserve energy where possible.

Using slope to generate friction surfaces meant that simulated corridors often coincided with rivers, directly superimposing on or cutting across them. This was to be expected since both rivers and simulated corridors follow paths of least resistance. This outcome was not considered as a problem in and of itself for the reason that waterways can often act as an 'attractor' for travellers by providing a consistent water supply, as well as acting to give them a sense of directionality in addition to a means of travelling by boat. It was, therefore, considered important to retain any paths that were simulated along rivers. However, it was also considered as a desideratum to ensure that corridors were modelled on the land adjacent to water and not directly in water. This would have the advantage of both avoiding deep water crossings and avoiding the higher costs of movement at such locations that arise due to greater risks of flooding and the ground becoming waterlogged during periods of heavy and prolonged rainfall.

Generating Friction Surfaces and Modelling Cost Corridors and Pathways to Cairn Sites

The first step in the cost corridor analysis was the generation of meaningful caloric representations from raw slope surfaces, using DEM data from the OS LandForm PROFILE dataset. A 'hiker function' was used to determine how much energy would be required to travel across each map unit, each representing $10m^2$ (Whitley 2003). This is a mathematical formula that determines walking speed based on slope. Walking speed is then used to calculate caloric expenditure of travel based on assumptions regarding an average prehistoric person's size, weight, gender and age, and approximations of energy expenditure from comparable exertion activities, e.g. walking on a 0° slope (flat terrain), climbing a 45° slope (100% slope) and rock-climbing on a 90° slope (vertical cliff). This established lower and upper limits of 0.67kcal and 66.67kcal for how much energy could be used to cross 10m. In the range set by these limits, it was necessary to model energy expenditure to slope as building gradually, so that a walking up a 2° incline, say, is not twice as difficult as walking up a 1° incline. It was found that, in this terrain dataset, a simple power 2 exponential curve represents closely human terrain caloric costs in reality, as are seen in the caloric values for walking on flat terrain, climbing a 45° slope, and rock-climbing.

After slope was used to derive the baseline caloric expenditure for crossing terrain, a modification was included to model the difficulty of crossing water and traversing water-saturated grounds that may have been prone to flooding.[9] This modification would ensure that where corridors would otherwise coincide with rivers they would, instead, be modelled on the land adjacent to water and not directly in water, providing a closer representation of pathways that would form on the margins of streams and wetlands and not down their centres. This step entailed the generation of a second friction surface that functioned as a 'repulser', moving (or pushing) the simulated corridors away from the centre of waterways. A limit was set so that paths were not moved further than 50m from the edge of water or waterlogged terrain, to account for a buffer zone of water-edge erosion or migration, yet not force artificial routes around water bodies. As a consequence of this limit, this second friction surface only affected corridors simulated in extreme proximity to rivers or directly superimposed along the centre of waterways, so that the general simulation of human movement was unchanged. The two friction surfaces, as respectively dependant on slope and flooding, were then weighted so that corridors would avoid waterways but not at any cost or to an absolute extent. Rather, an allowance was made to model prehistoric travellers choosing to walk through water briefly where necessary for greater efficiency but staying out of it for long stretches.

To generate travel corridors within which pathways might be drawn to model prehistoric peoples' movement over the landscape and towards the cairn sites, all points around a 1.5km radius of the sites were identified as 'possible starting points'. The distance of 1.5km was chosen to define

[9] BGS Geological Indicators of Flooding (GIF) dataset is a digital map based on the BGS Digital Geological Map of Great Britain at the 1:50,000 scale (DiGMapGB-50, BGS, 2010).

the radii studied around each site as it closely approximates the distance of 1 mile, which may be considered as an intuitive measurement that captures the sense of a phenomenologically significant distance. Corridors were then identified as those areas, between the starting points and the end point (cairn site), in which the costs were low, or lower, so that the analyses identified the possible routes from any point outside of the radius (from potentially any direction) to the site itself. Distinct, or more definitive, starting points were then be identified as those that led from the outside of the 1.5km radius along and area of low cost, excluding the masses of starting points around the circumference on areas in which travel was more costly. This was considered to be an effective method of identifying how sites may likely have been accessed, particularly in areas that had especially hilly terrain. As mentioned earlier, this method had a distinct advantage over that of generating least-cost paths to cairn sites, by allowing scope for identifying various possible ways to approach a site, as opposed to the one uniquely least costly way of accessing a cairn site. Hence, with travel corridors identified, several example pathways could be identified within the areas demarcated by the travel corridors, as routes that may have been taken by prehistoric people to reach sites (see Figure 4.21).

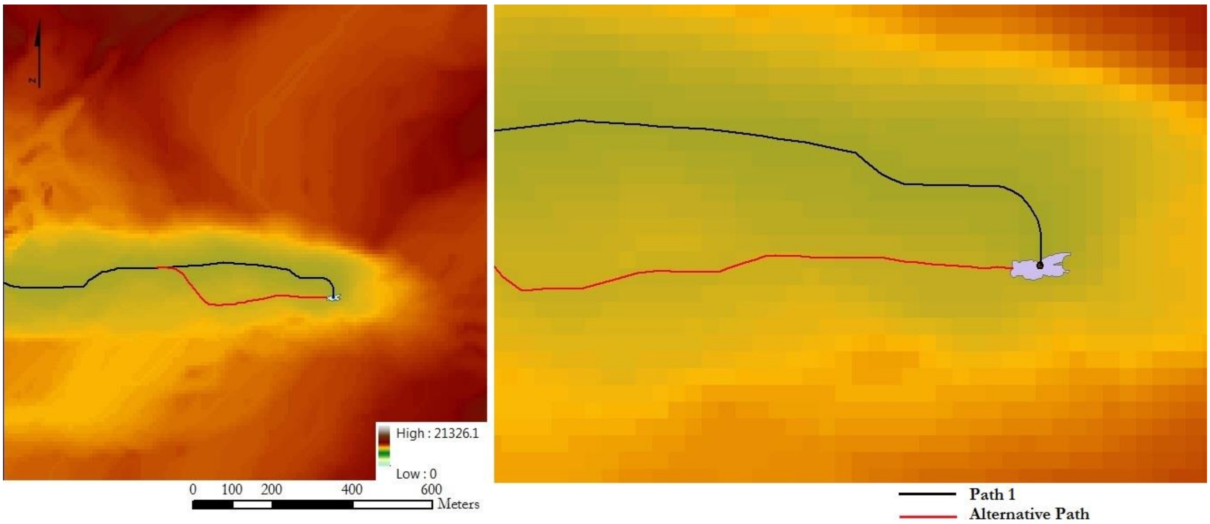


Figure 4.21: Two 'example pathways' were charted within low-cost areas of the last 400m on the approach to Glen Lussa, in Dumfries and Galloway.

Assessing Pathways for Revelatory Views

Affordance values along the example pathways were then analysed to identify whether long cairns were placed in locations that offered revelatory views of the sea. This was achieved through the creation of vertical profile graphs, which depict affordance along paths relative to distance from sites, as seen in the case of site 'X' (shown earlier, and below in Figure 4.22).

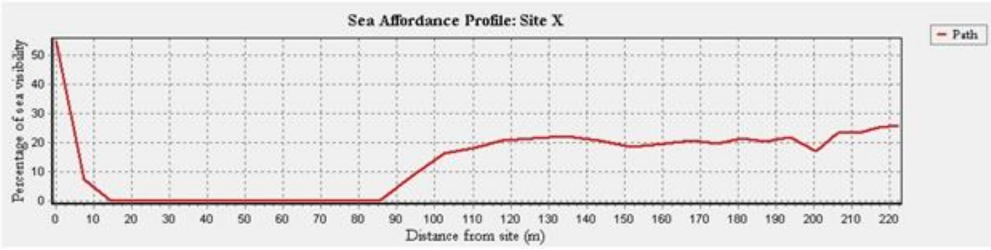


Figure 4.22: Affordance profile of site X'

As a preliminary step, pathways that approach sites from the direction of the sea were excluded from the analyses for the reason that views of the sea would occur behind the person approaching the site and would not form a backdrop to the site to form a revelatory view. Hence, only paths that approach the sites in a seaward direction and, therefore, those that could potentially have revelatory views were considered for further analysis. This meant that a pathway must roughly or 'indirectly' align with the direction of the sea for it to be considered as a potential candidate for offering a revelatory view. Pathways forming an angle of less than 45º to the direction of sea views were considered as able to offer such views.

Several factors were considered in assessing whether a site was placed in a location that affords a revelatory view of the sea. The most important criterion for a revelatory view was that affordance increased within a certain distance of a site. This particular criterion led to the identification of two forms of revelatory views, both of which are considered of interest. 'Sudden and dramatic revelatory views' involved sharp and substantial increases in affordance within approximately 200m of a site, whereas 'gradual revelatory views' involved more gradual increases in affordance within approximately 600m of a site. For a view to be considered revelatory, an increase in affordance was not required to be in terms of absolute values, as a fixed increase in the percentage of affordance. Instead, to be considered as indicative of a revelatory view, affordance values must increase in proportion to the values present along a pathway. For instance, some locales may see affordance values increase substantially at site locations, in the order of 20–50%. However, in other landscapes, affordance values of around 5% were typical. Where affordance values in such landscapes increased to, say, 10% upon arrival at a site, either suddenly or gradually, such an increase was considered to be indicative of a potentially revelatory view. Such increases were, then, considered as prompting further investigation both with additional GIS techniques and, ideally, through onsite visitation—although any such further visitations were not within the projected scope of this study and could not be conducted.

All sudden as well as gradual, potentially revelatory views were investigated further with additional GIS techniques for two reasons. First, as described in Section 3, the shadow effect could account for increases in affordance even under situations where there are no substantial increases in visible sea area. Thus, a 5% increase in affordance might not be indicative of a (particularly) revelatory view, and sea views in such a case may remain relatively constant to an approaching observer, despite affordance values seeming to depict otherwise. This possibility was tested for, in each instance, using standard viewshed and Horizon panoramas —both of which display visible sea areas. However, Horizon panoramas were more effective at depicting increases in sea views, and these displays are referred to in the analyses to be discussed in the chapters to follow. This is due to the fact that while increases in affordance values are strongly correlated with and related to increases in sea views, it is possible to have an increase in sea views, in terms of the area taken up in an observer's visual field, without an increase in affordance. As described in Section 3, this is because closer areas of sea will take up more space in the visual field than the same quantity of sea area placed further away. Thus, as discussed earlier, since Horizon panoramas depict the area taken up in an observer's visual field by the area of visible sea, those profiles were a more effective test than standard viewsheds for establishing whether increases in affordance values were due to the presence of revelatory views.

Horizon was, then, used as a primary tool for the analysis and interrogation of pathways and pathway profiles to provide evidence to confirm or reject the notion that sites were placed intentionally to afford revelatory views of the sea. This entailed several steps. First, as just described, views afforded at site locations were examined to determine in the first instance whether they are sufficient to be treated as revelatory. Second, the views at site locations were then compared to locations along the pathways approaching sites that afforded comparable or better affordance values. Such locations are described as offering 'previews of sea'. Rather than attempting to deduce these locations using sampling at regular intervals, say, they were identified using peaks and troughs from affordance profiles as indications of sea views, which were then interrogated and verified using Horizon panoramas—see Figure 4.23 for an example of an affordance profile that indicates the presence of a potential preview location. In each case, this method was sufficient to provide an illustration of a narrative of how a site might have been approached.

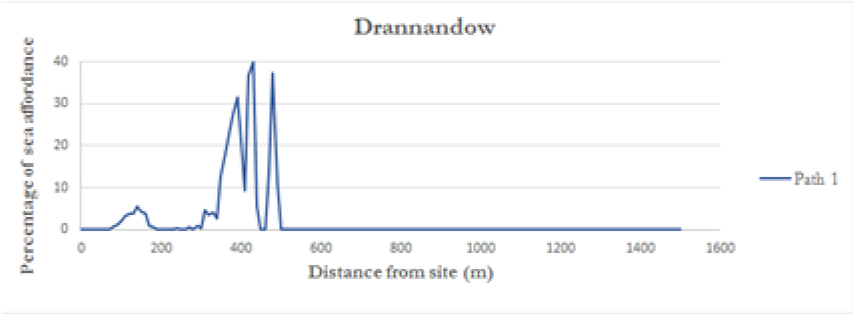


Figure 4.23: Sea Affordance Profile of Drannandow, in Dumfries and Galloway, showing preview location at 430m from the site.

Following the assumption that sites were placed intentionally so as to afford sea views, it was queried why preview locations were not chosen for site placement, as they might be considered as potential alternatives for a monument location if in fact a site location was chosen for its sea views. The previews of sea, as available at these alternative locations were accordingly investigated using Horizon and compared to sea views available at the cairn sites. Atmospheric conditions, as also modelled by Horizon, were one such factor taken into account in such analyses, and which were considered as helpful in testing for comparative views at site locations and alternatives. Hence, in light of the availability or unavailability of alternative (preview) locations, it was determined whether it is plausible to suppose that cairn locations might have been chosen for their revelatory views.

4.6 Alignments of Long Cairns' Axes, Sea Views and Pathways

The final step in the investigation was a recording and compiling of the various ways that cairn construction and placement within their landscapes might reference the sea. This investigation was guided by two notions in particular. First, the long cairn's long axis, which is distinctive of this somewhat loosely defined monument-building tradition, poses an opportunity for prehistoric people to reference the sea, by being oriented in relation to the sea. Second, a revelatory view would be particularly effective at accentuating and referencing the sea if it were visible not just from the site itself, but also from a location along the seaward pathway that approaches the cairn. Having a revelatory view visible from such a location, which requires the given seaward pathway to align with the sea view, would mean that the sea forms a backdrop to the cairn site, evoking heightened emotions in prehistoric peoples' experiences, in addition to making more obvious any orientation of the cairn structure in relation to the sea to the effect of referencing its location. Hence, to determine whether and how often such effects and references were respectively achieved and made, monument orientations were examined alongside the direction of the sea views available from their locations and the directions of the seaward pathways that may have been used to approach them, so that any potential alignments between those features of each site could be discovered.

There were, consequently, three species of alignment that could occur at cairn sites. The first species of alignment is, in part, incorporated by the potential revelatory views offered at long cairn sites, as at least an indirect or general alignment between a seaward pathway and available sea views is required for a revelatory view to occur. However, as noted above, the presence of a 'direct line of sight' from a pathway to the sea would frame the site against a backdrop of the sea for people arriving at the site. The instances in which pathways either directly align or align more generally with sea views were, thus, noted. The second species of alignment occurs where a cairn's long axis aligns with the available sea views. This could be achieved by the long axis pointing in the direction of the sea, which is described as an 'axis-alignment', or through the long axis being constructed parallel to the sea, which is described as a 'side-alignment'. The third species of alignment recorded concerns the way in which a seaward pathway may align with a cairn's structure. An alignment of that kind may occur where a pathway approaches a cairn structure in alignment with its long axis, so that observers using the path would arrive at the site either at the monument's proximal or distal end. Alternatively, a further variety of this kind of alignment occurs where a pathway approach from an angle perpendicular to the cairn's long axis, in such a way that an observer is presented with the side of the cairn's long axis upon their approach to the site.

A 'sightline' results in places where these three species of alignment occur together. An observer approaching a cairn site from a seaward pathway may, in such an instance, be presented with the cairn structure and the sea in view in one of three ways: a 'proximal–distal sightline', a 'distal–proximal sightline', or a 'sideway sightline' (see Figure 4.24). For a proximal–distal sightline or a distal–proximal sightline to occur, a pathway must approach a cairn in at least a rough alignment with its long axis, with sea views appearing behind the cairn. For a sideway sightline to occur, the pathway must approach roughly perpendicular to the cairn's long axis, with the sea appearing behind the cairn body. The presence of such sightlines is of interest as they may be especially indicative of an intention to reference the sea through monumental construction. Additionally, the nature of such sightlines, and the way in which prehistoric people's movements may have been orchestrated to approach the monuments, may take on further significance where they occur alongside the magnificent façades and forecourts that complement many of these structures.

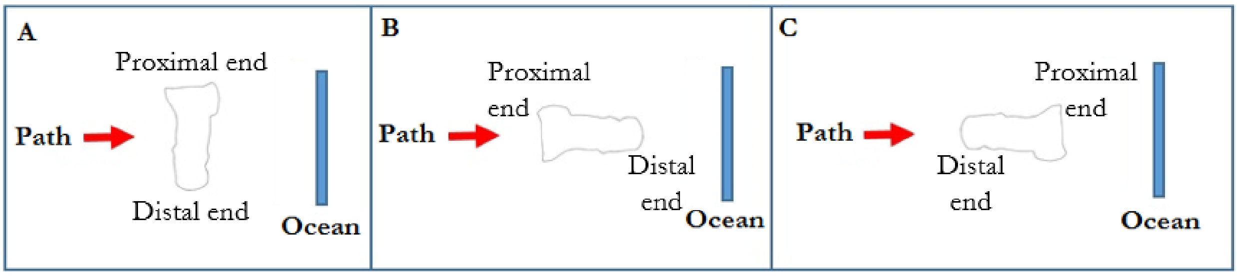


Figure 4.24: This diagram illustrates the three types of sightlines created by the alignment of paths, monuments and ocean (sea) views. A) Sideway sightline with the ocean (sea), B) proximal–distal sightline with the ocean (sea), and C) distal–proximal sightline with the ocean (sea).

There is some variation regarding the nature and degree of such alignments in terms of their precision, and this led to three different ways of recording them. First, a 'direct alignment' holds when a cairn long axis points inside the range of the azimuthal direction of sea views or is placed parallel to the sea, such that the long axis is perpendicular to an area (or point) of sea that can be found inside the range of sea views. Second, an 'indirect alignment' was identified under the condition that a cairn long axis could be askew of direct alignment by no more 5º, in pointing in the azimuthal direction of the sea or being parallel with sea views. This meant that an otherwise direct alignment might once have held before subsequent changes in a cairn structure's orientation due to poor preservation. Third, a 'general alignment' was identified under the condition that a cairn long axis could be askew of a direct alignment so that a monument oriented toward the general cardinal direction N, for example, could be considered as roughly aligned with the direction of a sea view that lies on the heading of an adjacent secondary intercardinal direction, such as NNE or NNW. Despite their imprecision, general alignments between cairns and sea views were nevertheless considered as a subject of interest as there may be other factors, such as the shape of the landscape and the amendment of a cairn structure over successive generations, that may have contributed to the final orientation of a monument to being askew from referencing the sea directly, even if a direct or precise reference may have been preferred by its builders.

A similar method was used to identify instances where pathways aligned with sea views. Thus, it was recorded whether: a pathway approaches a monument on a heading that falls directly within the range of sea views, which is described as providing a 'direct line of sight'; or, whether the angle of approach is generally aligned, by being askew of a direct alignment by no more than one secondary intercardinal direction. Regarding alignments between pathways and cairn structures: pathways were considered as forming at least a rough alignment with a cairn structure, if they approach that structure from an angle that askew of a direct alignment with its long axis (in the sense of being either parallel or perpendicular to the axis) by no more than one secondary intercardinal direction.

In instances where sea views were particularly expansive, the finding of alignments of cairn axes with those views may be of trivial importance in that they may not reliably indicate an intentional orientation of a cairn structure towards the sea. This is because it may be more likely that a monument could point in the direction of the sea (axis-alignment) or be placed parallel to the sea (side-alignment) than that it is askew of either of those forms of alignment—indeed, in certain cases of particularly expansive sea views, it would be impossible for a cairn to be askew of both forms of alignment. This is not to detract from the significance of the placement of cairn structures in locations with expansive sea views, but only to note that a prehistoric intention to reference the sea cannot be inferred on the basis of such alignments alone, that is, where they occur in locations with particularly expansive sea views. However, in cases where sea views are narrow, the likelihood of nonintentional cairn alignments towards the sea is profoundly reduced. Therefore, even an indirect or general orientation of a long axis toward sea views, as opposed to a direct alignment with those views, may be indicative of prehistoric builders' awareness and regard for the sea and what it may have represented to them. Moreover, in cases where sea views are expansive, a specific alignment between a long axis and the pathway used to approach it may, nevertheless, be indicative of an intention to choreograph prehistoric movements within the landscape. Hence, it was considered to be especially important for the investigation to record instances where cairn axes are aligned with sea views in addition to instances where all three components of a site form a sightline, as incorporating the seaward pathway, cairn monument, and sea views.

4.7 Summary

This thesis investigates on several dimensions the notion that the long cairns of Scotland were placed so as to reference the sea. It is determined whether cairn sites offer sea views, and any such views are compared against the typical sea views offered in the landscapes in which the cairns are situated. Data on those particular respects provide evidence to suppose that site locations were chosen for sea views, rather than being placed in areas that may incidentally afford them. Sites are subsequently tested to determine whether they also afford revelatory views. A substantial amount of analysis is devoted to testing the latter, as it is a more complicated as well as interesting claim regarding site placement. Finally, cairn sites are examined in their wider landscape contexts, including any available sea views and seaward pathways that approach them, to determine whether they are oriented in particular ways that may be further indicative of prehistoric builders' intentions to reference the sea.

Chapter 5: Analysis of the Long Cairn of Dumfries and Galloway

Many of the long cairns of Dumfries and Galloway are placed in proximity to the Solway Firth, to the north of the Irish Sea. These cairns were investigated to determine whether and how they might reference that body of water (hereafter referred to as 'the sea') in any of the three ways described in Chapter 4. First, long cairn sites were assessed in terms of their affordance of sea views, to determine whether they offer sea views that are either typical or unique in comparison to the kinds of views generally available in the landscapes in which they are situated. This assessment was conducted both quantitatively, in terms of a statistical consideration of the sites as a collective, as discussed in Section 1, and in terms of a qualitative consideration of their landscape contexts on a site-by-site basis, as discussed in Section 2. Second, as described in Section 3, sites were assessed to determine whether they offer 'revelatory views' of the sea, as dependent on the pathways from which the monuments were likely to have been approached and as dependent on how much sea views are obscured to observers on their approach. Third, the details of sea views and revelatory views, where present at long cairn sites, were compiled and considered in Section 4, alongside the orientation of their long axes relative both to the sea and to the pathways that may have been used to approach them.

5.1 Sea Affordance Surfaces and Statistical Considerations

There are 19 sites that fit the long cairn criteria in the region of Dumfries and Galloway. However, of these 19 sites, 6 are located in areas that are over 13.5 km from the present-day coastline and are devoid of sea views. It was assumed that the sea may have had a reduced level of significance for the prehistoric people living in those inland areas, and on that basis those six sites were excluded from the analyses discussed here.[10] A distribution of sites analysed in this region is depicted below, in Figure 5.1.

To facilitate computer processing and reduce the time required to generate sea affordance viewshed maps, this region was divided into seven micro–regions or sectors, some of which contained multiple sites. With some sectors being processed simultaneously, it took 23 days

[10] The six excluded sites are: Crossford Hill, Fleuchlarg, Windy Edge, Cairn Avel, Capenoch Loch and Stiddrig, which are, respectively, 19 km, 16 km, 20 km, 35 km, 21 km and 21 km away from the coastline.

(555hrs) to generate all maps. With the resulting interpolated surfaces, the percentage of sea affordance for each site location was then recorded (for a detailed summary of these findings, see Table 5.1). In order to verify the accuracy of sea affordance results, a standard viewshed was run for each such location to determine which areas of the landscape and seascape, if any, were visible.

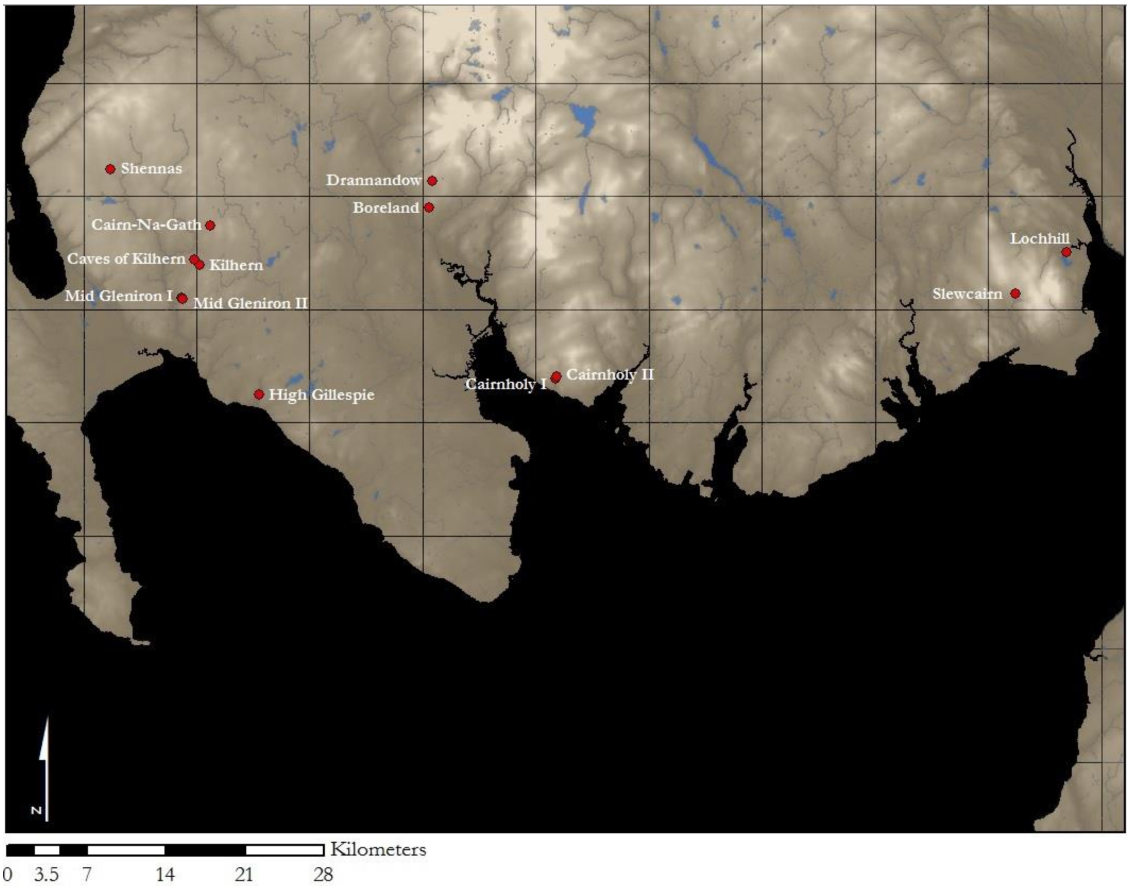


Figure 5.3: Dumfries and Galloway site distribution map

Site ID	Site Name	Site Elevation (m)	Distance to Nearest Body of Water (m)	Distance to Nearest Coastline (m)	Sea Affordance %
1	High Gillespie	24	90.38	1108.60	13.18
2	Lochhill	47	299.19	664.54	0.00
3	Slewcairn	207	469.53	4694.65	25.71
4	Cairnholy I	121	180.56	1108.20	25.29
5	Cairnholy II	136	225.64	1273.65	16.27
6	Boreland	152	584.04	4583.85	49.9495
7	Drannandow	200	880.39	6857.65	0.00
8	Cairn–Na–Gath	170	1187.79	11476.20	0.00
9	Kilhern	135	608.67	7913.18	0.00
10	Caves of Kilhern	131	390.74	8319.07	0.00
11	Mid Gleniron I	85	612.66	4758.49	3.04
12	Mid Gleniron II	86	634.00	4718.75	0.00
13	Shennas	196	1060.90	6754.82	0.00

Table 5.1: Results of sea affordance analysis

Sea Affordance Analysis and Verification of Results

Sea affordance results indicated that of the 13 sites, 7 were built in locations that afford 0% sea affordance. Standard viewsheds confirm that no sea views are available from Lochhill, Kilhern and Mid Gleniron II, however, they indicate visibility of areas of distant sea for the remaining four sites, Drannandow, Cairn–Na–Gath, Caves of Kilhern, and Shennas. At Shennas, for instance, a standard viewshed indicates that sea views are present in a SE direction, approximately 40km away from the site location (see Figure 5.2).[11] Similarly, at Caves of Kilhern, a standard viewshed indicates views of sea area approximately 71km away from the site location in a SSW direction (see Figure 5.3).[12] To determine how much space these areas of sea take up in the visual field of an observer, Horizon panoramas were generated for these four site locations. These panoramas

[11] Unless otherwise noted, all cairn sites in this chapter refer to monuments within the council area of Dumfries and Galloway.

[12] At Drannandow, standard viewshed indicates sea views which expand from SSE to SW direction. The nearest visible areas of sea are approximately 38km away. At Cairn–Na–Gath, sea views appear in the SW, of areas approximately 39km away from the current position of the site.

revealed that those areas of sea are situated at such a distance that they are not visible across the horizon. This was further confirmed by reviewing field observations (see Figure 5.4). In the instances of these four site locations, the results of the sea affordance analysis were, therefore, considered to depict these sites accurately as offering no sea views. The remaining six sites have affordance percentages as follows: Boreland (49.95%), Slewcairn (25.71%), Cairnholy I (25.29%), Cairnholy II (16.27%), High Gillespie (13.18%) and Mid Gleniron I (3.04%).

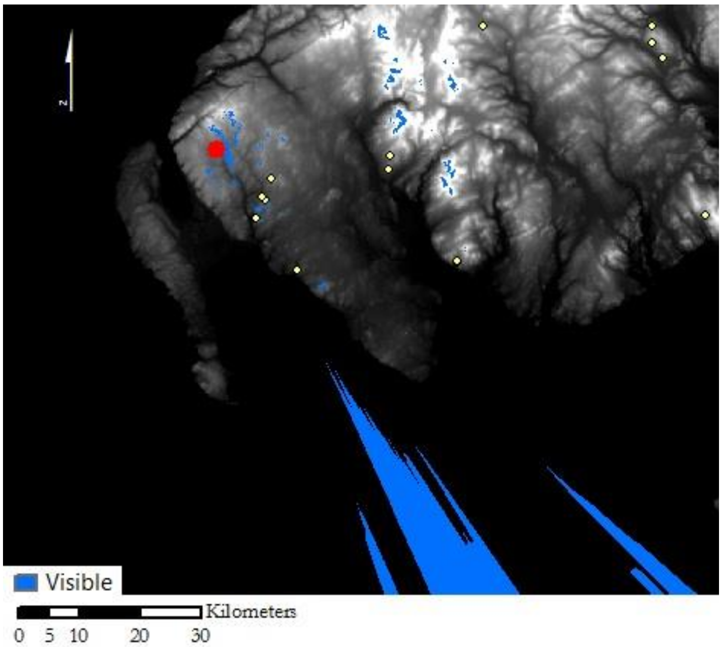


Figure 5.4 A standard viewshed showing the parts of the landscape and seascape (blue) that are, in principle, visible from Shennas (red).

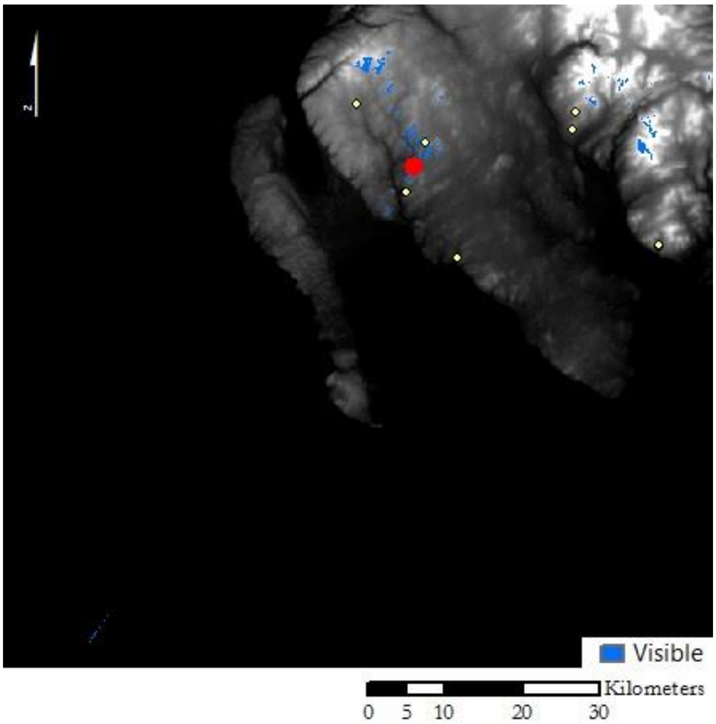


Figure 5.5: A standard viewshed showing the parts of the landscape that are visible from Caves of Kilhern (red).

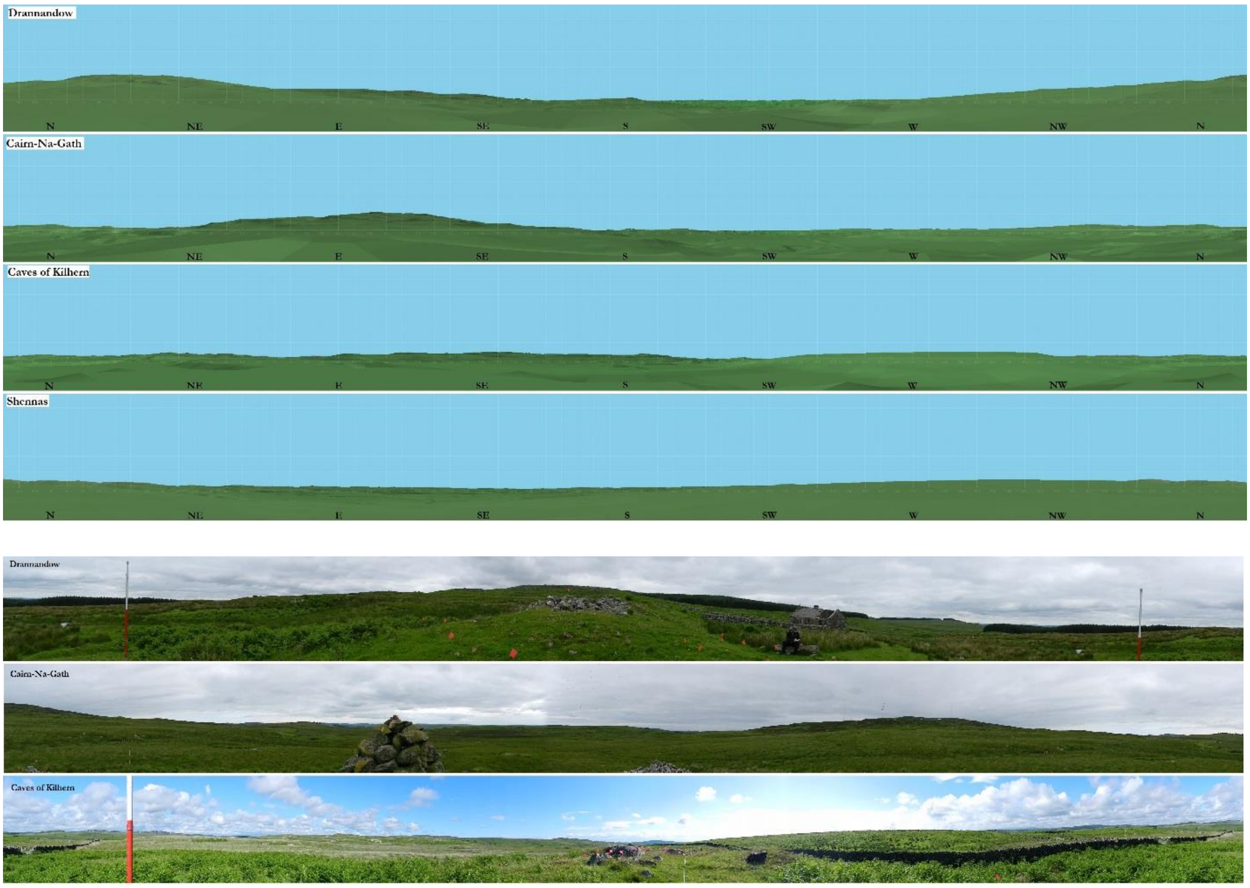


Figure 5.6: Horizon panoramas and photographs showing no apparent sea views.

(Above) Drannandow, Cairn–Na–Gath, Caves of Kilhern and Shennas, horizon. (Below) Panoramic photos of Drannandow, Cairn–Na–Gath and Caves of Kilhern, taken during field surveying.

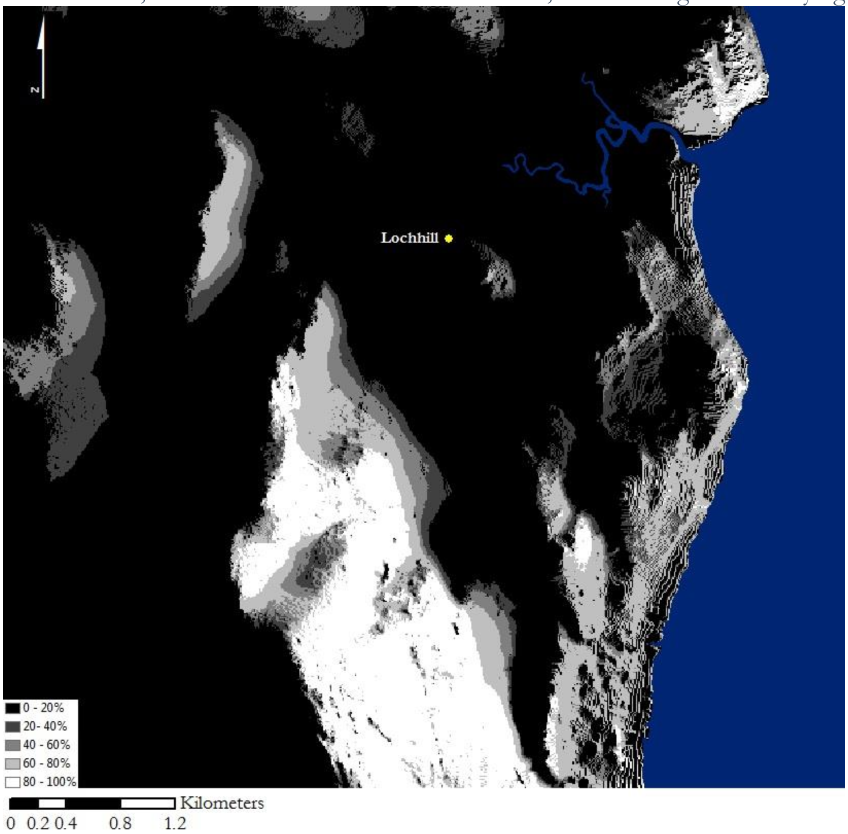


Figure 7.5: Lochhill is placed only a short distance away from the coastline but in a location that affords 0% sea visibility.

Statistical Considerations

It is noteworthy that despite being in relatively close proximity to the coast, less than half of the sites considered in this region afford sea views. Moreover, as is discussed below in Section 2, 9 of the 13 sites are placed in areas where there are locations that have substantially greater sea affordances nearby. Take, for example, Lochhill, which is only 665m distant from the nearest coastline but has no sea views (see Figure 5.5). These findings suggest that the hypothesis tested may not hold true in this region, that is, that the long cairns of Dumfries and Galloway may not have been placed to reference the sea.

To interrogate these findings further, and to determine whether any such suggestion has credibility, a chi–square significance test was used to assess whether the long cairns considered here were placed in locations that have more or less sea affordance than one would expect randomly. A 500m radius around each site was tested by reclassifying the interpolated sea affordance surfaces into six percentage categories: 0–5, 5–10, 10–20, 20–30, 30–40 and 40–100. Then, chi-square values and the p-value were calculated from the observed and expected frequencies (see Table 5.2). A p-value of less than 0.05 would indicate a statistically significant difference in the site locations compared to what could be expected from random distribution. However, with a chi–square value of 1.3 and a p-value of 0.9, results indicate no significant difference between the observed values (site locations) and expected values (random locations). Prehistoric builders may, then, have been able to place these monuments in many locations within a 500m radius of where they are now and achieve similar outcomes in terms of sea affordance values.

	Label (% categories)	Observed	Expected	Chi-Square Values
Dumfries and Galloway	1 (0–5)	8	8	0.03125
	2 (5–10)	0	1	0.25
	3 (10–20)	2	1	0.25
	4 (20–30)	2	1	0.25
	5 (30–40)	0	1	0.25
	6 (40–100)	1	1	0.25
				1.28125
			p-value =	0.999825

Table 5.2: Comparison of the observed and expected values, showing the chi–square values and the p–value.

On the basis of the above outcome, when the sea affordance data for all 13 sites are considered as a collective, there is no indication that prehistoric people selected any specific site location for its sea views. This may be to be expected as, despite their proximity to the sea, a majority of monuments in this region are built in parts of the landscape that afford either views of insignificant slivers of sea or no sea views at all. It was, however, of interest to determine how unique the observed sea views are in the particular areas where monuments are placed, for sites when they are considered individually and not as a collective.

To investigate this further, the interpolated sea affordance surfaces were once again reclassified, using the following percentage categories: 5–10, 10–20, 20–30, 30–40, 40–60 and 60–100. Since the interest in this analysis lay in sites' immediate vicinities, a 500m buffer was created around each site. Thereafter, for every site location, the number of pixels inside the buffer zone in each of the sea affordance percentage categories were counted. These pixel counts were then used to determine the percentages of the total tested land areas as falling into each of the sea affordance percentage categories (as listed above). For example, out of a total of 7860 pixels at and surrounding the site of Lochhill, 7112 fell into the 0–10% sea affordance category. Given that the sea affordance at the site of Lochhill also falls in this 0–10% range, this indicates that 90.5% of the area immediately surrounding Lochhill has very similar views to those found at the site itself (which offers no sea views). It, thus, stands to reason that an absence of sea views, as seen at Lochhill, is characteristic of the site's local landscape (for these results, see Table 5.3). A point of import from this outcome is that even though this result is consistent with prehistoric builders having no intention of incorporating sea views, it remains the case that if they were actively seeking a topographic location with sea views such a location would have been difficult find in this particular area. It may, for instance, have been next to impossible to incorporate broad panoramic sea views at a monument's location (in the range of 40–100% sea affordance) as such views are extremely rare in this particular area—there is, roughly, only a 2% chance of finding such views within a 500m radius of the site.

Sea Affordance % Categories	High Gillespie	Lochhill	Slewcairn	Cairnholy I	Cairnholy II	Boreland	Drannandow
0–10	28.8	**90.5**	14.4	35.8	45	39.4	**75.1**
10–20	**20.7**	5.9	24.2	26.4	**24.6**	0.8	2.1
20–40	38.2	1.8	**60.9**	**36.2**	30.4	3.4	3.7
40–60	11.7	1.6	0.5	1.613	0.2	**1.81**	3.9
60–100	0.6	0.4	0	0	0	54.5	15.3

Sea Affordance % Categories	Cairn-Na-Gath	Kilhern	Caves of Kilhern	Mid Gleniron I	Mid Gleniron II	Shennas
0–10	**100**	**100**	**100**	**92.7**	**94.4**	**100**
10–20	0	0	0	7.3	5.6	0
20–40	0	0	0	0	0	0
40–60	0	0	0	0	0	0
60–100	0	0	0	0	0	0

Table 5.3: The percentage of the total tested land area (0.8km^2, or a 500m radius) as falling into each of the sea affordance categories. Percentages in bold indicate the categories that sites fall into.

As seen in the cases of Lochhill, Slewcairn, Drannandow, Cairn-Na-Gath, Kilhern, Caves of Kilhern, Mid Gleniron I, Mid Gleniron II and Shennas, a large proportion of each of the tested areas around sites appear to belong to just one of the five sea affordance percentage categories, so that, as a collective, these sites are located in reasonably homogeneous areas with respect to sea affordance. This contrasts with the areas immediately surrounding High Gillespie, Cairnholy I, and Cairnholy II, which are more heterogeneous, and proportionately distributed among the various sea affordance percentage categories. Given that, in a majority of cases, a large percentage of the tested areas fell into the lowest category of affordances values, it may come as no surprise that ten of the sites were also found to be placed in topographic locations that offered affordance values in that low category.[13] A notable exception is Boreland, where it seems that the area immediately surrounding the site is split between the two extreme ends of the sea affordance spectrum, with 39.4% of the tested area falling in the 0–10% sea affordance category, and 54.5% falling in the range of 60–100%. Only 1.81% of the 0.8km^2 area tested has views that fall in the same range as that of the site, and only 6% of the area falls in the intermediate categories, from 10–60%. These figures might seem to suggest that this site is unique and may plausibly present an example of megalithic builders searching for a particular kind of view or having a particular preference, such as for a narrow sea view as opposed to a more expansive view. However, as depicted through the investigation of 'previews' below in Section 3, the sea views available from Boreland Location A (which has a sea affordance of 83.4%) are largely indistinguishable from the views that may have been available at the site, suggesting that in terms of sea views the monument's location is equivalent to locations in its vicinity in the high sea affordance range, and thus that the variability in sea affordance in that area is of no significance.

These results can be used to address the claim made by Fowler and Cummings (2003, p. 4) that if certain monuments were moved short distances then their views of the sea would have been lost. The 500m buffer discussed above enables an assessment of the immediate vicinity of each site location. From the results displayed in Table 5.3, it is apparent that although Fowler and Cummings' (2003) claim might be true at a few of the sites, such as High Gillespie, and Cairnholy I and II, it does not hold in the case of the vast majority of sites in Dumfries and Galloway, many of which offer no or insignificant sea views. Hence, the sites Cairn-Na-Gath, Kilhern, Caves of Kilhern, Mid Gleniron I, Mid Gleniron II and Shennas are all placed in topographical locations

[13] The exceptions in this sample were High Gillespie, Cairnholy II and Boreland.

where the immediate landscape is dominated by the same views, and moving any such site a few hundred meters this or that way would have had no bearing on the types of views they achieve.

These findings were further substantiated when the buffer was increased to include a larger area around the sites. Table 5.4 shows how the sea affordances are distributed across the landscape within a 1.5km radius of the sites. With the exception of Slewcairn, increasing the buffer to include a larger portion of the landscape had little effect on the results observed, which indicate that the views from the site locations are generally very similar to those of their surroundings. This lends credibility to the suggestion made above that prehistoric people could have placed these monuments more or less anywhere within a sizable radius of their locations and achieved similar outcomes. Moreover, given that these views are such a frequent occurrence in the landscape, it may even have been difficult to avoid them. Although there may be individual site locations in this sample that have been chosen deliberately, the statistical data considered here suggests that intentionality cannot be maintained for these sites as a collective, with respect to their sea views.

Sea Affordance % Categories	High Gillespie	Lochhill	Slewcairn	Cairnholy I	Cairnholy II	Boreland	Drannandow
0–20	**59**	**91.6**	60.9	44	**46**	72.9	**87.1**
20–40	21	3.1	**31.9**	**27**	27	3.2	1.9
40–60	9	2.7	7	15	14	**3.4**	2.3
60–80	6	2.6	0.2	11	10	8.4	3.8
80–100	5	0	0	3	3	12	4.9

Sea Affordance % Categories	Cairn-Na-Gath	Kilhern	Caves of Kilhern	Mid Gleniron I	Mid Gleniron II	Shennas
0–20	**100**	**100**	**100**	**84.6**	**84.2**	**100**
20–40	0	0	0	7.6	8.1	0
40–60	0	0	0	4.4	4.3	0
60–80	0	0	0	3.4	3.4	0
80–100	0	0	0	0	0	0

Table 5.4: The percentage of the total tested land area (7.1 km^2 or a 1.5km radius) which fell into each of the sea affordance categories. Percentages highlighted in bold indicate the category that the sites fell into.

5.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones

While the statistical analysis of the sample of sites considered above does not reveal any trends that would support the notion that the long cairns of Dumfries and Galloway were placed in order to reference the sea, there remained to be a further possibility that individual sites were placed with such an intention. Hence, sites were considered on an individual and qualitative basis to investigate this possibility. This involved analysing the monuments' surrounding areas to determine whether there were viable alternative locations for site placement that offer greater sea views. For if long cairn site locations were in some cases optimal in terms of available sea views, there would be support for the notion that locations were chosen for those sea views and that the monuments may have been intended to reference the sea wherever that was possible or practical to achieve.

Alternative locations for site placement were selected, each one affording noticeably greater sea views when compared with where monuments were placed (see Table 5.5 and Figure 5.6, below). As there are multiple alternative locations for some sites they are labelled A, B or C, or the locations are simply referred to as lying in 'zones'. The following locations present examples of some of the more stark contrasts in affordance values in comparison to site locations:

1) Cairnholy I Location C (726 m SW of Cairnholy I): sea affordance falls in the range of 80–100%, which is roughly up to three times the value found at Cairnholy I.
2) Cairnholy II Location A (459m WSW of Cairnholy II): sea affordance more than doubles in value compared to Cairnholy II.
3) Cairnholy II Location C (877 m SW of Cairnholy II): sea affordance percentages are five times the value found at Cairnholy II.
4) Boreland: within a very short distance from the cairn site, there are a numerous high sea affordance zones, with values falling in the 80–100% range, almost double that of the site.
5) Mid Gleniron I Location A (1.1km W of Mid Gleniron I): here and at numerous other locations in proximity, sea affordance is up to nine times the value found at Mid Gleniron I.

As the above results show, a majority of the sites in Dumfries and Galloway have inferior sea views in comparison to their surroundings. This raises the question as to why locations in higher sea affordance zones were not chosen instead for the construction of these particular long cairns. Were the greater sea views offered there intentionally avoided? As discussed in Chapter 2, one strain of thought is that, although it may have been desirable to construct monuments in locations from where the sea was visible, in order to achieve a particular visual effect, there was a preference for a narrow or restricted view of the sea as opposed to panoramic or expansive sea views (Cummings and Whittle 2004, p. 33). Moreover, there is also the possibility is that prehistoric builders were not concerned with sea views or with referencing the sea in any significant way. However, some important factors should not be overlooked. As discussed in the previous section, if higher sea affordance zones were rare in a given landscape, then there may have been a corresponding difficulty in finding such locations to use for site placement. Another factor is that forest cover may once have obscured ideal locations so that prehistoric people were unaware of them. Moreover, it may be plausible to suppose that, due to the effect of atmospheric conditions on visibility, sea views from otherwise ideal locations may not have always been as clear. Thus, prehistoric people traversing the landscape may not always have been aware of the sea views offered at a given location, even in situations where they were familiar with the landscape. These factors may, therefore, explain why some alternative locations with higher sea affordance were overlooked, such as the choice of the Lochhill site over the high sea affordance location in close proximity (Lochhill Location A), shown in Figure 5.6 below.

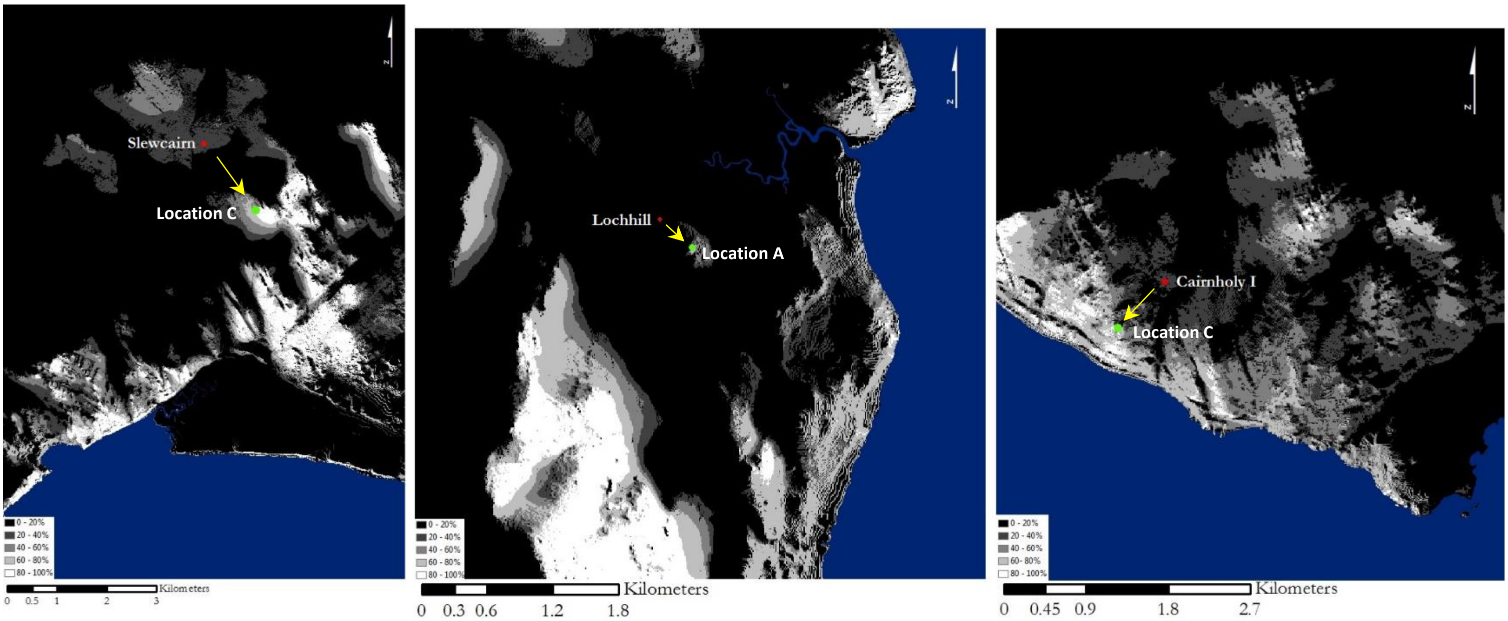


Figure 5.8: Yellow arrows indicate the high sea affordance zones near Slewcairn, Lochhill and Cairnholy I.

Elevation is a further factor that may explain the monuments' location choices over alternative locations that offer superior sea views (as seen in Table 5.2). A comparison of the elevations of site locations with those of the alternative locations listed above reveals that some alternative locations are found on higher ground: the elevation of Mid Gleniron II Location B is

58m above that of Mid Gleniron II; the elevation of Drannandow Location C is 22m above that of Drannandow; and, the elevation of Slewcairn Location C is 38m above that of Slewcairn (see Figure 5.7, below). Hence, those alternative locations may not have been easily accessible. Sharp rises in incline may have acted as a significant deterrent, especially in light of the hardship associated with transporting uphill the megalithic stones and large quantities of building material that were used in monument construction. The higher elevations of these alternative locations may, then, have been a determining factor in avoiding these places for construction. However, for Cairnholy I, Cairnholy II, and Boreland, the elevation of alternative locations (with higher sea affordances) are comparable to if not lower than the site locations. Elevation does not, therefore, account for location choice in these instances.

Site Name	Site elevation (m)	Nearby high sea affordance locations	Elevation at alternative location (m)	Distance from site (m)	Directionality of location	Sea Affordance (%)
Cairnholy I	121	Location A	114	346	SW	41.8
	121	Location B	104	500	SSW	56
	121	Location C	106	726	SW	81.2
Cairnholy II	136	Location A	134	459	WSW	41.8
	136	Location B	115	495	W	41
	136	Location C	103	877	SW	83
High Gillespie	24	Location A	25	850	S	82
Boreland	152	Location A	139	120	SW	86
	152	Location B	144	72	SW	83
Mid Gleniron I	85	Location A	95	1100	W	27
Mid Gleniron II	86	Location A	103	647	S	26
	86	Location B	144	656	SE	71
Drannandow	200	Location A	213	190	ENE	26.2
	200	Location B	216	156	N	64.4
	200	Location C	222	236	NE	80
Slewcairn	207	Location A	277	459	NE	40
	207	Location B	267	919	N	41
	207	Location C	245	1600	SE	90
Lochhill	47	Location A	68	406	SE	62.5

Table 5.5: Comparison of sea affordance values between site locations and locations in their immediate surroundings.

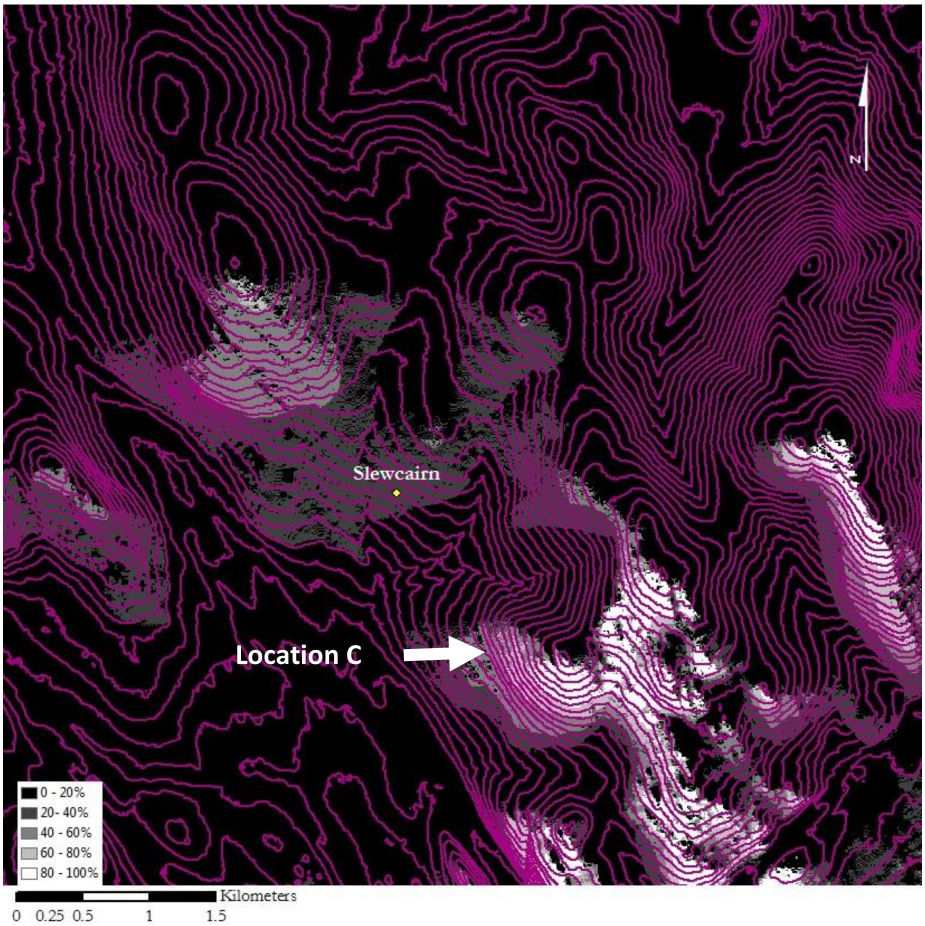


Figure 5.9: 15m contour lines show the sharp incline at Slewcairn Location C

Analysis of Site Locations and Alternative Locations using Horizon Panoramas

The sea views available at site locations and the alternative locations described above were investigated further using Horizon panoramas to determine whether and how they differ from each other in each instance. As can be seen in Figure 5.8, of the locations considered, the most significant differences between site locations and their counterpart alternatives occur at Slewcairn, Lochhill and Cairnholy I. At Slewcairn, the sea affordance is 25.71%. There, the sea appears as a very narrow sliver across the horizon, spanning 41° (from approximately 159º to 200º). Yet, 1.6km away, the sea affordance around Slewcairn Location C falls in the range of 80–100%, while sea views from there expand further across the horizon, spanning 95º (from approximately 135º to 230º, see Figure 5.8) and are more substantial and more prominent to an observer than from the site location. The result was similar for Lochhill, which is built in an area with 0% sea affordance: at Lochhill Location A (406m away in a SE direction), the sea affordance jumps to 62.5% (see Figure 5.8). Although sea views there appear only as a sliver of water on the horizon, they are noticeable and expand across the horizon for 105.5º (from approximately 51º to 156.5º). This is considerable given that there is a 0% sea affordance value at the monument location. This trend of greater sea views at alternative locations continues: at Cairnholy I sea affordance is 25.29% and sea views span 75º (from approximately 155º to 230º), yet, at Cairnholy I Location C (726m away in a SW direction) the sea affordance is 81.2%, and sea views span 173.5º, from approximately 122.5º to 296º (see Figure 5.8). The higher sea affordance value for Cairnholy I Location C, therefore, translates to a profound effect in the observer's visual field. In all three cases, the sea views offered at the alternative locations, thus, expand much further across the horizon and appear to be more prominent when compared with the sea views from the locations where sites were ultimately placed—which appear to be narrower, fainter or, in the case of Lochhill, non–existent.

Horizon panoramas were also essential for comparing sea views from the sites of Drannandow and Mid Gleniron I with their counterpart alternatives. Drannandow had a sea affordance value of 0%, and the Horizon panorama for its location depicts no sea views. Yet, despite Drannandow Location B having a sea affordance value of 64.4%, the Horizon panorama depicts only a faint sliver of sea to be visible, spanning 13º, from approximately 152º to 165º. With a sea affordance value of 27%, it seemed as though Mid Gleniron I Location A might have greater sea views than those available from Mid Gleniron I, which had a sea affordance value of 3%. However, the Horizon panorama depicts only a sliver of sea to be visible from Mid Gleniron I Location A, spanning 17.5º, from approximately 152.5º to 170.5º. Despite the significant sea affordance values of both of these counterpart locations, Drannandow Location B and Mid Gleniron I Location A, it is clear from the Horizon panoramas that neither offered impressive sea views. Moreover, taking into consideration the impact of vegetation, the views of narrow slivers of sea they offer may have been obscured, and were likely to be unnoticeable at the distance of these locations from the coastline.

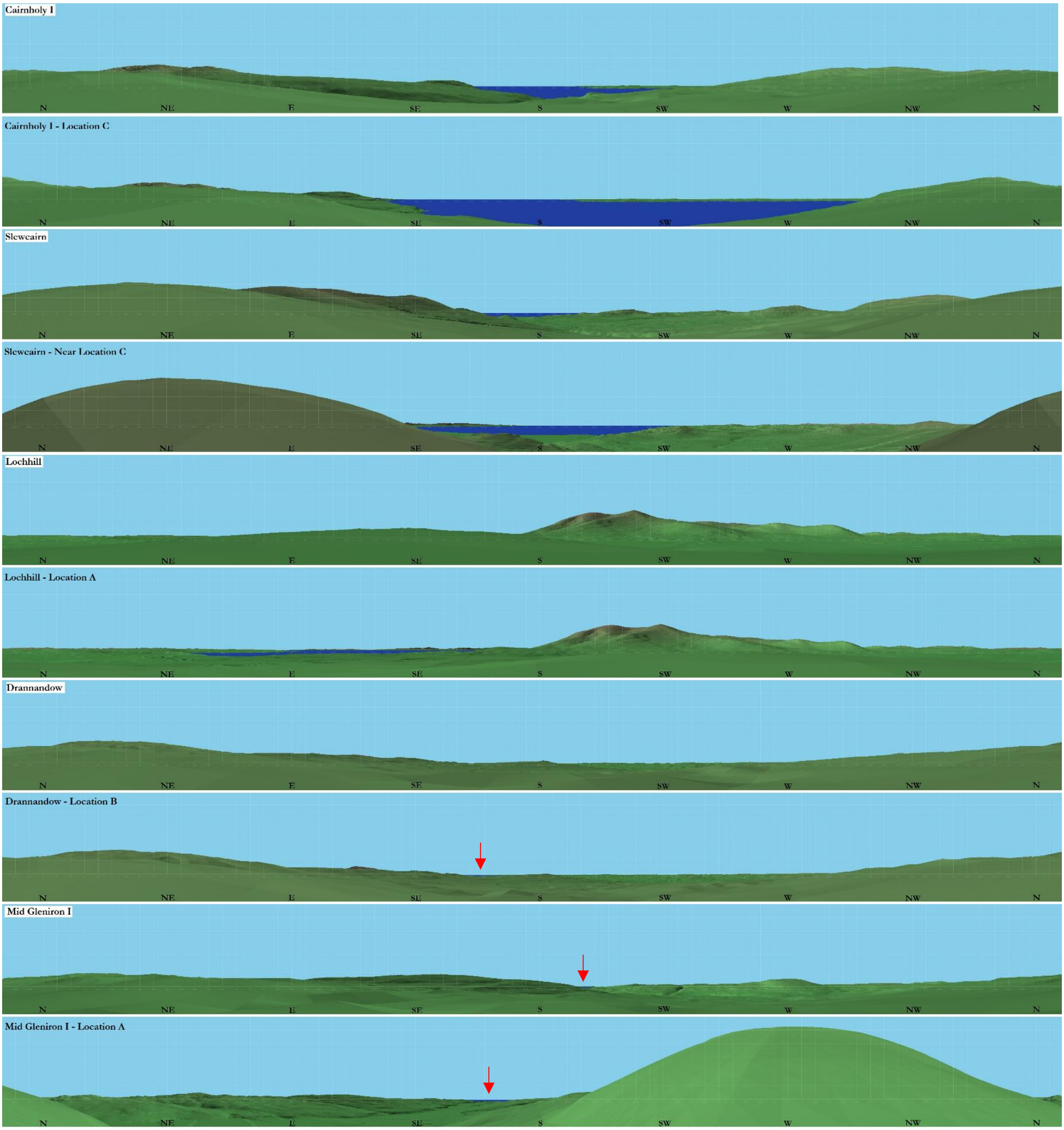


Figure 5.10: Horizon panoramas of Cairnholy I, Slewcairn, Lochhill, Drannandow and Mid Gleniron I, together with alternative locations in high sea affordance zones near these sites, identified in Table 5.2. Red arrows indicate sea views where not obvious.

A comparison of the Horizon panoramas with the panoramic photographs taken during field visits confirms that sea views at Cairnholy I and Cairnholy II are indeed noticeable despite occupying a narrower area in the visual field (see Figure 5.8 above and Figure 5.9 below). However, panoramic photos taken at Mid Gleniron I and Boreland do not indicate the presence of sea views in the distant horizon (Figure 5.10). In the case of Boreland, plantation trees and foliage block any such views. At Mid Gleniron I, sea views that appear in the Horizon panorama seem to be too distant to be seen with the naked eye.

Figure 5.11: Photographic panoramas of Cairnholy I and Cairnholy II, showing narrow views of the sea.

Figure 5.12: Photographic panoramas of Mid Gleniron I and Boreland taken during field surveying. No sea views are apparent in the distant horizon.

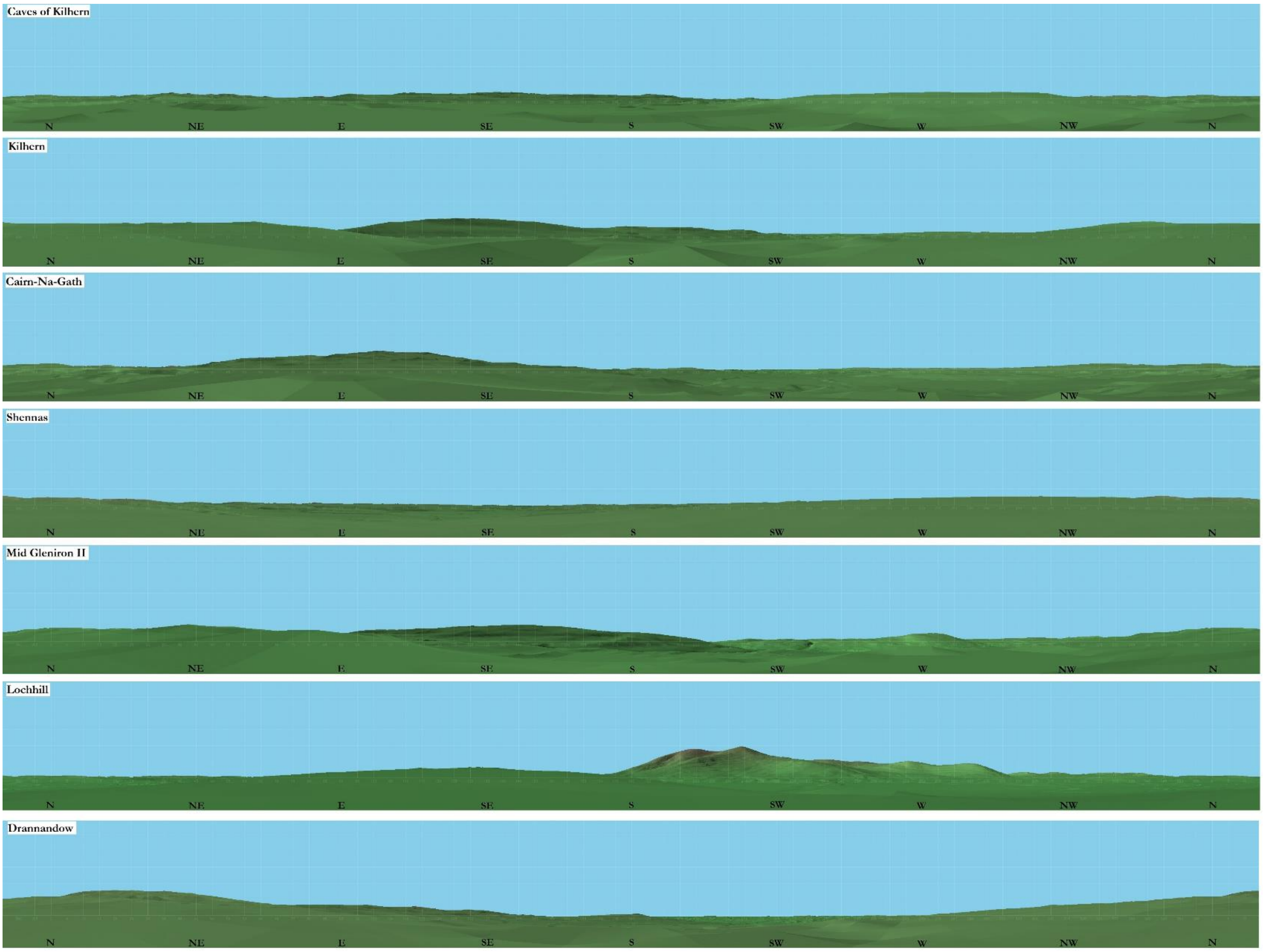


Figure 5.13: Horizon panoramas of Caves of Kilhern, Kilhern, Cairn-Na-Gath, Shennas, Mid Gleniron II, Lochhill and Drannandow.
These panoramas show 0% sea affordance at these site locations.

Considering the Effect of Atmospheric Conditions

The Horizon panoramas discussed above simulated daytime visibility, with perfectly clear atmospheric conditions. However, as Scotland's geography ensures unpredictable and rapid changes in weather, sometimes in a matter of hours, visibility can often be limited by poor weather conditions. Thus, the panoramas above were re-generated to depict what an observer might be able to see under what are, at least in certain times of the day and year, more typical atmospheric conditions, where the horizon is blanketed by a layer of haze or fog. A finding of significance is seen at Mid Gleniron I Location A, where re-generated Horizon panoramas depict visibility as critically impaired by fog (see Figure 5.13). This suggests that neither the site nor the alternative location offer sufficient sea views to have made a difference in terms of location choice.

A comparison of Cairnholy I Location C with Cairnholy I substantiated the finding that the alternative location affords significantly greater sea views. When a layer of haze spreads out across the horizon, the available sea views from Cairnholy I Location C remain prominent, occupying a substantially larger portion of an observer's visual field, and standing out as significantly clearer (see Figure 5.12) than the sea views from Cairnholy I. All things considered, however, the relevance of this observation in aiding to confirm or reject the notion that sea views were an important factor of location choice for this site should not be overstated: Cairnholy I Location C is particularly unique in that only 3% of the area surrounding Cairnholy I in a 1.5km radius shares the same level of sea affordance. It is entirely possible, then, that Cairnholy I Location C was simply unintentionally overlooked for monument placement, as may have been Lochhill Location A, described above. Of course, a further possibility is that, on the assumption that sea views held importance, the sea views available from Cairnholy I sufficed for its builders' purposes.

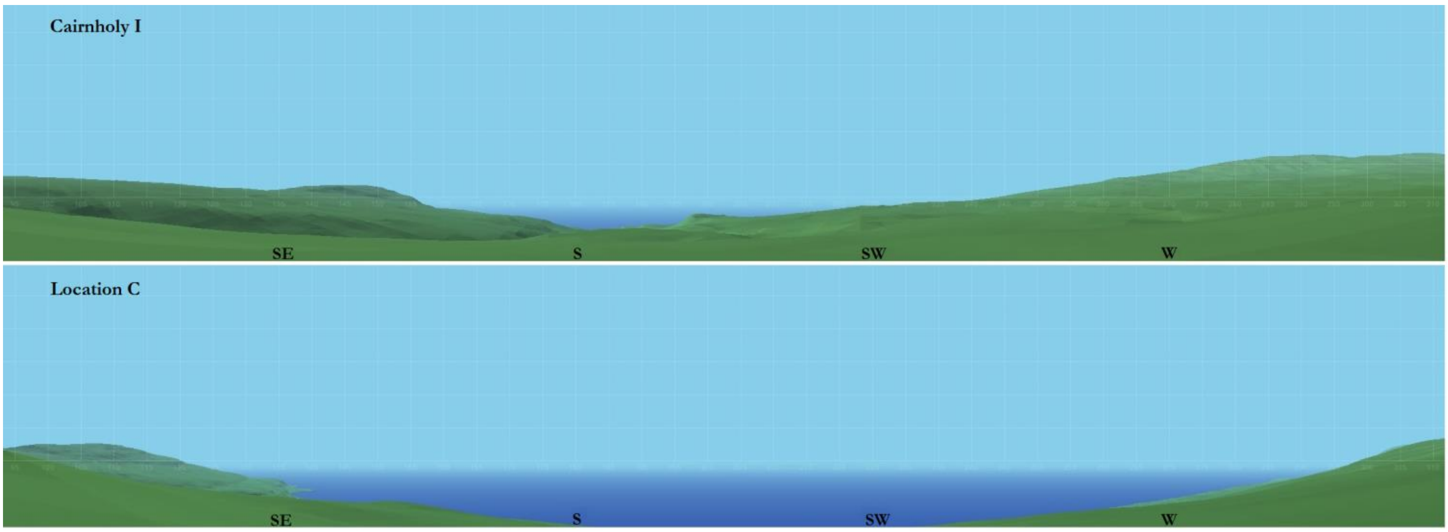


Figure 5.14: The Horizon panoramas of Cairnholy I, and Cairnholy I Location C (Location C) where the sea affordance is 89%.
These panoramas demonstrate how sea views can be impaired by atmospheric conditions (set at 2km visibility).

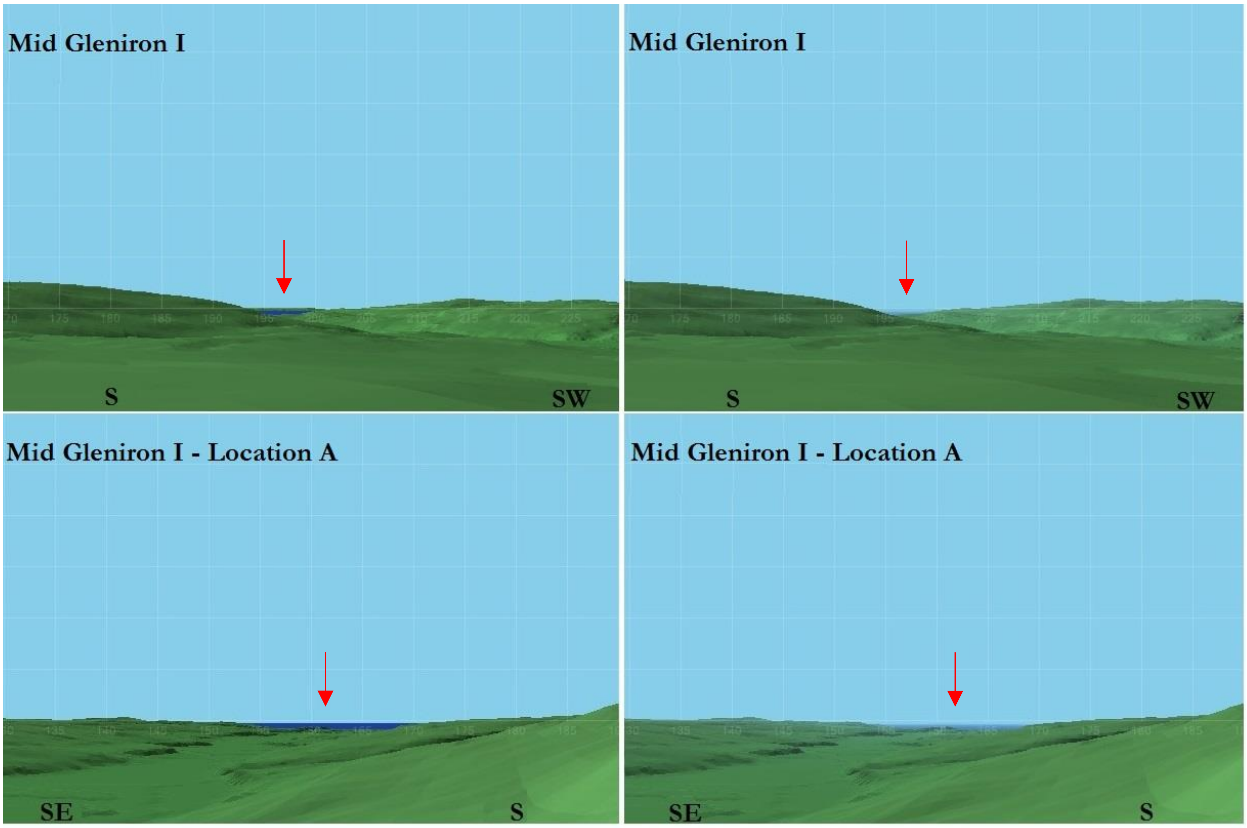


Figure 5.15: (Left) The original Horizon panoramas of Mid Gleniron I and Mid Gleniron I Location A, on a perfectly clear day.
(Right) The re-generated images of these when atmospheric haze (with visibility set at 10km) is taken into consideration. Red arrows indicate sea views, which are obscured in the images on the right.

5.3 Testing for Revelatory Views

As described in the previous chapter, travel corridors within a 1.5km radius of each site were used to identify the pathways that prehistoric people could have taken to approach the monuments in this region. The identified pathways were used in conjunction with sea affordance surfaces to generate vertical profile graphs (sea affordance profiles) that depict the nature of observers' sea views on their approach to monuments. As the purpose of these graphs was to investigate whether the placement of monuments in this region were associated with having a 'revelatory view' of the sea upon approach of the site, only those pathways that could potentially have revelatory views were considered. This condition required that pathways approach a site from inland towards the sea, so that on an observer's arrival the sea would form a backdrop to the site. Of the 13 sites considered here, Lochhill was the only site that did not have a pathway fitting this criterion. A total of 19 paths were identified for the remaining 12 sites.

Sea affordance profiles of the paths approaching these 12 sites indicate that for 5 sites there are no sea views either on the pathways that approach them or at the sites themselves (Figure 5.14). One further site, Drannandow, offers no sea views at the location of the monument although there are sea views available on the pathway that approaches it. The six remaining sites all offer sea views where monuments are located. A total of 12 paths were identified as approaching those 6 sites. Five of those sites offer what might be described as revelatory views (see Figure 5.15). However, the affordance value at one, Mid Geniron I, was very small (3%) in comparison with the other four sites, which are more substantial and more convincing examples of revelatory views. The number of paths approaching each site and the number of paths offering a revelatory view are detailed in Table 5.6.

The Presence of Sea Previews along Pathways

Sea views are depicted at a number of places along the final legs of the approaches of Path 1 to Boreland, Path 2 to Cairnholy I and Path 3 to Cairnholy II, suggesting that prehistoric people had 'previews' of the sea before reaching these sites. On the assumption that the revelatory views at such sites were intended, there is some question as to whether such previews would spoil the effect of any 'dramatic final reveals' or enrich them. However, at the location of the preview to Boreland, 140m from the site, sea affordance reaches 85.29%, 1.7 times greater than the affordance available at the site location. This suggests that the location of the preview may have been a better option for site placement if sea views were an integral part of construction. Moreover, this particular location is shown to be relatively easily accessible as it is placed on an existing pathway to (and is 2m lower than) the actual site unlike some of the alternative site locations considered Section 2), which may have been avoided due to their higher elevation. Therefore, in this particular case, the considerations yet taken into account do not explain why the site location was preferred to the location of the preview.

Site ID	Site Name	Site Elevation (m)	Distance to Nearest Body of Water (m)	Distance to Nearest Coastline (m)	General Direction of paths	Paths offering 'revelatory' views	Sea Affordance %
1	High Gillespie	24	90.38	1108.60	Path 1 (SE); Path 2 (SE)	N/A	13.18
2	Lochhill	47	299.19	664.54	N/A	N/A	0.00
3	Slewcairn	207	469.53	4694.65	Path 1 (S)	Path 1 (S)	25.71
4	Cairnholy I	121	180.56	1108.20	Path 1 (SW); Path 2 (SW); Path 3 (S)	Path 1 (SW); Path 2 (SW)	25.29
5	Cairnholy II	136	225.64	1273.65	Path 1 (SSE); Path 2 (SW); Path 3 (SW)	Path 2 (SW); Path 3 (SW)	16.27
6	Boreland	152	584.04	4583.85	Path 1 (SE)	Path 1 (SE)	49.9495
7	Drannandow	200	880.39	6857.65	Path 1 (SE)	N/A	0.00
8	Cairn–Na–Gath	170	1187.79	11476.20	Path 1 (S)	N/A	0.00
9	Kilhern	135	608.67	7913.18	Path 1 (S)	N/A	0.00
10	Caves of Kilhern	131	390.74	8319.07	Path 1 (SSE); Path 2 (SW)	N/A	0.00
11	Mid Gleniron I	85	612.66	4758.49	Path 1 (S); Path 2 (SW)	Path 2 (SW)	3.04
12	Mid Gleniron II	86	634.00	4718.75	Path 1 (SW)	N/A	0.00
13	Shennas	196	1060.90	6754.82	Path 1 (W)	N/A	0.00

Table 5.6: Results of sea affordance analysis in combination with travel corridors.

Similar observations can be made for the pathways to the sites of High Gillespie and Drannandow. Significant sea views are present on these pathways but are not similarly present at the site locations. The sea affordance profiles for the paths to High Gillespie depict a positive increase in sea affordance in both Paths 1 and 2, from about 700–800m; with Path 1 reaching its maximum peak of 25% at around 700m, and Path 2 reaching its maximum peak of 30% at around 470m. However, from approximately 400m from High Gillespie both pathways to the site exhibit a gradual decrease in sea affordance before finally dropping to 13.2% at the site location (see Figure 5.16). A similar observation can be made from the profile of Path 1 to Drannandow, where there is a dramatic increase in sea affordance from 496–390m, reaching 40%, followed by a sudden decline, with sea affordance dropping to 0% before the path reaches the site. Even though neither site has revelatory views, these findings are of significance as they raise the question of why such alternative locations were not preferred for site placement.

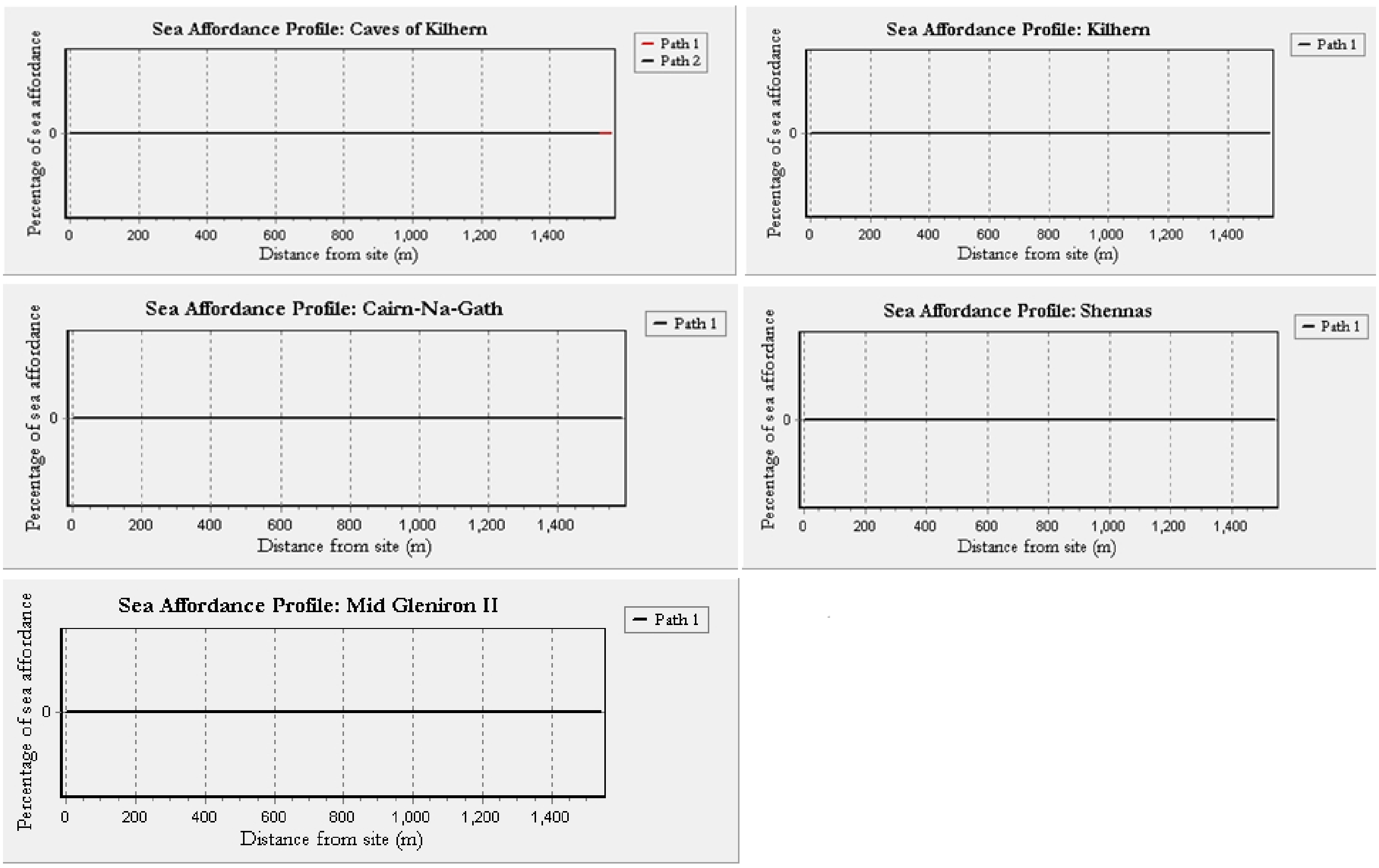


Figure 5.16: Affordance profiles of paths to Caves of Kilhern, Kilhern, Cairn-Na-Gath, Shennas and Mid Gleniron II.

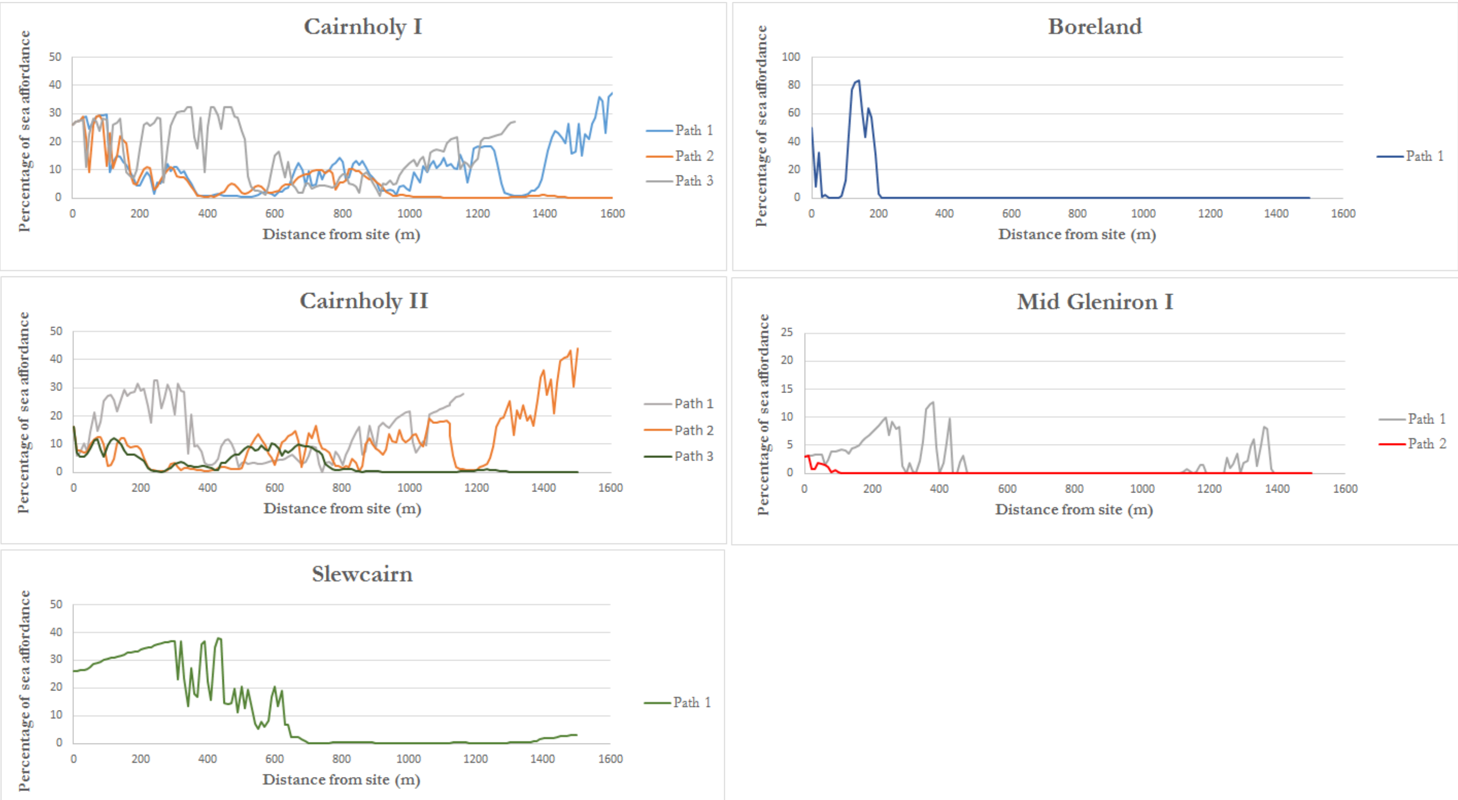


Figure 5.17: Sea affordance profiles of Cairnholy I, Cairnholy II, Slewcairn, Boreland and Mid Gleniron I.

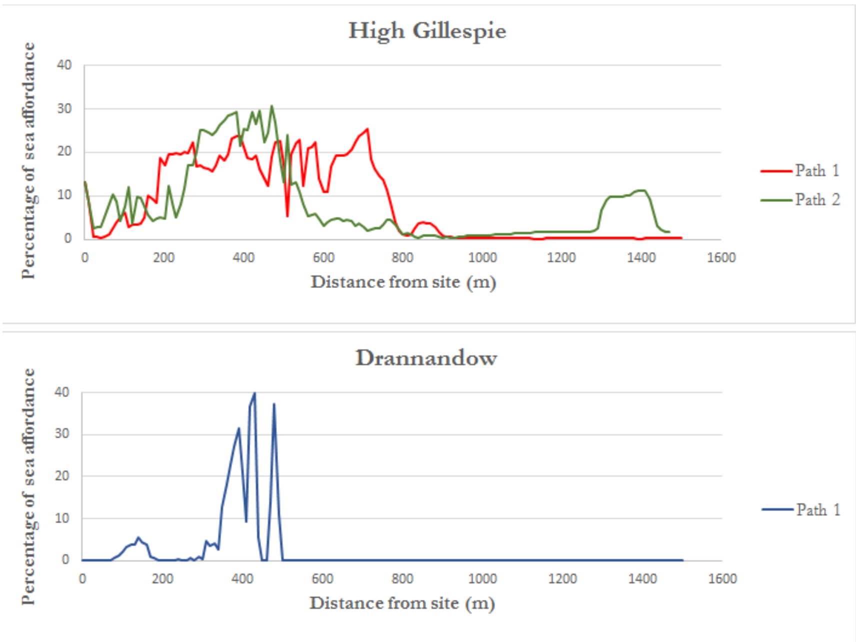


Figure 5.18: Sea affordance profiles of High Gillespie and Drannandow.

Comparison of Site Locations and Preview Locations using Horizon Panoramas

Horizon panoramas were generated for the sea previews present on the pathways to Boreland, Drannandow, Slewcairn and High Gillespie to determine their significance. As mentioned above, the sea affordance value of the preview available at Boreland Location A is almost twice as high as the value observed at Boreland. Yet, perhaps surprisingly, an assessment of Horizon panoramas revealed that despite such a high affordance value, the sea views at both locations are comparable, appearing as tiny slivers, barely noticeable in the distant horizon (see Figure 5.17).[14] Therefore, in terms of their visual properties, neither of these locations stand out as more preferable to the other.

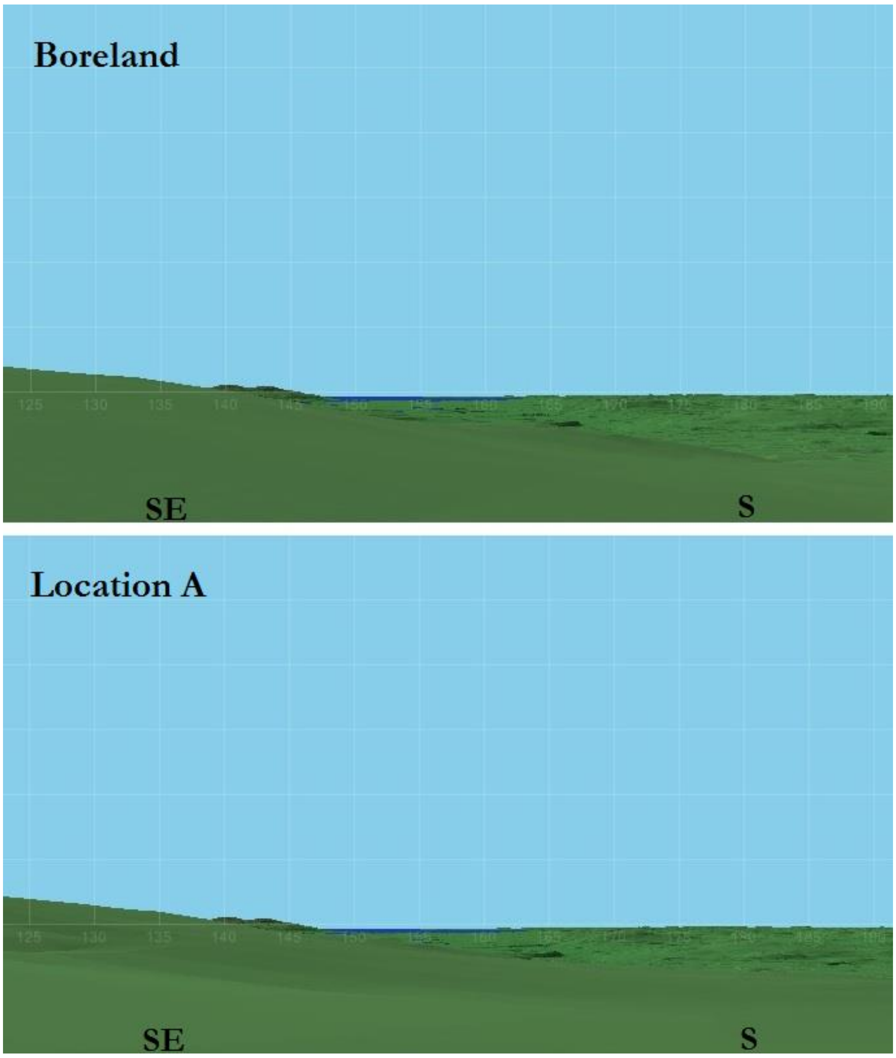


Figure 5.19: Horizon panoramas of Boreland and the sea preview on the path to the site, Boreland Location A. Panoramas demonstrate that sea views at both locations are comparable, despite Location A having almost double the sea affordance than that of Boreland.

[14] This may be attributed to Boreland Location A's distance from the coastline and its decreased elevation of 2m. As mentioned above (Section 6.4) distance and elevation play a critical role in how much sea is captured from a particular location.

At Drannandow Location A, the sea preview location along the pathway to Drannandow, at about 430m from the site, there is a dramatic increase in sea affordance, peaking at 39.8%. Although this is a substantial increase in affordance, it only appears as a thin sliver of sea across the horizon, spanning from approximately 151º to 162º (see Figure 5.18). There may be reason to suppose that such a view holds some significance, given that there is almost 0% sea affordance along the rest of the pathway, including where the site was placed (one exception is a nominal increase of 4.3% at 150m). Therefore, such a sliver of sea might have been sufficient to enhance the experience of this location. If true, Drannandow Location A may have been the optimal location to place this long cairn, and placing the monument there may have provided a subtle revelatory view for people approaching the site (Figure 5.18).

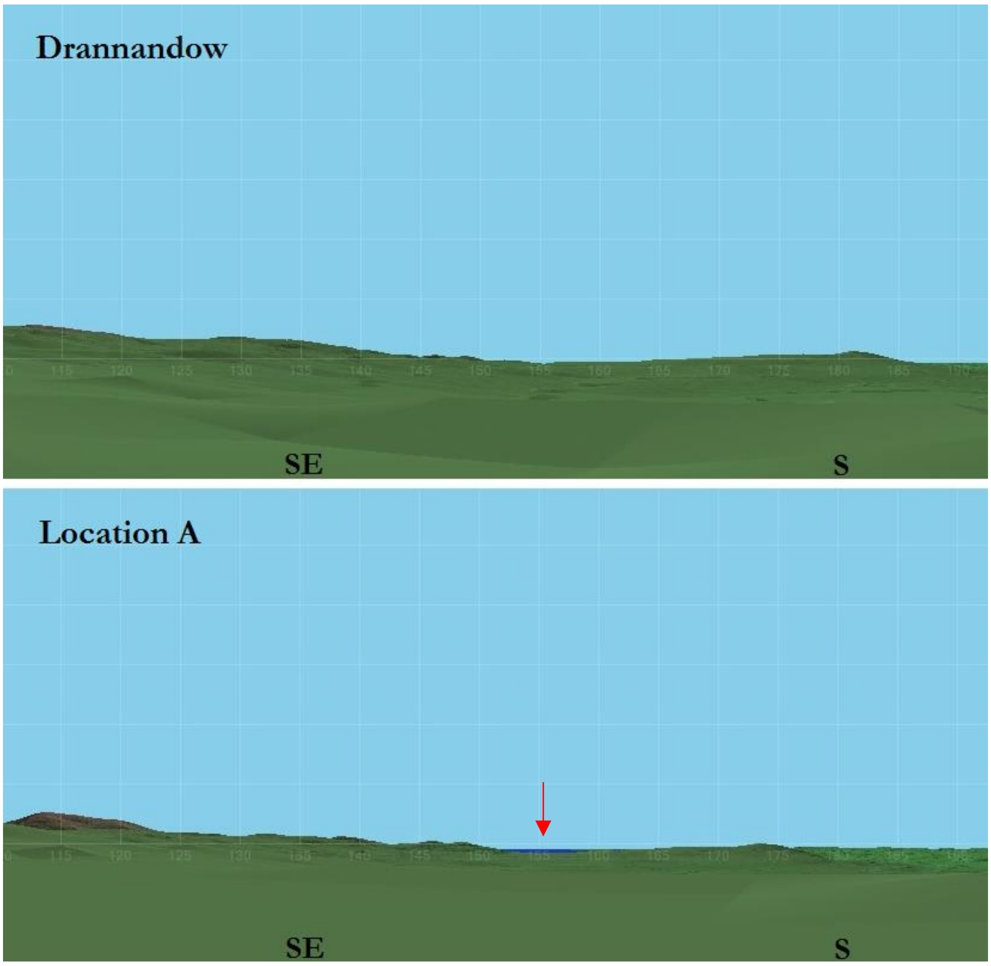


Figure 5.20: Horizon panoramas of Drannandow and Drannandow–Location A (Location A), along the pathway, with 0% and 39.8% sea affordance, respectively.
The red arrow indicates the sea view from Drannandow–Location A.

On the path to Slewcairn, there is a slight and gradual decrease in sea affordance from 37% to 26%, starting at around 300m from the site. The peak in sea affordance along Path 1 (seen in Figure 5.15, above) is observed at Slewcairn Location A. Assuming the importance of sea views, this would seem to suggest that Slewcairn Location A is the ideal position for the monument. However, Horizon panoramas reveal that sea views are comparable between the two locations (as seen in Figure 5.19). Considering this in conjunction with the fact that Slewcairn Location A is situated at some 60m above Slewcairn, it seems that the current placement may indeed be the better position. Horizon panoramas reveal another noticeable difference between these locations. The part of the sea indicated by the red arrows (in Figure 5.19) is much more visible from Location A. However, taking into account the impact of vegetation and atmospheric conditions, it is highly unlikely that this part of sea may have been visible to an observer so far away from the coastline.

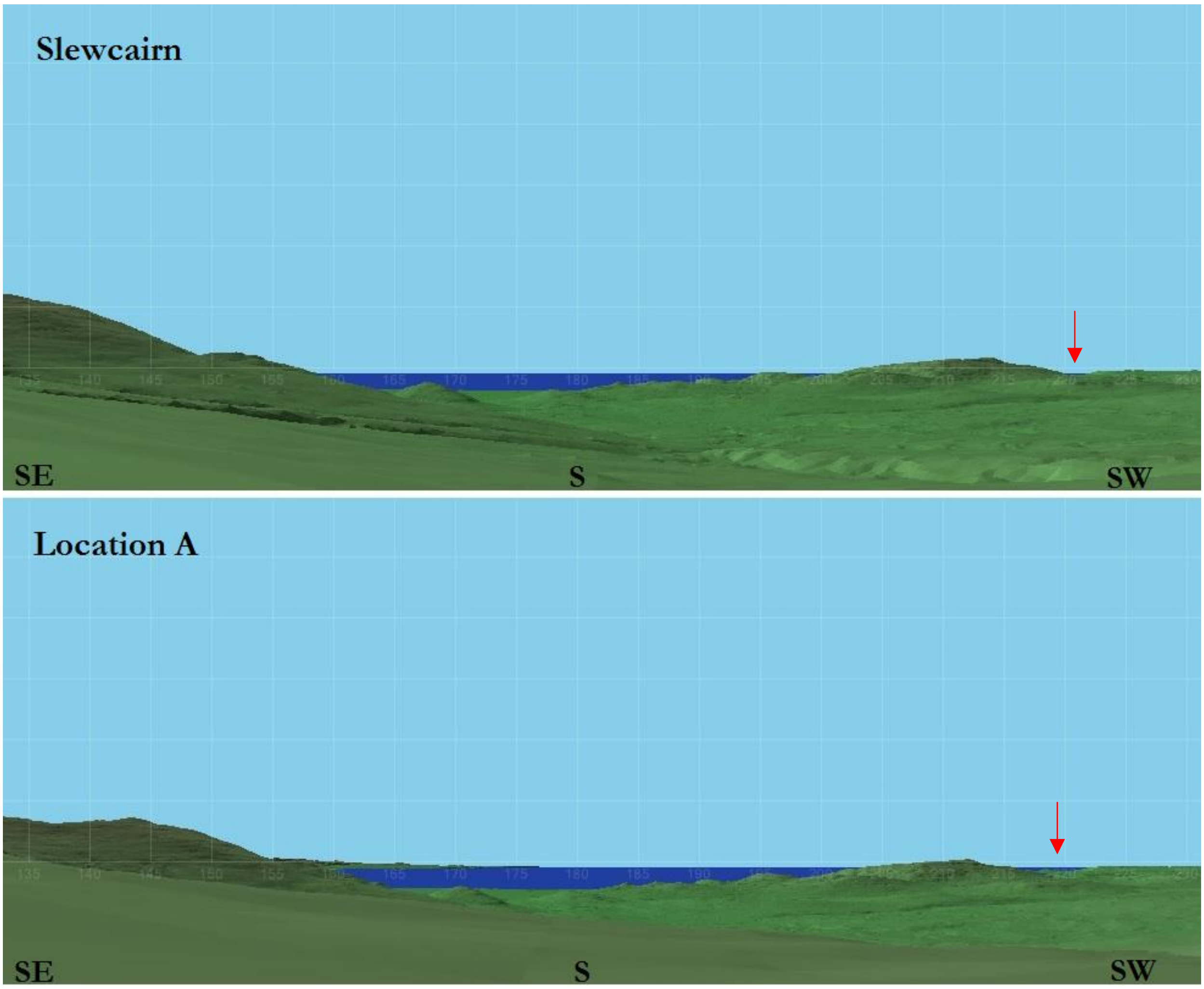


Figure 5.21: Horizon panoramas of Slewcairn and Slewcairn Location A, along the pathway.

High Gillespie presents an interesting case. At around 400m from the site on Path 2 to the cairn site, High Gillespie Location A not only offers more expansive sea views across the horizon from approximately 154.5º to 202.5º, but, to an observer, these sea views are significantly more prominent in the visual field than the views available from the cairn site (see Figure 5.20). Therefore, if megalithic builders were to have placed the monument at High Gillespie Location A, they could have relatively easily achieved a dramatic final reveal (see the sea affordance profile in Figure 5.16). As High Gillespie is in a low sea affordance zone (13.18%), despite the availability of places such as High Gillespie Location A, this finding places some doubt that having a revelatory view was an important factor for prehistoric builders in this particular instance.

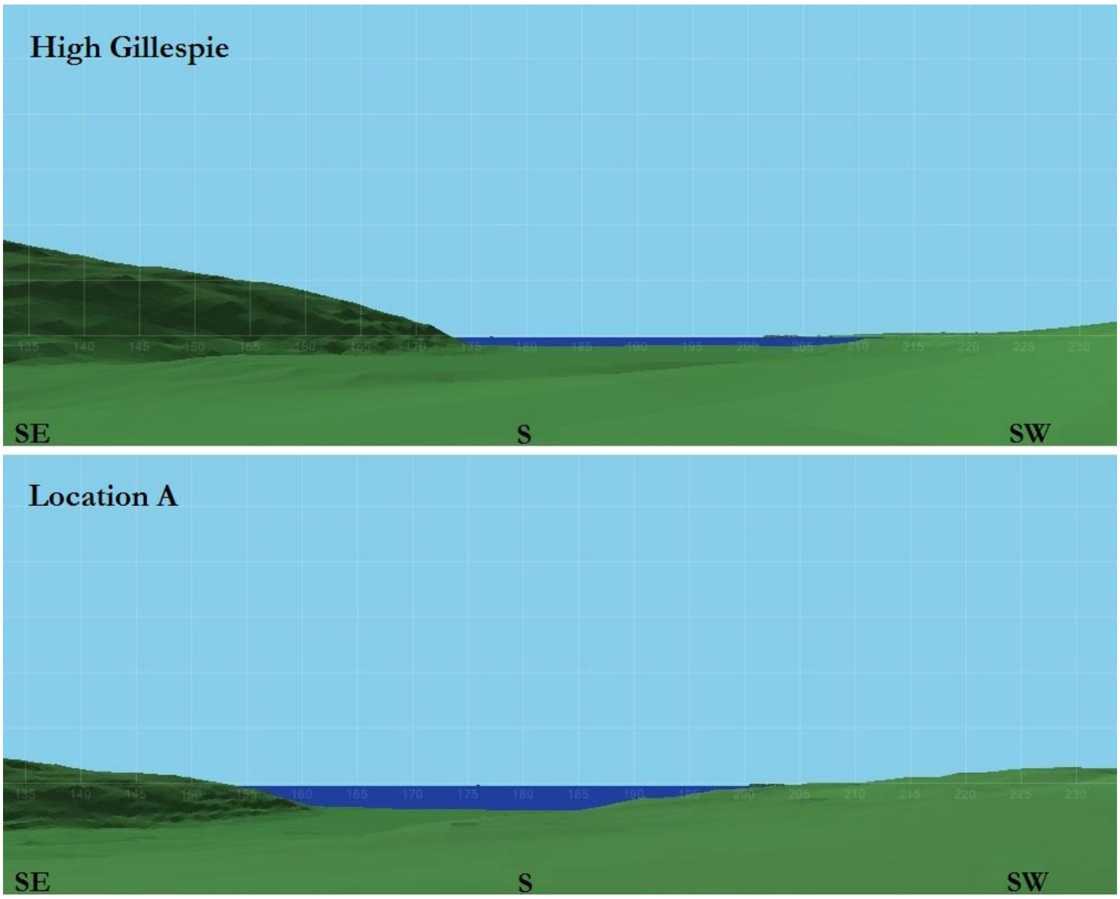


Figure 5.22: Horizon panoramas of High Gillespie and High Gillespie–Location A (along the pathway), with sea views expanding from 173º to 213º and 154.5º to 202.5º, respectively.

The four sites discussed above are instructive in that they present different outcomes of the Horizon panorama analysis and, accordingly, demonstrate that sea affordance values alone are an insufficient basis from which to draw conclusions: sea affordance values must first be interrogated before their significance can be ascertained. Nevertheless, collectively, these cases present little evidence to support the claim that prehistoric builders chose specific topographical locations that offered sea views for the construction of these monuments.

Considering the Effect of Atmospheric Conditions

As in Section 2, visibility from site locations and alternative locations (along pathways) were compared under what are more typical atmospheric conditions for Scotland. In the case of High Gillespie Location A, a comparison with High Gillespie further substantiated the finding that it offers greater sea views (see Figure 5.21). However, the same cannot be said about the comparison made between the views available at Slewcairn and Slewcairn Location A, which exhibited no significant differences when atmospheric conditions are considered (Figure 5.22). What was perhaps the only noticeable difference between visibilities at these locations is that, under clear atmospheric conditions, the narrow strip of sea in the SW direction appeared to be much more visible from Slewcairn Location A than from the site.[15] It became apparent that the narrow strip of sea detected in the SW is entirely invisible from both locations under more typical atmospheric conditions. This suggests that either of these locations would have been equally suitable for monument construction as their sea views are often indistinguishable from one another, despite differing affordance values.

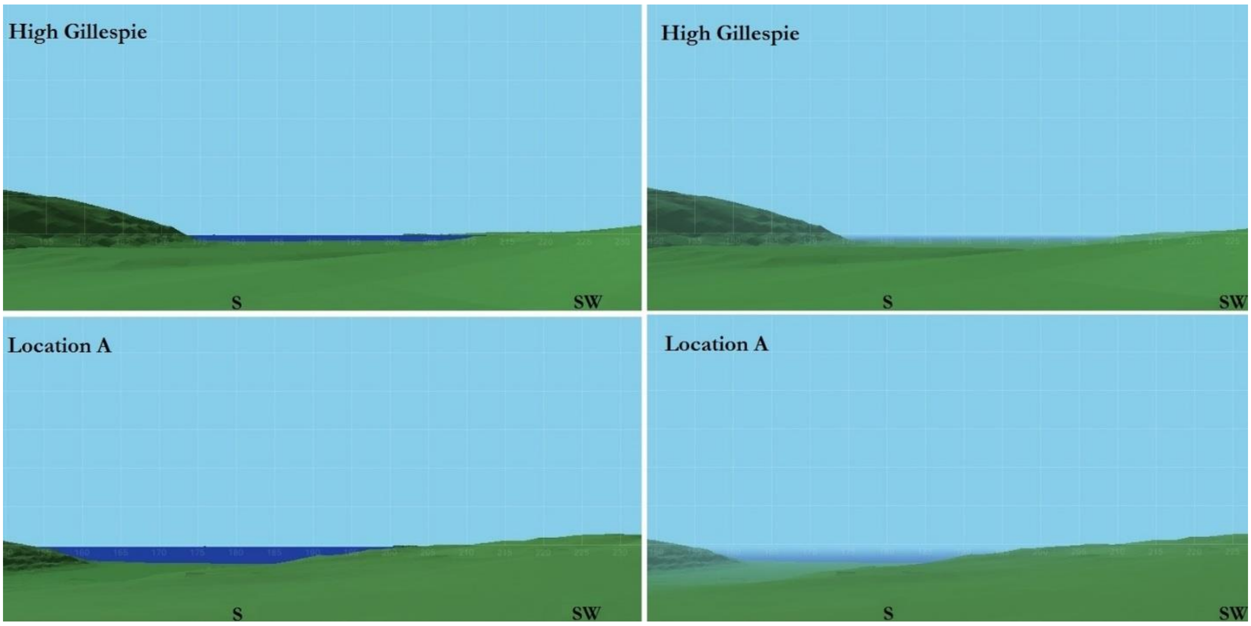


Figure 5.23: The Horizon panoramas with and without atmospheric conditions of High Gillespie and High Gillespie Location A.

[15] The examination of the sea affordance profile at the site of Slewcairn revealed a dramatic revelatory view along the path at Location A (NX 92474 61842) around 300m, which slightly decreased as the site was approached—a drop of approximately 10% in sea affordance.

(Right) The re-generated Horizon panoramas of these two locations when atmospheric haze (set at 2km visibility) is taken into consideration. At Location A, sea views are still visible, even with a layer of fog, while at the location of the site, these views are greatly obscured.

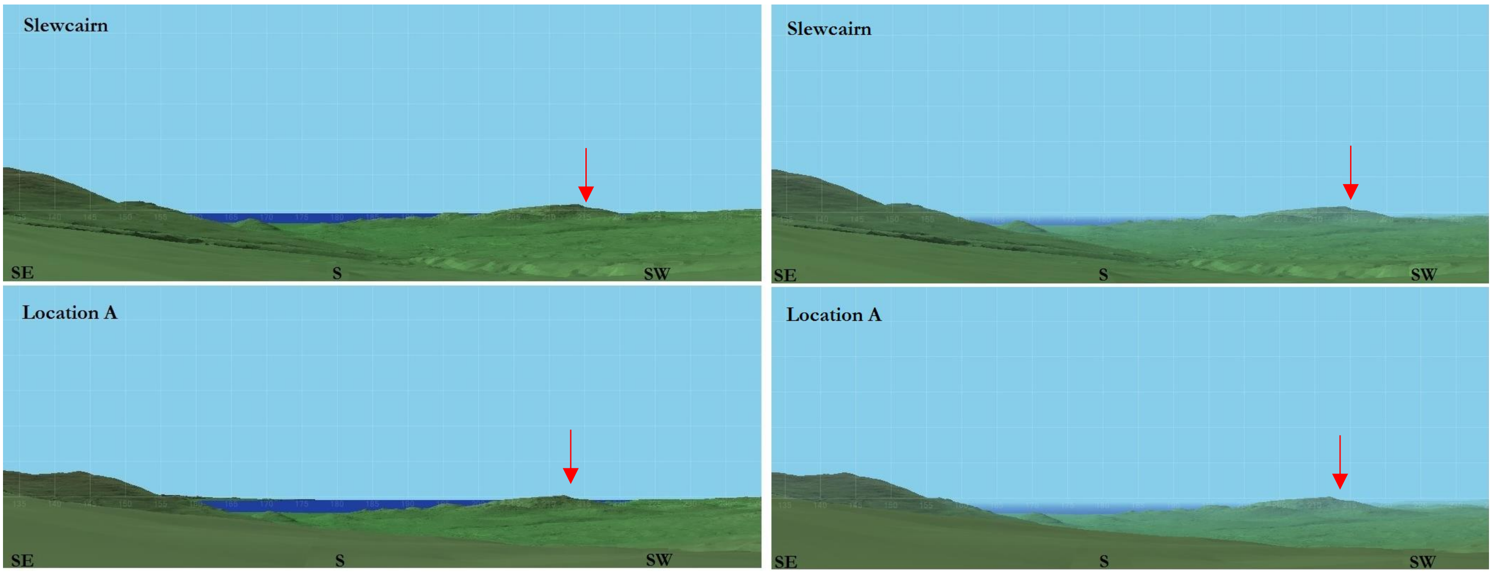


Figure 5.24: The Horizon panoramas with and without atmospheric conditions of Slewcairn, and Slewcairn Location A, along the pathway—where the sea affordance is 37% (NX 92474 61842).
The panoramas in the two on the right take into consideration atmospheric clarity (set at 10km). Red arrows indicate sea views, which are hidden in the two on the right.

The sea affordance profile of Boreland showed that the revelatory 'preview' observed at Boreland Location A (on the path approximately 140m from the site) was substantially greater in terms of sea affordance value (83.4%) than what is seen at the site itself (49.9%). Horizon panoramas revealed that despite the higher sea affordance at Location A, sea views in the visual field of an observer at these locations were comparable to each another. Re-generated panoramas with more typical atmospheric conditions reveal that even scant levels of fog obscure the distant horizon (i.e. with visibility set at 10km), making it extremely difficult to detect the sea from either location (see Figure 5.23). Therefore, when this very mild level of atmospheric deterioration is taken into consideration, neither of these locations could be considered as suitable options for cairn placement if sea views were an important criterion for location choice. This example does not, then, lend credibility to the notion that sea views were an important criterion for prehistoric builders. A similar observation can be made from the panoramas generated for Drannandow Location A. Sea views from that location are critically impaired by fog, as seen in Figure 5.24. Moreover, as the effects of cover from vegetation on visibility may be similar to or worse than that of atmospheric deterioration, it is questionable whether such views were visible at all in prehistoric times, even on a perfectly clear day.

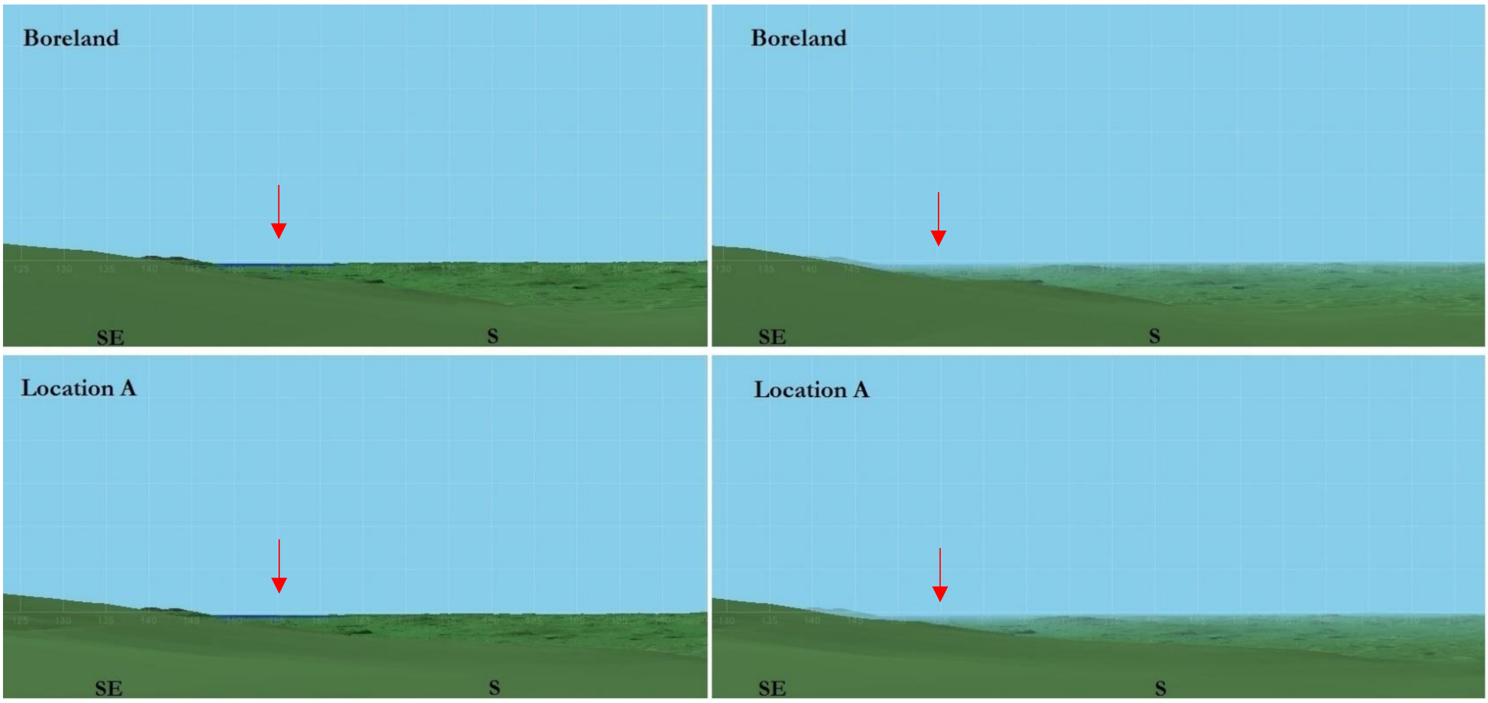


Figure 5.25: The Horizon panoramas with and without atmospheric conditions of Boreland, and Boreland Location A, along the pathway, where the sea affordance is almost twice as high as the cairn site (NX 40478 69101). Panoramas on the right demonstrate how sea views are barely visible from either of these locations when atmospheric clarity is taken into consideration (with visibility set at 10km). Red arrows indicate sea views, which are hidden in the images on the right.

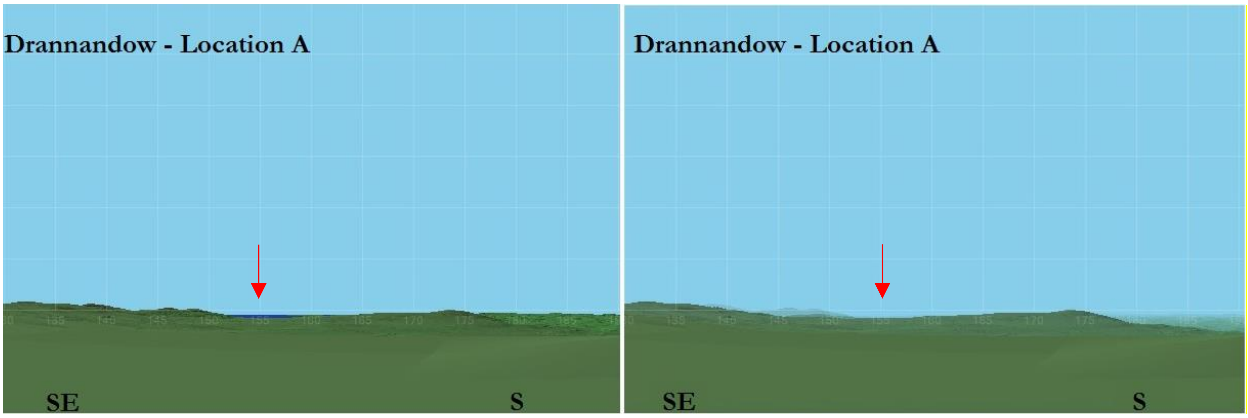


Figure 5.26: Horizon panorama of Drannandow with and without atmospheric conditions.
(Left) The original Horizon panorama of Drannandow Location A, on a perfectly clear day. (Right) The re-generated image when atmospheric haze (with visibility set at 10km) is taken into consideration. Red arrows indicate the sea view, which is obscured in the image on the right.

For the majority of locations discussed in this chapter, findings suggest that even though sea views may be present to some extent due to poor weather conditions they may not be visible to an observer. The re-generated Horizon panoramas discussed here, therefore, offer no support for and potentially question the claim that prehistoric builders considered sea views when choosing where to place these monuments.

Some considerations are worth noting here. The impact of vegetation and the seasons during which these monuments were likely to be used are two more factors which are potentially detrimental to visibility. The prospects for visibility can be dramatically hindered by forest cover, but this may not have always been the case. Deciduous trees lose their leaves in autumn, making it easier to see through the forests in winter (Cummings and Whittle 2003). However, atmospheric conditions tend to worsen during the winter months, blanketing the horizon with fog or haze. Conversely, while clear skies can be expected more often during the summer months, this is when visibility is most diminished by foliage. Therefore, both atmospheric conditions and vegetation can and do severely affect the visibility of sea views in the distant horizon, presenting a cumulative problem for sea affordance throughout the year. As seen with the examples discussed in this section, this is especially a problem for locations that have either narrow or expansive sea views that appear as tiny slivers on the horizon.

As discussed in Chapter 2, Section 1, phenomenologists and landscape archaeologists assert that sea views were significant and that specific topographical locations that afford such views were deliberately chosen for the placement of sites (Fowler and Cummings 2003; Scarre 2002). Yet, the findings above do not affirm this notion. They raise questions regarding megalithic builders' intentionality, and seem to suggest that the incorporation of sea views may have been fortuitous, at least in many instances. For example, if megalithic builders were concerned about sea views and had a familiarity with the landscape, it would be expected that they would have chosen topographical locations that afforded sea views that are not so easily affected by the impact of climatic conditions and vegetation. Thus, if incorporating sea views were an integral part of their core belief systems, they may have favoured locations with better prospects for the placement of these megalithic constructs, such as Cairnholy I Location C shown in Figure 5.12. Of course, one possibility is that the locations they did choose were preferred for reasons of practicality. Other, perhaps, more important considerations that might have factored into location choice include: access to building materials, shelter from wind, elevation, and proximity to settlements and bodies of water. This is not to mention other qualities or properties of the landscape which may have been significant to prehistoric builders, but about which theorists are as yet unaware.

5.4 Alignments of Long Cairn Axes, Sea Views and Pathways

Orientation of Cairns Relative to Sea Views

Alignments between cairn long axes and sea views were found at five of six sites in this region from which the sea is visible, including the two cases where the sea views are extremely subtle and, as discussed above, potentially unnoticeable—Boreland and Mid Gleniron I. Long cairn axis were aligned to point in the direction of sea views, forming axis-alignments, at the four sites of Slewcairn, Cairnholy II, Boreland, and Mid Gleniron I. These alignments were direct at Slewcairn and Cairnholy II, with the monuments' long axes pointing inside the range of sea views. The indirect alignment of Mid Glenrion I's long axis with the sea, which is barely visible from that location, was only slightly askew, by 5º. A direct side-alignment is seen at Cairnholy I (see Table 5.7).

Orientation of Pathways Relative to Sea Views and Monuments

Twelve pathways were identified as potential means of accessing from a seaward direction the six cairns sites in this region that offer sea views. Nine of those pathways, which access five of those cairn sites, form a direct line of sight with the available sea views. The outliers in this regard were: Path 1 to Mid Gleniron I which forms a general but not a direct alignment with the sea; and, Paths 1 and 2 to High Gillespie which are slightly too far askew to be considered as general alignment under the specified criterion (see Chapter 4, Section 6).

While some long cairns in Scotland have façades and forecourts at both their proximal and distal ends, in Dumfries and Galloway these architectural features seem to appear only at one end. Hence, in this region there was a greater interest in identifying whether paths did in fact approach sites' façades and forecourts. The results of this study are summarized in Table 5.7, which shows that the majority of sites were either approached from paths that terminated at their the distal ends (as seen in the cases of Cairnholy II, Boreland, Cairn-Na-Gath, Mid Gleniron I and Mid Gleniron II), or at the sides of the monuments (as seen in the cases of High Gillespie, Lochhill, Cairnholy I and Drannandow). Only two sites had paths that approached their proximal ends (Slewcairn and Caves of Kilhern).

Site name	Direction of seaward pathways	Direction of sea views	Orientation of monument long axis	Part of monument approached by pathway(s)
High Gillespie	Path 1 (SE) Path 2 (SE)	S–SSW (173–213º)	ENE–WSW (76–256º)	side
Lochhill	N/A	N/A	NE–SW (50–230º)	side
Slewcairn	Path 1 (S)	SSE–SSW (159–200º)	N–S (0–180º)	proximal end
Cairnholy I	Path 1 (SW) Path 2 (SW) Path 3 (S)	SSE–SW (155–230º)	E–W (87–267º)	side
Cairnholy II	Path 1 (SSE) Path 2 (SW) Path 3 (SW)	SSE–SW (160–235º)	NE–SW (37–217º)	distal end
Boreland	Path 1 (SE)	SE–SSE (146–163º)	SE–NW (131–311º)	distal end
Drannandow	Path 1 (SE)	N/A	ENE–WSW (71–251º)	side
Cairn–Na–Gath	Path 1 (S)	N/A	N–S (8–188º)	distal end
Kilhern	Path 1 (S)	N/A	N/A	N/A
Caves of Kilhern	Path 1 (SSE) Path 2 (SW)	N/A	NE–SW (49–229º)	proximal end
Mid Gleniron I	Path 1 (S) Path 2 (SW)	SSW (194–200º)	N–S (9–189º)	distal end
Mid Gleniron II	Path 1 (SW)	N/A	NNE–SSW (31–211º)	distal end
Shennas	Path 1 (W)	N/A	N/A	N/A

Table 5.7: Long cairn, pathway and sea view orientations.

In five out of six sites with sea views, the pathways, monuments and sea views aligned such that sightlines could be identified. A proximal–distal sightline was found on the pathway to Slewcairn. Distal–proximal sightlines were identified on Paths 1 and 2 to Cairnholy II, and on all paths to Boreland and Mid Gleniron I (see Figures 5.25, 5.26 and 5.27). A sideway sightline was found on Path 1 to Cairnholy I, which was confirmed to terminate at the side of the cairn body as oppose to either of its proximal or distal ends.

Of these sites with sightlines, Cairnholy I, Cairnholy II, Slewcairn and Boreland were also the only four sites in Dumfries and Galloway indicated by the sea affordance profiles as having revelatory views. These cairns' sightlines would, then, seem to suggest that they reference the sea in a particularly meaningful way. However, it should be noted that, as discussed in Section 3, neither the site of Boreland nor Mid Gleniron I appear to offer sufficient sea views to be reliably visible and noticeable so that, on investigation, their locations cannot be said to afford a truly *revelatory* view as such. Nevertheless, whether that means that the sites also do not reference the sea is another question; it remains plausible that the orientation of these monuments towards the sea held some significance. Moreover, although the paths that approach these sites on a seaward direction do not terminate with a revelatory view of the sea, the direction of those pathways towards the sea could, similarly, also hold significance.

There is little support here for the notion that façades and forecourts (which are at sites' proximal ends) were placed to receive prehistoric people as they approached sites, as only one of these four sites (Slewcairn) formed the proximal–distal sightline with the sea required to achieve such an effect.[16] Moreover, from the sample considered in this region, three of the sites with sea views (Cairnholy II, Boreland and Mid Gleniron I) had pathways that approached monuments in a direction toward those monuments' distal ends, which hold no forecourts. Thus, at those sites, prehistoric people could not directly approach the monuments toward their façades and forecourts while also experiencing a revelatory view. If such people approached from land towards the sea, as would be necessary to have a revelatory view, they would have had to walk along the monument before reaching the curving façades of standing stones and forecourts, the arenas for ritual and ceremonial activities. Conversely, in the case that prehistoric people approached these three sites in a direction toward monuments' proximal ends, it would suggest that they were travelling from an inland direction, facing away from the sea. Sea views would not form direct visual backdrops to the monuments, and there would be no revelatory views or sea views along the pathways—which might be the case if they travelled via boat as opposed to walking from a settlement that was located further inland. To be sure, these observations do not challenge the claim that the monuments' locations were carefully chosen. Rather, these monuments' alignments of seaward pathways, long axes and sea views, in not coinciding with forecourts, challenges the notion that people's movements were choreographed so as to achieve the particular kind of visual exposure that involved their being received by forecourts upon their arrival. Such a notion presupposes that there were consistent directions from which prehistoric people approached these monuments, and may be misleading, as it is also likely that these monuments attracted people who may have approached from different places and from multiple directions.

[16] Of the sites considered in Dumfries and Galloway, only one other site (Caves of Kilhern) had a pathway approaching the monument towards the proximal end; and there are no sea views available at that site.

Another noteworthy possibility is that, where a site is placed parallel to the sea, a chamber opening on the side of the monument may have been relevant and perhaps used to reference the sea. Five of the sites considered in this region possess side chambers. Hence, chambers may have played a significant role in the way these monuments were used.[17] Therefore, if the sea played an integral part of prehistoric builders' belief systems, it would be expected that side chambers could have been used to reference the sea in this way. In Dumfries and Galloway, two sites with sea views are orientated parallel to the sea: Cairnholy I, which is precisely parallel to the sea; and High Gillespie, which forms a looser alignment that is slightly too far askew to be considered 'generally aligned' under the criterion used in this study (see Chapter 4, Section 6). While there are no visible side chambers at Cairnholy I, at an examination of the site plan for High Gillespie reveals chambers on both sides of the monument. There, the alignment of the side chamber does appear to coincide roughly with the visible sea views.

[17] These sites are Drannandow, Mid Gleniron I, Mid Gleniron II, Caves of Kilhern and High Gillespie.

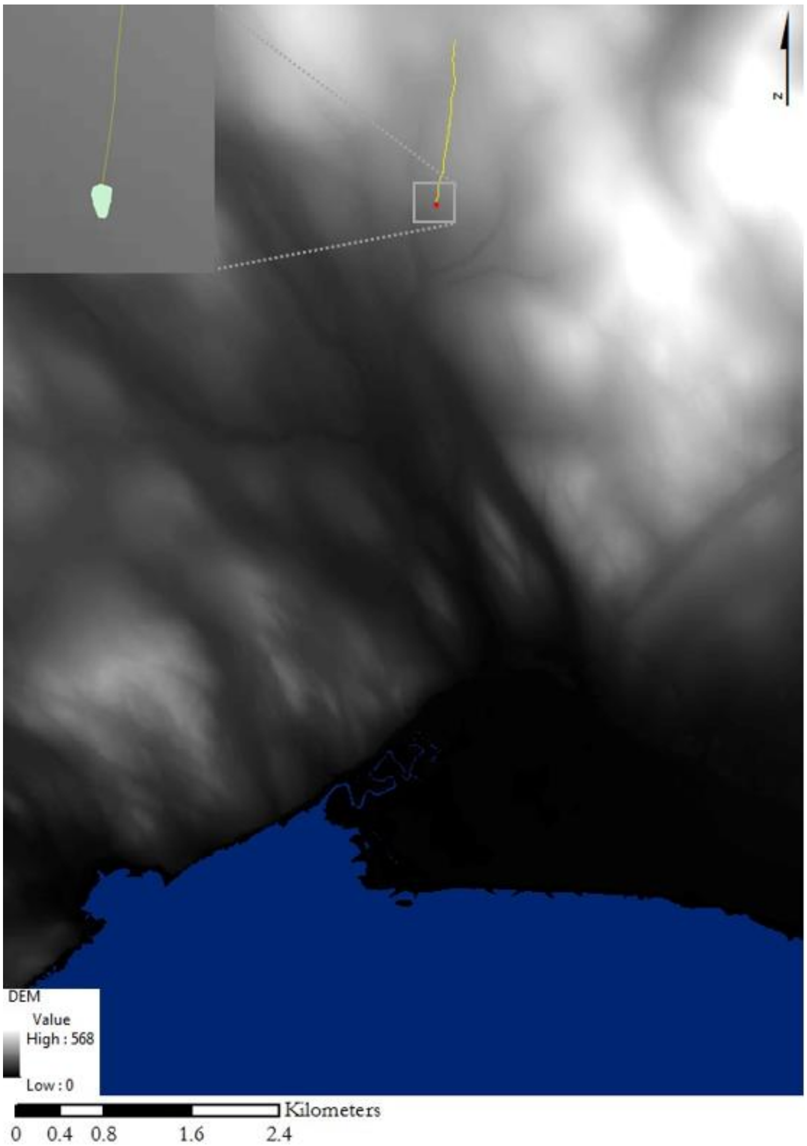


Figure 5.27: Slewcairn. The pathway forms a proximal–distal sightline with the sea.

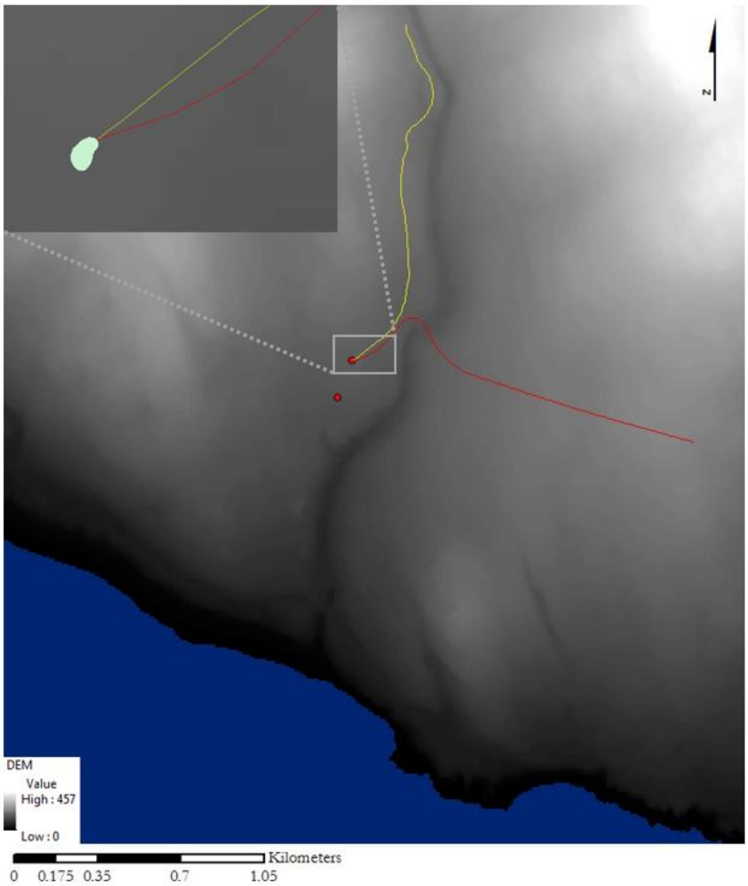


Figure 5.28: Cairnholy II. Pathways appear to form distal–proximal sightlines with the sea.

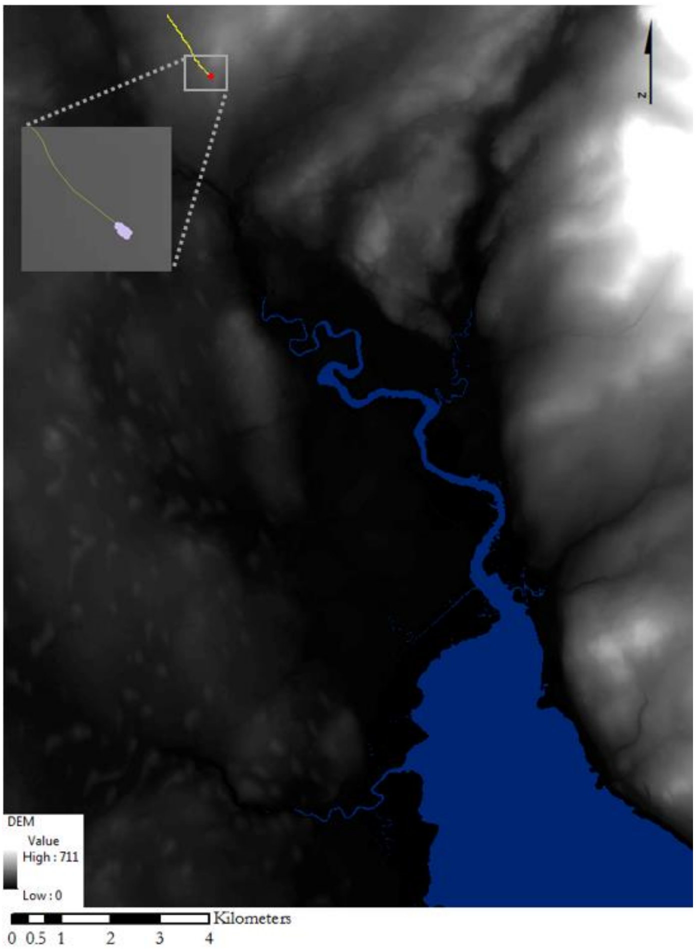


Figure 5.29: Boreland. The pathway forms a distal–proximal sightline with the general direction of the sea, although sea views are insufficient to be reliably noticeable.

5.5 Summary

As discussed in 5.1, the long cairns of Dumfries and Galloway are often placed in proximity to locations that hold sea views that are more prominent or more expansive than the views available from the sites themselves. This seems to imply either of two possibilities: first, there were other factors, independent to sea views, that were of significance and perhaps of overriding importance, which led prehistoric people to select the locations they did for the placement of long cairns in this region; or, second, that sea views were simply not held with a level of importance that motivated prehistoric builders to achieve them at their chosen locations for monument construction. In support of these possibilities, statistical analysis of the 13 sites considered here indicates that these monuments were not placed in unique locations in terms of their sea views; and, thus, that they were not placed to reference the sea. However, further investigation of the landscape contexts surrounding these sites and their sea affordance values indicates that four sites hold revelatory views, which is a particularly interesting and salient way for a monument to reference the sea. Analysis of those site locations using Horizon panoramas under different atmospheric conditions showed that one site, Boreland, offers insufficient sea views to remain visible and noticeable. Boreland was also the only monument of the five in this region holding sightlines that offered only a general and not also a direct alignment between its long axis and the sea. However, the direct alignments of all such monuments' long axes, and the pathways likely used to approach them suggest that the sea is referenced by those monuments. Thus, while analysis of the 13 sites considered in this region, taken together, does not evince wholesale support for the notion that the long cairns of Scotland reference the sea, that notion does see some confirmation in the handful of sites that incorporate alignments and the sightlines those alignments produce, and especially in the sites that also offer revelatory views.

Chapter 6: Analysis of the Long Cairns of Argyll and Bute

The region of Argyll and Bute encompasses the peninsula of Argyll and the Isle of Bute, both situated in the Firth of Clyde, an inlet of the Atlantic Ocean. This is considered here as a key region of interest due both to the number of long cairns within it as well as to their relatively close proximity to the Firth of Clyde and the many Lochs in the area. As with the long cairns of Dumfries and Galloway, the long cairns of Argyll and Bute were investigated to determine whether they reference the firth or the lochs in this region (hereafter described as 'sea') in any of the three ways described in Chapter 4. First, sites were assessed in terms of their affordance of sea views, to determine whether their locations are either typical or unique in that respect in the landscapes in which they are situated. The quantitative assessment of these cairns in terms of statistical considerations, as described in Section 1. The qualitative consideration of the landscape contexts of these monuments on a site by site basis is discussed in Section 2. In Section 3, it is described how sites were assessed to determine whether they offer 'revelatory views' of the sea, as dependent on the pathways that these monuments were likely to have been approached from and whether sea views are obscured to observers on their approach. As a final step in the analysis of this region, the details of sea views and revelatory views where present at long cairn sites are compiled and considered in Section 4, alongside the orientation of their long axes relative both to the sea and to the pathways that may have been used to approach them.

6.1 Sea Affordance Surfaces and Statistical Considerations

In the region of Argyll and Bute, there are 31 sites that fit the long cairn criteria. All such sites are situated less than 13.5km away from the present-day coastline. Therefore, all 31 sites were considered suitable for sea affordance analysis. Their distribution in this study region is depicted below, in Figure 6.1. In order to reduce processing time, the region of Argyll and Bute was sub-divided into 22 micro-regions or sectors. It took a total of 51 days (1229hrs) to generate all sea affordance viewshed maps for these 22 micro-regions. These surfaces were then used to extract the percentage of sea affordance held at each of the 31 site locations (for a detailed summary of these findings see Table 6.1).

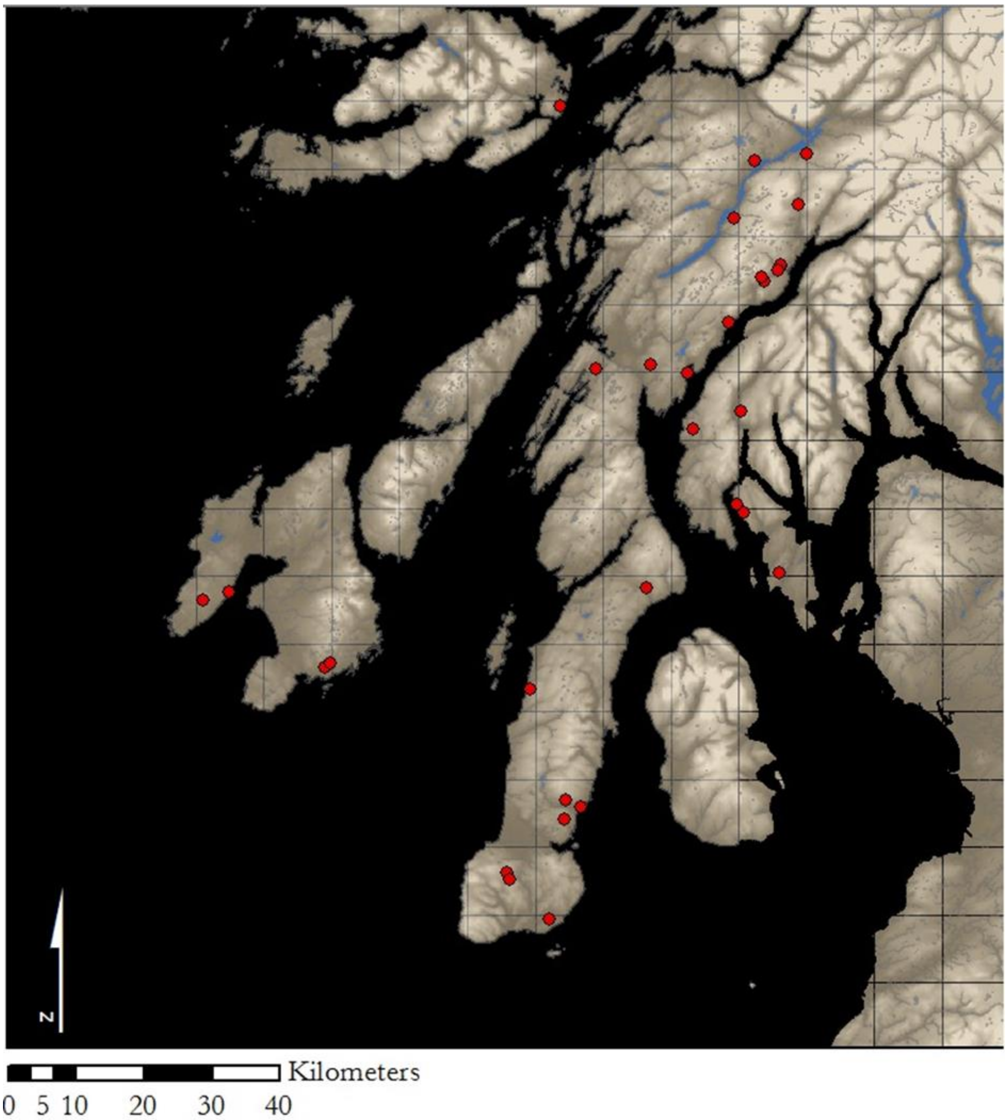


Figure 6.1: Argyll and Bute site distribution map.

It was evident from the generated surfaces that 12 sites in this region were built in areas that offer significant sea affordance.[18] Of these, Ballynaughton (74.99%), Port Charlotte (74.38%), Beacharr (73.79%), Glenvoidean (62.57%), Giant's Grave (60.31%) and Crarae (58.72%) have the highest sea affordances, while the sites of Ardnacross II (42.88%), Port Donain (37.37%), Gort Na H-ulaidhe (32.59%), Pointhouse (24.70%), Greenland (23.72%) and Carnbaan (23.31 %) also exhibit substantial sea affordances (for some examples, see Figure 6.2). However, 19 of the 31 sites are either placed in areas that afford no sea views at all or in low sea-affordance zones. Of these 19 sites, 11 have 0% sea affordance. Five sites (Cnoc an Altair, Glenreasdale Mains, Lephinkill, Auchindrain and Barmore Wood) are placed in close proximity to the sea (in the range of 1.27–2.83km from the coastline). Three sites (Lochorodale 1, Lochorodale 2 and Drimfern) are found

[18] Unless otherwise noted, all cairn sites in this chapter refer to monuments within the council area of Argyll and Bute.

at a mid-range distance from the coastline (4.28–5.95km away). A further three sites (Auchachenna, Cladich and Ardchonnell) are situated much further inland (10.69–13.27km away). The remaining eight sites have relatively low or insignificant sea affordance values. Of these eight sites, the only with noteworthy values are Bicker's Houses, Auchnaha and Achnagoul II, with 16.51%, 11.34% and 10.85%, respectively.

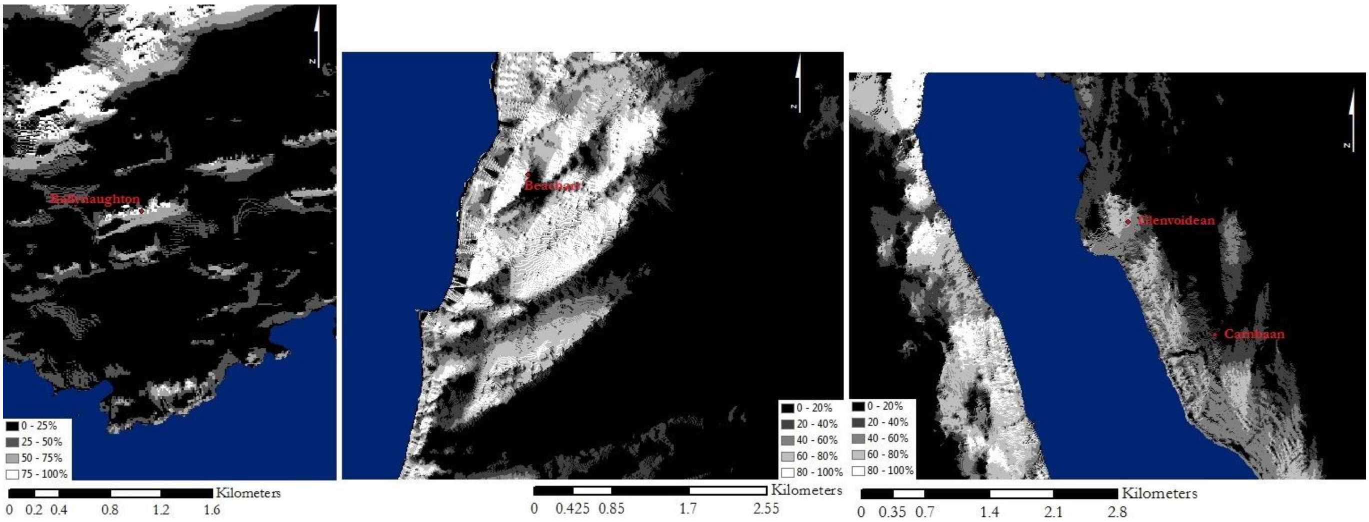


Figure 6.30: Sea affordance surfaces of Ballynaughton (74.99%), Beacharr (73.79%), Glenvoidean (62.57%) and Carnbaan (23.31 %).
Ballynaughton (left), Beacharr (middle), Glenvoidean (right). These sites were placed in some of the highest sea affordance zones in their respective areas.

Table 6.1: Results of sea affordance analysis.

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	Sea Affordance %
1	Gort Na H-ulaidhe, Glen Lussa	154	776.00	2238.83	32.59
2	Ardnacross II	11	264.52	114.83	42.88
3	Greenland	152	617.95	1692.73	23.72
4	Blasthill	108	642.80	1140.17	6.08
5	Lochorodale 1 (ARG 41)	151	161.95	4954.79	0.00
6	Lochorodale 2	151	861.26	5950.38	0.00
7	Beacharr	83	835.10	512.39	73.79
8	Carnbaan	100	1928.25	641.15	23.31
9	Glenvoidean	78	2147.05	411.66	62.57
10	Bicker's Houses	89	109.11	1739.93	16.51
11	Ballynaughton	59	469.61	1360.86	74.99
12	Cnoc an Altair	49	448.76	1540.31	0.00
13	Glenreasdale Mains	43	184.05	2152.05	0.00
14	Port Charlotte	13	691.43	126.19	74.38
15	Gartnagreanoch	64	295.59	1589.17	6.41
16	Auchoish	126	1767.24	3150.25	8.72
17	Pointhouse	12	517.28	233.63	24.70
18	Lephinkill	139	646.11	2735.56	0.00
19	Auchnaha	112	258.54	1478.21	11.34
20	Giant's Grave, Nereabolls	143	1356.28	2271.30	60.31
21	Auchindrain	111	1037.70	2830.11	0.00
22	Creag Mhor, Auchindrain	252	850.16	3471.56	8.93
23	Achnagoul I	109	711.43	1074.36	6.47
24	Achnagoul II	139	688.78	1165.55	10.85
25	Barmore Wood	41	132.22	1265.35	0.00

26	Crarae	11	59.83	145.67	58.72
27	Auchachenna	50	109.23	13266.37	0.00
28	Cladich	101	391.37	10685.82	0.00
29	Ardchonnell	122	459.02	10792.48	0.00
30	Drimfern	89	76.41	4279.99	0.00
31	Port Donain	14	1858.62	140.35	37.37

A chi-square significance test was used to evaluate whether the 31 long cairns considered in this region were placed in locations that have more or less sea affordance than could be expected from a random distribution. A 500m radius around each site was tested by reclassifying the interpolated sea affordance surfaces into nine percentage categories: 0–5, 5–10, 10–20, 20–30, 30–40, 40–50, 50–60, 60–80 and 80–100. Chi-square values and the p-value were then calculated from observed and expected frequencies (see Table 6.2 for more details).

The test yielded a chi-square value of 22.5 and a p-value of 0.17. As the standard probability distribution function resulted in a p-value greater than 0.05, there were no statistically significant differences observed between site locations and what could be expected from a random distribution. Prehistoric builders may, then, have been able to place these monuments in many locations within a 500m radius of where they are now and achieve similar outcomes in terms of sea affordance values. This does not necessarily mean that sea views were not a significant factor for prehistoric builders at every single site, but rather that, when all 31 sites are considered as a collective, recorded sea affordance values give no indication that prehistoric people selected any specific site location in virtue of its sea views. In fact, a majority of long cairns are placed in zones that afford very little sea views or none at all: 17 sites fall into the 0–10% sea affordance category, while only 5 sites fall in the high sea affordance range of 60–80%.

	Label (% categories)	Observed	Expected	Chi-Square Values
Argyll and Bute	1 (0-5)	11	19	2.960526
	2 (5-10)	6	2	6.125
	3 (10-20)	2	2	0.125
	4 (20-30)	3	2	0.125
	5 (30-40)	2	2	0.125
	6 (40-50)	1	1	0.25
	7 (50-60)	1	1	0.25
	8 (60-80)	5	1	12.25
	9 (80-100)	0	1	0.25
				22.46053
			p-value =	**0.167651**

Table 6.2: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results suggest no significant difference between the observed values (site locations) and expected values (random locations).

6.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones

While statistical analysis of the sample of sites considered here does not support the notion that the long cairns of Argyll and Bute were collectively placed to reference the sea or other bodies of water, it is possible that individual long cairns in this region may reference the sea in meaningful ways. Thus, sites were considered further on an individual and qualitative basis. This involved investigating the sea views offered at each site location to determine, in the first instance, whether they are accurately reflected by the recorded sea affordance values. Horizon panoramas were generated for each of the 31 sites considered, and these confirmed the results indicated by the sea affordance analysis that 20 of the 31 sites were placed in locations that afforded sea views while the remaining 11 sites were built in areas that offer none.[19]

This analysis of Horizon panoramas revealed further details regarding views in terms of how much space the sea took up in an observer's visual field at each site, and whether such a view was narrow or broad. Nine of the 20 sites offer significantly broad sea views that expand far across the horizon. As shown in Figure 6.3, the approximate ranges of these views are as follows: Ballynaughton 82.5–238º, Port Charlotte 35–201º, Beacharr 201–15º, Glenvoidean 155–306º, Giant's Grave 57.5–255º, Crarae 50–210º, Ardnacross II 64–199º, Pointhouse 17–66º and 102.5–207.5º, and Carnbaan 160–286º. The remaining 11 sites offer narrower sea views. Three of these sites' views are, nevertheless, broad by objective standards, as seen in Figure 6.4, they are: Port Donain 86.5–167.5º, Gort Na H-ulaidhe 93.5–164º, and Greenland 60–157.5º. The other eight sites in this region offer sea views that are significantly narrow. The approximate ranges of these views are: Bicker's Houses 155º–177º, Achnagoul II 110–152.5º, Auchoish 189–193º, Achnagoul I 115–146º, Gartnagreanoch 213–218.5º, Blasthill 212.5–248º, Auchnaha 242.5–269º and 286.5–313º, and Creag Mhor 59–80º and 192.5–212º (see Figures 6.4 and 6.5). As is apparent in Figure 6.4, sea views from these locations are not only narrow but also appear as mere slivers in the distant horizon. Sea views from Bicker's Houses, Auchnaha, Creag Mhor and Blasthill are barely noticeable and, similarly, Horizon panoramas of the views available at Gartnagreanoch and Auchoish require magnification before areas of water are evident. As will be addressed further below, such scant sea views may have been obscured by moderate levels of vegetation or atmospheric deterioration, making it less likely that that those views as such were particularly

[19] Horizon panoramas of Auchindrain, Barmore Wood, Cnoc an Altair, Glenreasdale Mains, Lephinkill, Auchachenna, Cladich, Ardchonnell, Drimfern, Lochorodale 1 and Lochorodale 2 show no visible traces of ocean views in distant horizons.

meaningful—as distinct from the direction of the sea, which may be a separate factor of significance.

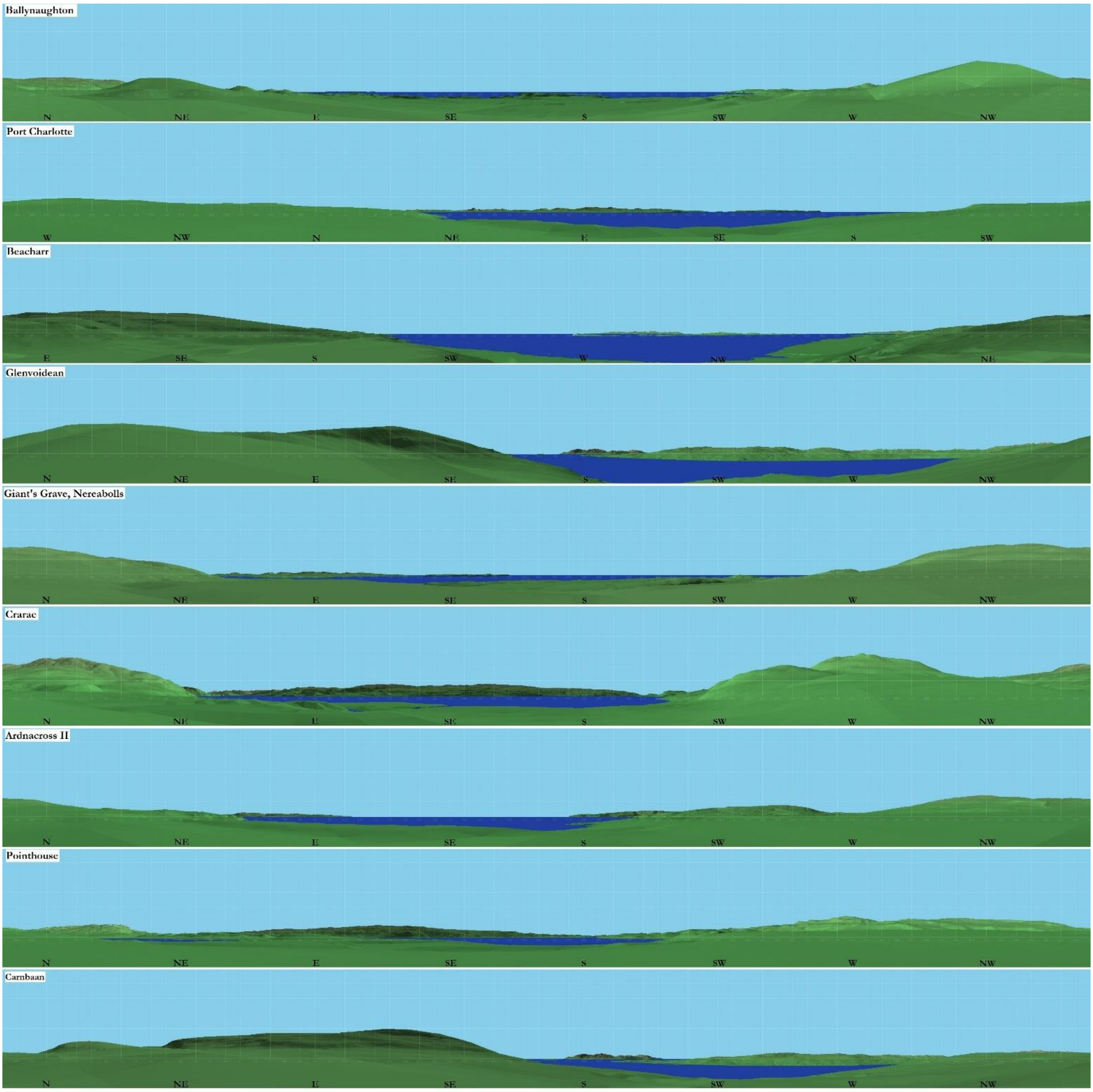


Figure 6.31: Horizon panoramas of Ballynaughton (74.99%), Port Charlotte (74.38%), Beacharr (73.79%), Glenvoidean (62.57%), Giant's Grave (60.31%), Crarae (58.72%), Ardnacross II (42.88%), Pointhouse (24.70%) and Carnbaan (23.31%) showing expansive views of the sea.

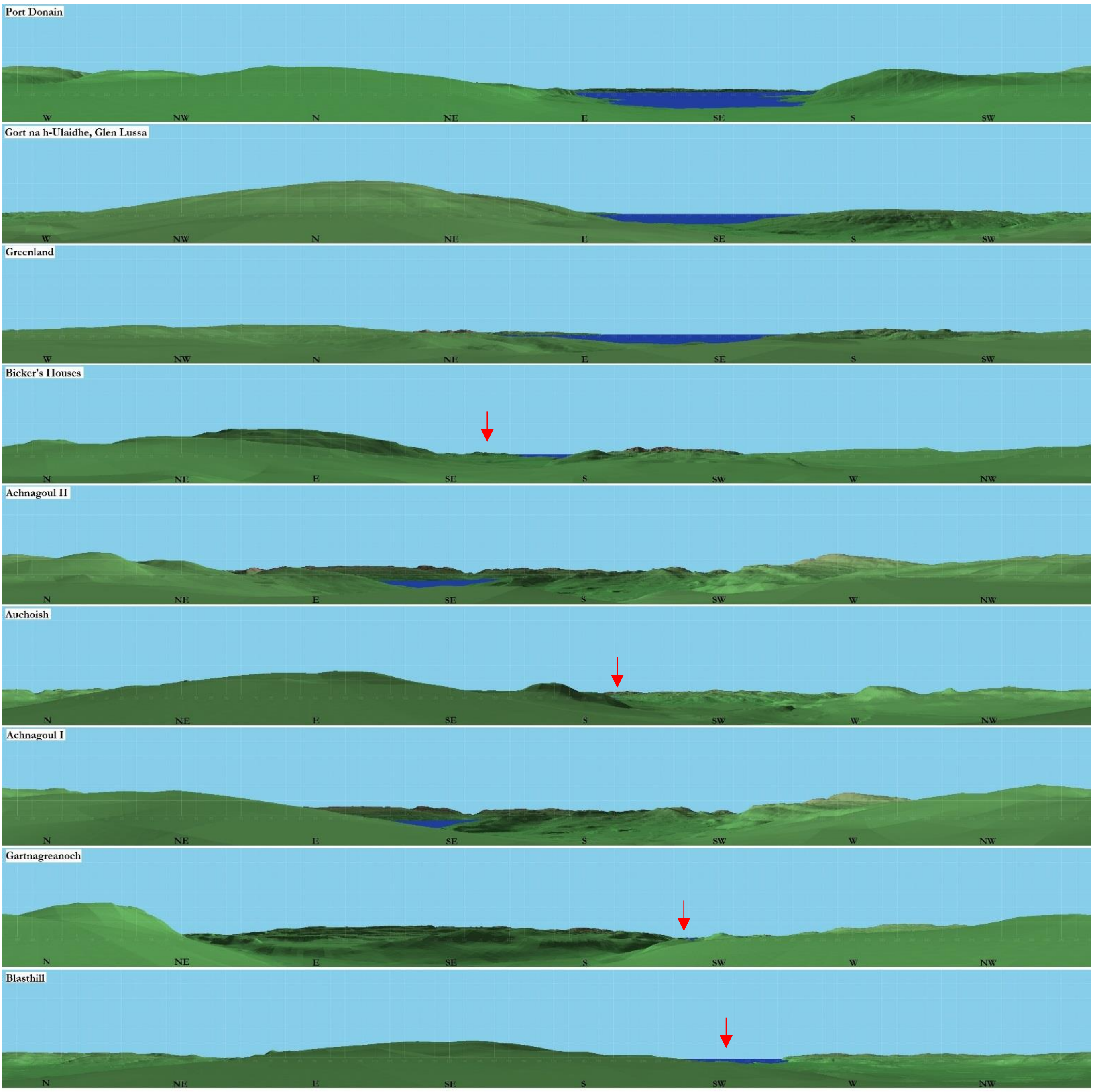


Figure 6.4: Horizon panoramas of Port Donain (37.37%), Gort Na H-ulaidhe (32.59 %) Greenland (23.72%), Bicker's Houses (16.51%), Achnagoul II (10.85%), Auchoish (8.72%), Achnagoul I (6.47%), Gartnagreanoch (6.41 %) and Blasthill (6.08%) depicting narrow views of the sea.
Red arrows indicate sea views.

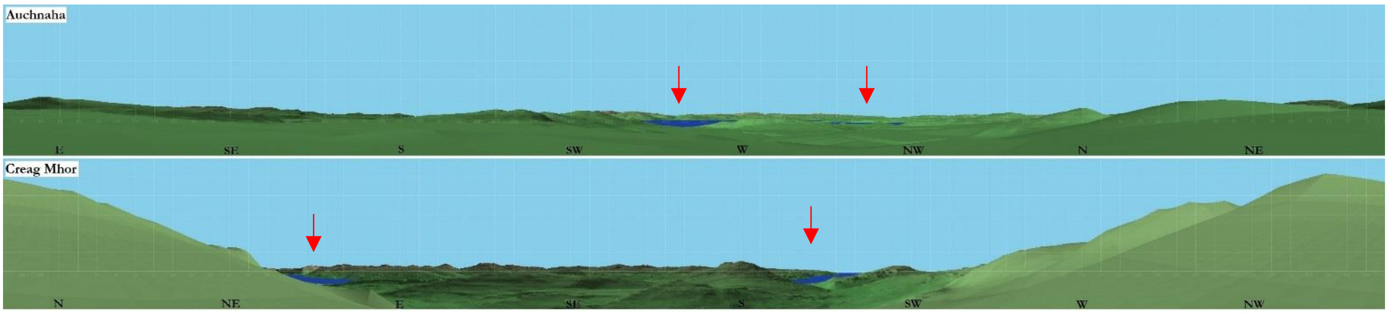


Figure 6.5: Horizon panoramas of Auchnaha (11.34%) and Creag Mhor (8.93 %) showing narrow views of the sea. Red arrows indicate sea views.

Investigation of Cairns' Surrounding Landscapes and the Presence of 'Alternative Locations'

Further consideration of the generated sea affordance surfaces reveals that five sites were built in areas that are completely devoid of sea views. At Lochorodale 1 (ARG 41) and Lochorodale 2, the nearest locations affording sea views are approximately 2km away (see Figure 6.6). Moreover, for Auchachenna, Cladich and Ardchonnell, the distance from cairn to locations with sea views increases to 6km (see Figure 6.7). In these five instances, the observed absence of sea affordance values in the proximity of site locations likely meant that the sea did not play a significant role in determining cairn placement and construction, as may have been the case for other sites found further inland in other regions of Scotland.

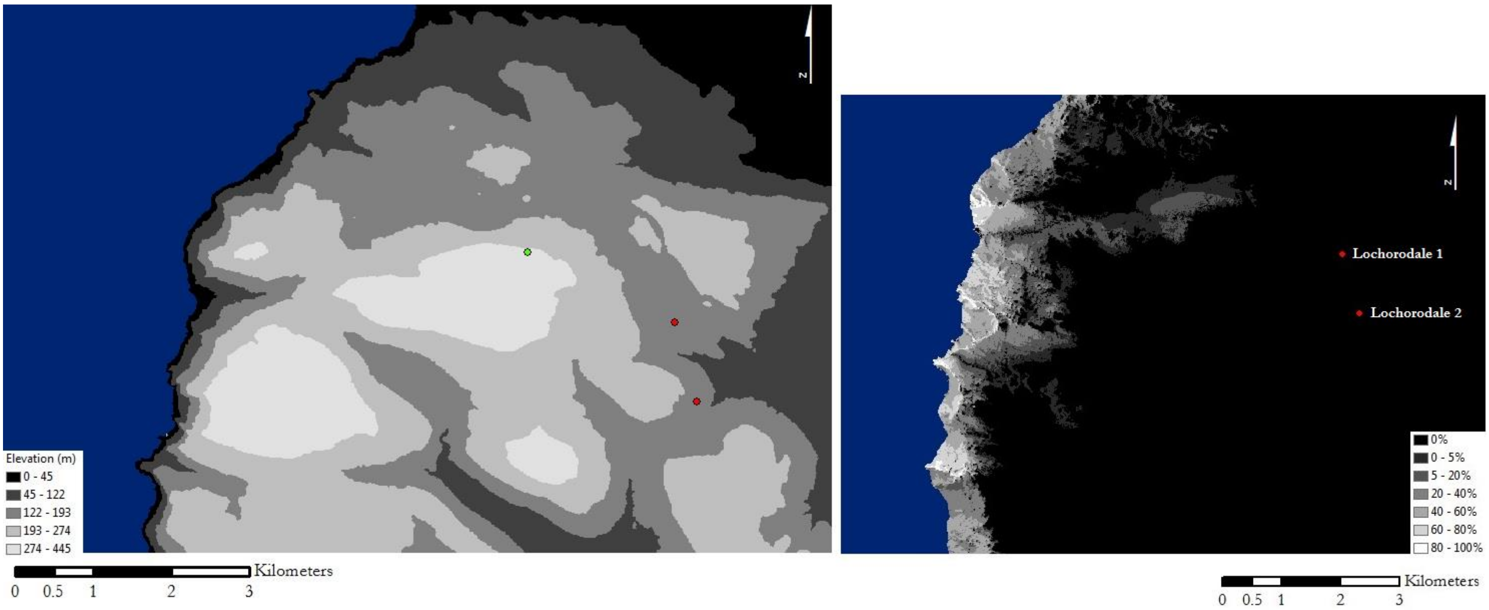


Figure 6.6: Elevation and sea affordance surfaces for Lochorodale 1 and 2 and Lochorodale 1 Location A. (Left) Elevation of Lochorodale 1 and Location A, where Location A situated in the highest band of elevation (274–445m). (Right) Affordance surface displaying the higher sea affordance zones around the sites of Lochorodale 1 and Lochorodale 2.

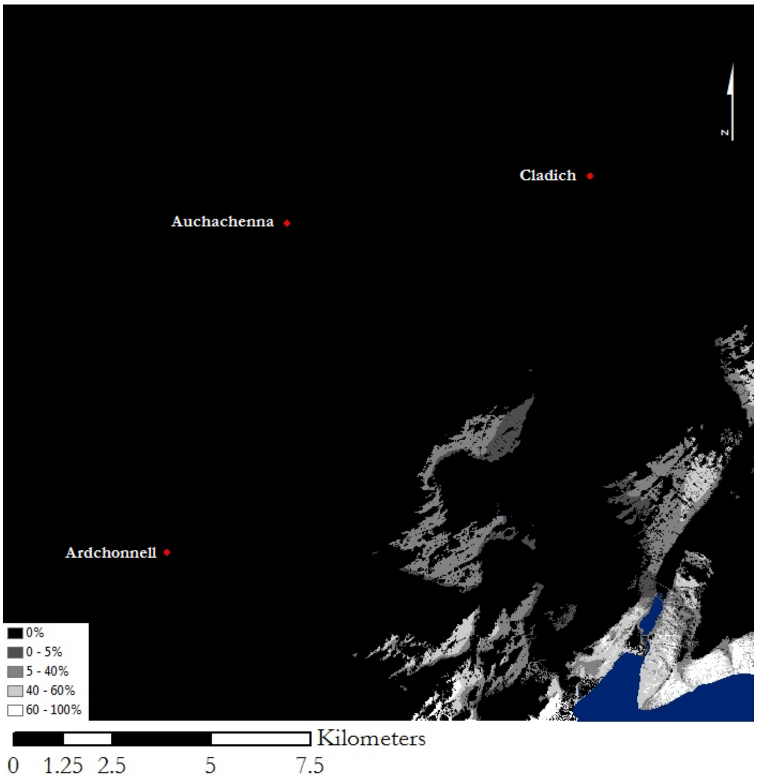


Figure 6.7: This affordance surface displays an absence of sea views around the sites of Auchachenna, Cladich and Ardchonnell, where the nearest sea views are from locations approximately 6km away.

As mentioned earlier, there are 8 sites in Argyll and Bute that offer only narrow and insignificant sea views (as shown in Figure 6.4), and a further 11 sites that offer no sea views at all. Of these (19) sites with no or insignificant sea views, 13 are placed within a 1.5km radius of locations that have substantial or substantially greater sea affordance values than are observed at corresponding cairn locations. The presence of such locations raise the question of why prehistoric builders did not chose them for construction, if in fact they intended to reference the sea. Therefore, alternative candidate locations with high sea affordance were investigated to determine their suitability for cairn placement (see Table 6.3), and whether there might have been countervailing reasons as to why those locations were not ultimately used.

Site Name	Site elevation (m)	Nearby high sea affordance locations	Elevation at this new location (m)	Distance away from the site (m)	Directionality of this location	Sea Affordance (%)
Blasthill	108	Location A	108	282.36	SSE	64.99
	108	Location B	110	231.74	SSW	46.63
	108	Location C	111	246.45	SSE	70.49
	108	Location D	117	211.79	SE	82.56
Cnoc an Altair	49	Location A	46	379.06	SSW	50.66
	49	Location B	48	322.05	S	54.26
	49	Location C	54	302.09	SSW	60.83
	49	Location D	57	653	SE	70.08
Auchoish	126	Location A	126	238.22	SSW	20.38
	126	Location B	140	205.93	S	31.71
	126	Location C	149	176.24	E	38.21
	126	Location D	130	541.27	NW	32.07
Gartnagreanoch	64	Location A	58	354.91	S	26.43
	64	Location B	91	118.09	NE	27.84
	64	Location C	98	227.62	NE	30.23
Creag Mhor	252	Location A	251	77.45	ENE	20.12
Barmore Wood	41	Location A	46	670	ENE	20.14
Achnagoul I	109	Location A	109	661.39	E	40.81
	109	Location B	109	910.62	ENE	55.71
Achnagoul II	139	Location A	135	665.70	ESE	45.55
	139	Location B	141	764.63	E	54.70
Auchindrain	111	Location A	227	1070	E	20.94
	111	Location B	245	1088	ESE	51.99
Glenreasdale Mains	43	Location A	80	724.95	SSE	26.52
	43	Location B	108	992.09	SE	49.05
Auchnaha	112	Location A	109	794.33	WNW	74.79
	112	Location B	111	726.45	W	58.75
Lephinkill	139	Location A	307	956.31	SE	3.16
Drimfern	89	Location A	267	1251.53	NW	3.76
	89	Location B	228	1441.36	SW	6.49

Table 6.3: Comparison of available sea affordances between site locations and their immediate surroundings.

Several factors may explain why prehistoric builders did not choose such alternative locations for site placement. Many of the alternative locations identified in Table 6.3 may have been situated too far from an otherwise desired location. This may have been a factor at Barmore Wood Location A, which is 670m away from the corresponding cairn site, a distance that may have deterred prehistoric builders in spite of the location's sea affordance value of 20%, which contrasts with the 0% affordance found at Barmore Wood. A similar problem may be attributed to the area of high sea affordance adjacent to Auchnaha. Auchnaha Location A and Auchnaha Location B have respective sea affordance values of 74.79% and 58.75%, however, those locations may simply have been too far away to have been appealing, at 794m and 726m from the Auchnaha cairn site. The same pattern can be observed at Achnagoul I Locations A and B, Achnagoul II Locations A and B, Auchoish Location D and Cnoc an Altair Location D. While those alternative locations hold relatively high sea affordance values, they are also found at relatively far distances from the cairn sites to which they correspond. Elevation is a further factor that may also have deterred prehistoric people from locations with high sea affordance values, as seen in the cases of Auchindrain, Glenreasdale Mains, Lephinkill and Drimfern. For instance, Auchindrain Location B is 134m higher in elevation than Auchindrain, in addition to being over 1km distant. Similarly, Lephinkill Location A is 168m higher in elevation than Lephinkill, while also around 1km away from that site (see Figure 6.8).[20]

[20] Other examples include: Drimfern Location B and Glenreasdale Mains Locations A and B. These locations are not only situated at much higher elevations than their corresponding long cairns, but are also at some distance from those monuments.

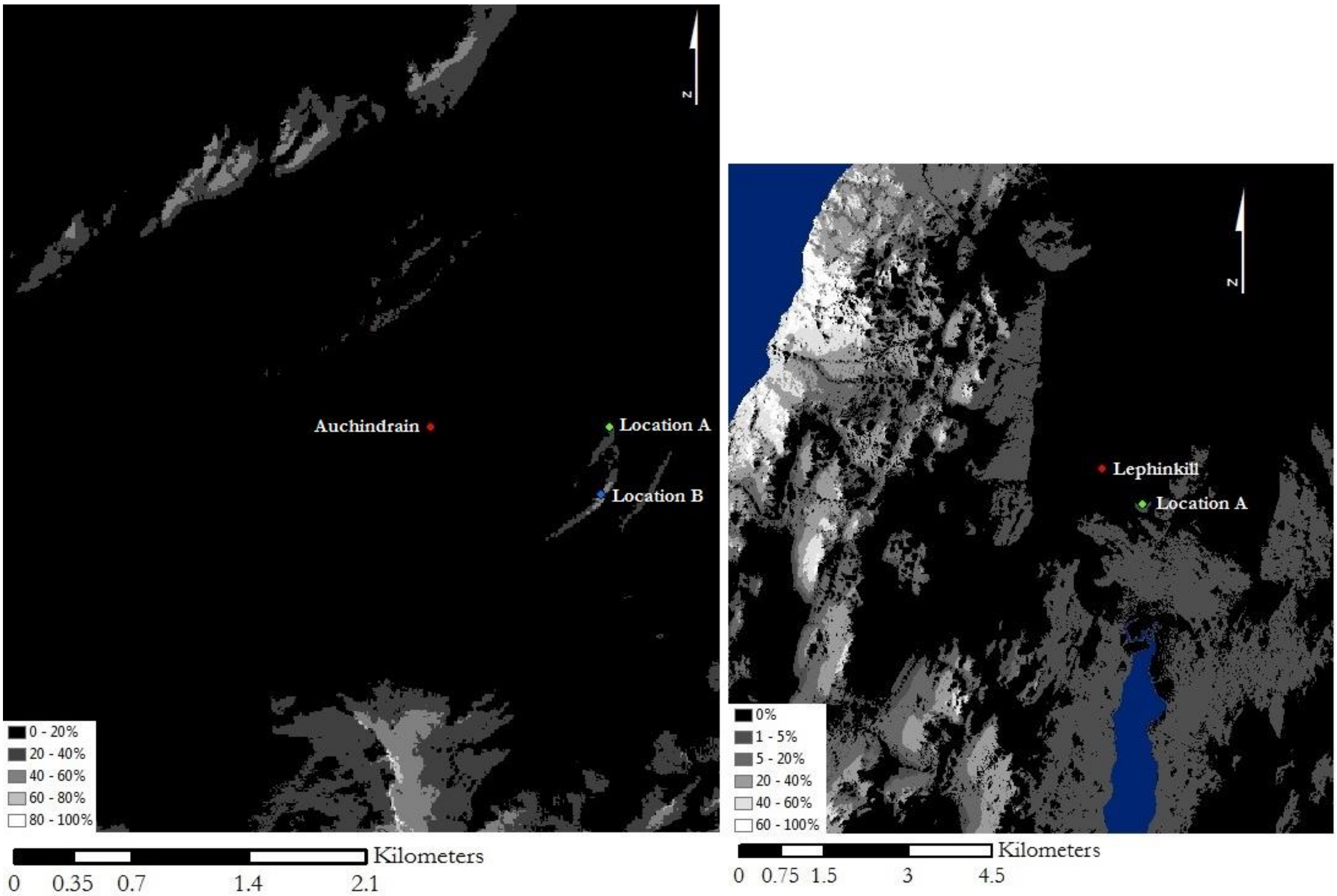


Figure 6.8: Affordance surfaces displaying the higher sea affordance zones around the sites of Auchindrain (Left) and Lephinkill (Right).

Distance from desired locations and elevation may, therefore, account for many cases where long cairns were placed in areas of comparatively lower sea affordance. However, some alternative locations offering high affordance values appear to be ideal in terms of both distance and elevation relative to the location of cairn sites. As depicted in Figure 6.9, examples of these alternative locations are as follows (for more details, see Table 6.3):

1) Blasthill, Locations A, B, and C, are less than 300m away from the cairn site. In the case of Blasthill Location D, sea affordance reaches 13 times the value found at the cairn site.
2) Within a relatively short distance from Cnoc an Altair (of 400m) there are numerous high sea affordance zones falling in the 50–80% range. This is considerable given that there is 0% sea affordance at Cnoc an Altair.
3) At Auchoish Location A (238m from the cairn site), sea affordance reaches as high as 20.38%, more than double the value found at Auchoish.
4) At Gartnagreanoch Location A (354m from the cairn site), sea affordance is 26%, more than four times the value found at Gartnagreanoch.

5) At Creag Mhor Location A (77m from the cairn site) sea affordance is 20.12%, more than double the value found at Creag Mhor.

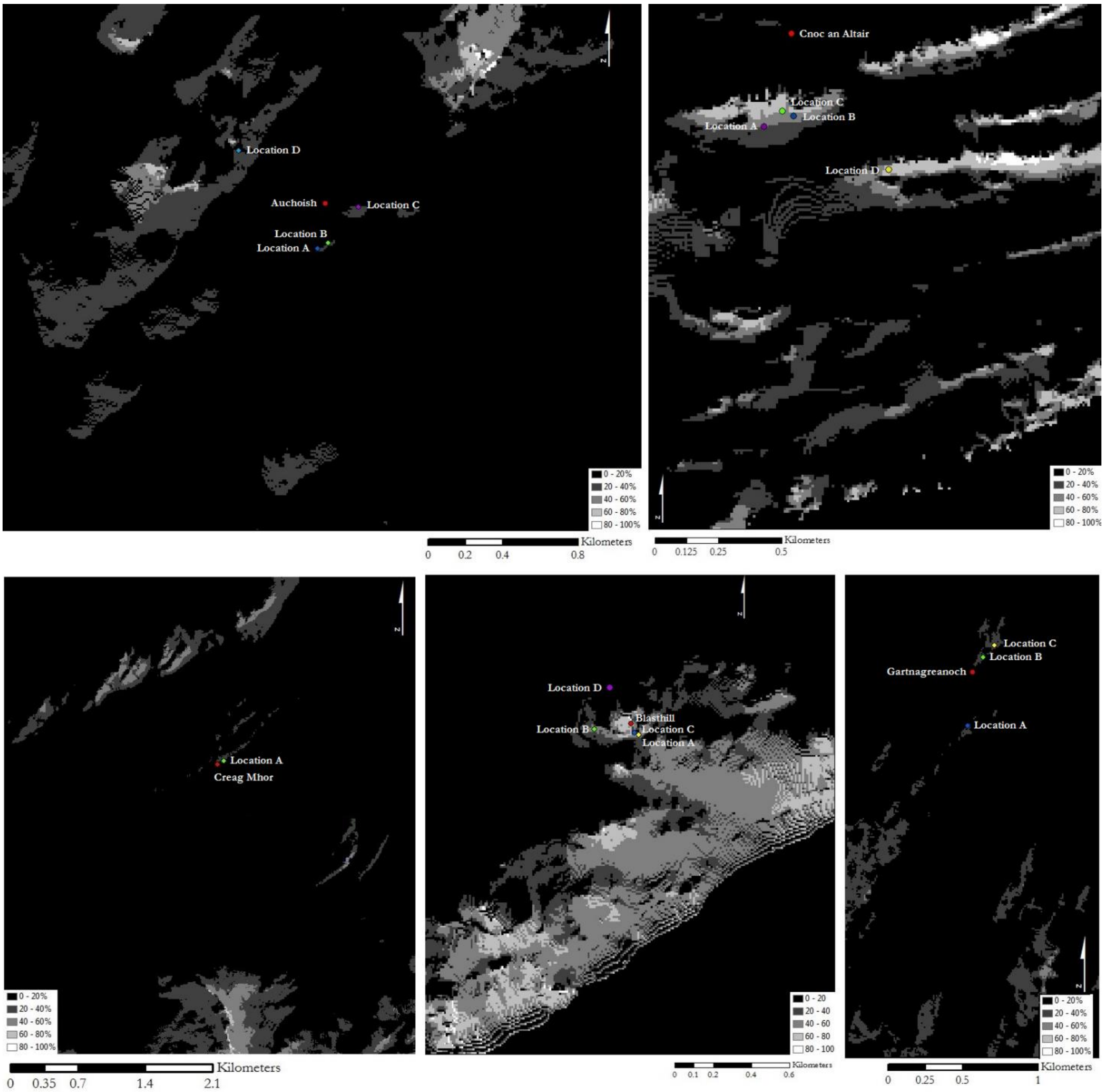


Figure 6.9: These affordance surfaces display high sea affordance zones in close proximity to some of the sites mentioned above.

Horizon panoramas were generated to further interrogate the significance of these locations, and to determine how the sea views they offer appear in the visual field of an observer as well as if and how they differed from what are available at the actual site locations (see Figure 6.10, below).

Investigation of Alternative Locations using Horizon Panoramas

As can be seen from the panoramas (below) the most significant differences between site locations and their counterpart alternatives occur at Blasthill and, to a much lesser extent, Cnoc an Altair. At Blasthill, sea affordance is 6.08%, and the sea appears as a very narrow sliver across the horizon, spanning 36º, from 212.5–248.5º. Yet, sea affordance reaches 65% only 282m away, at Blasthill Location A, where panoramic sea views expand 190º across the horizon, from approximately 61.5–251.5º. Those views are incomparably more substantial and prominent to an observer than the sea views found at the long cairn site, making Blasthill Location A an obvious choice if prehistoric builders intended to achieve a distinctly striking backdrop of the sea.

As discussed in Chapter 2, Section 1, Cummings and Whittle (2004) make the suggestion that prehistoric builders may have wanted and intended to construct monuments in locations that afford narrow or restricted sea views as opposed to expansive and panoramic sea views. The apparent preference for the narrow views available at Blasthill over Blasthill Location A may, thus, lend credibility to that idea. Such speculation cannot, however, be accepted uncritically, as other possibilities may also account for the particular location choice observed. Prehistoric builders might have been attracted to a range of other attributes at the location of the Blasthill site, such as proximity to building materials, other practicalities, or a different feature of the landscape that may have held some symbolic significance.

Cnoc an Altair Location A is another noteworthy example of an alternative location. While Cnoc an Altair offers 0% sea affordance, 379m away from that site sea affordance jumps to 50.7% at Cnoc an Altair Location A (see Figure 6.10). Although the sea views from that alternative location are not as prominent as those found at Blasthill Location A, they are noticeable, and expand 110º across the horizon, from approximately 117–227º. This is not a trend seen at the two other alternative locations, Auchoish Location A and Gartnagreanoch Location A. Although those locations offer higher sea affordance values, of 20.38% and 26.43% respectively, the Horizon panoramas reveal that the sea views they afford are restricted in the visual field. At Auchoish Location A, sea views span 21.5 º, from 173.5 195º, and at Gartnagreanoch Location A, sea views span a mere 14º, from 216–226º. In both cases, views from these alternative locations are only marginally more noticeable in comparison to what may be seen from where their counterpart long cairns are placed. Moreover, as is examined below, there is some question as to whether either of those alternative locations could be said to offer more impressive sea views than the cairn sites they correspond to when the impacts of vegetation and weather conditions are taken into account.

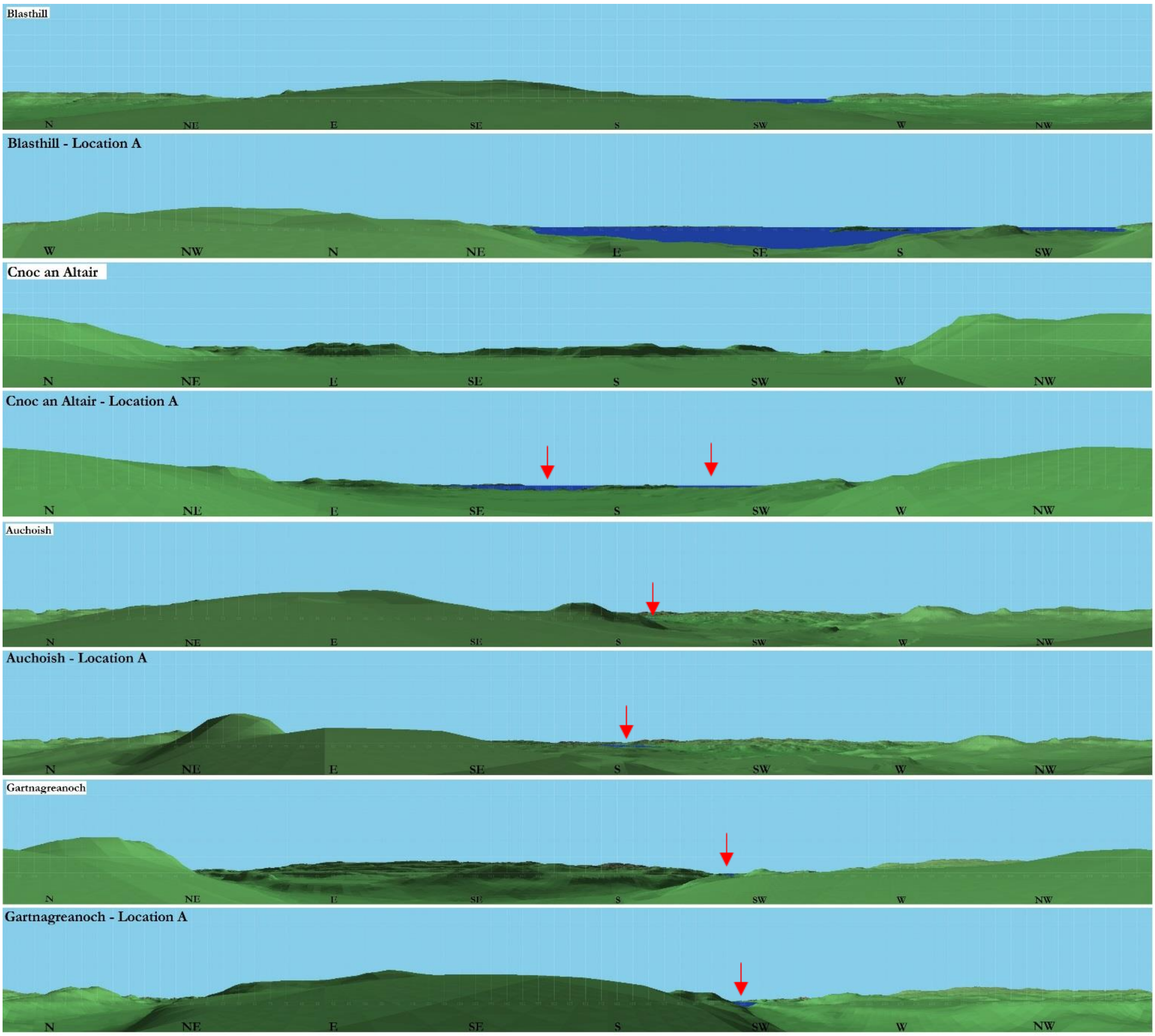


Figure 6.10: Horizon panoramas of Blasthill, Cnoc an Altair, Auchoish and Gartnagreanoch as well as the high sea affordance zones nearby to these sites, identified in Table 6.3.
The red arrows indicate sea views.

Considering the Effect of Atmospheric Conditions

Horizon panoramas were used to model the effects of atmospheric deterioration on the sea views available from Gartnagreanoch, Auchoish and Cnoc an Altair, and the alternative locations for those sites, as identified above (see Figures 6.11, 6.12 and 6.13). It was found that sea views would be obscured when visibility was set at different thresholds. At Gartnagreanoch, there has to be a minimum of visibility for 10km for sea views in the distance to be observable and noticeable. Sea views available from Gartnagreanoch Location A are clearer than from Gartnagreanoch, remaining apparent until visibility falls under 3km. Views from Auchoish and Auchoish Location A are comparable with each other under atmospheric deterioration: when visibility is restricted to less than approximately 6km and 8km, respectively, sea views are completely masked behind layers of fog (see Figure 6.12). As the sea views offered at that pair of sites were not substantial to begin with, the presence of atmospheric detriments, such as fog, compounds the difficulty of detecting those views—an effect that can also be caused by vegetation, which is a factor that cannot be considered here in depth. A similar effect is observed at Cnoc an Altair Location A, which affords two stretches of sea views: the most substantial view lying between SE and S, and a separate, minor stretch between S and SW, expanding from approximately 197.5–226.5º. Under conditions of low visibility (of, say, 2km) the minor stretch of sea is completely obscured, to be revealed only when visibility reaches over 5km, at which point it is barely noticeable. With the exception of Gartnagreanoch Location A, atmospheric conditions (as well as vegetation) seem may have affected these sea views, rendering them equivalent to the sea views offered at the alternative locations' corresponding cairn sites. It remains plausible, then, that the prehistoric builders who constructed the cairns of Argyll and Bute had an interest in referencing the sea, as the views offered at these sites were among the greatest available given what may have been prevalent weather conditions

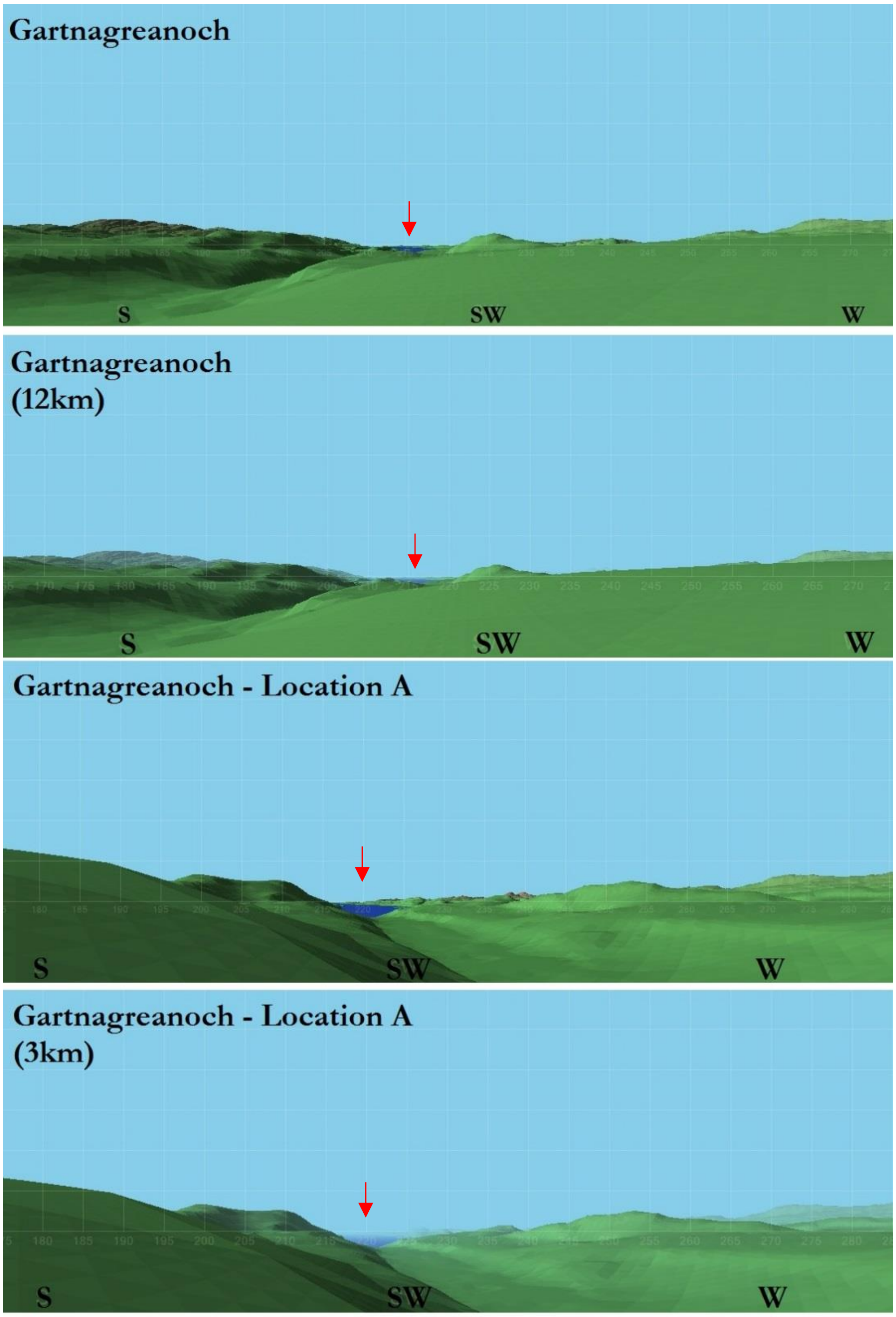


Figure 6.32: Original Horizon panoramas of Gartnagreanoch and Gartnagreanoch Location A, on a clear day, as well as the re-generated panoramas of those locations that model atmospheric haze (with visibility set at 12km and 3km, respectively).
Red arrows indicate sea views.

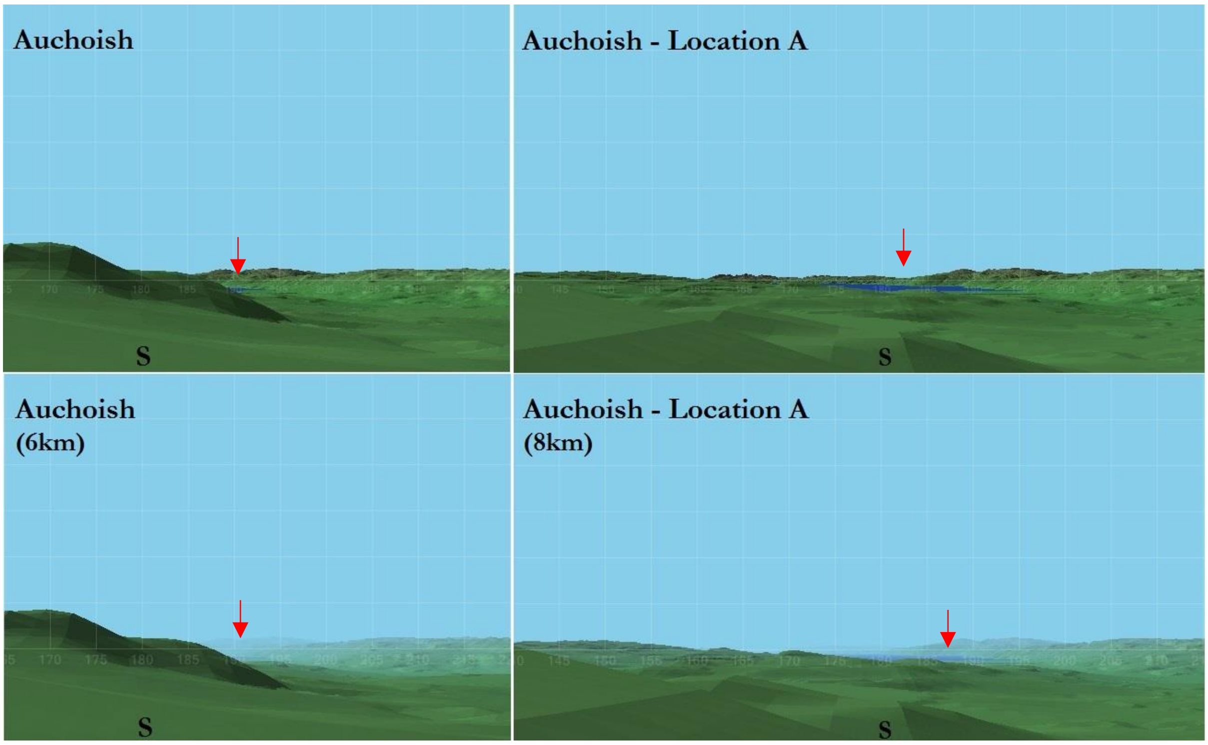


Figure 6.12: Top-left and top-right: original Horizon panoramas of Auchoish and Auchoish Location A, depicting a clear day. Bottom-left and bottom-right: re-generated panoramas, taking atmospheric haze into consideration.
Red arrows indicate sea views.

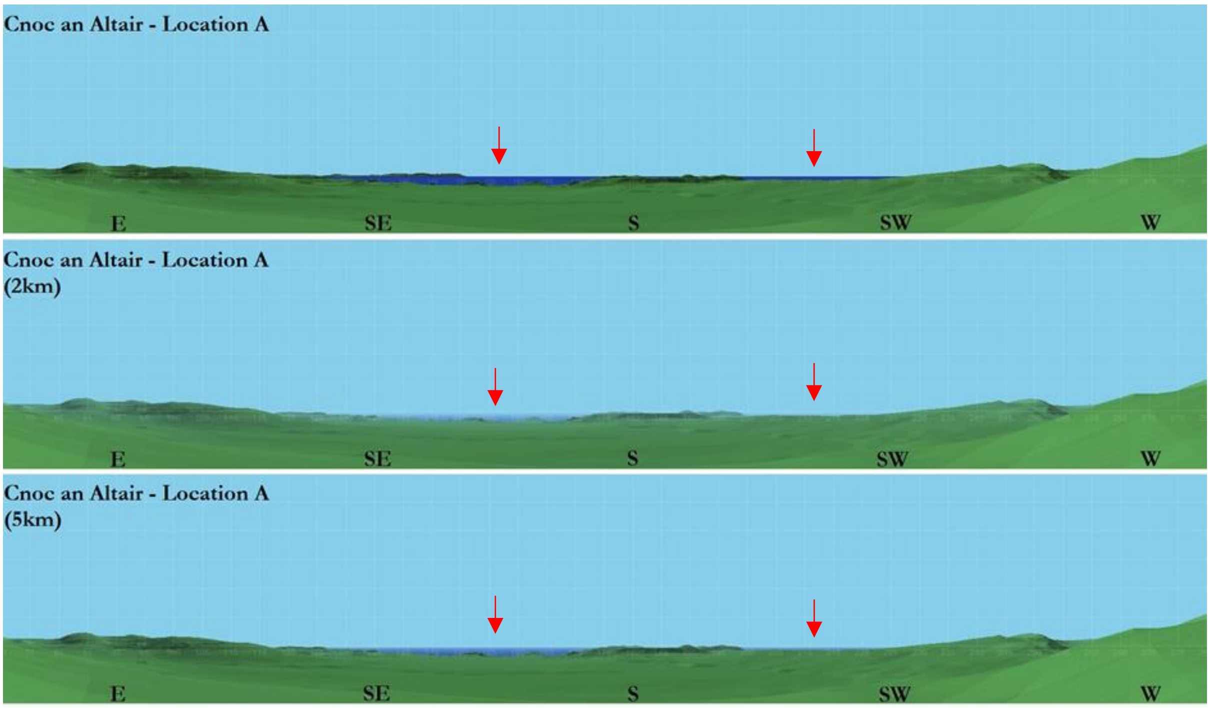


Figure 6.13: Top image shows the original Horizon panoramas of Cnoc an Altair Location A, on a clear day. Middle and bottom images show re-generated panoramas that model atmospheric haze (with visibility set at 2 and 5km, respectively).
Red arrows indicate sea views.

6.3 Testing for Revelatory Views

As was the case for Dumfries and Galloway, the pathways that prehistoric people could have taken to approach the monuments in this region were identified with the use of travel corridors generated within a 1.5km radius of each cairn site. Pathways were then used in conjunction with sea affordance surfaces to generate sea affordance profiles.

A first criterion for examining affordance profiles and identifying revelatory views was that only those pathways that approach monuments in a seaward direction were considered. It was found that there were pathways (paths) that approach each of the 31 sites in such a direction, which could thus potentially offer revelatory views. As shown below, in Table 6.4, some sites have multiple pathways approaching them. A total of 58 such paths were identified, and the generated affordance profiles indicate that 35 of those paths offer what are considered revelatory views for the purpose of this analysis. These 35 paths approach 20 of the 31 sites (see Figure 6.14).

Two distinct sets of paths fall under the first of the three categories of revelatory views described in Chapter 4, Section 5, as offering dramatic and sudden revelatory views of the sea. The first set of paths holds particularly high affordance values, comprising: Glenvoidean, Paths 1 and 3; Port Donain, Path 3; Ballynaughton, Path 1; and, Pointhouse, Path 1. The second set of paths appears to offer similar revelatory views in that they are also sudden and dramatic, although with diminished levels of sea affordance in comparison to the first set. This second set of paths comprises: Bicker's Houses, Path 1; Auchnaha, Paths 1 and 3; Creag Mhor, Path 2; and, Auchoish, Path 1 (see Figure 6.14).[21]

Revelatory views on the approach of many other sites fall into either of the second or third categories. Giant's Grave presents an instance of the second category, where the paths that approach it exhibit steady and gradual increases in sea affordance. These increases start on path 1 at 570m from approximately 20%, and on path 2 at 360m also from approximately 20%, to reach 60.3% at the site. Similar observations can be made for paths that approach Crarae, Carnbaan, and to a lesser extent Gartnagreanoch (see Figure 6.14). Examples belonging to the third category of revelatory views, of paths offering glimpses or previews before reveals of sea views, are seen on the approaches of: Ballynaughton, Path 1;[22] Port Charlotte, Path 1; Beacharr, Path 1; Ardnacross

[21] In the case of Creag Mhor and Auchoish, paths depict which might be considered unpersuasive cases of revelatory views, exhibiting only a small increase in sea affordance of around 9% in each case.

[22] Path 1 of Ballynaughton falls into two categories as this path offers a dramatic and sudden reveal as well as providing ocean preview.

II, Path 1; Port Donain, Path 1; Gort Na H-ulaidhe, Path 1; Glenvoidean, Path 2;[23] Pointhouse, Path 3; Greenland, Path 1. To a lesser extent, owing to lesser values of sea affordance, the following paths also exhibit examples of previews before reveals: Auchnaha, Path 2; Achnagoul II, Paths 1 and 2; Creag Mhor, Path 1; Achnagoul I, Paths 1 and 2; and, Blasthill, Path 1 (see Figure 6.14).

Certain aspects of the generated profiles that fall under this third category of revelatory views (involving previews) raise questions and perhaps doubts regarding the notion that monuments were deliberately placed in locations that afforded prehistoric people with revelatory views of the sea. Namely, as depicted in Figure 6.14, many paths' previews offer comparative, and in some cases even higher, sea affordance values than what are present at site locations. For instance, Path 1 to Port Charlotte, Path 1 to Ardnacross II, Path 1 to Port Donain, Path 1 to Greenland, Path 2 to Achnagoul II, and both Paths to Achnagoul I, all offer comparable sea affordance values within 650m of monuments. In addition, at 283m from Beacharr on Path 1, and at 500m from Blasthill on Path 2, sea affordance values are higher than what are available at respective cairn sites.

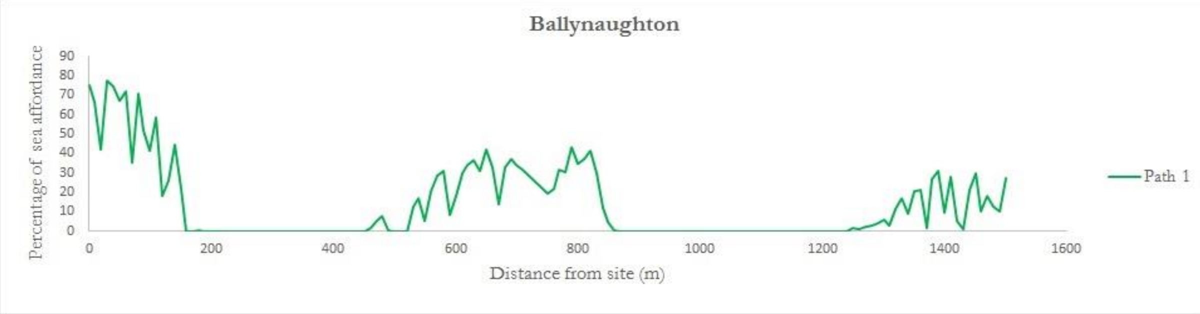
[23] This path offers slight previews along the entire pathway.

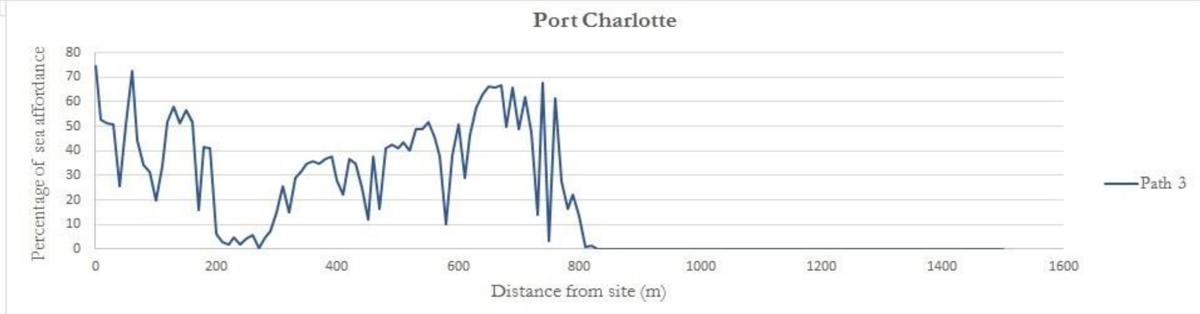
Site ID	Site Name	Site Elevation (m)	General Direction of all paths drawn in	Paths that offer 'revelatory' views	Sea Affordance %
1	Gort Na H-ulaidhe, Glen Lussa	154	Path 1 (E)	Path 1 (E)	32.59
2	Ardnacross II	11	Path 1 (SSW); Path 2 (SE); Path 3 (E)	Path 3 (E)	42.88
3	Greenland	152	Path 1 (E)	Path 1 (E)	23.72
4	Blasthill	108	Path 1 (SW)	Path 1 (SW)	6.08
5	Lochorodale 1 (ARG 41)	151	Path 1 (SW)	N/A	0.00
6	Lochorodale 2	151	Path 1 (NNW/N)	N/A	0.00
7	Beacharr	83	Path 1 (W-WNW)	Path 1 (W-WNW)	73.79
8	Carnbaan	100	Path 1 (S); Path 2 (SSW)	Path 1 (S); Path 2 (SSW)	23.31
9	Glenvoidean	78	Path 1 (SW); Path 2 (SSE); Path 3 (SW)	Path 1 (SW); Path 2 (SSE); Path 3 (SW)	62.57
10	Bicker's Houses	89	Path 1 (SSE)	Path 1 (SSE)	16.51
11	Ballynaughton	59	Path 1 (SE); Path 2 (E)	Path 1 (SE); Path 2 (E)	74.99
12	Cnoc an Altair	49	Path 1 (Westerly); Path 2 (Westerly)	N/A	0.00
13	Glenreasdale Mains	43	Path 1 (SSE); Path 2 (SE)	N/A	0.00
14	Port Charlotte	13	Path 1 (NE); Path 2 (E); Path 3 (SSE)	Path 3 (SSE)	74.38
15	Gartnagreanoch	64	Path 1 (SSW)	Path 1 (SSW)	6.41
16	Auchoish	126	Path 1 (SW)	Path 1 (SW)	8.72
17	Pointhouse	12	Path 1 (ESE); Path 2 (E); Path 3(ENE)	Path 1 (ESE); Path 2 (E); Path 3(ENE)	24.70
18	Lephinkill	139	Path 1 (WNW); Path 2 (W)	N/A	0.00
19	Auchnaha	112	Path 1 (WSW); Path 2 (WNW); Path 3 (NNW)	Path 1 (WSW); Path 2 (WNW); Path 3 (NNW)	11.34
20	Giant's Grave, Nereabolls	143	Path 1 (E); Path 2 (W)	Path 1 (E); Path 2 (W)	60.31
21	Auchindrain	111	Path 1 (S)	N/A	0.00

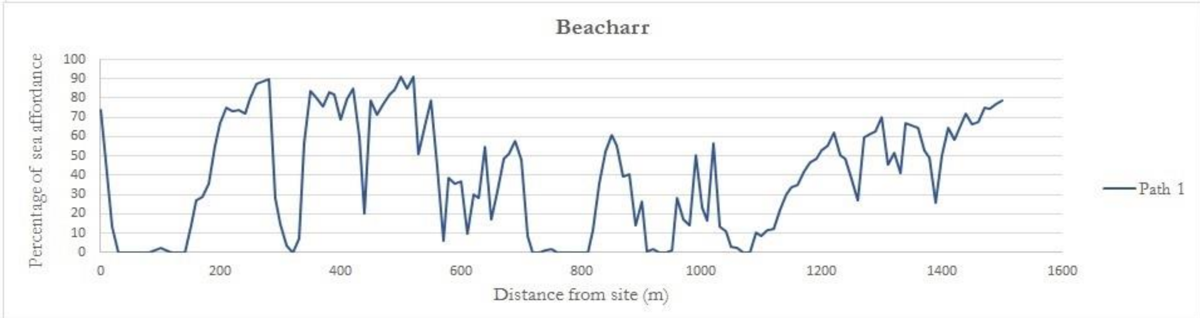
22	Creag Mhor, Auchindrain	252	Path 1 (SSW); Path 2 (E)	Path 1 (SSW); Path 2 (E)	8.93
23	Achnagoul I	109	Path 1 **(ESE)**; Path 2 (ESE)	Path 1 **(ESE)**; Path 2 (ESE)	6.47
24	Achnagoul II	139	Path 1 (S); Path 2 (SE)	Path 1 (S); Path 2 (SE)	10.85
25	Barmore Wood	41	Path 1 (SW); Path 2 (S); Path 3 (E)	N/A	0.00
26	Crarae	11	All 3 Pathways (SE)	Gradually - All 3 Pathways (SE)	58.72
27	Auchachenna	50	Path 1 (SW)	N/A	0.00
28	Cladich	101	Path 1 (S)	N/A	0.00
29	Ardchonnell	122	Path 1 (SSW); Path 2 (E)	N/A	0.00
30	Drimfern	89	Path 1 (E); Path 2 (SE)	N/A	0.00
31	Port Donain	14	Path 1 (ENE); Path 2 (E); Path 3 (SSW)	Path 1 (ENE); Path 3 (SSW)	37.37

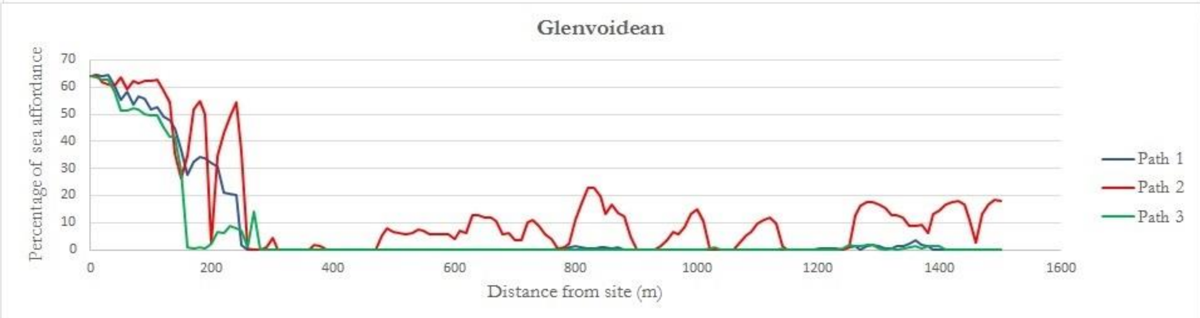
Table 6.48: Pathways that offer revelatory views.

Figure 6.14 (1): (1–4) Sea affordance profiles of Ballynaughton, Port Charlotte, Beacharr, Glenvoidean, Giant's Grave, Crarae, Ardnacross II, Port Donain, Gort Na H-ulaidhe, Pointhouse, Greenland, Carnbaan, Bicker's Houses, Auchnaha, Achnagoul II, Creag Mhor, Auchoish, Gartnagreanoch, Achnagoul I and Blasthill.









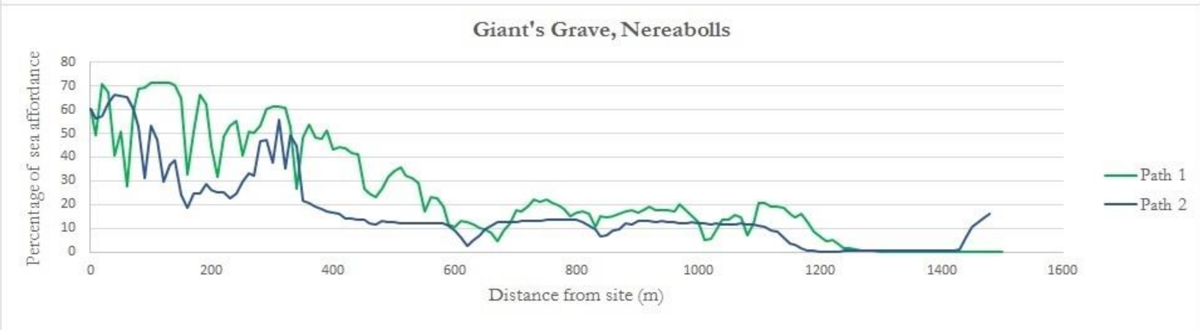


Figure 6.14 (2)


Crarae
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2
Path 3
Ardnacross II
Percentage of sea affordance
Distance from site (m)
Path 3
Port Donain
Percentage of sea affordance
Distance from site (m)
Path 1
Path 3
Gort na h-Ulaidhe, Glen Lussa
Percentage of sea affordance
Distance from site (m)
Path 1
Pointhouse
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2
Path 3

Figure 6. 14 (3)

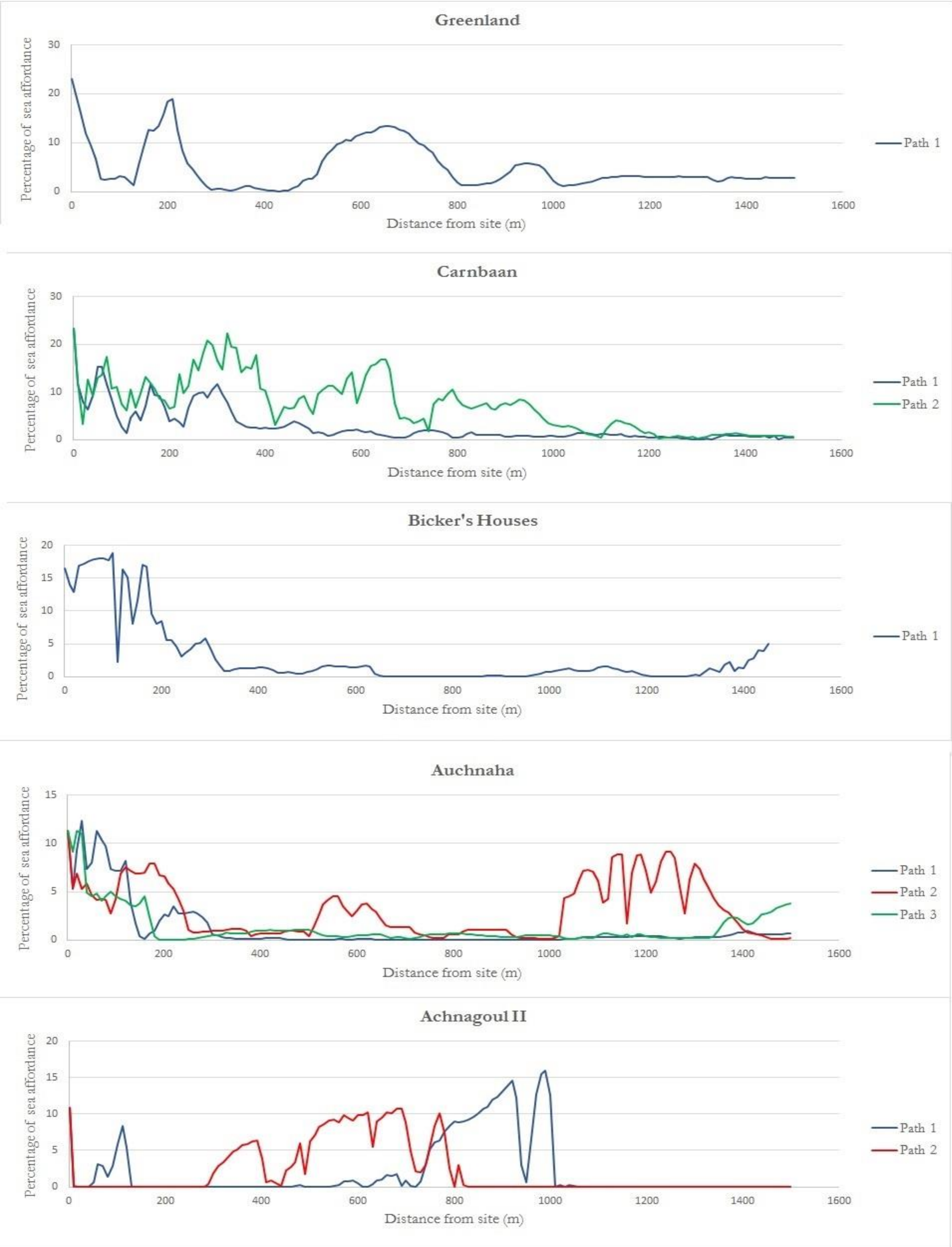
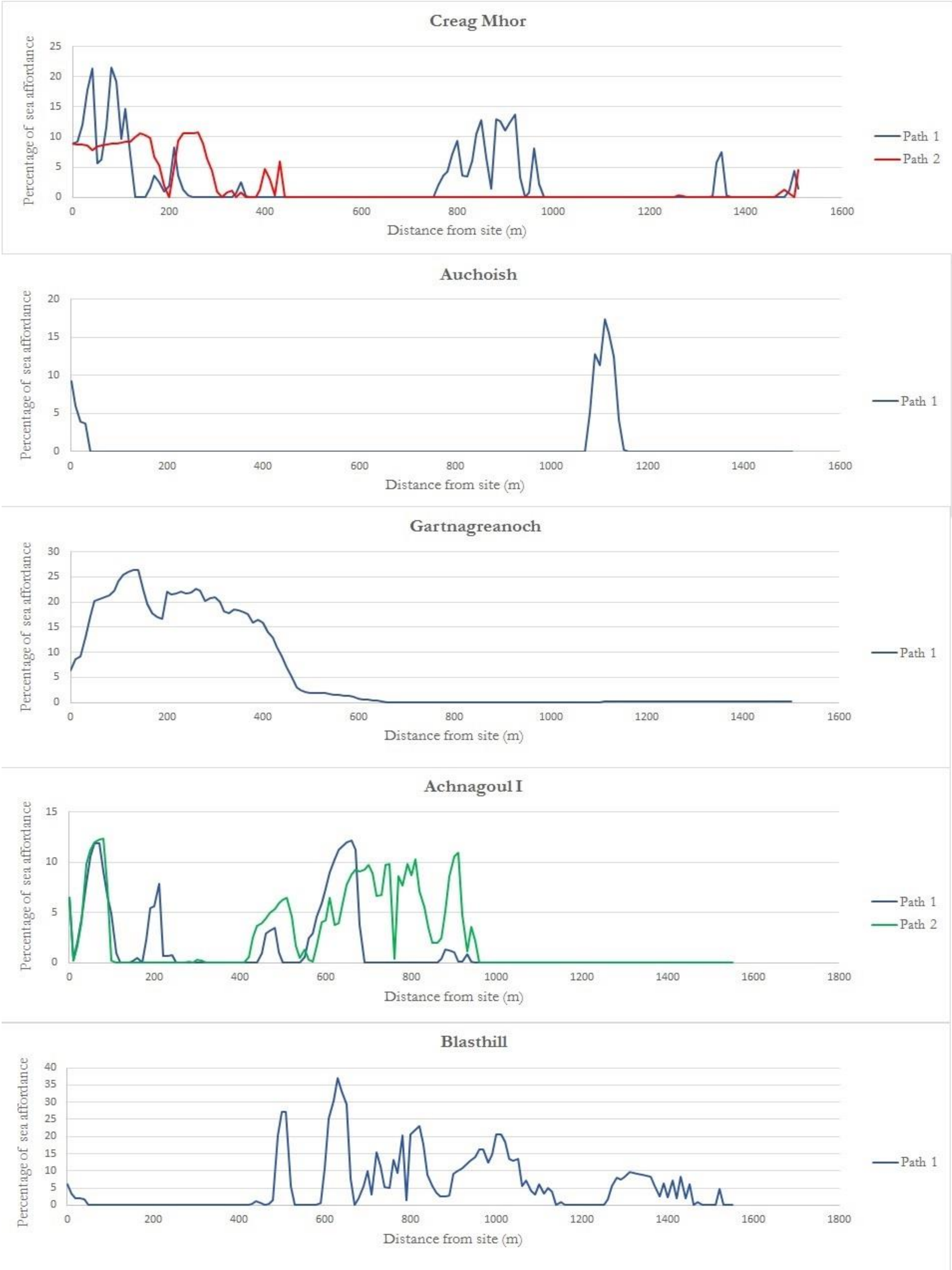

Greenland
Percentage of sea affordance
0
10
20
30
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Carnbaan
Percentage of sea affordance
0
10
20
30
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Path 2
Bicker's Houses
Percentage of sea affordance
0
5
10
15
20
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Auchnaha
Percentage of sea affordance
0
5
10
15
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Path 2
Path 3
Achnagoul II
Percentage of sea affordance
0
5
10
15
20
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Path 2

Figure 6.14 (4)


Creag Mhor
Percentage of sea affordance
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Path 2
Auchoish
Percentage of sea affordance
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Gartnagreanoch
Percentage of sea affordance
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
Distance from site (m)
Path 1
Achnagoul I
Percentage of sea affordance
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
1800
Distance from site (m)
Path 1
Path 2
Blasthill
Percentage of sea affordance
40
35
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
1800
Distance from site (m)
Path 1

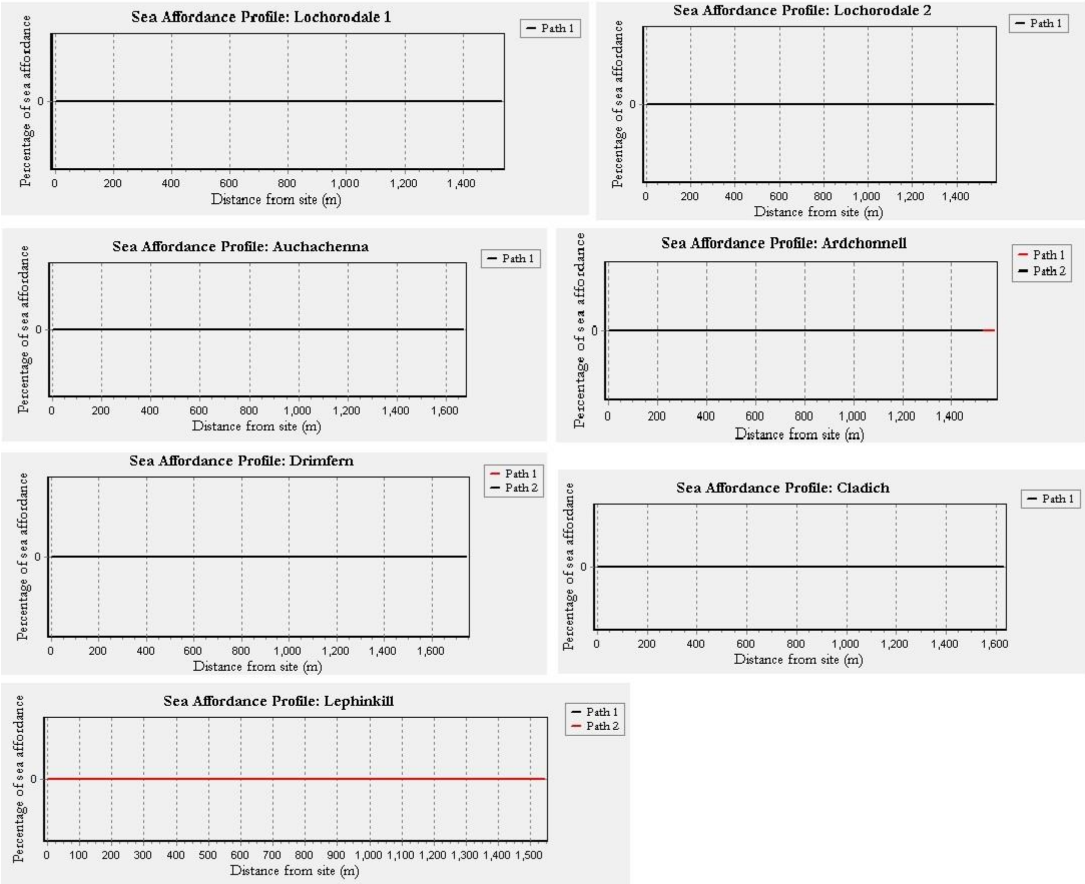


Figure 6.15: Sea affordance profiles of Lochorodale 1, Lochorodale 2, Auchachenna, Ardchonnell, Drimfern, Cladich and Lephinkill.

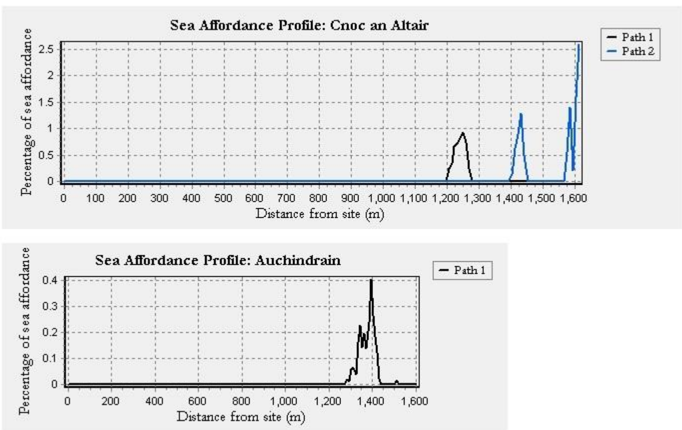


Figure 6.16: Sea affordance profiles of Cnoc an Altair and Auchindrain.

Analysis of Sea Affordance Profiles and Preview Locations

Affordance profiles show that, for seven sites (Lochorodale 1, Lochorodale 2, Auchachenna, Ardchonnell, Drimfern, Cladich, and Lephinkill), there are no affordance values either at monument locations or anywhere along the paths that approach them (see Figure 6.15). The paths to Cnoc an Altair and Auchindrain similarly lack sea affordance values, with the exception of temporary spikes in values at over 1200m from each site (see Figure 6.16).

Some affordance profiles depict dramatically higher affordance values along the paths that approach sites, in comparison to the values observed at site locations. A noteworthy example is Blasthill. As seen in Figure 6.17, several sharp increases in sea affordance occur along the path; and, at 630m (Blasthill Location E), affordance reaches 37.1%, which is six times the value found at the site. Moreover, given that this location is also at a much lower elevation, 22m below the location of the cairn site, it could be argued that it is a more suitable candidate for the placement of the megalithic construction. These findings suggest that prehistoric builders included other factor(s), than elevation and the affordance of sea views, in their criteria for the placement of the Blasthill monument.

The paths to Glenreasdale Mains and Barmore Wood hold higher sea affordance values than what are observed at the respective cairn sites, and in that sense exhibit similar cases to the path to Blasthill. The path to Glenreasdale Mains shows an increase in sea affordance at around 1000m from the cairn, reaching its maximum peak of 18.9% at 910m (at Glenreasdale Mains Location C), and gradually decreasing to 0% before reaching the site. Along Path 2 to Barmore Wood, there are several upticks in sea affordance, with a maximum peak of 9.4% at Barmore Wood Location B, 509m from the cairn site. This peak is followed by a sudden decline, with sea affordances dropping to 0% approximately 350m away from the site. These findings are of significance as any one of the aforementioned preview locations could have been chosen if prehistoric builders intended or wanted to incorporate a revelatory view upon approach, yet those locations were disregarded. One possible explanation may appear to be the higher elevation of the preview locations for Glenreasdale Mains and Barmore Wood. Unlike at Blasthill Location E, those locations are at much higher altitudes than their corresponding long cairns: Glenreasdale Mains Location C is 90m higher than Glenreasdale Mains, and Barmore Wood Location B is 54m higher than Barmore Wood. However, given that these preview locations fall along simulated pathways prehistoric people would likely have travelled over those areas on their ways to the cairn sites. Elevation may not, then, fully account for why these locations were overlooked or disregarded for site placement.

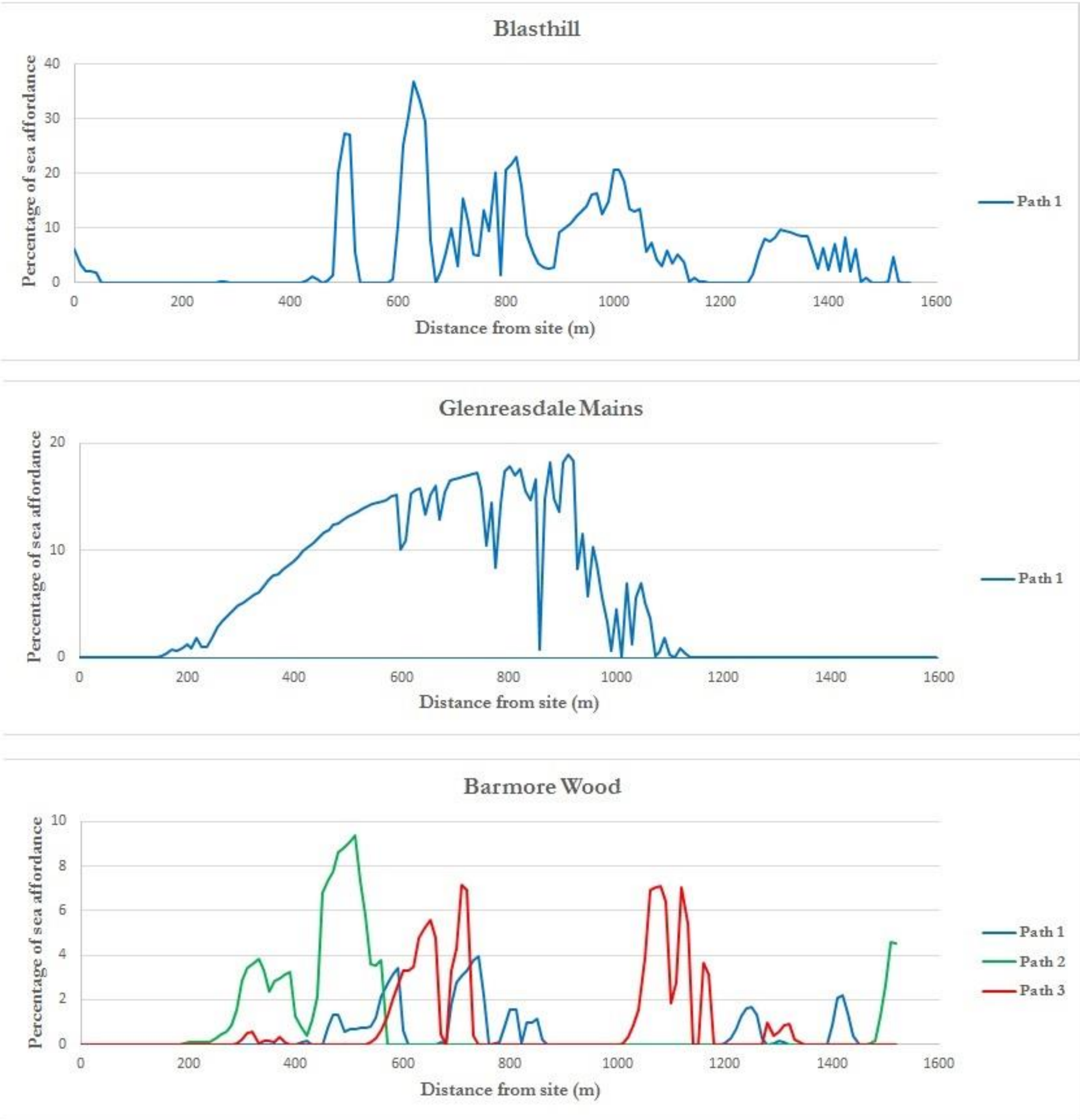


Figure 6.17: Sea affordance profiles of Blasthill, Glenreasdale Mains and Barmore Wood.

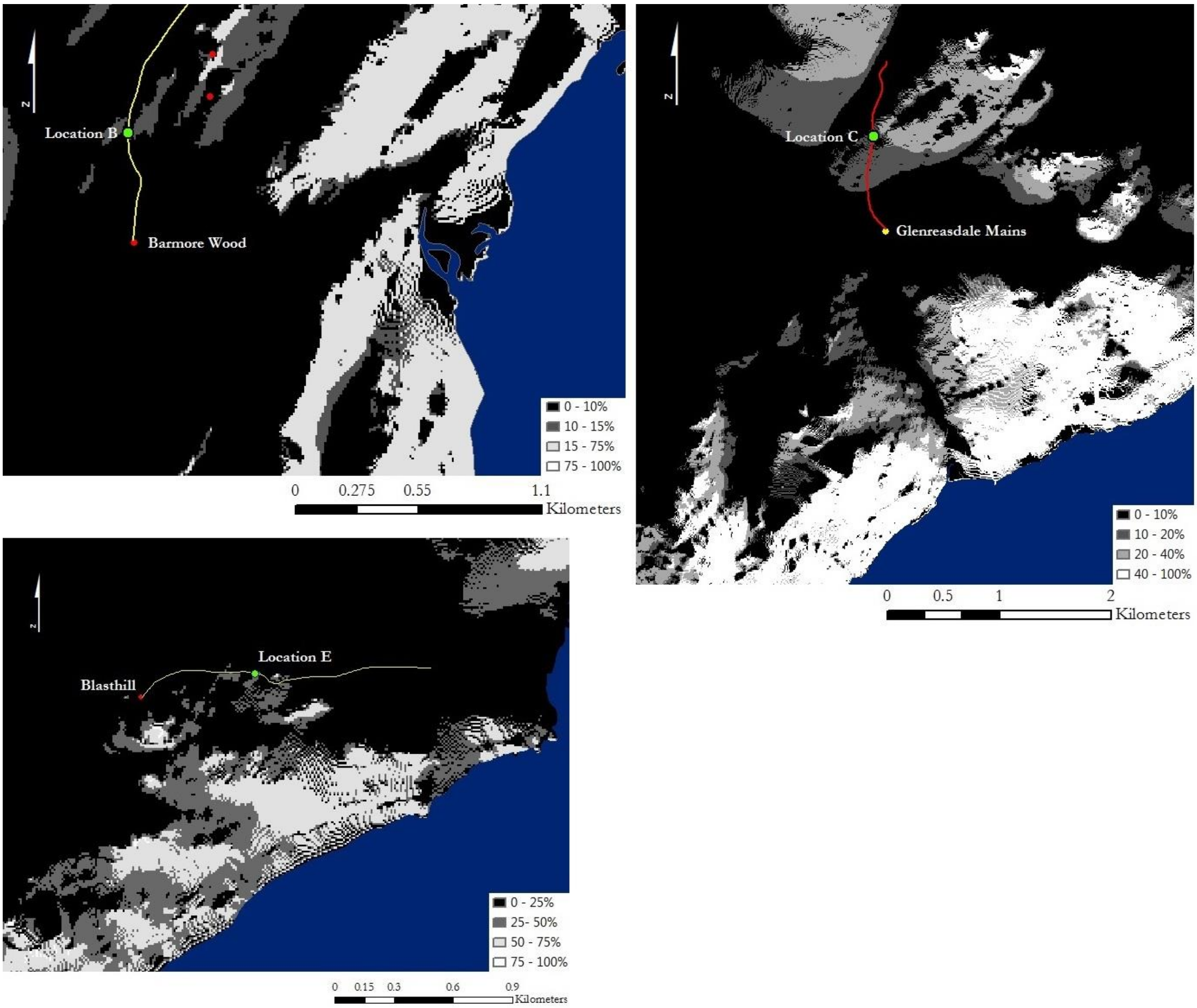


Figure 6.18: Affordance surfaces displaying the high sea affordance locations along the pathways, discussed above.

Comparison of Site Locations and Preview Locations with Horizon Panoramas

As seen in Figure 6.14, sea preview locations on the paths to many sites provide higher sea affordance values than what are observed at site locations themselves. These results raise the question of why monuments were placed where they are and not at preview locations instead, that is, if sea views were a vital criterion for the placement of these megalithic monuments. To investigate the significance of these results further, Horizon panoramas were generated to identify what the sea affordance values of preview locations translate to as sea views in the visual field of an observer and whether they are significantly different from the sea views at site locations, where present. See Figure 6.19, for Horizon panoramas of the views available from the sites and previews along the paths to the sites of Beacharr, Blasthill, Glenreasdale Mains and Barmore Wood.

Beacharr is situated in an area that affords substantial sea views, with affordance reaching as high as 74%. Nevertheless, the sea affordance profile of the path approaching the site indicates several significant sea previews. For instance, at 283m from Beacharr, identified here as Beacharr Location A, there is a preview with sea affordance reaching as high as 90%. Although this is a substantial difference in affordance from the site location, Horizon panoramas reveal that sea views at Beacharr Location A span across the horizon to a lesser extent (11.5º less) than the views from Beacharr. Furthermore, sea views appear to be more conspicuous across the horizon at Beacharr than they are at Beacharr Location A (see Figure 6.19). This can be explained due to the areas of sea visible from Beacharr being closer to that location and appearing larger to an observer than the areas of sea visible from Beacharr Location A, which is situated further inland. These considerations, then, support the notion that the cairn location at Beacharr was more ideally situated in terms of affording revelatory views of the sea.

Initial analysis of the sea affordance profile for the path that approaches Blasthill, discussed above, led to the discovery of Blasthill Location E, where an sea preview achieves six times the value of sea affordance found at the cairn site. It seemed that on the basis of those observed sea affordance values together with elevation data for the area, it is likely that prehistoric builders took some other factor(s) into account, other than elevation and the affordance of sea views, in their criteria for the placement of the Blasthill monument. Further comparison of the views available from Blasthill and Blasthill Location E confirms this conclusion. Horizon panoramas reveal that the sea views at Location E take up a deeper space in an observer's visual field making them more prominent, in addition to expanding an additional 100.5º across the horizon from that location—totalling 136º, from 66–202º, as opposed to the mere 35.5º of sea visible from Blasthill, which span from approximately 212.5–248º (see Figure 6.19). Hence, in terms of sea views, elevation, and the fact that it appears to have been an accessible point that prehistoric people traversed on their way to the Blasthill cairn, Blasthill Location E is an obviously preferable choice for monument placement. This lends further support for the notion noted above that it is likely that other factors beyond the affordance of sea views led prehistoric people to build at the Blasthill location instead.

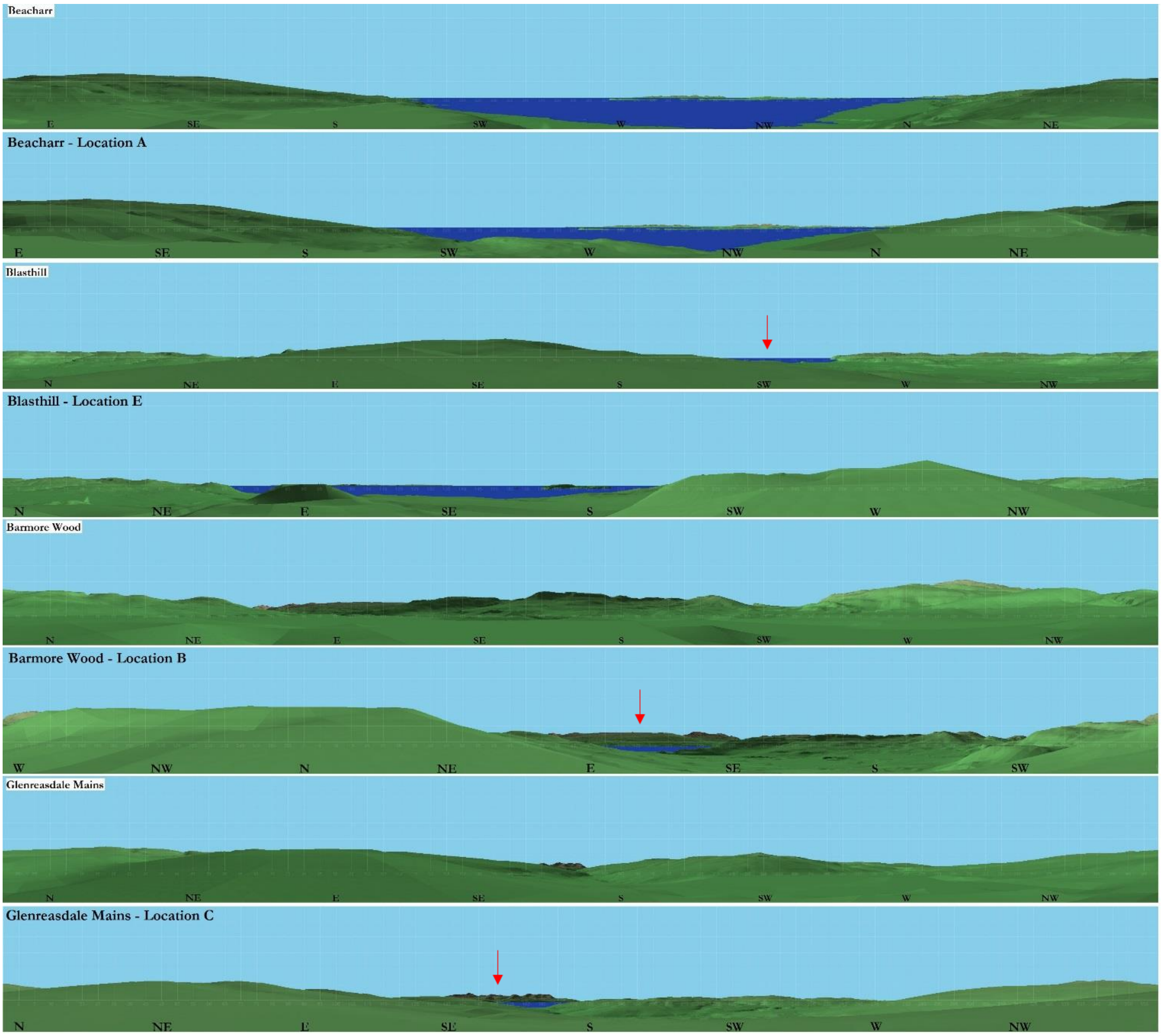


Figure 6.19: Horizon panoramas of Beacharr, Blasthill, Glenreasdale Mains and Barmore Wood as well as the views from the preview locations.
The red arrows indicate sea views.

Barmore Wood and Glenreasdale Mains both hold sea affordance values of 0%, and yet there are significant sea affordance values along the paths to those sites. The Horizon panorama of Barmore Wood Location B reveals a narrow view of the sea, appearing as a sliver and spanning 35.5º, from approximately 93.5–129º. A similar observation is made at Glenreasdale Mains Location C, which has a sea affordance value of 19%. At that location, sea views appear in a narrow gap between hills, spanning 24º, from around 150–174º. Although these sea views are not as obvious as those offered at other locations considered above, they are undoubtedly noticeable in the visual field. If there was a preference towards selecting specific locations of the landscape that offered narrow or restricted sea views, as has been suggested by Cummings and Whittle (2004), then these alternative locations would seem to be optimal for cairn construction.

Considering the Effect of Atmospheric Conditions on Preview Locations

Several of the locations considered above offer sea views that were either narrow or could be described as slivers of sea in the visual field. To determine more accurately what significance they held in what are, at certain times of the day and year, more typical atmospheric conditions in Argyll and Bute, Horizon panoramas were re-generated for those locations to examine the effect of atmospheric deterioration on those sea views. This technique was used to determine the nature of visibility on a perfectly clear day, the minimum distance of visibility required for sea views to start being noticeable and the minimum distance of visibility required for sea views to be substantially clear.

Horizon panoramas indicate that visibility of the sea could be critically impaired at both Barmore Wood Location B and Glenreasdale Mains Location C. At Barmore Wood Location B sea views are masked completely in times of poor weather, i.e., when visibility is less than 2km, only to appear distinctly when visibility reaches 6km (see Figure 6.20). A similar observation at Glenreasdale Mains Location C. When visibility is less than 3km, sea views were completely obscured at that location, and even when visibility is 6km, those views do not appear to be markedly noticeable (see Figure 6.21).

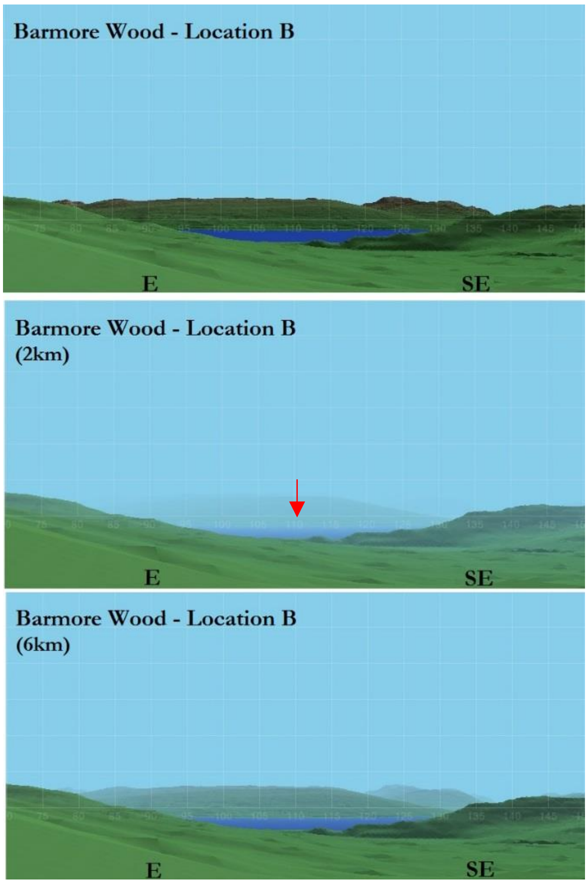


Figure 6.20: Top image shows the original Horizon panorama of Barmore Wood Location B, which depicts visibility on a clear day. The middle and bottom images show re-generated panoramas that depict atmospheric haze, with visibility set at 2 and 6km, respectively.
The red arrow indicates sea views.

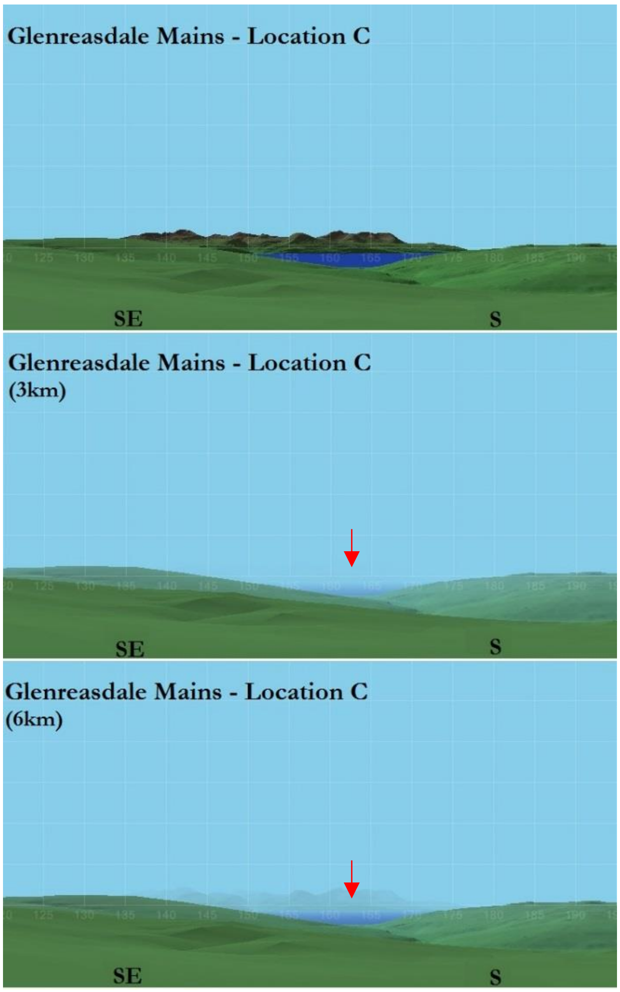


Figure 6.21: Horizon panoramas of Glenreasdale Mains Location C with and without atmospheric conditions. The top image shows the original Horizon panorama of Glenreasdale Mains Location C, which depicts visibility on a clear day. The middle and bottom images show re-generated panoramas that depict atmospheric haze, with visibility set at 3 and 6km, respectively. Red arrows indicate sea views.

A similar phenomenon is observed at Blasthill and at its preview location, Blasthill Location E. The areas of sea that are visible from those locations are situated far away, appearing on the distant horizon. Re-generated Horizon panoramas, thus, reveal that in both instances atmospheric conditions such as fog or haze seriously diminish the visibility of those views, although these conditions had a greater impact at Blasthill than at Blasthill Location E (see Figure 6.22). Again, this confirms the earlier conclusion that Blasthill Location E appears to be a more suitable option for monument placement. If the affordance of sea views held a place in prehistoric people's criteria for location choice, then it follows that it would be all the more important for sea views to remain visible, despite moderate levels of fog. However, that may not have been achieved with merely narrow and restricted sea views, such as those found at Blasthill. The findings here, therefore, give reason to suppose that if sea views were valued highly, more prominent views would be preferred, such as those seen at Blasthill Location E. Such a conclusion runs contrary to

Cummings and Whittle's (2004) suggestion that monuments may have been deliberately placed so as to achieve a narrow or restricted view of the sea.

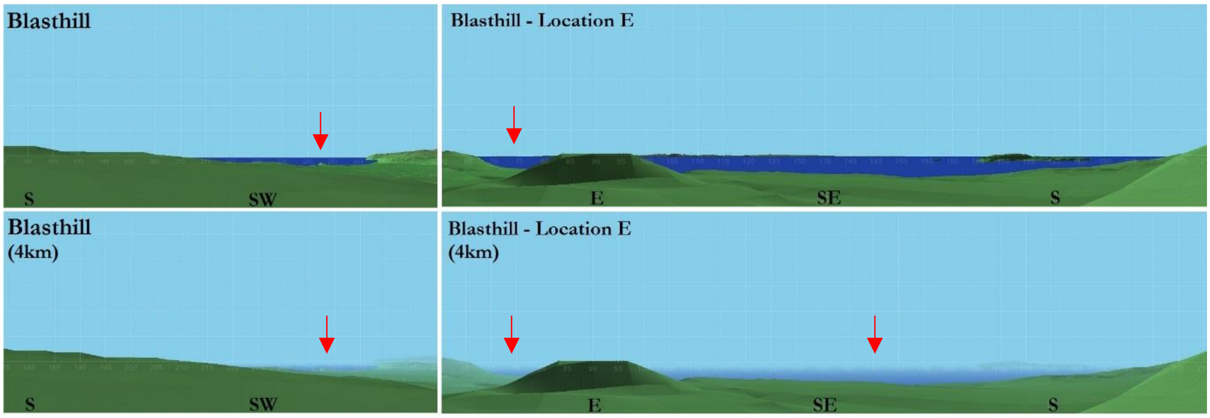


Figure 6.22: Horizon panoramas of Blasthill and Blasthill Location E with and without atmospheric conditions. The top left and right images show the original Horizon panoramas of Blasthill and Blasthill Location E, which depict visibility on a clear day. The bottom left and right images show re-generated panoramas of those locations that depict atmospheric haze, with visibility set at 4km. Red arrows indicate sea views.

6.4 Alignments of Long Cairn Axes, Sea Views and Pathways

Orientation of Cairns Relative to Sea Views

For various reasons, including poor cairn preservation, there were no available site plans for 13 of the 31 sites considered in this region. This meant that the complete range of details regarding the orientation of the long axes of those monuments could not be obtained. The missing information often concerned a cairn's precise orientation as opposed to the general direction it faces, which is sometimes available in records and databases, such as CANMORE. Further information that often could not be obtained regarded the extent of a structure, or whether its proximal or distal end faces a certain way. This is especially unfortunate as among the sites for which only partial information is available are Ardnacross II, Beacharr, Gartnagreanoch, Giant's Grave, and Crarae. These sites all offer revelatory views and it would, therefore, be of interest to examine the full extent of how those monuments might have referenced the sea during the time of their use.[24] Nevertheless, at least rough orientations of cairn long axes were able to be obtained for all 20 long cairn sites in this region that also offer sea views. It was found that all such sites offer one form of alignment or another with sea views (see Table 6.5).

[24] While there are no site plans for Auchindrain, Cladich, Drimfern or Cnoc an Altair, those sites have 0% sea affordance and were not considered as subjects of interest.

Table 6.5: Long cairn, pathway and sea view orientations.

Site name	Direction of seaward pathways	Direction of sea views	Orientation of monument long axis	Part of monument approached by pathway(s)
Gort Na H-ulaidhe, Glen Lussa	Path 1 (E)	E–S (93.5–164º)	E–W (85–265º)	side/distal end (uncertain)
Ardnacross II	Path 1 (SSW) Path 2 (SE) Path 3 (E)	NE–S (64–199º)	NE–SW (37–217º)	N/A
Greenland	Path 1 (E)	NE–S (60–157.5º)	S–N (177.5–357.5º)	side
Blasthill	Path 1 (SW)	SW–W (212.5–248º)	ENE–WSW (78–258º)	proximal end
Lochorodale 1	Path 1 (SW)	N/A	SE–NW (136–316º)	side
Lochorodale 2	Path 1 (NNW/N)	N/A	E–W (82–262º)	N/A
Beacharr	Path 1 (W/WNW)	SSW–N (201–15º)	NE–SW (35–215º)	N/A
Carnbaan	Path 1 (S) Path 2 (SSW)	SSE–WNW (160–286º)	NE–SW (50–230º)	Path 1: side/proximal end (uncertain) Path 2: proximal end
Glenvoidean	Path 1 (SW) Path 2 (SSE) Path 3 (SW)	SSE–NW (155–306º)	S–N (170–350º)	Path 1: side Path 2: proximal end Path 3: side
Bicker's Houses	Path 1 (SSE)	SSE–S (155–177º)	N–S (10–190º)	proximal or distal end (uncertain)
Ballynaughton	Path 1 (SE) Path 2 (E)	E–WSW (82.5–238º)	NE–SW (53–233º)	Path 1: distal end Path 2: side/proximal end (uncertain)
Cnoc an Altair	Path 1 (W) Path 2 (W)	N/A	NE–SW (53–233º)	N/A
Glenreasdale Mains	Path 1 (SSE) Path 2 (SE)	N/A	NE–SW (47–227º)	side
Port Charlotte	Path 1 (NE) Path 2 (E) Path 3 (SSE)	NE–SSW (35–201º)	NNE–SSW	Path 1: side Path 2: distal end (uncertain) Path 3: distal end (uncertain)
Gartnagreanoch	Path 1 (SSW)	SSW–SW (213–218.5º)	NE–SW (54.5–234.5º)	N/A
Auchoish	Path 1 (SW)	S–SSW (189–193º)	NNE–SSW (29–209º)	proximal end
Pointhouse	Path 1 (ESE) Path 2 (E) Path 3 (ENE)	NNE–NE (17–66º) ESE–SSW (102.5–207.5º)	E–W (90–270º)	uncertain
Lephinkill	Path 1 (WNW) Path 2 (W)	N/A	N–S (4–184º)	Path 1: side/distal end (uncertain) Path 2: side

Auchnaha	Path 1 (WSW) Path 2 (WNW) Path 3 (NNW)	SW–W (242.5–269º) W–NW (286.5–313º)	NE–SW (46–226º)	Path 1: proximal end Path 2: side Path 3: side/distal end (uncertain)
Giant's Grave, Nereabolls	Path 1 (E) Path 2 (W)	ENE–WSW (57.5–255º)	NE–SW	N/A
Auchindrain	Path 1 (S)	N/A	ENE–WSW (73–253º)	N/A
Creag Mhor	Path 1 (SSW) Path 2 (E)	NE–E (59–80º) S–SW (192.5–212º)	ENE–WSW (75–255º)	Path 1: proximal end Path 2: distal end
Achnagoul I	Path 1 (ESE) Path 2 (ESE)	ESE–SE (115–146º)	NNE–SSW (18–198º)	side
Achnagoul II	Path 1 (S) Path 2 (SE)	E–SE (110–152.5º)	NE–SW (44–224º)	side/proximal end (uncertain)
Barmore Wood	Path 1 (SW) Path 2 (S) Path 3 (E)	N/A	N/A	N/A
Crarae	All 3 Paths (SE)	NE–SSW (50–210º)	E–W	N/A
Auchachenna	Path 1 (SW)	N/A	SSE–NNW (148–328º)	side
Cladich	Path 1 (S)	N/A	NE–SW (56–236º)	N/A
Ardchonnell	Path 1 (SSW) Path 2 (E)	N/A	ENE–WSW (67–247º)	Path 1: proximal end Path 2: distal end
Drimfern	Path 1 (E) Path 2 (SE)	N/A	NNE–SSW	N/A
Port Donain	Path 1 (ENE) Path 2 (E) Path 3 (SSW)	E–S (86.5–167.5º)	NE–SW (40–220º)	Path 1: distal end Path 2: side Path 3: proximal end

Six cairns' long axes are directly aligned with the azimuthal direction of sea views, forming direct axis-alignments. These sites are: Carnbaan, Glenvoidean, Ballynaughton, Beacharr, Craerae, and Creag Mhor. Axis-alignments were also found for eleven further sites, the orientation of cairns' long axes match the general direction of sea views without directly aligning with the azimuthal range of available sea views. These sites are: Gort Na H-ulaidhe, Ardnacross II, Greenland, Gartnagreanoch, Blasthill, Bicker's Houses, Auchoish, Giant's Grave, Pointhouse, Port Charlotte, and Auchnaha.[25] To illustrate, at Gort Na H-ulaidhe, the long axis of the monument points to the east, to 85º, while sea views from its location span from east to south (93.5–164º). Thus, despite

[25] Port Charlotte may have offered a direct alignment, but only the general direction of its long axis was able to be obtained.

the long axis demonstrating a general alignment toward the sea, in an easterly direction, its orientation falls 8.5º outside the azimuthal range of the available sea views.[26]

These apparent misalignments might be explainable in terms of human error, and inaccuracies in measurements. Cairn material can be displaced over time, falling to one side of a monument more than the other and, therefore, giving the false appearance that a monument originally aligned in one direction over another. Bodies of water are similarly mutable, and may vary with a range of geological factors that have changed over the millennia. Hence, current measurements may not accurately reflect cairns original orientations. A further source of error is that not all sites in this study were (re)surveyed as a part of this thesis, so survey plans made by Henshall among others were used to obtain required information for a number of sites. Yet, as noted in Chapter 4, Section 2, Henshall's survey plans could deviate from the surveys conducted in the course of this research by as much as 10º, which is attributable to variance in magnetic north at the time that Henshall took her measurements in this region. Moreover, such deviation was especially frequent in survey plans of monuments from the southwest region of Scotland, where Argyll and Bute are situated. These deviations may, then, account for some instances where long cairn axes' orientations are slightly askew from the direction of sea views, but not all.[27] At Greenland, for instance, the alignment of the monument's long axis with sea views was askew by approximately 20º, which is outside the range of deviation seen in those survey plans.

In total, 17 long cairns in this region form general or direct axis-alignments with sea views. Twelve long cairns also evinced side-alignments in addition to axis-alignments. In all twelve cases these long cairns offered expansive sea views. Both direct axis-alignments and direct side-alignments are seen at Beacharr, Glenvoidean, Ballynaughton, and Crarae. Carnbaarn has a direct axis-alignment but also holds a general side-alignment. While Ardnacross II, Giant's Grave, Greenland and Port Charlotte only have general axis-alignments, they also have direct side-alignments. Gort Na H-ulaidhe, Auchnaha, and Pointhouse evince general axis-alignments as well as general side-alignments. Of notable interest is the placement of Pointhouse: the monument is situated in the landscape such that there are two separate sea views (in NE and S directions) on

[26] In the case of Giant's Grave, there is a lack of information, with only a general direction mentioned for orientation of the monument in the CANMORE database.

[27] The alignment of the long axes of Gort Na H-ulaidhe, Ardnacross II, Greenland, Gartnagreanoch, Blasthill, Auchoish and Bicker's Houses were respectively outside the direction of sea views by approximately 8.5º, 18º, 20º, 16º, 10º, 16º and 13 º.

either side of the monument, both running parallel to the monuments' long axis (see Figure 6.3 for the Horizon panorama for this location).

The remaining three long cairns in this region with sea views were placed parallel to sea views, forming side-alignments while forming neither direct nor general axis-alignments. At Port Donain and Achnagoul II, these side-alignments were direct, while Achnagoul I's long axis is askew 7º from being parallel to the narrow area of sea visible from that site.

Orientation of Pathways Relative to Sea Views and Monuments

Thirty five pathways were identified as potential means of accessing from a seaward direction the 20 cairns sites in this region that offer sea views. As described in Section 6.3, all 35 pathways offer revelatory views. A comparison of these 35 paths with the azimuthal directions of sea views revealed that the angle of approach for 25 paths, to 13 sites, formed a 'direct line of sight' with the sea, thus framing the respective monuments against a backdrop of the sea for people arriving at the sites. This is the case for all (22) paths that approach the 12 sites of Gort Na H-ulaidhe, Greenland, Blasthill, Beacharr, Carnbaan, Glenvoidean, Bicker's Houses, Ballynaughton, Port Charlotte, Giant's Grave, Achnagoul I and Creag Mhor. A direct line of site is also found on four paths, to two further sites: Paths 1 and 2 to Auchnaha, and Paths 2 and 3 to Ardnacross II.

The nine exceptions are as follows. Path 3 to Auchnaha does not align directly with the direction of the sea. Path 1 to Achnagoul II has an angle of approach that indirectly frames the monument against a backdrop of the sea. The paths to Gartnagreanoch and Auchoish only form general alignments with the narrow sea views in the distant horizon. Moreover, despite revelatory views being available on all three paths to Crarae and Paths 1 and 3 to Port Donain, it seems that none of those paths form a direct alignment with sea views.[28]

At some site locations, the simulated corridors depict a certain amount of fluidity for movement in and around monuments' immediate vicinities. This means that there are a number of ways to access some monuments that are calorically comparable. It was also found that often those different ways to access monuments hold relatively similar affordance values to each other. The site of Gort Na H-ulaidhe presents an example of this. As seen from the projected caloric cost of travel (see Figure 6.23), the most efficient way to reach the site is through Path 1 (marked in black), however, the monument could also have been reached via an alternative route (indicated

[28] The remaining 11 sites are placed in locations that do not afford sea views.

in red), which holds comparative caloric costs. A comparison of the sea affordance profiles of each of those paths exhibit only slight variations between them (see Figure 6.24), suggesting that prehistoric people could have accessed the site from either path and had similar sea views. Ultimately, for the purposes of this study, the only notably difference between these paths is that Path 1 approaches the monument towards its side while the alternative route approaches the monument towards its distal end, which would have affected how the monument was framed against available sea views and, moreover, in what further ways the monument might reference the sea.

In instances such as these, where more than one plausible route exists, it is not clear which path may have been preferred by prehistoric people. Accordingly, the direction of approach relative to monument orientation is noted as being 'uncertain' (see Table 6.5). Examples include Auchnaha Path 3, where slight variations along the last leg of the journey could have resulted in the site being approached either towards its side or its distal end. Similarly, there are slight variations along Path 2 to Ballynaughton, Path 1 to Carnbaan, and Paths 1 and 2 to Achnagoul II, which are all sites that could have been approached either towards their sides or proximal ends.

Owing to variations in pathways' final legs, some monuments could, therefore, be accessed from multiple points. Nevertheless, those different access points would often yield similar sea views. This is largely due to, first, pathways' general angles of approach being in the same direction, despite variations (see Figures 6.23 and 6.24), so that angles made between observers' vantage points on those paths and the sea are identical. Second, as the variations in pathways are in extreme proximity to each other, the same features in the landscape that obscure or reveal sea views from locations on one path would frequently do so for other path as well. Therefore, it was often deemed unnecessary to draw in and present each and every minor variation in such paths. Rather, it was merely noted that there were such possible variations in relevant cases. As described above, such details may have been of significance if prehistoric builders deliberately chose topographic locations overlooking the sea and orchestrated the approach to monuments so as not only to achieve a revelatory view of the sea but also to frame monuments against a backdrop of the sea, whether with a structure's proximal or distal end, or its side.

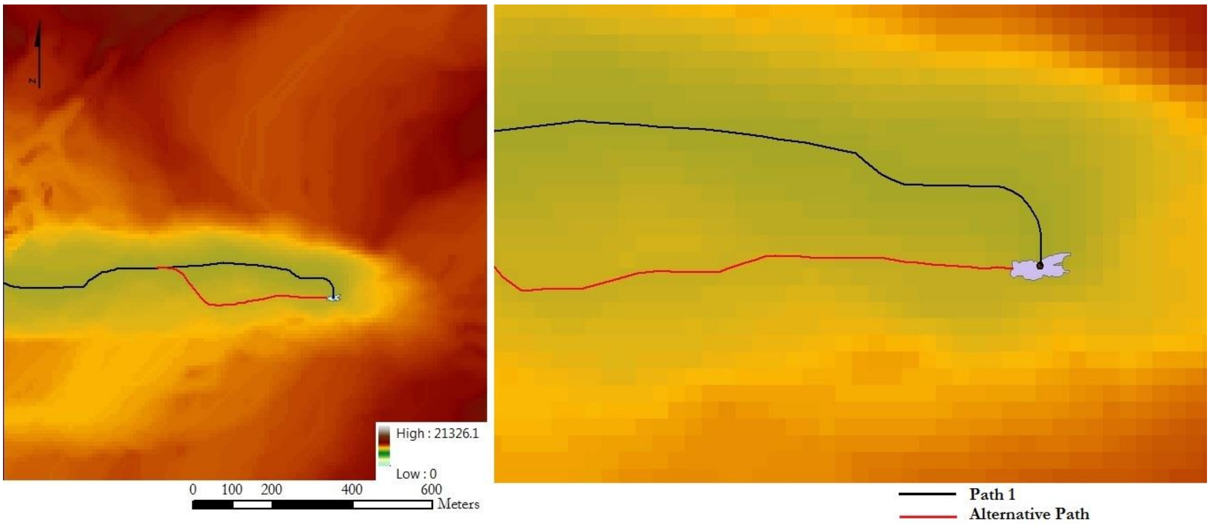


Figure 6.23: Path 1 and an alternative path approaching Gort Na h-Ulaidhe, Glen Lussa.
Left image shows the projected caloric cost of travel following the corridor analysis around the site of Gort Na h-Ulaidhe, Glen Lussa. Right image is a close-up, showing the angle of approach of Path 1 and the alternative path relative to the orientation of the monument.

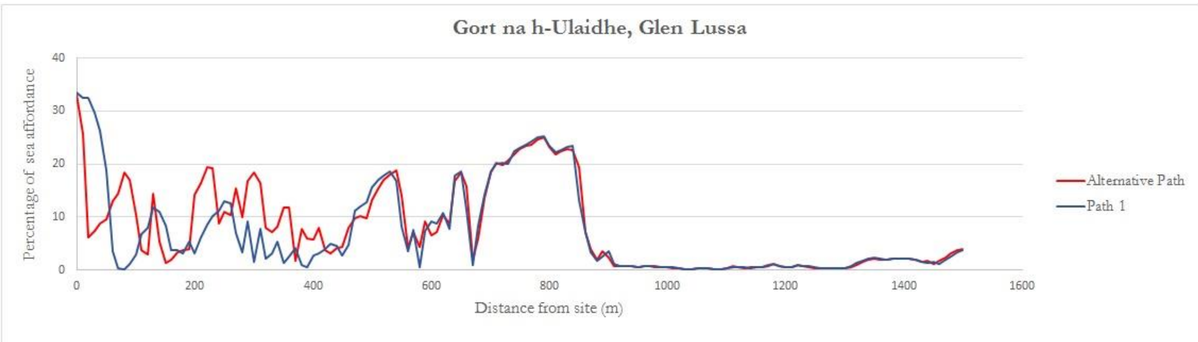


Figure 6.24: The comparison of sea affordance profiles of Path 1 and the alternative path at Gort Na H-ulaidhe, Glen Lussa.

In the kinds of situations described above, minor variations in pathways yield equivalent revelatory views. However, there are further cases, where multiple paths to a site lead to noticeably varying sea affordance values. These are cases where different paths approached sites from different directions. Take, for instance, the paths to Glenvoidean. Three paths were identified as offering revelatory sea views upon approach to the site, two of which (Paths 1 and 3 both heading in a south-westerly direction) approach the monument from the side, while Path 2 (heading in a south-easterly direction) approaches the monument towards its proximal end. Port Donain is another noteworthy example. The two paths that offer revelatory sea views approach the monument towards its opposite ends: Path 1 approaches the monument's distal end, while Path 3 approaches its proximal end. These differing pathways lead to two differences in how these monuments could be experienced. First, as discussed above, monuments could be framed differently against sea views in the background, with or without forecourts in view, for instance. Second, depending on which path is taken, sea views might or might not be obscured from observers until their arrival. As seen in the affordance profiles for these sites (Figure 6.14), these differing pathways can, then, lead to marked differences in the extent that the observer's final view of the sea was 'revelatory', or revealed in a dramatic way upon their approach. Thus, the observer's experience of the monument and site is largely shaped by and dependent on which route is taken. In instances such as these, where there are relevant differences between paths, all such paths were examined.

Investigation of the direction of pathways relative to monument orientation revealed that at seven sites paths approach monuments towards their proximal ends forming proximal–distal sightlines. This is seen at: Path 1 to Blasthill, Path 2 to Carnbaan, Path 2 to Glenvoidean, Path 1 to Auchoish, Path 1 to Auchnaha, Path 1 to Creag Mhor, Path 3 to Port Donain. Only three paths approach monuments towards their distal ends, and two of these create distal–proximal sightlines. These are: Path 2 to Creag Mhor, and Path 1 to Port Donain. The only path approaching Bicker's Houses does so towards one of the monument's ends, but due to the poor state of the cairn remains it is difficult to ascertain whether that is the proximal or distal end. Nevertheless, the path to Bicker's Houses offers either a proximal–distal sightline or a distal–proximal sightline. At eight sites, paths approach monuments towards their sides in a way that creates a sideway sightline. This is observed on Path 2 to Ardnacross II, Path 1 to Greenland, Path 1 to Beacharr, Path 1 to Ballynaughton, Path 2 to Port Charlotte, Paths 2 and 3 to Auchnaha, Paths 1 and 2 to Achnagoul I, and Path 2 to Achnagoul II. Pathways approach the sides of the cairn structures at three of these sites, Auchnaha (Path 2), Achnagoul I (Paths 1 and 2), and Greenland (Path 1). Thus, at least one form of sightline was found at each of 17 cairn sites, out of a total of 20 sites that offer sea views in this region.

6.5 Summary

With 31 long cairn sites, all in relatively close proximity to bodies of water, Argyll and Bute presented an ideal region for the type of study conducted in this thesis. Statistical analysis of the affordance surfaces did not support the notion that these cairns reference the sea with their placement within the landscape. Furthermore, qualitative investigation of the landscape contexts of these sites revealed that there were often seemingly suitable locations with higher affordance values and that were not chosen for monument placement. As the sample of sites in its entirety does not achieve unique affordance values or sea views, a further inference that may be drawn is that, as mentioned in 6.2, there were likely other factors not considered here which overrode prehistoric peoples' preferences for monument placement. In other words, while prehistoric people may have, nevertheless, held a preference to reference the sea by building in places that achieved greater sea views, other factors may have held greater importance, such as proximity to other places of significance, other symbols of importance, and practical considerations such as shelter from wind and accessibility to building resources.

Further interrogation of this collection of 31 sites revealed that 20, a significant proportion of these cairns, are constructed in locations that achieve revelatory views, a particularly significant way to reference the sea. Again, sites are not always placed in optimal locations to afford revelatory views, and this is confirmed by consideration of atmospheric conditions (facilitated by Horizon panoramas). However, that fact alone does not establish that those views were not an intended and or valued feature of the monuments that afforded them. To the contrary, support for that notion is found in the way that the cairns are orientated, relative both to the pathways that approach them and to the direction of sea views taken together. Of the 18 sites that afford revelatory views and for which sufficient data was available for investigation, 13 present reasonable cases of alignment of long axes towards sea views, 5 of these being direct and 8 slightly askew though still of interest. In addition to the 17 of 20 sites with sea views that demonstrate at least one form of sightline, these are non-trivial cases that support the contention that the long cairns of Scotland were, at least sometimes and at least in this region, placed so as to reference the sea.

Chapter 7: Analysis of the Long Cairns of the Highlands

The Highlands of Scotland are an expansive region that include the Straths, the Firthlands, and Caithness. It is the largest area examined in this study and holds 49 long cairns, the largest amount out of any region in Scotland. These cairns are grouped together in this chapter as a set of monuments for the reason that, as discussed in Chapter 3, they share common characteristics indicative of a common culture. Hence, there is an interest in determining whether these cairns share further trends, such as the claim investigated in this thesis, of whether these monuments reference the bodies of water that they often overlook, which are in this case the North Atlantic Ocean, the North Sea, the Moray Firth, and various smaller firths and lochs in the region (such bodies of water are generically referred to as 'sea'). These cairns were, therefore, investigated to determine whether and how they may reference the 'sea' in any of the three ways described in Chapter 4.

First, sites were assessed in terms of their affordance of sea views, to determine whether their locations are either typical or unique in that respect in the landscapes in which they are situated. This assessment was conducted both quantitatively, in terms of the statistical consideration of the sites as a collective as discussed in Section 1, and in terms of a qualitative consideration of their landscape contexts on a site by site basis, as discussed in Section 2. Second, as described in Section 3, sites were assessed to determine whether they offer 'revelatory views' of the sea, as dependent on the pathways from which these monuments were likely to have been approached and whether sea views are obscured to observers on their approach. Third, the details of sea views and revelatory views, where present at long cairn sites, were compiled and considered in Section 4, alongside the orientation of their long axes and the pathways that may have been used to approach them.

7.1 Sea Affordance Surfaces and Statistical Considerations

There are 49 long cairns in the Highlands. Two sites, Sithean Mor and Kinbrace Hill, are placed too far inland, at 11.9km and 20.3km respectively, for the sea affordance analysis to be conducted while the remaining 47 sites are situated less than 10km from the present-day shoreline and were, therefore, treated as suitable for consideration of sea affordance.[29] The distribution of these 47

[29] Unless otherwise noted, all cairn sites in this chapter refer to monuments within the council area of the Highlands.

sites is depicted below, in Figure 7.1. A majority of 30 sites are situated in close proximity to the coast, between 0–5km.[30] Thirteen sites are situated in a mid-range category, between 5–7.5km from the coast, and four sites are found further from the coast, at a distance ranging between 7.5–10km.

The long cairns of the Highlands can be divided into groups that are situated in three topographical zones: the Straths, the Firthlands and Caithness. Exceptions are the two sites, Ardnamurchan and Pairc A' Chlaiginn, which are outside the boundaries of these three zones and are considered here as outliers.[31] To aid in analysing the cluster of sites found in the Strath of Kildonan, along the River Helmsdale, the Straths zone was further divided into the two subcategories, of the particular cluster of sites in the Strath of Kildonan and other sites in that zone considered separately (see Figures 7.2, 7.3, 7.4 and 7.5 for site distribution maps of these zones and subcategories).

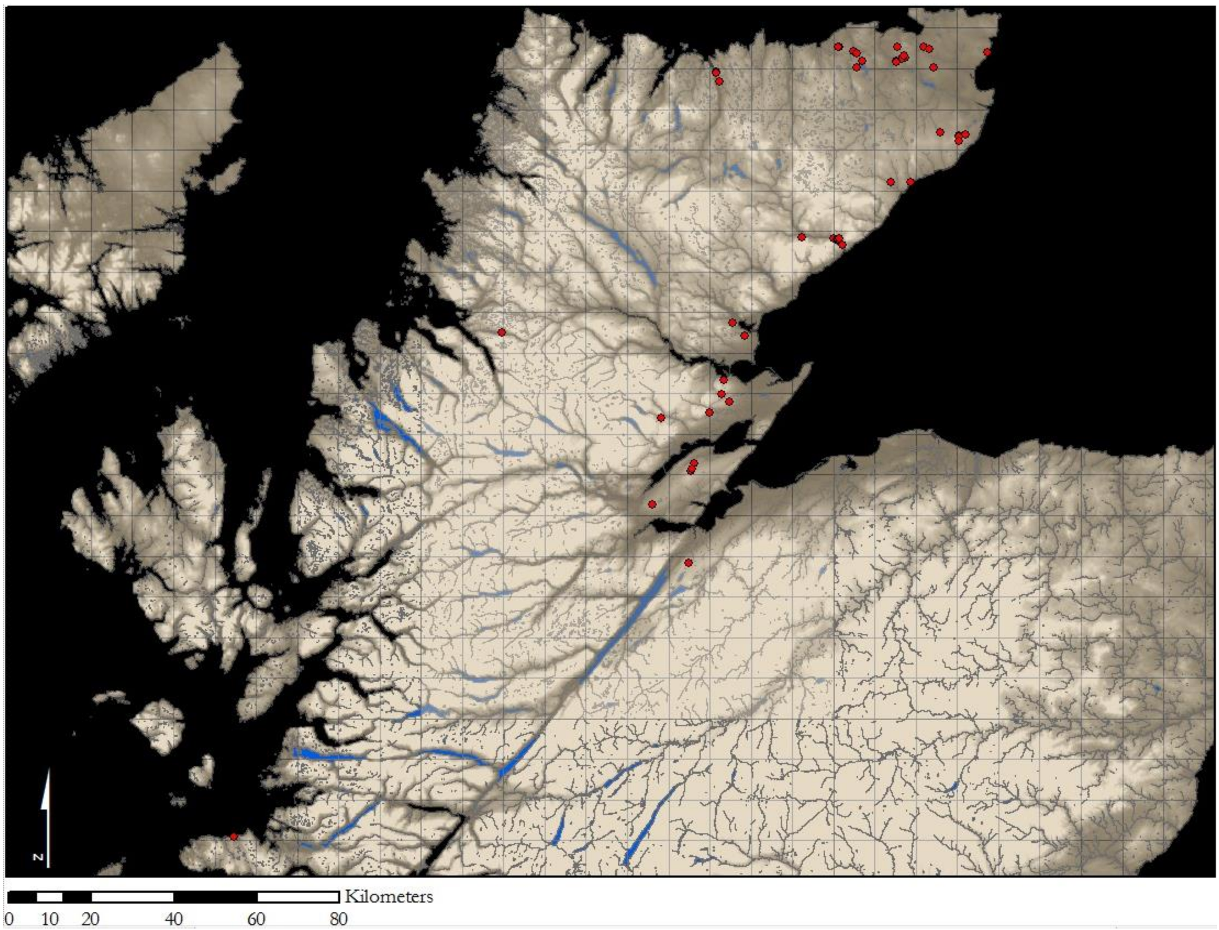


Figure 7.1: Highland site distribution map.

[30] Of these 30 sites, 12 are placed in extreme proximity (0–2.5km) while the remaining 18 are found in moderate proximity to the coast (2.5–5km).

[31] Ardnamurchan and Pairc A' Chlaiginn belong to the parish of Ardnamurchan and parish of Lochbroom, respectively.

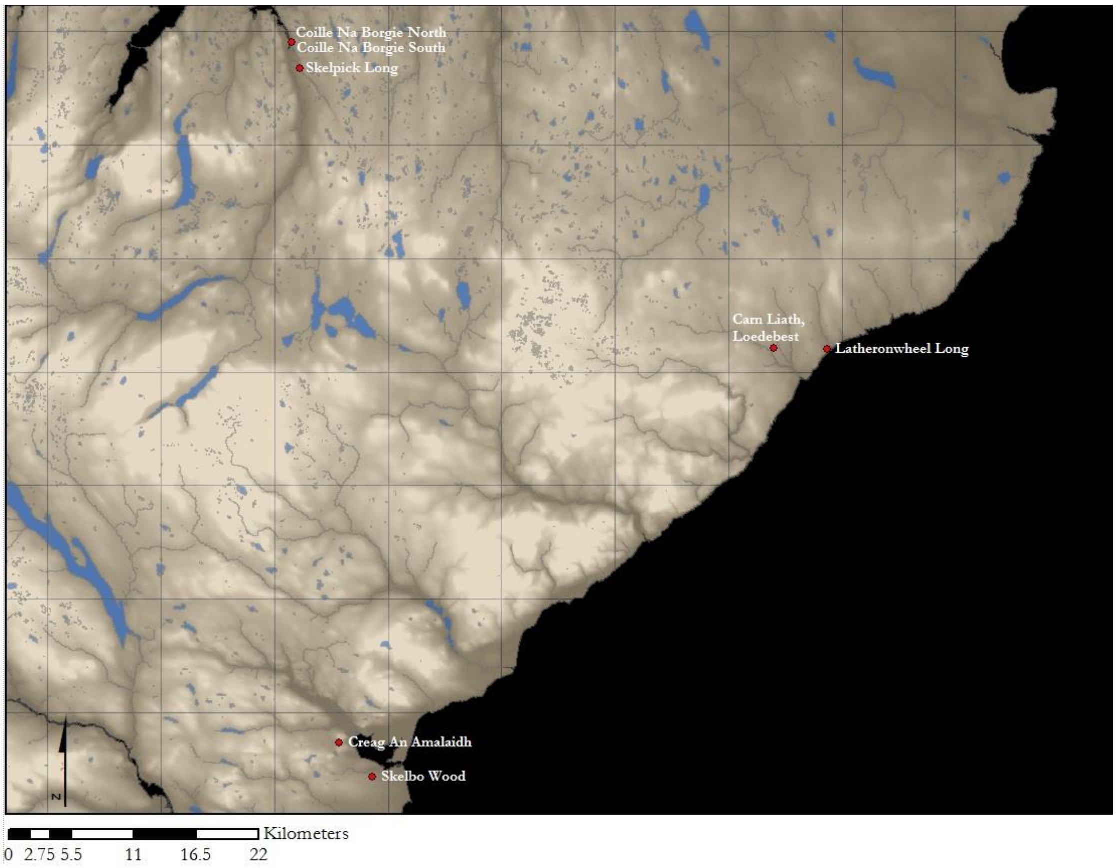


Figure 7.2: Sites in the Straths Zone (except for sites along the Strath of Kildonan).

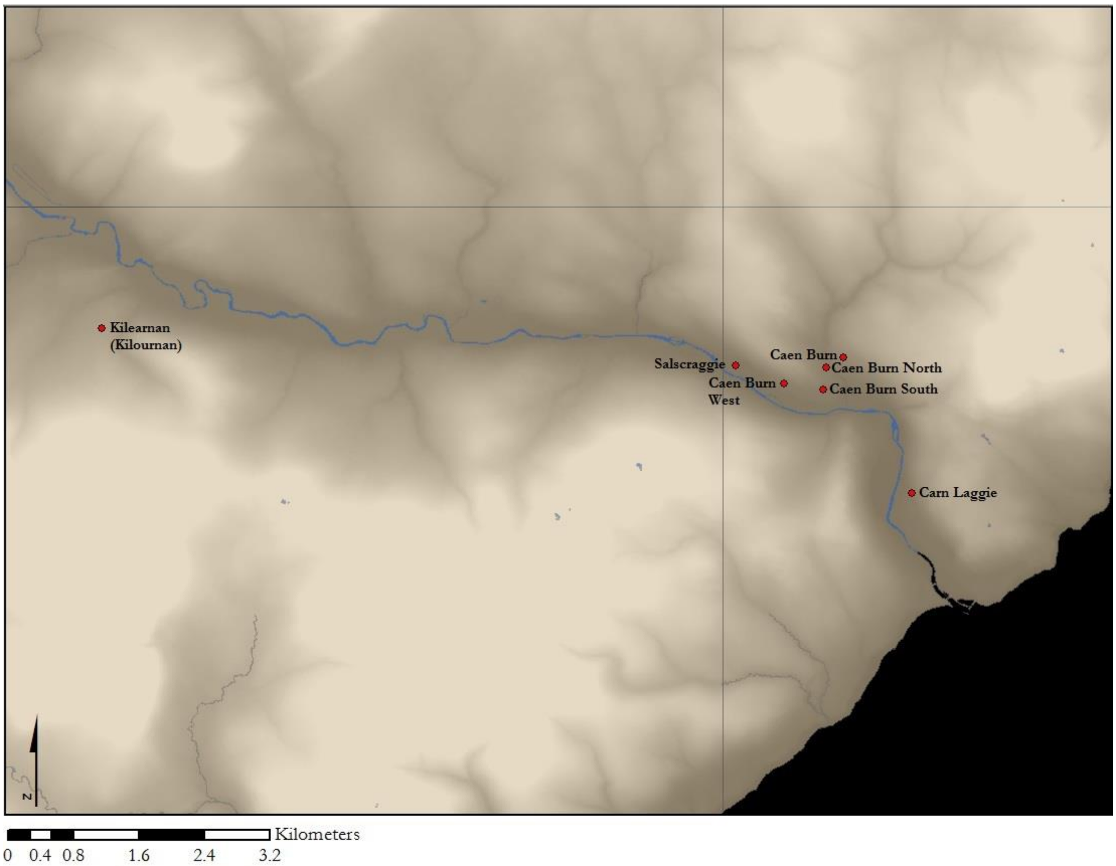


Figure 7.3: Sites in the Straths Zone (only those sites found along the Strath of Kildonan).

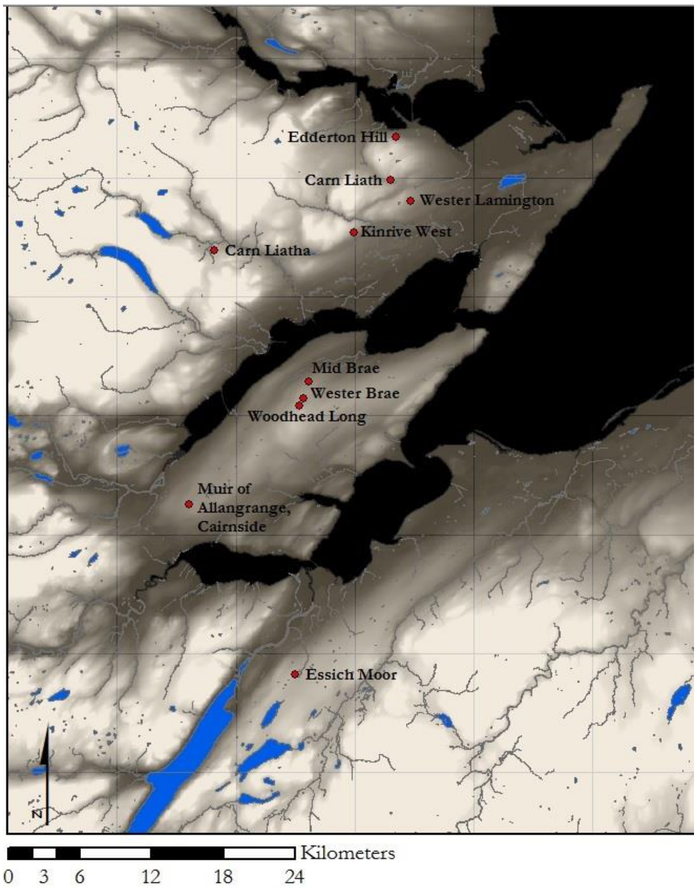


Figure 7.4: Sites in the Firthlands.

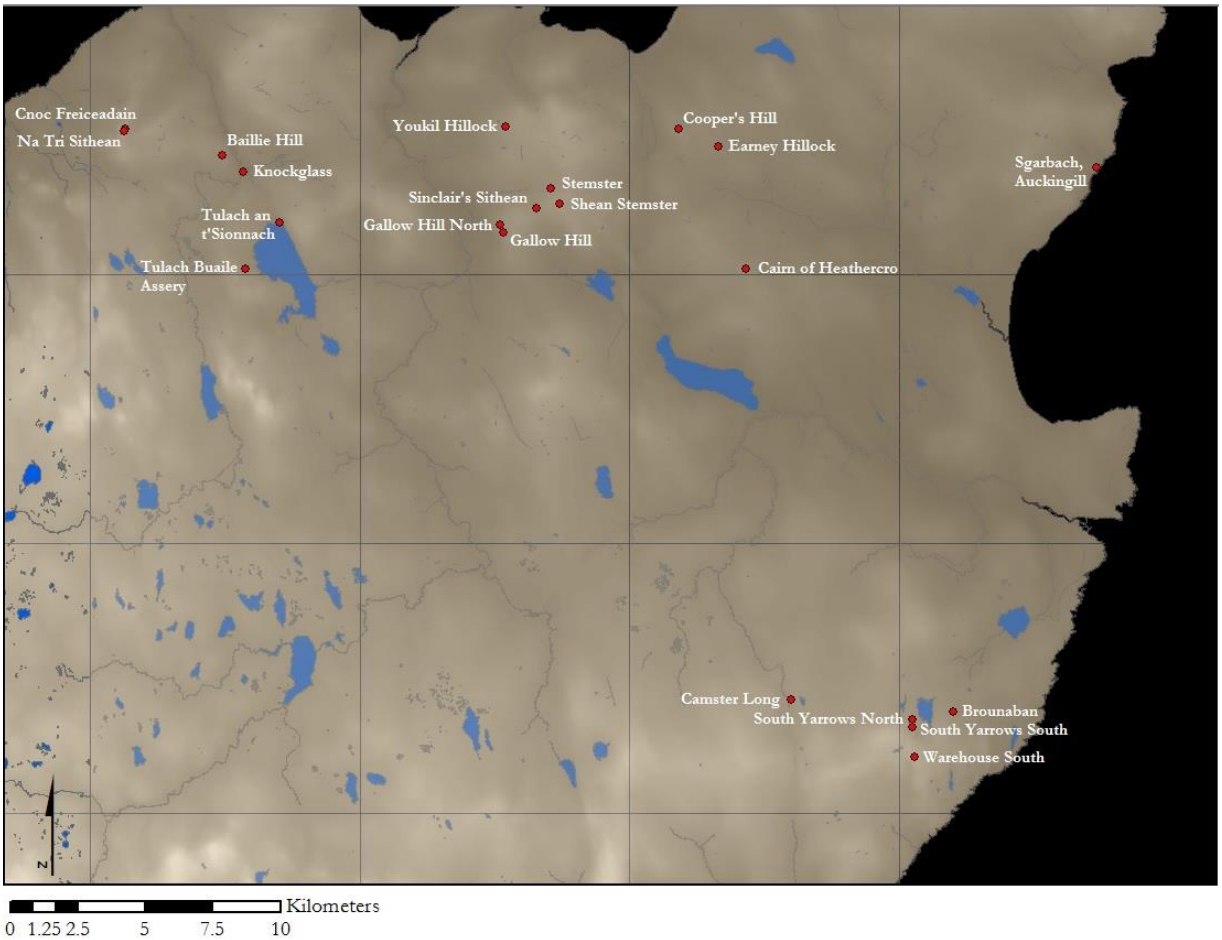


Figure 7.33: Sites in the Caithness zone.

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	Sea Affordance %
1	Coille Na Borgie North	21	594.76	147.34	3.47
2	Coille Na Borgie South	16	527.22	187.10	0.93
3	Skelpick Long	41	68.22	1982.22	4.08
4	Cnoc Freiceadain	126	1028.41	3234.23	27.89
5	Na Tri Sithean	130	1098.15	3259.41	33.64
6	Baillie Hill	81	450.37	5908.03	6.32
7	Tulach an t'Sionnach	66	2.58	7145.15	0.00
8	Tulach Buaile Assery	86	388.86	9303.16	0.00
9	Knockglass	42	30.90	6764.41	0.00
10	Youkil Hillock	98	314.56	4023.61	29.57
11	Shean Stemster	126	1315.24	6233.16	0.00
12	Stemster, Sinclair's Sithean	96	778.54	6709.04	0.00
13	Stemster	95	840.52	5913.29	0.00
14	Gallow Hill North (Sordale Hill Long)	91	1032.90	6982.22	0.00
15	Gallow Hill	96	1246.25	7280.54	0.00
16	Cooper's Hill	75	893.51	3183.66	39.20
17	Cairn of Heathercro	81	513.80	8773.37	19.34
18	Earney Hillock	60	1415.98	4503.43	0.00
19	Sgarbach, Auckingill	20	345.46	106.11	22.42
20	Camster Long	110	126.44	7150.17	0.00
21	South Yarrows North (Yarhouse)	129	266.73	3340.94	16.28
22	South Yarrows South (Yarhouse)	142	438.82	3164.37	19.94
23	Warehouse South	181	550.97	2352.66	22.47
24	Brounaban	92	592.22	2593.23	30.67
25	Latheronwheel Long	34	306.99	219.86	57.52
26	Carn Liath, Loedebest	109	324.68	3357.13	5.56
27	Kilearnan (Kilournan)	147	817.24	9634.76	0.00
28	Salscraggie	22	117.03	3189.21	0.00
29	Caen Burn West	43	191.94	2636.57	0.00

30	Caen Burn South	40	246.84	2293.22	0.00
31	Caen Burn North	40	192.68	2511.88	0.57
32	Caen Burn	73	231.13	2541.72	11.79
33	Carn Laggie	29	195.36	717.90	3.55
34	Creag An Amalaidh	135	605.35	1176.51	0.00
35	Skelbo Wood	77	542.46	1202.62	25.37
36	Wester Lamington	151	849.02	5097.06	22.23
37	Carn Liath	176	231.70	4251.38	3.34
38	Edderton Hill	121	1236.33	638.74	93.45
39	Kinrive West	176	710.86	5787.96	95.13
40	Woodhead Long	187	1870.49	3727.78	1.03
41	Mid Brae	147	847.34	2602.85	9.74
42	Wester Brae	176	1855.99	3380.15	1.62
43	Muir of Allangrange, Cairnside	140	1525.35	3426.53	0.00
44	Essich Moor (Carn Glas)	211	84.04	6194.72	56.45
45	Pairc A' Chlaiginn	88	261.88	5203.30	0.00
46	Carn Liatha	207	390.09	7944.49	0.00
47	Ardnamurchan, Cladh Aindreis	10	50.52	120.51	26.25

Table 7.9: Results of sea affordance analysis.

Sea Affordance Analysis and Verification of Results

The Highlands were sub-divided into 22 micro-regions to reduce processing time. It took a total of 51 days (1229hrs) to generate all sea affordance viewshed maps for the 22 micro-regions. These surfaces were then used to extract the percentage of sea affordance held at each of the 47 site locations (for a detailed summary of these findings see Table 7.1). It was found that 18 sites were placed in locations that offered sea affordance values of 0%; however, contrary to that result, standard viewshed analysis of those locations indicated sea views at 7 of those 18 sites (Tulach Buaile Assery, Knockglass, Gallow Hill North, Gallow Hill, Sinclair's Sithean, Shean Stemster, and Earney Hillock). The reason for this discrepancy is that the parts of the sea that may be visible from these locations are found beyond the areas of sea tested in the sea affordance analysis, which are defined by a 3km stretch or buffer from the coastline.[32]

The views available from these seven sites were further investigated using Horizon panoramas, which reveal that the areas of sea shown to be visible under the standard viewshed tests were, in each instance, too distant on the horizon to be noticeable, if at all visible. At Sinclair's Sithean, for example, a standard viewshed depicts areas of sea to be visible in the NW–NNW and SE–SSE, at respective distances of approximately 29km and 50km from the site (Figure 7.6). However, the Horizon panorama for that location reveals that those areas of sea are too distant to register as visible to an observer (Figure 7.7). Similar observations are made from Horizon panoramas for the locations of Tulach Buaile Assery, Knockglass and Earney Hillock, which demonstrate that sea views are too distant to be seen with the naked eye (see Figure 7.8). The same result is observed for Shean Stemster. A standard viewshed analysis shows sea views in multiple directions, none of which are captured by the 3km buffer used by the sea affordance analysis (see Figure 7.9). Those areas of sea lie beyond a distance of 15–17km in the NE, ESE and NW, with the visible area spanning an approximate total of 31.5º, from 24–40º, 96–105º, and 321–327.5º. Nevertheless, the Horizon panorama for that location reveals that those sea views should be barely noticeable, if not almost impossible to detect with the naked eye. Taking into account also the effects of vegetation cover and moderate to low levels of fog or haze, and other poor weather conditions, those views can, therefore, be confidently disregarded as they lack significance (Figures 7.10 and 7.11). The sites Gallow Hill and Gallow Hill North present further cases where Horizon panoramas indicate sea views as occupying miniscule areas in an observer's visual field. In these instances, the sea is barely visible on the distant horizon even when the generated images are inspected closely, making it improbable that prehistoric people would have been aware of such views, let alone see them clearly (Figure 7.12).

These examples support the methodology used here in the following respects. As elucidated in Chapter 4, Section 3, due to limitations in computer processing, it was necessary to reduce the areas of sea considered in the sea affordance analysis to within 3000m of the coastline. While this means that, from any given location, views of sea areas outside that buffer would not be identified, the views of such distant areas tend to occupy extremely insignificant areas in an observers' visual field. Therefore, while the methodology does not identify all available sea views,

[32] This issue is addressed in 5.3. Of the 112 sites examined across Scotland, this anomaly only occurs at relatively few sites: these seven sites, in the Highlands, four in Dumfries and Galloway, two in Aberdeenshire, and one in the Isle of Arran, North Ayrshire.

per se, it does identify all available and significantly meaningful sea views, so that the pragmatic limitations that were necessary to make this study possible likely have little to no effect on the import of the conclusions that it may draw.

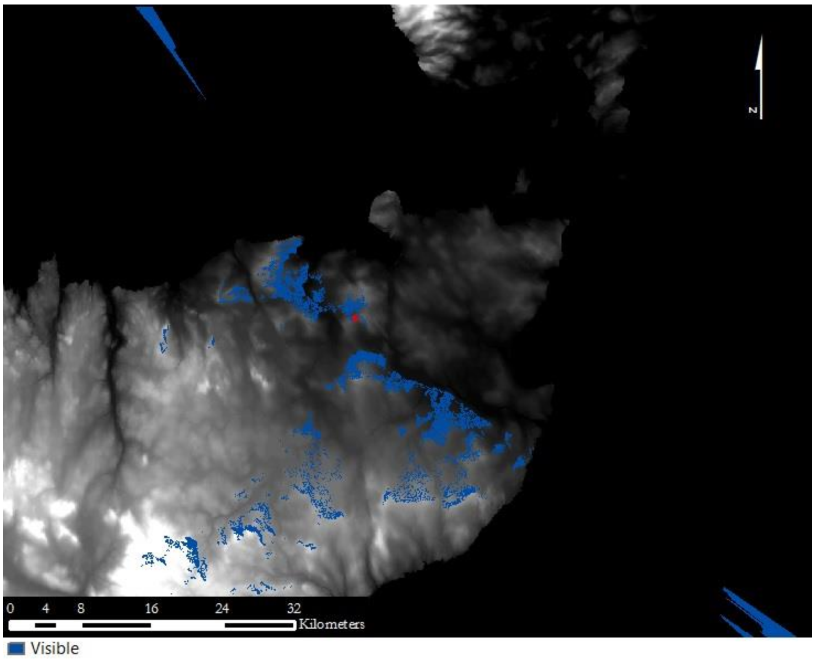


Figure 7.6: Standard viewshed showing in blue, areas of the landscape and seascape that are, in principle, visible from Sinclair's Sithean.

Figure 7.7: Horizon panorama depicting views from Sinclair's Sithean showing no visible sea in the distant horizon.

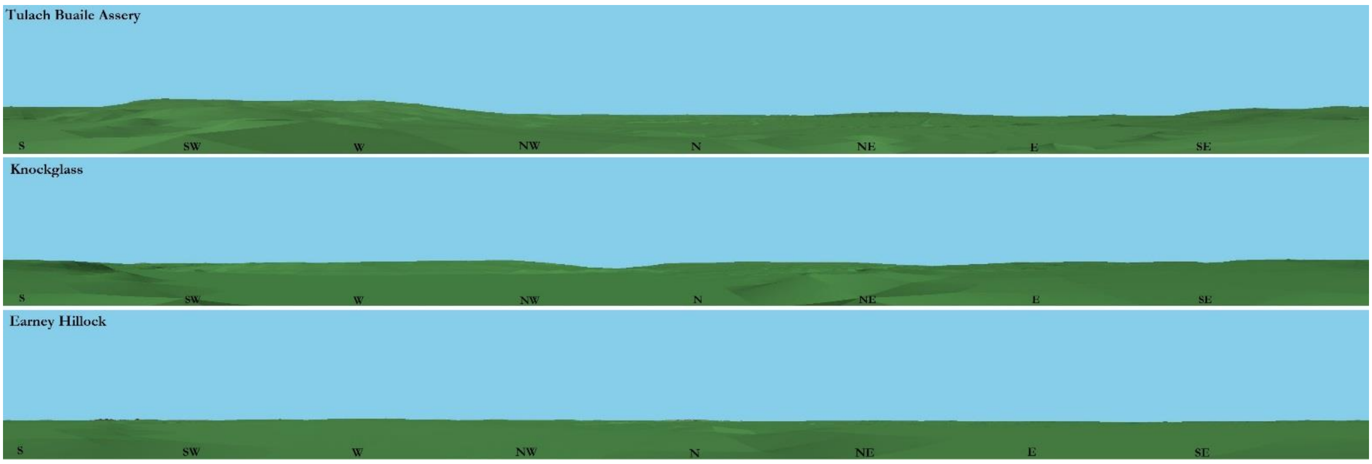


Figure 7.8: Horizon panoramas of Tulach Buaile Assery, Knockglass and Earney Hillock showing no visible sea in distant horizons.

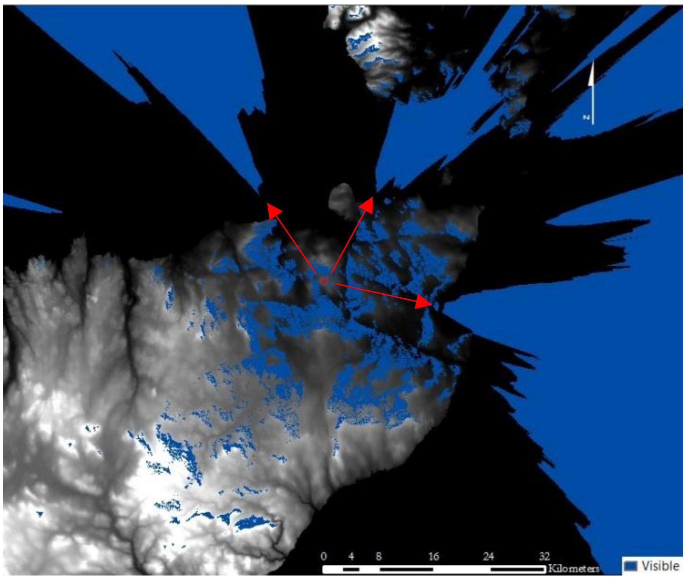


Figure 7.9: Standard viewshed showing (in blue) the parts of the landscape and seascape that are visible from Shean Stemster.
Red arrows indicate areas of the sea that are theoretically visible from that location, and which correspond to the sea views depicted in the Horizon panorama seen in Figures 7.10 and 7.11 below.

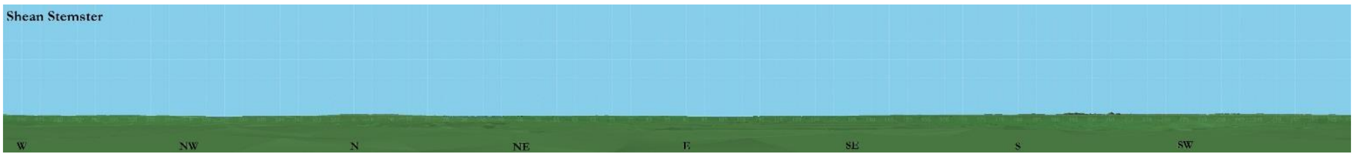


Figure 7.10: The Horizon panorama for Shean Stemster.

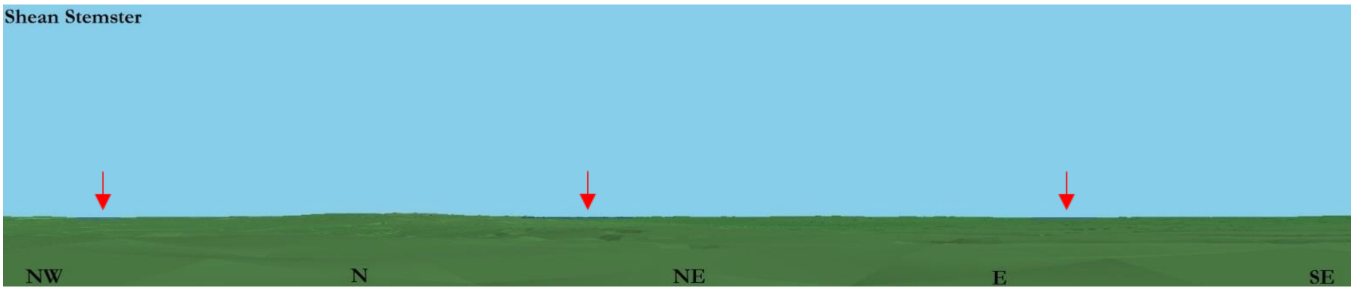


Figure 7.11: A close-up image of the Horizon panorama for Shean Stemster.
Red arrows indicate ‘sea views’, which are barely if at all recognizable.

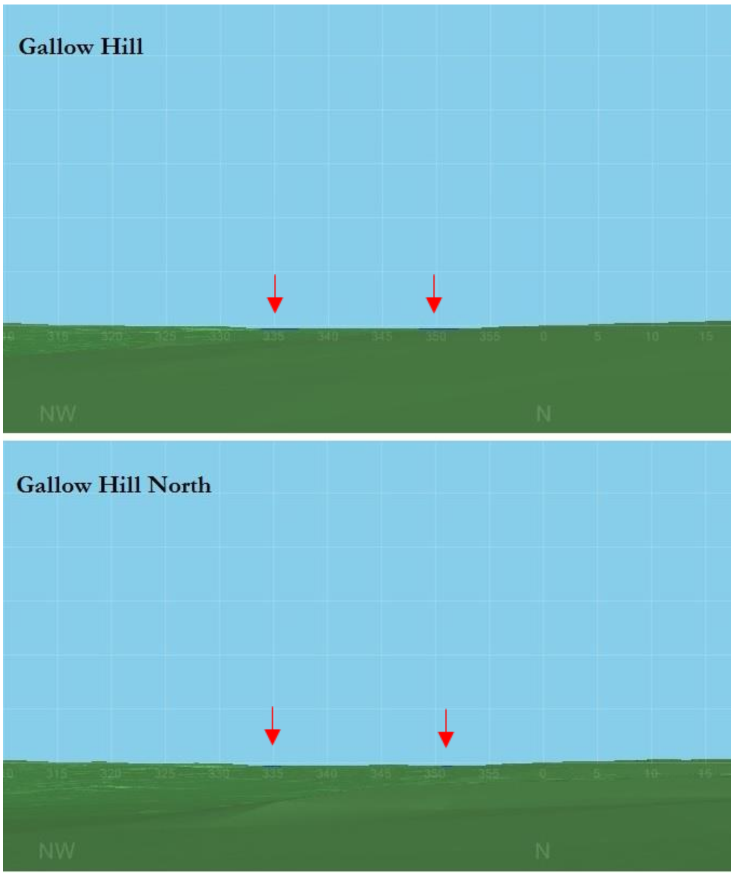


Figure 7.12: Horizon panoramas of Gallow Hill and Gallow Hill North. Red arrows indicate 'sea views', which are barely if at all recognizable.

A 1.5km radius of the area around each site was examined to reveal that, of the 18 sites mentioned above that offer sea affordance values of 0%, 12 are placed in areas holding the lowest range of sea affordance values (see Table 7.1). Another noteworthy detail is that 10 of those 18 sites are situated only a short distance (less than 3km) from the nearest coastline while the rest are, in comparison, situated further inland (see Table 7.1). The import of this information is that, despite their proximity to the coast, there are areas in the Highlands where sea views are simply non-existent. Prehistoric builders in those particular places may not, then, have been concerned with achieving such views in their choice of monument location.

Discounting those 18 sites where sea views are not present in the surrounding landscapes, there are 29 sites remaining in this region. Fifteen of those 29 sites are located in either low or extremely low sea affordance zones: South Yarrows South (19.94%), Cairn of Heathercro (19.34%), South Yarrows North (16.28%), Caen Burn (11.79%), Mid Brae (9.74%), Baillie Hill (6.32%), Carn Liath - Loedebest (5.56%), Skelpick Long (4.08%), Carn Laggie (3.55%), Coille Na Borgie North (3.47%), Carn Liath (3.34%), Wester Brae (1.62%), Woodhead Long (1.03%), Coille Na Borgie South (0.93%) and Caen Burn North (0.57%). An additional 10 sites are located in areas of mid-range sea affordance, with values ranging from 20–50%. These sites are: Cooper's Hill (39.20%), Na Tri Sithean (33.64%), Brounaban (30.67%), Youkil Hillock (29.57%), Cnoc Freiceadain (27.89%), Ardnamurchan (26.25%), Skelbo Wood (25.37%), Warehouse South (22.47%), Sgarbach (22.42%) and Wester Lamington (22.23%). Results show that the majority of sites examined in this region, were, therefore, not placed in topographic locations dominated by prominent sea views. It seems that only four sites were built in locations that offer significant sea views: Kinrive West (95.13%), Edderton Hill (93.45%), Latheronwheel Long (57.52%) and Essich Moor (56.45%). Of these four sites, Kinrive West and Edderton Hill were placed in the highest sea affordance zones.

It should be noted here that while Latheronwheel Long and Edderton Hill are situated in close proximity to the sea, at 219m and 638m, respectively, both Kinrive West and Essich Moor are found further inland, with Kinrive West located 5.8km and Essich Moor 6.2km from the nearest coastline. Despite these distances, prehistoric builders chose to place these megalithic constructions in areas of the landscape that encompassed vast sea views. These details raise several questions. Were such sea views prevalent in the immediate vicinity? Is it likely that prehistoric builders achieved these or similar outcomes unintentionally? If the views from Kinrive West and Essich Moor were a rare occurrence, especially at such distances from the nearest coastline, that might suggest that prehistoric builders had deliberately sought after topographic locations that afforded expansive sea views. Moreover, if such efforts were taken, this may not only indicate a particular preference towards incorporating sea views but also signify that sea views, or the sea more generally, held a meaningful place in their belief systems (for more details on this point, see Chapter 2, Section 4). These questions will be explored further below.

Statistical Considerations

Statistical analyses were carried out to discover trends regarding the sites as a collective. Two outlying sites located far away from others in the region were, therefore, excluded on the grounds that they may present deviations from possible trends.[33] Thus, only 45 sites of the 47 in the Highlands examined through sea affordance analysis were considered for statistical analysis.

The Highlands region occupies a vast geographical expanse and is diverse both topographically and environmentally. Because of its size, and because the monuments in this region appear in geographically defined groups, statistical analysis was conducted on relatively

[33] These two sites are Pairc A' Chlaiginn and Ardnamurchan.

small areas or 'site clusters' that contain monuments. These site clusters are: 'Sites in the Straths Zone' excluding the Strath of Kildonan (except Kildonan), 'Sites in the Strath of Kildonan', 'Sites in the Firthlands', 'Sites in Caithness' (entire zone), and 'Sites on Hill-tops and Ridges in Caithness'.

A careful analysis of the landscape contexts of long cairns in Caithness reveals that 15 of the 21 sites in that region are built in topographic locations, such as crested hill tops or ridges, that offer commanding views of the surrounding landscape. In order to discover if there are any patterns in how those sites are placed, those 15 sites were considered both with and apart from the other sites in Caithness.

A chi-square significance test was used to evaluate whether the long cairns in each of the five clusters were placed in locations that have more or less sea affordance than could be expected from a random distribution. A 500m radius around each site was tested. Chi-square values and p-values were calculated from observed and expected frequencies. Results are summarized in Table 7.2., and further details for each cluster are given in Tables 7.3, 7.4, 7.5, 7.6 and 7.7. With p-values greater than 0.05, the standard probability distribution function in each of these instances indicates that there are no statistically significant differences between site locations and what could be expected from a random distribution.

Site Zone	**Chi-Square Value**	**P-value**
Straths Zone (except Kildonan)	0.8125	0.997314284
Strath of Kildonan	0.291666667	0.96158806
Firthlands	1.675	0.97562606
Caithness (entire zone)	12.890625	0.167618143
Caithness (crested hill tops or ridges)	11.75	0.227772843

Table 7.2: Summary of results of Chi-square significance test for each zone tested.

	Label (% categories)	Observed	Expected	Chi-Square Value
Sites in the Straths Zone (except Kildonan)	1 (0-5)	4	4	0.0625
	2 (5-10)	1	1	0.25
	3 (10-20)	0	1	0.25
	4 (20-100)	2	1	0.25
				0.8125
			p-value =	**0.997314284**

Table 7.3: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results indicate no significant differences between the observed values (site locations) and expected values (random locations).

	Label (% categories)	Observed	Expected	Chi-Square Value
Sites in the Strath of Kildonan	1 (0-5)	6	6	0.041666667
	2 (5-100)	1	1	0.25
				0.291666667
			p-value =	**0.96158806**

Table 7.4: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results indicate no significant differences between the observed values (site locations) and expected values (random locations).

	Label (% categories)	Observed	Expected	Chi-Square Value
Sites in the Firthlands	1 (0-5)	5	5	0.05
	2 (5-10)	1	1	0.25
	3 (10-20)	0	1	0.25
	4 (20-100)	4	2	1.125
				1.675
			p-value =	**0.97562606**

Table 7.5: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results indicate no significant differences between the observed values (site locations) and expected values (random locations).

	Label (% categories)	Observed	Expected	Chi-Square Value
Sites in Caithness (entire zone)	1 (0-5)	10	16	1.890625
	2 (5-10)	1	1	0.25
	3 (10-20)	3	1	2.25
	4 (20-30)	4	1	6.25
	5 (30-100)	3	1	2.25
				12.890625
			p-value =	**0.167618143**

Table 7.6: Comparison of observed and expected values, showing chi-square values and the p-value. Results indicate no significant differences between the observed values (site locations) and expected values (random locations).

	Label (% categories)	Observed	Expected	Chi-Square Value
Sites in Caithness (on crested hill tops or ridges)	1 (0-5)	5	11	2.75
	2 (5-10)	1	1	0.25
	3 (10-20)	3	1	2.25
	4 (20-30)	4	1	6.25
	4 (30-100)	2	1	0.25
				11.75
			p-value =	**0.227772843**

Table 7.7: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results indicate no significant differences between the observed values (site locations) and expected values (random locations).

Two-sample KS tests were also performed for each of the five clusters. Results confirm the findings of the chi-square significance tests, as indicating no significant differences between observed and expected affordance values. Of course, this does not imply that sea views did not hold significance at any single site, or that prehistoric builders had no intention of situating long cairns in topographic locations that afforded higher sea affordances. Rather, from the results of these tests, there is no indication that site locations, taken as a collective, were selected for the sea views they offer. As 28 of the 45 sites fall into the 0–10% sea affordance category, such a result may be expected despite these sites being placed in close proximity to the coastline.

It was also of interest to determine, on a site-by-site basis, how unique the observed sea affordance values are in the particular locations where monuments are placed, that is, whether the sea views afforded at site locations are abundant or rare in their immediate vicinities, and hence whether those views were difficult to achieve. To this end, sea affordance surfaces were reclassified into the following percentage categories: 10–20, 20–30, 30–40, 40–60 and 60–100. Pixel counts were taken for the total areas falling within each category, within a 500m buffer of each site, and those counts were then used to determine the percentage of the total tested land area in each category. The results of this investigation are summarized in Table 7.8.

Sea Affordance % Categories	Coille Na Borgie North	Coille Na Borgie South	Skelpick Long	Cnoc Freiceadain	Na Tri Sithean	Baillie Hill	Knockglass	Tulach an t'Sionnach	Tulach Buaile Assery
1 - (0-10)	88.6	88.174675	94.7	46	40.8	100	100	100	100
2 - (10-20)	11.3	11.825325	5.3	12.6	14.2	0	0	0	0
3 - (20-40)	0	0	0	26.4	28.4	0	0	0	0
4 - (40-60)	0	0	0	6.4	7.9	0	0	0	0
5 - (60-100)	0	0	0	8.7	8.6	0	0	0	0

Sea Affordance % Categories	Youkil Hillock	Shean Stemster	Stemster, Sinclair's Sithean	Stemster	Gallow Hill North	Gallow Hill	Cooper's Hill	Earney Hillock	Cairn of heathercro	Sgarbach
1 - (0-10)	85.5	100	100	100	100	100	60.1	99	92.5	27.9
2 - (10-20)	4.6	0	0	0	0	0	11.3	1	3.9	26
3 - (20-40)	9.8	0	0	0	0	0	26.6	0	3.5	20.3
4 - (40-60)	0	0	0	0	0	0	1.9	0	0	15.1
5 - (60-100)	0	0	0	0	0	0	0	0	0	10.8

Sea Affordance % Categories	Warehouse South	Camster Long	South Yarrows North	South Yarrows South	Brounaban	Latheronwheel Long	Carn Liath, Loedebest	Salscraggie	Caen Burn West	Caen Burn South
1 - (0-10)	53.3	100	89.4	78.8	63.1	26.8	98.8	100	100	97.5
2 - (10-20)	27.6	0	10.2	14.5	12.2	9.2	1.2	0	0	2.5
3 - (20-40)	15	0	0.4	4.1	17.6	21.3	0	0	0	0
4 - (40-60)	3.8	0	0	2.5	7.1	21.5	0	0	0	0
5 - (60-100)	0.2	0	0	0.05	0	21.1	0	0	0	0

Sea Affordance % Categories	Caen Burn North	Caen Burn	Carn Laggie	Kilearnan	Creag An Amalaidh	Skelbo Wood	Edderton Hill	Wester Lamington	Carn Liath	Kinrive West
1 - (0-10)	84.2	70.7	63	100	75.7	13.4	1.5	1.4	79.6	0.2
2 - (10-20)	15.8	24.4	9.1	0	4.4	29.9	0.1	6.4	8.5	0
3 - (20-40)	0	5	17.6	0	2.7	52.8	1.2	19.6	8.4	0.2
4 - (40-60)	0	0	6.5	0	1.9	3.9	28.1	33.3	3.5	1.3
5 - (60-100)	0	0	3.8	0	15.2	0	92.4	39.2	0	98.4

Sea Affordance % Categories	Woodhead Long	Mid Brae	Wester Brae	Muir of Allangrange	Essich Moor	Pairc A' Chlaiginn	Carn Liatha	Ardnamurchan
1 - (0-10)	80.3	53.9	92.5	100	76.2	100	100	26.6
2 - (10-20)	10.4	29.4	6.3	0.1	2.1	0	0	20.4
3 - (20-40)	8.8	14.3	1.2	0	3.8	0	0	37.1
4 - (40-60)	0.5	2.3	0	0	8.3	0	0	15.7
5 - (60-100)	0	0	0	0	9.6	0	0	0.3

Table 7.8: The percentage of the total tested land area around each site (0.8 km^2, or a 500m radius) in each of the sea affordance categories. Percentages highlighted in red indicate the categories sites fall into.

Results indicate that 33 of the 47 sites analysed are placed in locations that are not unique in terms of the availability of sea views, that is, when compared to their immediate surroundings, in the sense that a large proportion of the area immediately surrounding each site also offers very similar sea affordance values to those found at the site.[34] Take Carn Liath, for instance, where sea affordance is 3.3%, falling in the 0–10% category. As can be seen from the table above, a large

[34] All 47 sites in this region could be analysed this way. This includes the two outlier sites, Pairc A' Chlaiginn and Ardnamurchan, that was excluded from the chi-square significance tests and the KS-tests.

percentage (79.6%) of the immediate area surrounding that site also offers low levels of sea affordance. Similarly, the sea affordance at Mid Brae is 9.7%, falling in the lowest sea affordance percentage category. Once again, it is clear from the data that such sea affordances were common in that particular area. Similar observations are also made for numerous other sites, including Creag An Amalaidh, Woodhead Long and Caen Burn North, which hold sea affordance values that are common to large percentages of their surrounding areas.

It is also worth noting that in many cases there are sea affordance values of 0% both at site locations and in their immediate surroundings (i.e., within a 500m radius). As shown in Table 7.8, this is seen at Baillie Hill, Salscraggie, Kilearnan, Carn Liatha, Knockglass, Tulach an t'Sionnach, Tulach Buaile Assery, Shean Stemster, Sinclair's Sithean, Stemster, Gallow Hill North, Gallow Hill and Pairc A' Chlaiginn. On the other extreme, two sites, Edderton Hill and Kinrive West, fall into the highest sea affordance category, of 60–100%, with respective values of 93.4% and 95.1%, and similar sea affordance values are also available in their immediate surroundings. It is arguable, then, that a majority of sites are built in locations that have sea views that are typical, relative to those offered in their surrounding landscapes. This evidence does not lend credibility to the notion that prehistoric builders carefully and deliberately chose monument locations to achieve a specific view of the sea. In each of these cases, prehistoric people could have with relative ease placed the monument anywhere within the 500m radius of its location to obtain very similar if not the same views of the sea.

Although the above finding seems to hold for the majority of the sites in this study area, there are some exceptions. Take, for instance, Youkil Hillock. The data shows that 85.5% of the tested area around the site falls in the 0–10% sea affordance category, while only 4.6% and 9.8% of that area falls in the 10–20% and 20–40% categories, respectively. As can be seen from Table 7.8, with a sea affordance value of 29.57%, Youkil Hillock falls into the latter category which is both relatively high range and uncommon in the surrounding area. There is, then, reason to suppose that prehistoric people could have actively sought out that specific location, as it is of the few places in the area that offered better vistas of the sea.

A similar observation can be made at Essich Moor. A large majority of the area (76.2%) immediately surrounding the site lies in the lowest end of the sea affordance spectrum, in the 0–10% sea affordance category. The site itself has a sea affordance value of 56.4%, while only a relatively small percentage of landmass, 17.9%, offers sea affordance values of over 40% (see Figure 7.14, below). The sea views available at Essich Moor are, then, greater to and uncommon in comparison to the views readily available in the surrounding landscape. As is the case with

Youkil Hillock, this finding supports the claim that megalithic builders may have searched for a particular view.

The same pattern is also observed at a number of other long cairn sites, where there are non-typical sea views that are significantly better than the views predominantly available in the immediate surrounding areas. These locations are: Warehouse South, South Yarrows North, South Yarrows South, Brounaban, Caen Burn, Cooper's Hill and Cairn of Heathercro. These examples of sites with non-typical sea views support the notion that prehistoric peoples had a preference for choosing topographical locations that afforded such views, even in cases where those views were not readily available.

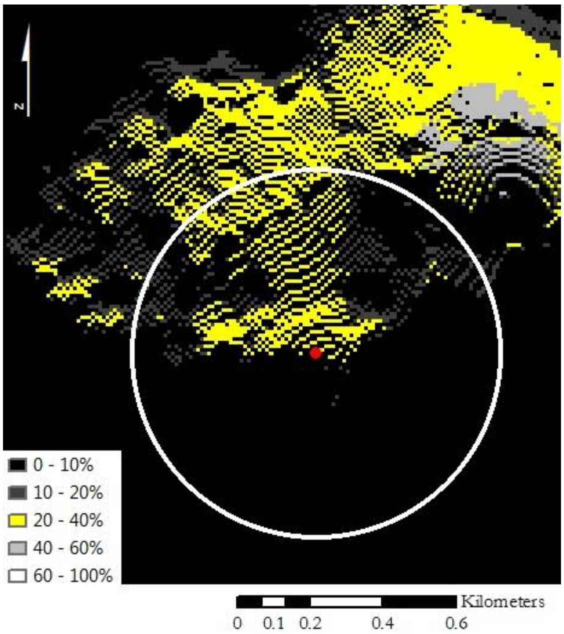


Figure 7.13: The land inside the 500m radius around Youkil Hillock that was tested. Highlighted in yellow is the 9.8% land area that falls in the 20–40% sea affordance category.

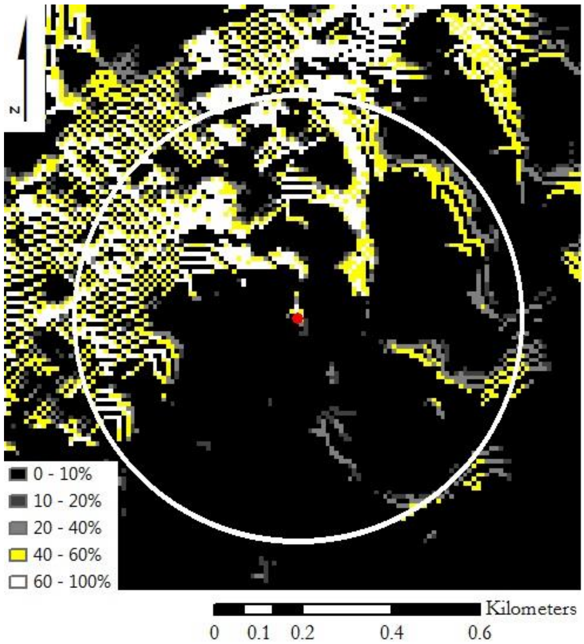


Figure 7.14: The land in the 500m radius around Essich Moor that was tested. Highlighted in yellow is the 8.3% land area that falls in the 40–60% sea affordance category.

In order to verify further the above findings, the 500m buffer of land tested around each site was increased to incorporate a larger area, within 1500m of each site. The results of this analysis are shown in Table 7.9. The data substantiate many of the findings. For instance, increasing the buffer to include a larger area does not seem to have affected the soundness of the conclusions drawn above regarding Essich moor and Youkil Hillock. Notwithstanding the larger area tested, both sites continue to offer uniquely high sea affordance values in comparison to their surrounds.

There are, however, a few notable exceptions where the results from the analysis of the larger, 1500m radius around each site yielded some different outcomes. An examination of the additional 1000m around those areas reveals a higher degree of heterogeneity than was previously evident. Contrasting with the earlier analysis of the smaller 500m radius, the results thus show that there is a high degree of variability in sea affordance values in the landscapes surrounding Carn Laggie, Creag An Amalaidh, Skelbo Wood, Edderton Hill and Wester Lamington. A further example of this is seen at Kinrive West, a site that offers a sea affordance value of 95.1%. Looking only at the 500m immediately surrounding the site, 98.4% of the tested area falls within the highest sea affordance category of 60–100%. To contrast with this high degree of homogeneity, results from the analysis of the 1500m around the site indicate a split between the two extreme ends of the sea affordance spectrum, with 50% of the tested area falling in the 0–10% sea affordance category and 40.7% of the area falling in the 60-100% sea affordance range. However, despite this split in sea affordance values, a substantially large percentage of land still offers similar sea affordances to what is available at the site location. Hence, prehistoric builders could have placed the cairn anywhere within a sizeable radius of where it is currently located and likely achieved similar outcomes. As above, this finding does not, then, support the case for prehistoric builders' had of any particular preference for placing monuments so as to afford sea views at their locations. For this reason, at Kinrive West, and for similar reasons in other cases, there are no markedly significant differences between the results of the studies of 500m and 1500m radii. Thus, the findings from the latter serve to substantiate the conclusions of the former, as drawn out above.

Sea Affordance % Categories	Coille Na Borgie North	Coille Na Borgie South	Skelpick Long	Cnoc Freiceadain	Na Tri Sithean	Baillie Hill	Knockglass	Tulach an t'Sionnach	Tulach Buaile Assery
1 - (0-10)	94.36	94.46	98.28	66.30	66.41	98.90	100.00	100.00	100.00
2 - (10-20)	5.35	5.25	1.72	17.84	17.84	1.10	0.00	0.00	0.00
3 - (20-40)	0.29	0.29	0.00	11.57	11.48	0.00	0.00	0.00	0.00
4 - (40-60)	0.00	0.00	0.00	3.25	3.25	0.00	0.00	0.00	0.00
5 - (60-100)	0.00	0.00	0.00	1.03	1.03	0.00	0.00	0.00	0.00

Sea Affordance % Categories	Youkil Hillock	Shean Stemster	Sinclair's Sithean	Stemster	Gallow Hill North	Gallow Hill	Cooper's Hill	Earney Hillock	Cairn of heathercro
1 - (0-10)	87.05	100.00	100.00	100.00	100.00	100.00	61.10	92.94	94.03
2 - (10-20)	4.73	0.00	0.00	0.00	0.00	0.00	11.38	3.15	5.28
3 - (20-40)	7.77	0.00	0.00	0.00	0.00	0.00	27.31	3.91	0.70
4 - (40-60)	0.45	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00
5 - (60-100)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sea Affordance % Categories	Sgarbach	Warehouse South	Camster Long	South Yarrows North	South Yarrows South	Brounaban	Latheronwheel Long	Carn Liath, Loedebest	Salscraggie
1 - (0-10)	22.66	64.84	100.00	75.42	70.20	71.14	40.06	90.70	90.95
2 - (10-20)	21.60	22.36	0.00	8.57	9.96	12.31	10.00	8.71	8.19
3 - (20-40)	28.27	9.73	0.00	7.70	9.69	11.23	20.34	0.59	0.49
4 - (40-60)	14.12	2.85	0.00	5.98	6.79	5.09	12.09	0.00	0.36
5 - (60-100)	13.36	0.22	0.00	2.33	3.36	0.22	17.51	0.00	0.00

Sea Affordance % Categories	Caen Burn West	Caen Burn South	Caen Burn North	Caen Burn	Carn Laggie	Kilearnan	Creag An Amalaidh	Skelbo Wood	Edderton Hill	Wester Lamington
1 - (0-10)	85.13	81.51	79.02	76.87	42.83	100.00	64.44	29.28	23.66	24.87
2 - (10-20)	11.66	11.67	15.01	15.98	14.27	0.00	4.76	28.61	3.07	14.95
3 - (20-40)	3.21	6.22	5.19	5.93	21.27	0.00	6.18	37.11	12.35	24.55
4 - (40-60)	0.00	0.60	0.78	1.22	8.00	0.00	3.67	4.48	10.64	21.58
5 - (60-100)	0.00	0.00	0.00	0.00	13.64	0.00	20.95	0.53	50.28	14.04

Sea Affordance % Categories	Carn Liath	Kinrive West	Woodhead Long	Mid Brae	Wester Brae	Muir of Allangrange	Essich Moor	Pairc A' Chlaiginn	Carn Liatha	Ardnamurchan
1 - (0-10)	66.13	50.07	74.76	68.02	69.80	85.51	73.08	100.00	100.00	37.09
2 - (10-20)	14.83	1.95	18.44	18.04	21.59	3.96	1.93	0.00	0.00	18.35
3 - (20-40)	13.89	3.25	6.44	13.60	8.25	5.70	3.19	0.00	0.00	23.34
4 - (40-60)	4.90	4.05	0.36	0.34	0.36	4.83	8.07	0.00	0.00	13.65
5 - (60-100)	0.26	40.67	0.00	0.00	0.00	0.00	13.74	0.00	0.00	7.57

Table 7.9: The percentage of the total tested land area (7.1 km^2 or 1500m radius) which falls into each of the sea affordance categories. Percentages highlighted in red indicate the category into which the sites fall.

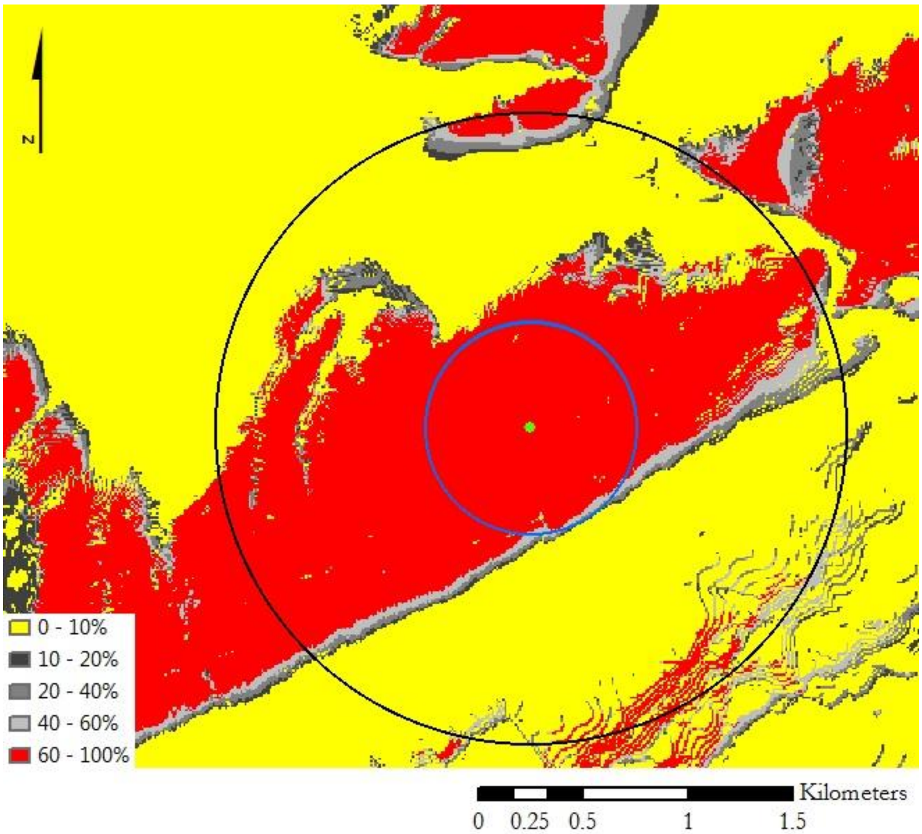


Figure 7.15: The radii tested around Kinrive West at 500m (blue) and 1500m (black). Highlighted in yellow is the land area that falls in the 0–10% sea affordance category while red represents the area that falls in the higher sea affordance category of 60–100%.

7.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones

To reiterate the above findings, statistical consideration of sea affordance surfaces give no indication that the long cairn sites of the Highlands were chosen deliberately by prehistoric people for the sea views available from those locations: the sea affordance surfaces indicate that a majority of the cairn sites are located in places that are typical, and not unique, for their areas in terms of the kinds of sea views they offer. The areas surrounding monuments were also analysed qualitatively to determine whether there were viable alternative locations for site placement that offer greater sea views. Thus, despite the above findings, if long cairn site locations were in some cases optimal in terms of available see affordance, there would be support for the idea that locations were chosen for sea affordance and that long cairns were intended to reference the sea.

Consideration of the sea affordance surfaces reveals that there are substantially greater sea affordance values in the vicinity of many of the sites discussed above, that is, within a radius of

1500m. Some of these locations afford markedly greater sea views when compared with where monuments were ultimately placed, are discussed below. However, as shown in Table 7.10, it is evident that some alternative locations may have been unsuitable for site placement. In some instances, alternative locations are situated at much higher elevations than corresponding long cairn sites, which may also have deterred prehistoric people from using those locations.

Take, for instance, Carn Laggie and Caen Burn North, with respective sea affordance values of 3.5% and 0.6%. Alternative locations identified for these sites offer respective sea affordance values of 63.9% and 20.9%, which are considerable differences (see Figure 7.15). Yet, upon a closer inspection, it is revealed that both Carn Laggie Location A and Caen Burn North location A are situated at much higher elevations than the corresponding cairn sites, at respectively 142m and 151m further above sea level. These elevations may, then, have stood as significant deterrents for prehistoric builders so that even if they held a preference for incorporating sea views, the monuments' locations may have, nevertheless, been optimal once all such relevant factors are taken into consideration. Similar explanations invoking the noticeably higher elevations of alternative locations may account for why they were not chosen by prehistoric builders, for the locations that correspond to Caen Burn, Caen Burn South, Caen Burn West, Salscraggie, South Yarrows North, South Yarrows South, Coille Na Borgie North, Coille Na Borgie South, Skelpick Long and Woodhead Long.

In several other instances, the alternative high sea affordance zones are located at a considerable distance from the sites to which they correspond, which may mean that they are also at a distance from otherwise desired locations, such as route ways through the landscape, settlements, meeting places, and easily accessible building materials or other resources. This is seen in the cases of Muir of Allangrange and Earney Hillock, where alternative locations offering higher sea affordance values are at respective distances of 936m and 1200m from the corresponding cairn sites (see Table 7.10). Similar observations can be made regarding the landscape surrounding two further locations: Cairn of Heathercro Location B, which offers a high sea affordance value but is approximately 2km from Cairn of Heathercro; and Coille Na Borgie South, where alternative locations A and B are approximately 1km from the site and are situated at much higher elevations.

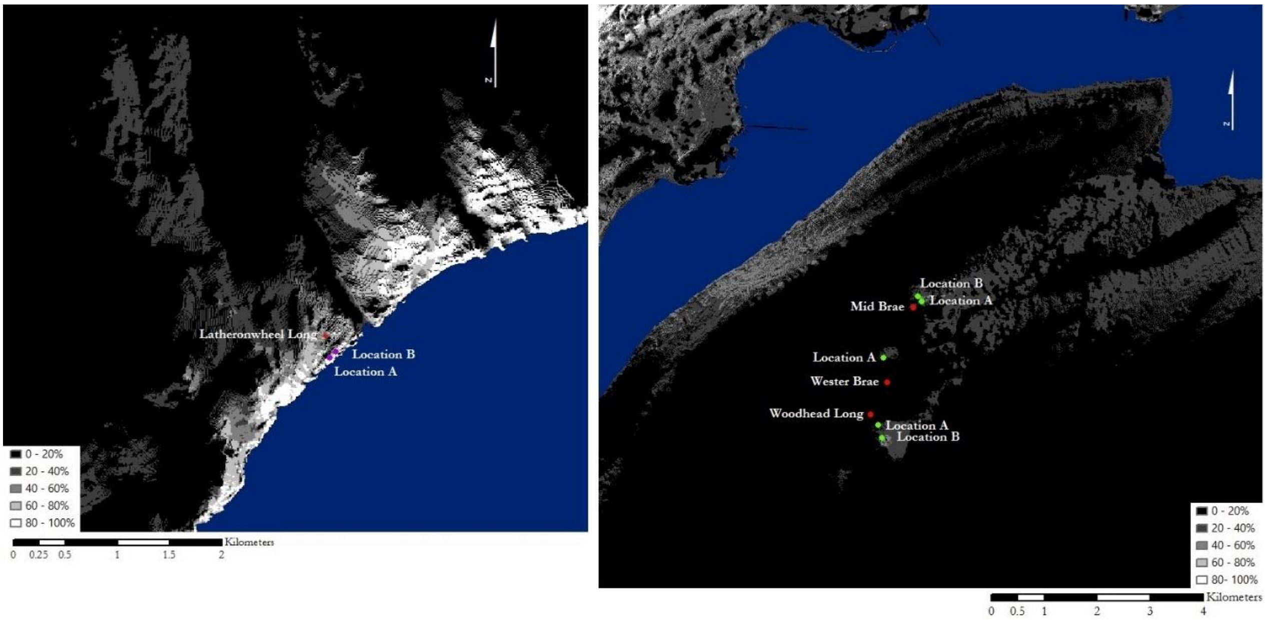


Figure 7.134: Sea affordance surfaces of Latheronwheel Long (57.52%), Wester Brae (1.62%) and Mid Brae (9.74%) displaying high sea affordance zones in the immediate vicinity of the sites.

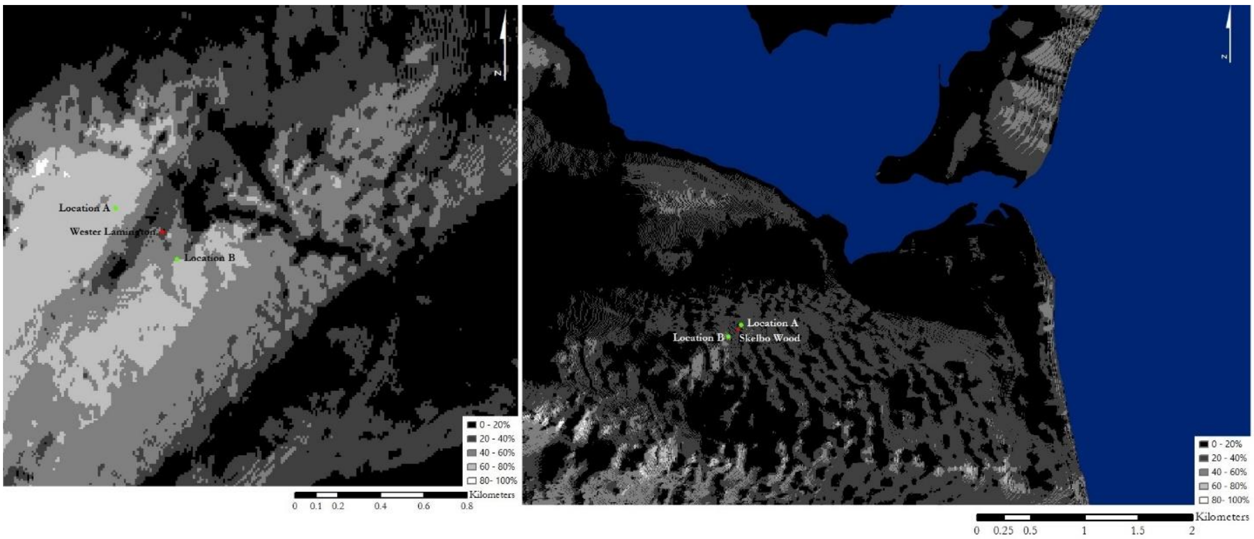


Figure 7.17: Sea affordance surfaces of Wester Lamington (22.23%) and Skelbo Wood (25.37%) displaying high sea affordance zones in the immediate vicinity of the sites.

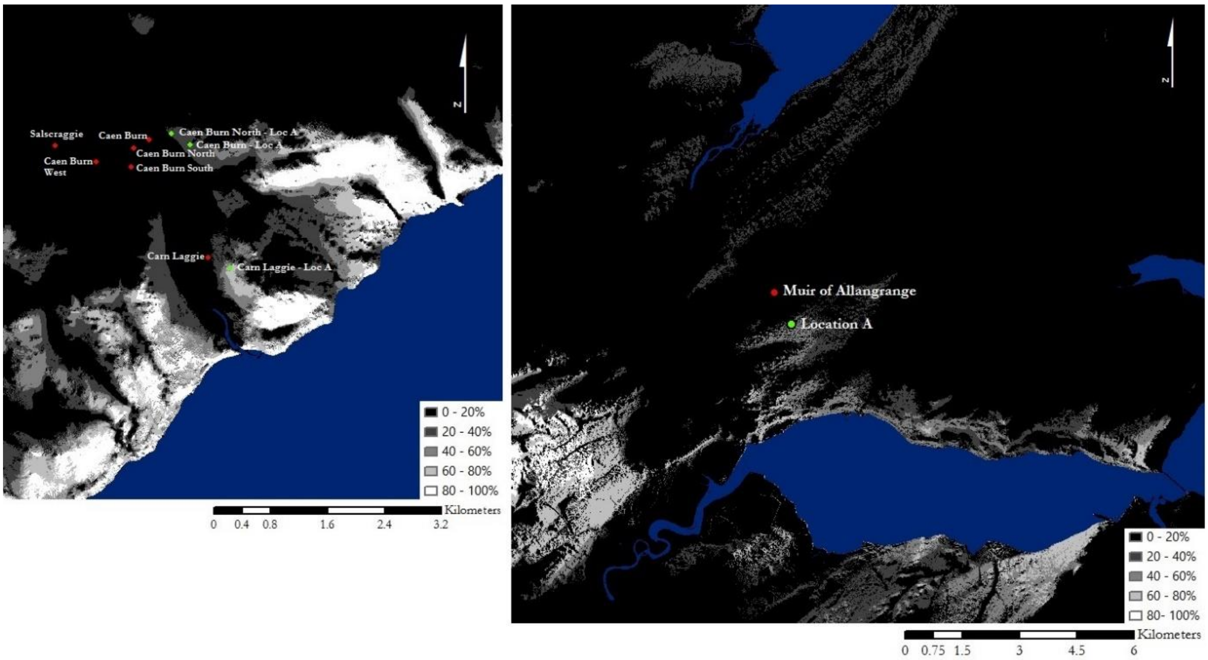


Figure 7.18: Sea affordance surfaces of Caen Burn (11.79%), Caen Burn North (0.57%), Caen Burn South (0.00%), Caen Burn West (0.00%), Salscraggie (0.00%), Carn Laggie (3.55%) and Muir of Allangrange (0.00%) displaying high sea affordance zones in the immediate vicinity of the sites.

As discussed above, in the cases of Carn Laggie and Caen Burn North, the alternative locations are situated at much higher elevations. The alternative location for Muir of Allangrange has comparable if not lower elevations to that of the site location but is found at some distance from the latter.

Site Name	Site elevation (m)	Nearby high sea affordance locations	Elevation at this new location (m)	Distance away from the site (m)	Directionality of this location	Sea Affordance (%)
Coille Na Borgie North	21	Location A	43	133	E	10.25
		Location B	141	144.9	WNW	20.17
Coille Na Borgie South	16	Location A	42	1044.19	E	10.00
		Location B	141	1066.27	WNW	20.17
Skelpick Long	41	Location A	81	270.8	NE	10.05
Cnoc Freiceadain	126	Location A	129	35.7	SW	83.02
Na Tri Sithean	130	Location A	131	32.2	NW	83.60
Baillie Hill	81	Location A	85	680	WNW	11.30
		Location B	90	1329	WNW	15.75
Youkil Hillock	98	Location A	107	753.5	NE	50.29
		Location B	98	593.44	NNE	42.09
Cairn of Heathercro	81	Location A	81	14.8	E	34.55
		Location B	81	2000	S	40
Sgarbach	20	Location A	16	68.4	SE	80.61
Warehouse South	181	Location A	181	59.1	ESE	67.94
		Location B	177	102.2	ESE	58.63
South Yarrows North	129	Location A	188	795	SW	69.06
South Yarrows South	142	Location A	188	584	SW	69.06
Brounaban	92	Location A	98	69	W	40.54
		Location B	88	1400	SE	67.22
Latheronwheel Long	34	Location A	26	207.3	S	94.44
		Location B	24	171.9	SSE	86.09
Carn Liath, Loedebest	109	Location A	90	1300	SE	22.24
Carn Laggie	29	Location A	142	332	SE	63.91
Caen Burn	73	Location A	169	565	E	25.64
Caen Burn North	40	Location A	151	568	ENE	20.92
Caen Burn South	40	Location A	127	408.5	NW	6.96

Caen Burn West	43	Location A	127	289.9	NE	6.96
Salscraggie	22	Location A	191	442.3	NNE	6.51
Wester Brae	176	Location A	175	473.4	NNW-northerly	30.20
Wester Lamington	151	Location A	164	239.4	WNW	70.29
		Location B	146	140.7	SSE	65.23
Skelbo Wood	77	Location A	76	44.3	NE	41.09
		Location B	83	114.5	SW	45.23
Mid Brae	147	Location A	145	191.5	ENE	48.16
		Location B	134	225.6	NE	39.86
Woodhead Long	187	Location A	200	232.5	SE	21.50
		Location B	224	484.4	SSE	43.38
Muir of Allangrange	140	Location A	139	936.1	SSE	46.36
Essich Moor	211	Location A	210	129.5	NNW-northerly	66.00
Ardnamurchan	10	Location A	8	198.6	NNW-northerly	49.40
Earney Hillock	60	Location A	64	1200	NW	33.16

Table 7.10: Comparison of available sea affordances between site locations and their immediate surroundings.

The aforementioned examples notwithstanding, there are many observed alternative locations that not only have comparable, if not lower, elevations from corresponding site locations but are also located not too far from where those sites are placed in the landscape. On those counts, these alternative locations may, then, have been ideal topographic locations for prehistoric builders if they had a preference or intention of framing monuments against prominent panoramic sea views or of referencing the sea with monument orientations. Consider the following alternative locations:

1) At Sgarbach, Location A, sea affordance reaches as high as 80.6%, which is three-and-a-half times the value found at the corresponding site location.
2) Near Latheronwheel Long, alternative Locations A and B are located only a very short distance from the corresponding site and, yet, have significantly higher sea affordances, falling in the 80–100% range (see Figure 7.16).[35]

[35] It should be noted that, despite Location A, near the site of Latheronwheel Long, offering high sea affordance values in the 90th percentile, these zones encompass a very small area of the immediate landscape. This could perhaps be one reason why such alternative locations may have been overlooked by prehistoric builders.

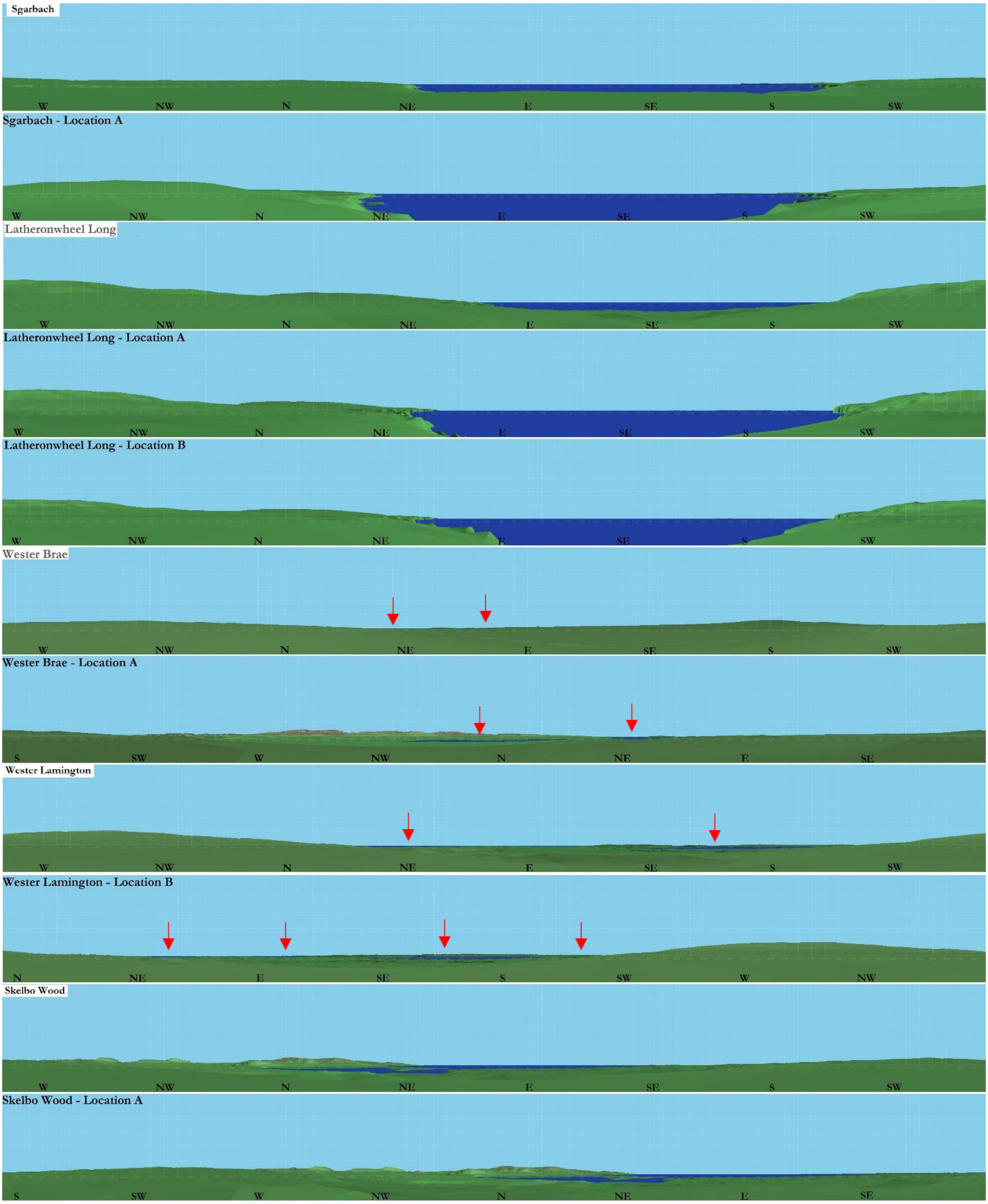
3) At Wester Brae, Location A, the sea affordance reaches as high as 30.2%, which is approximately 18 times the value of affordance found at corresponding site location (see Figure 7.16).
4) At Wester Lamington, Location B, sea affordance reaches as high as 65.2%, which is approximately three times the value found at the corresponding site location (see Figure 7.17).
5) At Skelbo Wood, Location A, sea affordance is 41.1%, which is approximately double that of the corresponding site location (see Figure 7.17).
6) At Mid Brae, alternative Locations A and B offer substantially greater sea affordances of 48.2% and 39.9%, respectively. This is considerable given that the sea affordance is only 9.7% at the corresponding site location (see Figure 7.16).
7) At Ardnamurchan, Location A, the sea affordances reaches as high as 49.4%., a value that is almost double that of the corresponding site location.

Horizon panoramas were generated to interrogate further the significance of these particular locations, and to determine how the sea views they offer appear in the visual field of an observer and if and how they differ from the views that are available at the corresponding site locations (see Figures 7.21–4).

Investigation of Alternative Locations using Horizon Panoramas

Panoramas reveal that sea views at Sgarbach span 157º, from approximately 44–201º, while sea views at Sgarbach Location A span 176.5º, from approximately 37–213.5º. At Location A, sea views are definitely more prominent and occupy a substantially greater space in the observer's visual field. At Latheronwheel Long, sea views span 129.5º, from approximately 71.5–201º. Yet, Latheronwheel Long alternative locations A and B both offer substantially greater sea views that are more expansive across the horizon and are also more visually prominent—respectively, these views span 162º and 154.5º, from approximately 55.5–217.5º and 58–212.5º. A similar observation is made at Ardnamurchan, where sea views span 87.5º, from approximately 280–7.5º. Although these sea views are certainly noticeable in the distant horizon, they pale in comparison to the views offered at Ardnamurchan Location A, which expand 172º, from approximately 200–12º and occupy a much greater depth in the observer's visual field (see Figure 7.19). In summary, despite sea views expanding far across the horizon at each of the three site locations of Sgarbach, Latheronwheel Long and Ardnamurchan, in comparison to the sea views available from the nearby alternative locations, those views seem to appear as only slivers of sea that encompasses insignificant spaces in an observer's visual field.

At Wester Brae, sea views are barely visible and segmented across the horizon. However, the views available from Wester Brae Location A are considerably noticeable, albeit appearing only as a sliver across the horizon in two parts, from approximately 325–27.5º and 39–69º. Arguably, then, this alternative location presents a better option for the construction of this megalithic structure, that is, given the assumption that sea views held sufficient significance. An analysis of the Horizon panoramas for the remaining sites and the corresponding alternative locations reveals no significant differences in the sea views they offer. At Wester Lamington, sea views appear to be segmented in three distinct sections which, taken together, span 178º from approximately 26–204º. Although the site-alternative, Wester Lamington Location B, offers over twice the value of sea affordance, the sea views it offers appear to occupy a similar space in the observer's visual field; these views are also segmented into distinct sections as they are at the cairn site, and span a comparable range, of 164º from approximately 48.5–212.5º. Similar observations can be made regarding the panoramas of Skelbo Wood and Skelbo Wood Location A, and Mid Brae and Mid Brae Locations A and B, where the sites and their alternative locations all have comparable sea views with respect to each other despite differences in sea affordance values.


Sgarbach
W NW N NE E SE S SW
Sgarbach - Location A
W NW N NE E SE S SW
Latheronwheel Long
W NW N NE E SE S SW
Latheronwheel Long - Location A
W NW N NE E SE S SW
Latheronwheel Long - Location B
W NW N NE E SE S SW
Wester Brae
W NW N NE E SE S SW
Wester Brae - Location A
S SW W NW N NE E SE
Wester Lamington
W NW N NE E SE S SW
Wester Lamington - Location B
N NE E SE S SW W NW
Skelbo Wood
W NW N NE E SE S SW
Skelbo Wood - Location A
S SW W NW N NE E SE

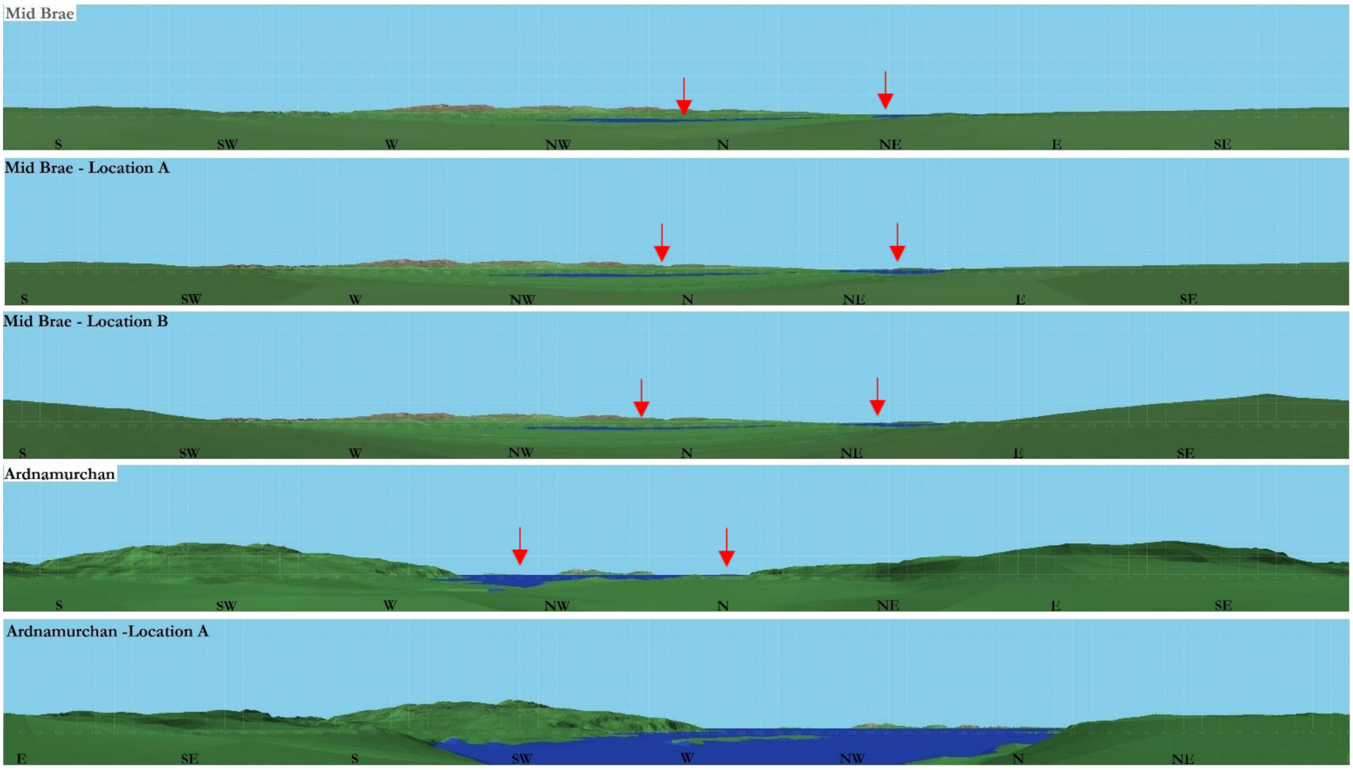


Figure 7.19: Horizon panoramas of Sgarbach, Latheronwheel Long, Wester Brae, Wester Lamington, Skelbo Wood, Mid Brae and Ardnamurchan as well as the nearby alternative locations with high sea affordance values, which are identified in Table 7.10.
The red arrows indicate sea views.

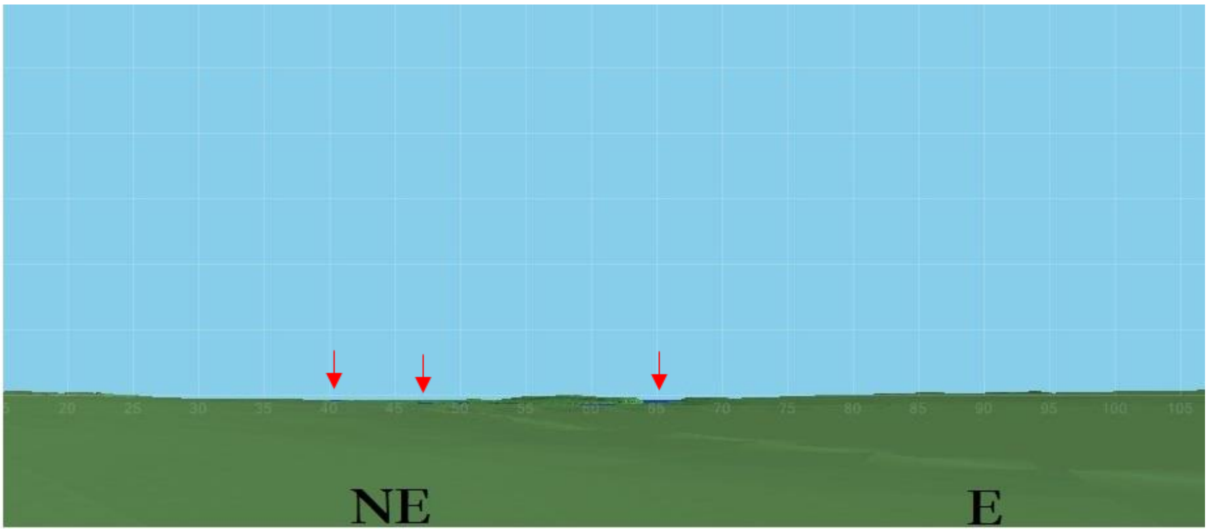


Figure 7.20: A close-up image of Wester Brae. Red arrows indicate sea views.

Considering the Effect of Atmospheric Conditions

As described above, an analysis of Horizon panoramas indicates that at five of the nine investigated alternative locations sea views occupy a larger space in the visual field than the sea views available at the corresponding cairn sites. This conclusion was revealed to hold true after additional Horizon panoramas were regenerated to model the effect of atmospheric deterioration on those views (see Figures 7.21–2). Sea views are visually noticeable and prominent even in very poor visibility at four of these sites, namely: Sgarbach Location A, Latheronwheel Long Locations A and B, and Ardnamurchan Location A. At Wester Brae Location A (Figure 7.23), the regenerated Horizon panorama shows that a minimum distance of 4km of visibility is required for sea views to appear; and even at that point the full range of views remains hidden from the observer until further visibility can be acquired. Nevertheless, a comparison of regenerated Horizon panoramas between this alternative location and the corresponding cairn site reveals that the alternative is still able to offer noticeably greater sea views under atmospheric deterioration.

The initial consideration of these sites, described earlier in this section, revealed no noticeable differences between the sea views available at cairns of and alternative locations identified for Wester Lamington Location B, Mid Brae Location A and B, and Skelbo Wood Location A. This conclusion also holds true when atmospheric conditions are taken into consideration (see Figures 7.24–6).

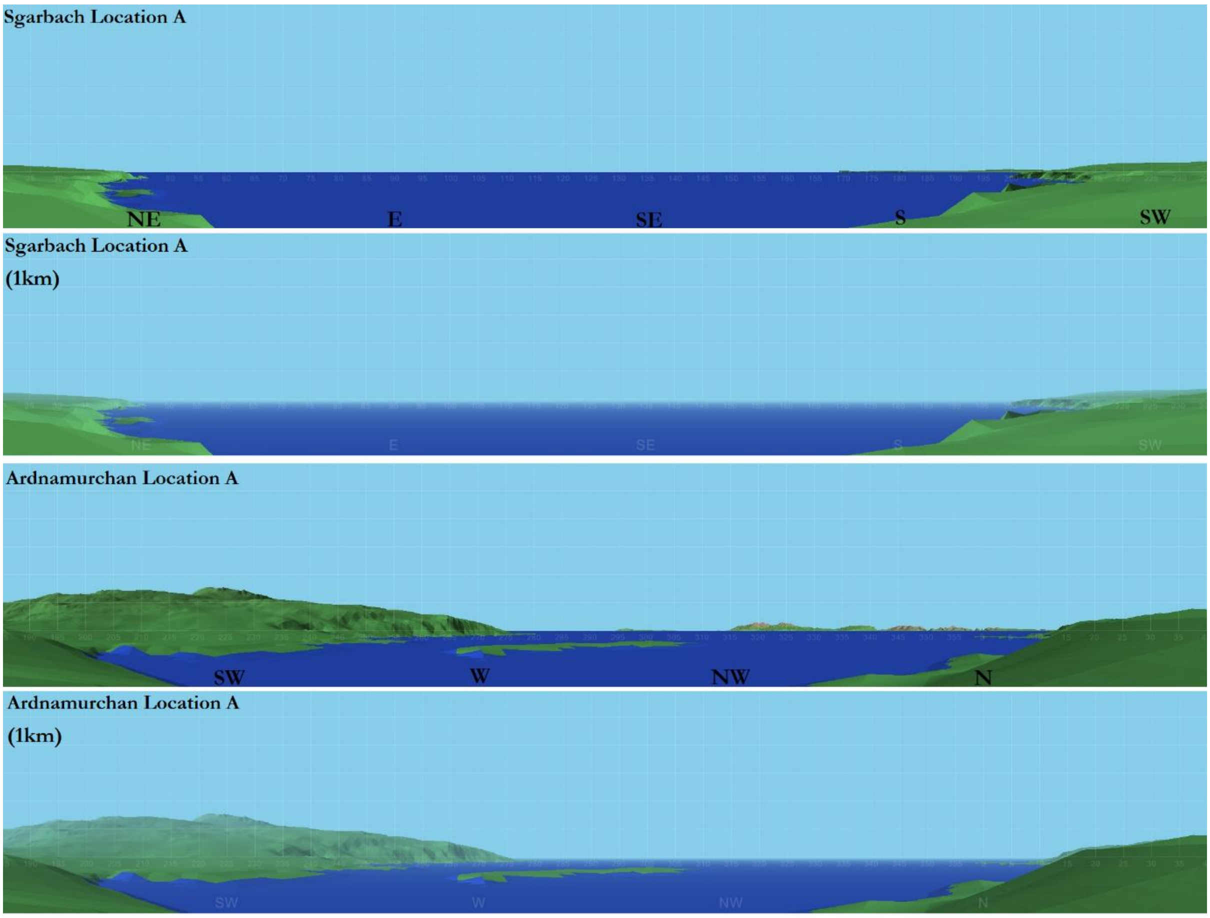


Figure 7.21: Horizon panoramas of Sgarbach Location A and Ardnamurchan Location A, contrasting sea views with and without the effects of atmospheric conditions.

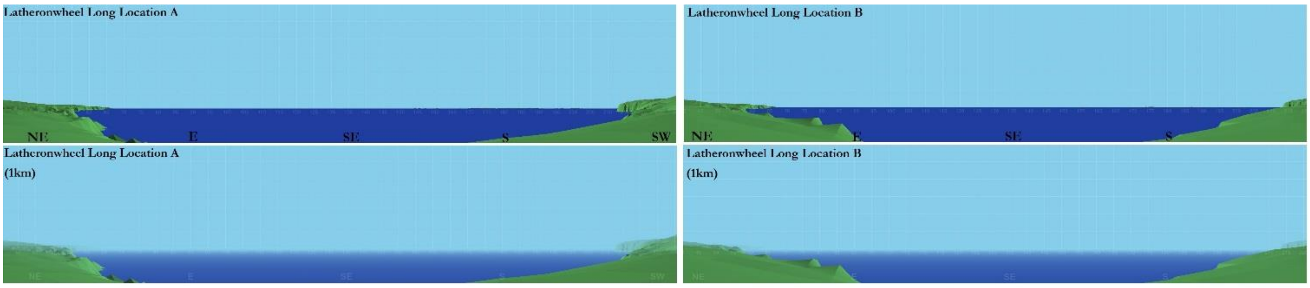


Figure 7.22: Horizon panoramas of Latheronwheel Long Locations A and B, contrasting sea views with and without the effects of atmospheric conditions.

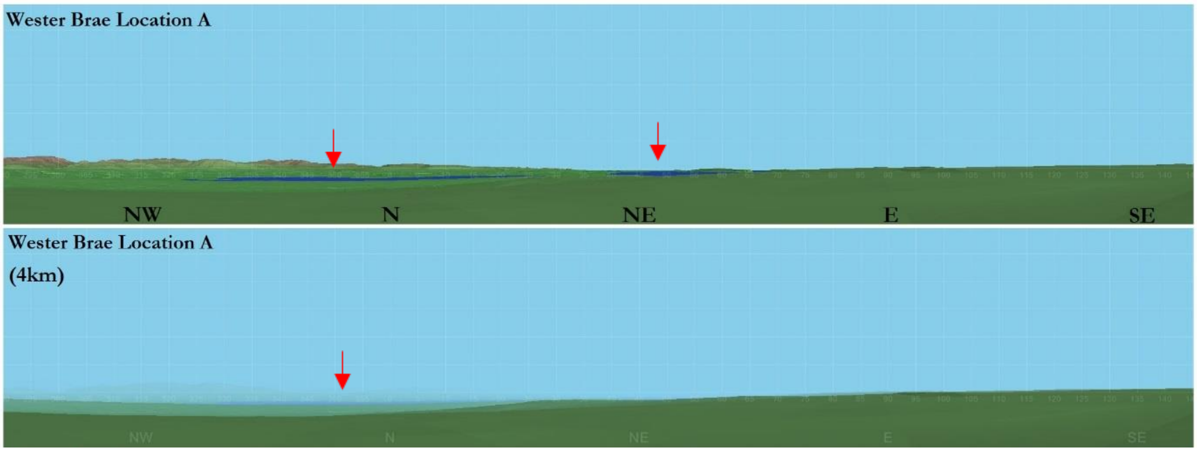


Figure 7.23: Horizon panoramas of Wester Brae Location A and Wester Lamington Location B, showcasing visible sea views with and without the effects of atmospheric conditions. Red arrows indicate sea views.

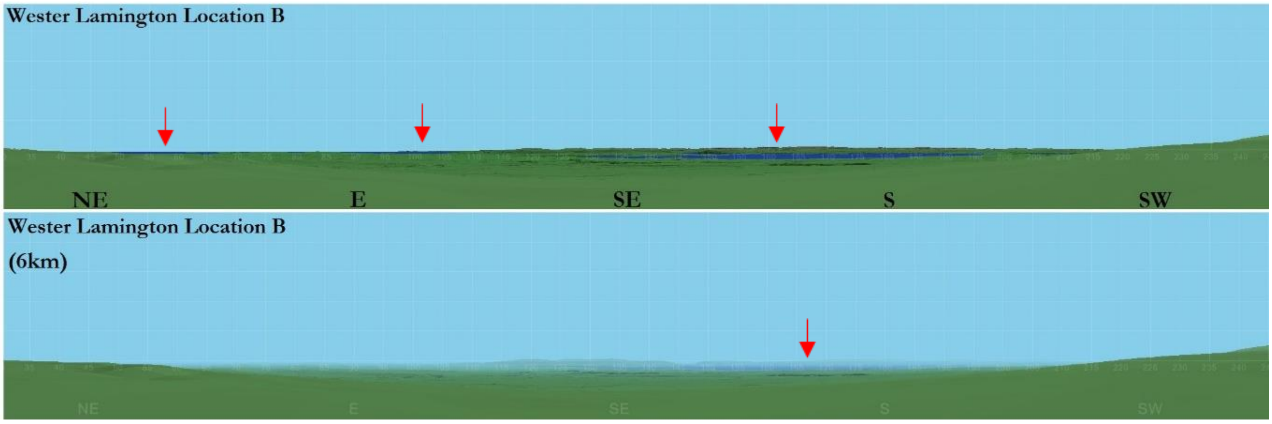


Figure 7.24: Horizon panoramas of Wester Lamington Location B contrasting sea views with and without the effects of atmospheric conditions.
A minimum distance of 6km of clear visibility is needed for these views to appear in the visual range of the observer. Red arrows indicate sea views.

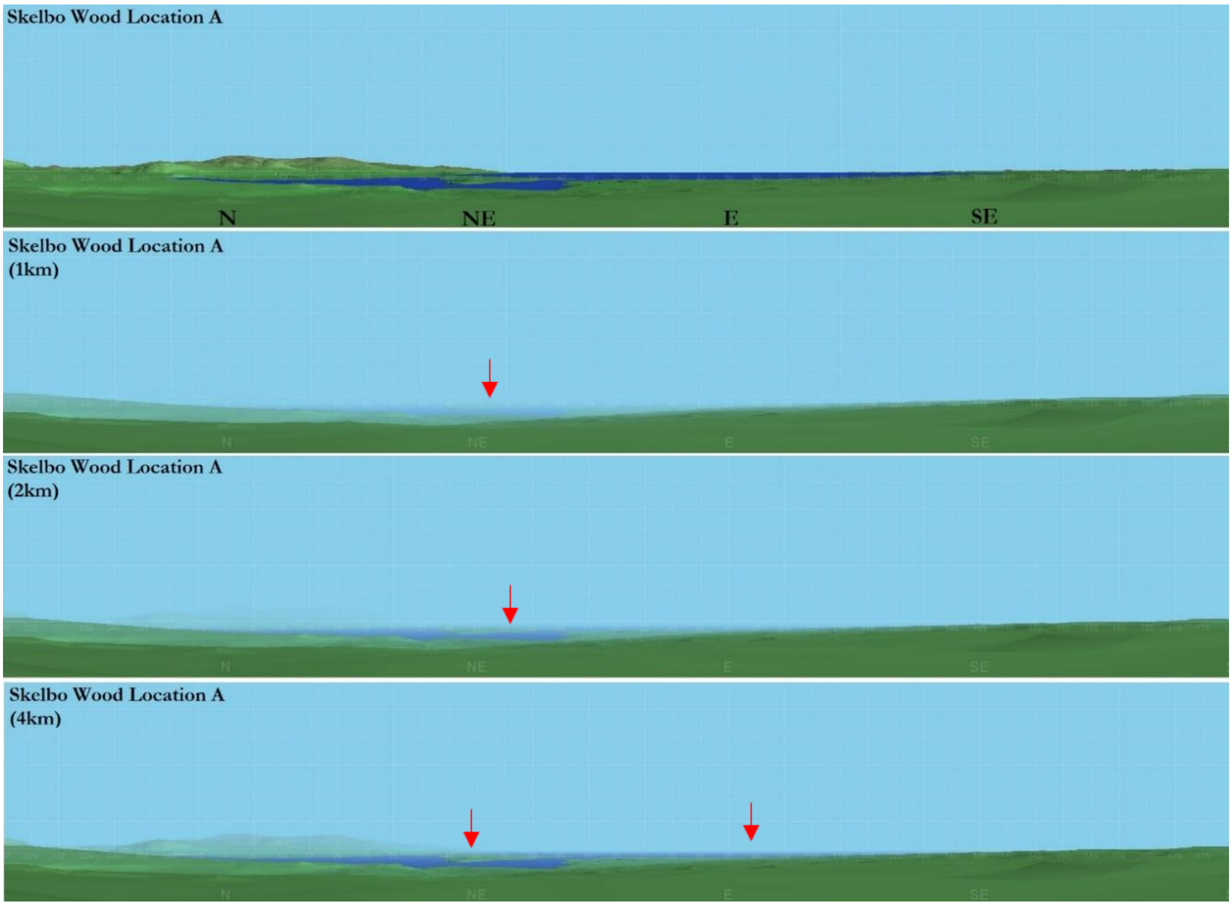


Figure 7.25: Horizon panoramas of Skelbo Wood Location A, showcasing the sea views with and without the effects of atmospheric conditions, with atmospheric clarity set at 1km, 2km and 4km.
With 1km distance of clear visibility, an observer can make out the presence of sea views in the distant horizon. With 2km of clear visibility, a sufficiently large body of water is visible to be noticeable to the naked eye. However, a minimum distance of 4km of clear visibility is required for the entire range of sea views to become visible, this is especially true for the sea views spanning from approximately 70–140º which could otherwise be masked by a layer of fog. Red arrows indicate sea views.

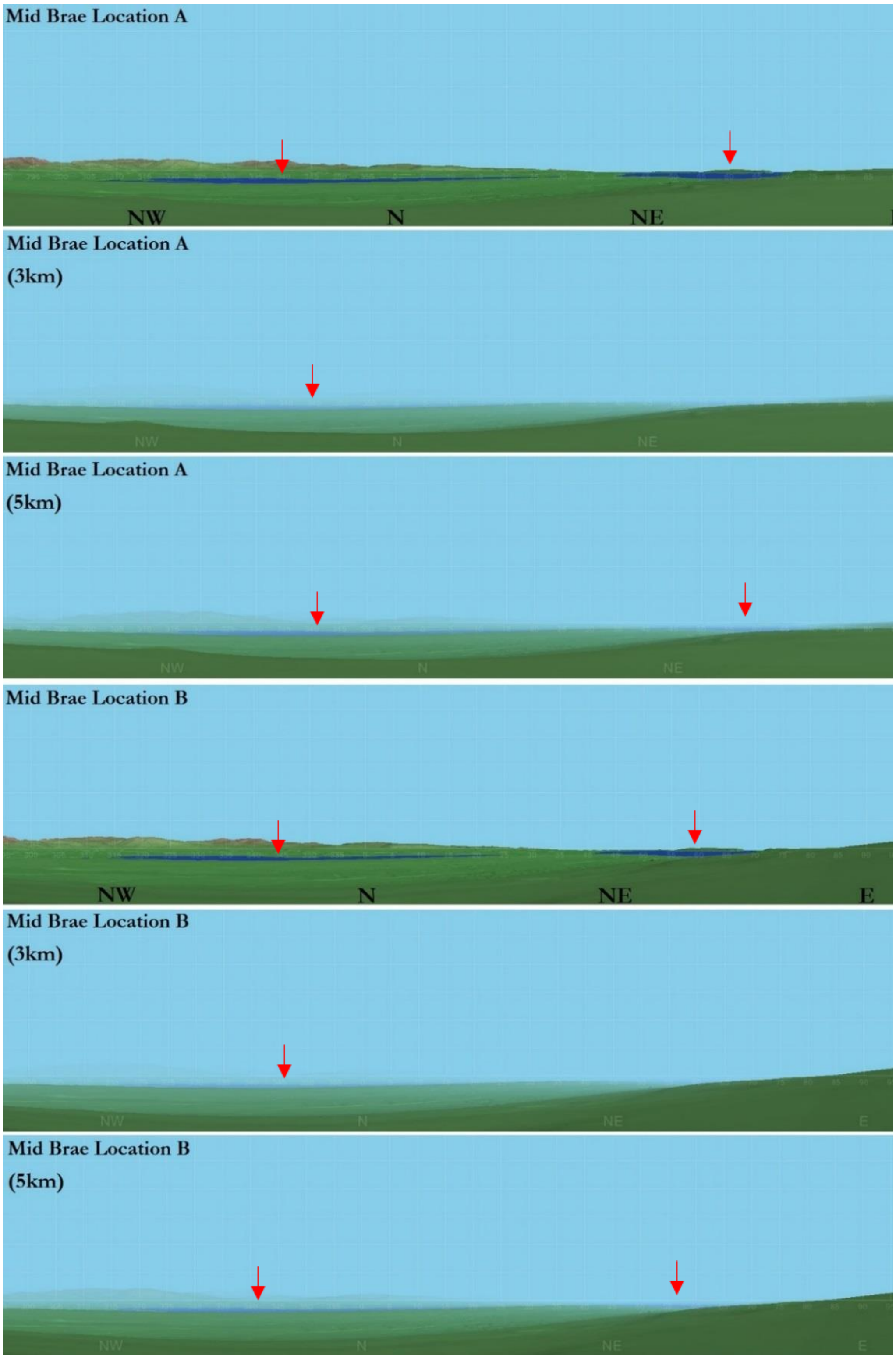


Figure 7.26: Horizon panoramas of Mid Brae Locations A and B, depicting the sea views with and without the effects of atmospheric conditions.
For each of the two alternative locations, atmospheric clarity was set at 3km and 5km. This is because at each of the two locations, sea views came into the visual range of the observer if there was a distance of 3km of clear visibility. Yet, in both cases, the sea views were only partial. The entire expanse of sea views only comes into view if there is a minimum distance of 5km of clear visibility. Red arrows indicate sea views.

7.3 Testing for Revelatory Views

A total of 90 paths were identified as having the potential for offering revelatory views to persons on their approach of the 47 sites considered here. The sea affordance profiles indicate that, according to the criteria described in Chapter 4, Section 5, only 44 of the 90 paths offer revelatory views and these occur at 26 of the 47 sites (see Figures 7.27–9).[36] As in earlier chapters, these pathways are categorized into three somewhat overlapping types, as defined by the differing degrees by which the final view of the sea is hidden and then revealed.

[36] Where possible, the y-axis of the generated sea affordance profiles were standardized in the hope that it will provide a better representation of these revelatory views when compared against each other.

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	General Direction of all paths drawn in	Paths that offer 'revelatory' views	Sea Affordance %
1	Coille Na Borgie North	21	594.76	147.34	Path 1 (NW)	Path 1 (NW)	3.47
2	Coille Na Borgie South	16	527.22	187.10	Path 1 (NW)	Path 1 (NW)	0.93
3	Skelpick Long	41	68.22	1982.22	Path 1 (NNW); Path 2 (NNW)	Path 1 (NNW); Path 2 (NNW)	4.08
4	Cnoc Freiceadain	126	1028.41	3234.23	Path 1 (N)	Path 1 (N)	27.89
5	Na Tri Sithean	130	1098.15	3259.41	Paths 1, 2 (N)	Path 1, 2 (N)	33.64
6	Baillie Hill	81	450.37	5908.03	Path 1 (NNW); Path 2 (NW); Path 3 (N)	Path 1 (NNW); Path 2 (NW); Path 3 (N)	6.32
7	Tulach an t'Sionnach	66	2.58	7145.15	Path 1 (NW)	N/A	0.00
8	Tulach Buaile Assery	86	388.86	9303.16	Path 1 (NE); Path 2 (NW); Path 3 (N)	N/A	0.00
9	Knockglass	42	30.90	6764.41	Path 1 (N); Path 2 (N)	N/A	0.00
10	Youkil Hillock	98	314.56	4023.61	Path 1 (NW); Path 2 (N); Path 3 (NE)	Path 1 (NW); Path 2 (N); Path 3 (NE)	29.57
11	Shean Stemster	126	1315.24	6233.16	Path 1 (N); Path 2 (NNW)	N/A	0.00
12	Stemster, Sinclair's Sithean	96	778.54	6709.04	Path 1 (NW); Path 2 (N); Path 3 (NE)	N/A	0.00
13	Stemster	95	840.52	5913.29	Path 1 (NE); Path 2 (NW)	N/A	0.00
14	Gallow Hill North (Sordale Hill Long)	91	1032.90	6982.22	Path 1 (NW); Path 2 (NE)	N/A	0.00
15	Gallow Hill	96	1246.25	7280.54	Path 1 (N); Path 2 (NW)	N/A	0.00
16	Cooper's Hill	75	893.51	3183.66	Path 1 (N); Path 2 (NW)	Path 1 (N); Path 2 (NW)	39.20
17	Cairn of Heathercro	81	513.80	8773.37	Path 1 (E)	Path 1 (E)	19.34
18	Earney Hillock	60	1415.98	4503.43	Path 1 (N); Path 2 (NW); Path 3 (NE)	N/A	0.00
19	Sgarbach, Auckingill	20	345.46	106.11	Path 1 (NE); Path 2 (S); Path 3 (E); Path 4 (SE)	Path 2 (S); Path 4 (SE)	22.42
20	Camster Long	110	126.44	7150.17	Path 1 (SE)	N/A	0.00
21	South Yarrows North (Yarhouse)	129	266.73	3340.94	Path 1 (SSE); Path 2 (ESE); Path 3 (E)	Path 1 (SSE); Path 2 (ESE); Path 3 (E)	16.28
22	South Yarrows South (Yarhouse)	142	438.82	3164.37	Path 1 (S); Path 2 (SE); Path 3 (N)	Path 1 (S); Path 2 (SE); Path 3 (N)	19.94

23	Warehouse South	181	550.97	2352.66	Path 1 (SE); Path 2 (SE)	Path 1 (SE); Path 2 (SE)	22.47
24	Brounaban	92	592.22	2593.23	Path 1 (SE)	Path 1 (SE)	30.67
25	Latheronwheel Long	34	306.99	219.86	Path 1 (ESE); Path 2 (S)	Path 1 (ESE); Path 2 (S)	57.52
26	Carn Liath, Loedebest	109	324.68	3357.13	Path 1 (SE); Path 2 (SE)	Path 1 (SE); Path 2 (SE)	5.56
27	Kilearnan (Kilournan)	147	817.24	9634.76	Path 1 (NE); Path 2 (S)	N/A	0.00
28	Salscraggie	22	117.03	3189.21	Path 1 (SE)	N/A	0.00
29	Caen Burn West	43	191.94	2636.57	Path 1 (SSE)	N/A	0.00
30	Caen Burn South	40	246.84	2293.22	Path 1 (SE); Path 2 (S)	N/A	0.00
31	Caen Burn North	40	192.68	2511.88	Path 1 (E)	N/A	0.57
32	Caen Burn	73	231.13	2541.72	Path 1 (S)	Path 1 (S)	11.79
33	Carn Laggie	29	195.36	717.90	Path 1 (SSW)	Path 1 (SSW)	3.55
34	Creag An Amalaidh	135	605.35	1176.51	Path 1 (E)	N/A	0.00
35	Skelbo Wood	77	542.46	1202.62	Path 1 (NE); Path 2 (NW); Path 3 (N); Path 4 (NE)	Path 1 (NE)	25.37
36	Wester Lamington	151	849.02	5097.06	Path 1 (NE); Path 2 (S); Path 3 (SE)	Path 3 (SE)	22.23
37	Carn Liath	176	231.70	4251.38	Path 1 (ESE); Path 2 (ESE)	Path 1 (ESE); Path 2 (ESE)	3.34
38	Edderton Hill	121	1236.33	638.74	Path 1 (NNW); Path 2 (E); Path 3 (E)	Path 2	93.45
39	Kinrive West	176	710.86	5787.96	Path 1 (SE); Path 2 (SW)	N/A	95.13
40	Woodhead Long	187	1870.49	3727.78	Path 1 (NE)	N/A	1.03
41	Mid Brae	147	847.34	2602.85	Path 1 (N); Path 2 (NE)	Path 1 (N); Path 2 (NE)	9.74
42	Wester Brae	176	1855.99	3380.15	Path 1 (N); Path 2 (E)	Path 1 (N)	1.62
43	Muir of Allangrange, Cairnside	140	1525.35	3426.53	Path 1 (ENE); Path 2 (SE)	N/A	0.00
44	Essich Moor (Carn Glas)	211	84.04	6194.72	Path 1 (ENE); Path 2 (NE)	Path 1 (ENE); Path 2 (NE)	56.45
45	Pairc A' Chlaiginn	88	261.88	5203.30	Path 1 (W)	N/A	0.00
46	Carn Liatha	207	390.09	7944.49	Path 1 (ESE)	N/A	0.00
47	Ardnamurchan, Cladh Aindreis	10	50.52	120.51	Path 1 (W)	Path 1 (W)	26.25

Table 7.11: Results of sea affordance analysis.

Varieties of Revelatory Views

Sixteen paths can be classed as falling under the first category; as offering a dramatic reveal with a sudden uptick in the sea affordance profile within approximately 200m of the site. These are: Essich Moor Path 2, Cooper's Hill Paths 1 and 2, Youkil Hillock Paths 1, 2 and 3, Sgarbach Paths 2 and 4, South Yarrows North Paths 1 and 2, Cairn of Heathercro Path 1, Carn Liath (Loedebest) Path 1, Baillie Hill Paths 1, 2 and 3, and Wester Brae Path 1. Of these, arguably the most convincing, dramatic and sudden revelatory views of the sea are from the paths approaching Essich Moor, Cooper's Hill, Youkil Hillock, South Yarrows North and Cairn of Heathercro.

The sea affordance profiles for paths 2 and 4 to Sgarbach require some explanation. While both paths offer sea views throughout the length of the journey to the site, there are also sudden upticks, with sea affordance more than doubling on either route just before approaching the site, from about 90m and 130m, respectively. These increases are sufficient for these pathways to be considered to offer revelatory views; however, sea affordance values drop in both cases from over 40% at those locations to 22.4% at the cairn site. This suggests that these pathways differ from what might be called the standard case of a revelatory view. However, such differences might not be genuine, but may merely be due to a complication that has arisen from not being able to visit the site in person: there is some uncertainty regarding at what point on or around the monument the GPS coordinates have been recorded. The location of the revelatory view, as depicted by the sea affordance profile, may possibly coincide with the monument's forecourt or in an adjacent location. This is because the long axis of Sgarbach measures approximately 61m, and, according to the sea affordance profile for Path 2, sea affordance begins to drop at 50m. There is every chance, then, that the drop in sea affordance actually occurs at or past the distal end of the monument, away from what might have been the centre of activity for prehistoric people. Whether or not this is the case, however, the locations of these changes in sea affordance values are interrogated further below through the use of generated Horizon panoramas, to determine their potential significance.

The paths of Carn Liath (Loedebest), Baillie Hill and Wester Brae provide sudden upticks in sea affordance during the final legs of their approaches, that is, approximately 20–30m from reaching the site in each case. However, in comparison to the sites described above they are much smaller increases in sea affordance. On that count, these paths present fairly unpersuasive cases of revelatory views. Nevertheless, there is the possibility that a 'narrow' view of the sea was either desired or an intended effect by the megalithic builders, as suggested by Cummings and Whittle (2004, p. 33), and that such a feature may have enhanced the experience of the site. This is especially true given that these views were well hidden from persons on their approach for some distance (approximately 600–700m) and in the case of Baillie Hill there are no sea views anywhere along the 1.5km path up until the last 30m.

The second category of revelatory views is characterised by a path's gradual – as opposed to sudden – increases in sea affordance values on approach towards a site location, so that values begin increasing in the last 600m of the path instead of the last 200m. Thirteen of the 44 pathways with revelatory views in this region have this kind of gradual increase in sea affordance. These are: Edderton Hill Path 2, Latheronwheel Long Paths 1 and 2, Brounaban Path 1, Ardnamurchan Path 1, Skelbo Wood Path 1, Wester Lamington Path 3, South Yarrows South Path 1 and 2, Mid Brae Paths 1 and 2, Caen Burn Path 1, and Carn Laggie Path 1. In two cases, Edderton Hill and South Yarrows South, the observer is privy to the presence of sea views through a steady and gradual increase of sea affordance values, which reach their highest point at the site locations. In other cases, there appears to be a slight dip in sea affordance at the site location; but, upon closer inspection, it is clear that the pathways still offer revelatory views in the sense that substantial lengths of the paths have either 0% or less than 1% sea affordance before gradually increasing on approach to the sites. Along Path 1 of Ardnamurchan, for instance, sea affordance remains relatively low and drops to 0% for most of its length before gradually increasing from about 250m and reaching its peak of 44% at 140m. Sea affordance remains relatively steady for the next 110m before dipping to a value of 26.2% at the site location. Despite this dip in the sea affordance value, the path would, nevertheless, have provided a revelatory view, as sea views are only revealed during the very last leg of the journey. A further factor that should be noted here is that, as with Sgarbach, Ardnamurchan could not be visited in person, and there are no available records identifying where the GPS coordinates for the site were taken in relation to the monument itself; that is, there is insufficient information to determine whether coordinates were taken from the monument's proximal or distal ends, its middle or elsewhere in its vicinity. Therefore, since the long axis of Ardnamurchan measures 47m, there is every possibility that the observed dip in sea affordance occurs somewhere inside the site area, and that the point of high sea affordance may, nevertheless, offer a revelatory view to persons on their approach to that site.

Similar observations can be made at Skelbo Wood, Wester Lamington, Mid Brae and Caen Burn, where the pathways gradually increase in sea affordance nearer to the site but dip slightly at the locations demarcated by the sites' GPS coordinates. In the case of Carn Laggie, there is a drastic increase in sea affordance, starting from approximately 400m from the site but dropping gradually under a distance of 200m, reducing from around 30.5% of sea affordance at that point to 3.5% at the site location. However, as the monument measures 62m along its long axis and it is unclear where the GPS coordinates for the site were taken, it is similarly unclear whether or how much the dip has an impact on the revelatory view that might be provided on the path. Hence, as the graph indicates that the sea affordance is 19.6%, 60m away from where the GPS coordinates were taken, if part of the monument were in or nearer to that particular area, then the drop in sea affordance on the pathway would only be 10.9%, far less than the drop of 27% mentioned above. Such a change in sea affordance values does not necessarily translate to a significant change in sea views. This path may, therefore, still offer gradual but significant revelatory views despite these changes. This is examined further below with the use of Horizon panoramas.

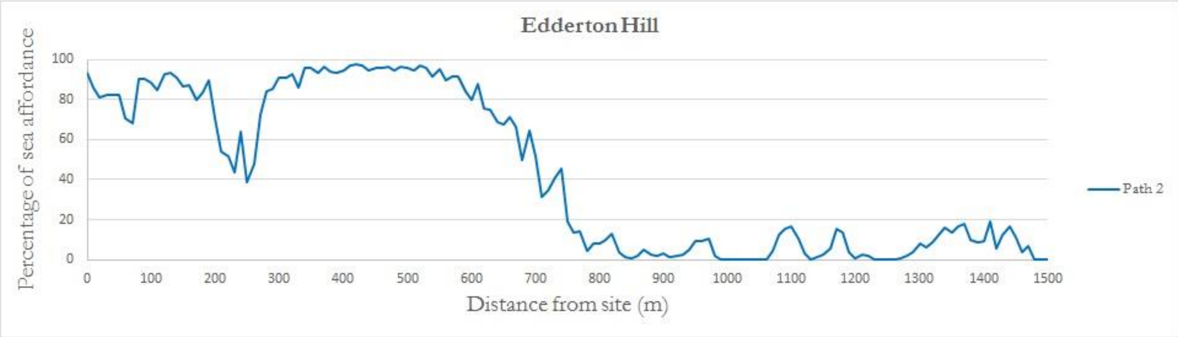
The third category of revelatory views is characterised by a pathway offering brief 'previews' of sea views to persons before they reach the site. This category can be subdivided into three further groups: first, previews that offer slight glimpses of sea views before a 'grand' reveal; second, previews that have higher sea affordance values than what are available at site locations; and third, previews with sea affordance values that are comparable to those at the cairn site. A total of 13 of the 44 identified pathways with revelatory views also offer previews. Of these 13, only 2 paths, Path 2 of Na Tri Sithean and Path 1 of Cnoc Freiceadain, fall into the first subgroup. In the case of Na Tri Sithean Path 2, for example, there are three fleeting previews between 440–120m, one of which reaches 10% at 300m to drop back to 0% at 110m and remain there until just before the site location where the sea affordance begins to rapidly increase, peaking at 33.6% at the site. Two paths fall into the second subgroup, as offering sea previews with higher sea affordance values than at site locations: Path 3 of South Yarrows South and Path 3 of South Yarrows North. Both of these paths offer significant and substantial previews along their approaches to their respective monuments. In the case of South Yarrows South, there are three unmissable peaks in the sea affordance profile, at 680m, 800m, and 920m, with respective values of 68.4%, 67.4% and 56.7%. At South Yarrows North, there are two noticeable sea previews with substantially higher sea affordances than is available at the site location. These occur at 810m and 1060m, with respective sea affordance values of 62.8% and 58.2%. All of these previews are more than three-and-a-half times the sea affordance values of those found at the considered sites. The presence of these previews, therefore, raises the question as to why prehistoric builders overlooked or did not choose these alternative locations, if sea views were indeed a critical factor in placing megalithic constructions.

In any case, a majority of the paths in this category, of revelatory views with previews, fall in to the third subgroup, where previews offer comparative sea affordance values to those observed at site locations. These are: Paths 1 and 2 to Carn Liath, Paths 1 and 2 to Skelpick Long, Path 2 to Carn Liath (Loedebest), Paths 1 and 2 to Warehouse South, Path 1 to Na Tri Sithean and Path 1 to Essich Moor. There are numerous locations along the pathway to Essich Moor, for instance, that offer previews of comparative sea affordances to those of the site location. The most notable of these previews occur at 310m, 340m and 410m from the site, with respective sea affordances of 55.63%, 62.95% and 64.91% (for more details see Figure 7.27). A similarly noticeable preview occurs along Path 1 to Na Tri Sithean, at only 470m away from the site and offering a slightly higher affordance value of 39.8% to the value found at the site (33.6%). With a sea affordance value of 4.08%, Skelpick Long offers minimal sea views, as does its immediate surroundings, however, the sea affordance profle indicates distinct previews along Path 2 at 520m, 580m and 660m from the site, with respective values of 8.48%, 6.96% and 9.58%. While these sea affordance values are in a low range in comparison to sites such as Essich Moor and Na Tri Sithean, they may, nevertheless, hold some significance given that the site was built in an area that offers relatively limited sea views.

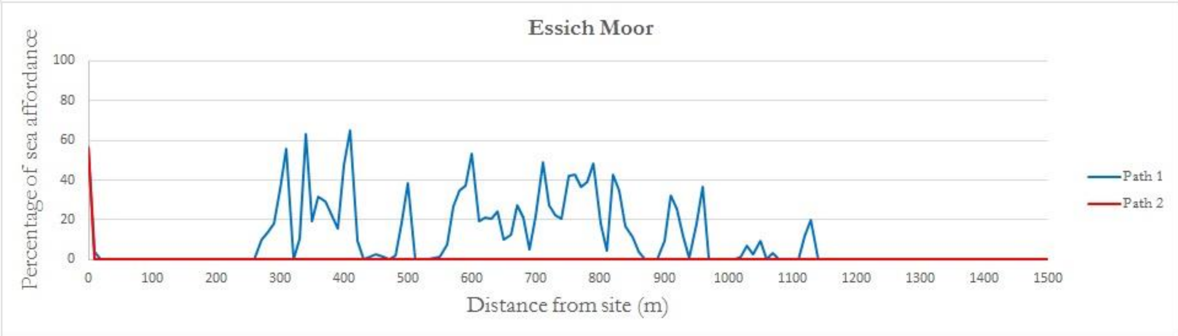
As with the alternative locations with high sea affordance values that were discussed in section 7.2, the presence of preview locations identified here raises the question of whether or not prehistoric builders actively sought out locations that offered sea views; if they did, why did they disregard such locations with higher sea affordances? It may, of course, be possible that, in the visual field of an observer, the sea views of preview locations were comparable with or no different from where sites are situated. This possibility and these questions will be explored further below through the use of Horizon panoramas.

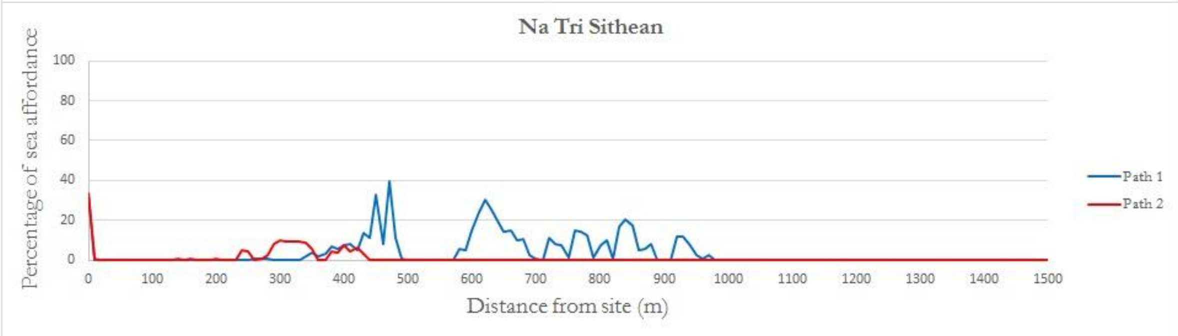
As mentioned further above, there is some overlap between the three categories of revelatory views. This is seen in Path 1 to Mid Brae, Path 1 to Ardnamurchan, Path 1 to Caen Burn, and Path 1 of Carn Laggie, where in addition to having gradual increases in sea affordance during the last legs of the approach to sites, there are also numerous previews of sea views along the way. Similarly, Path 1 to Essich Moor, Path 3 to South Yarrows North, Paths 1 and 2 to Skelpick Long, Paths 1 and 2 to Carn Liath and Path 2 of Carn Liath (Loedebest), offer dramatic and sudden reveals in addition to providing sea previews to those travelling along these pathways. There is some question as to whether such previews spoiled or enhanced the experience of these sites, and a determination may be unable to be made either way, however, a prior question is how these previews differed from the views from the site locations. This will be addressed further below through the analysis of Horizon panoramas.

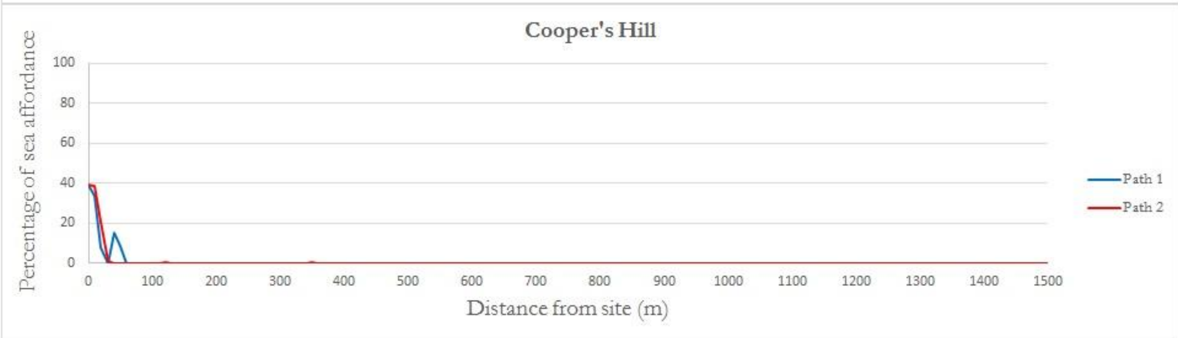
The sea affordance profiles of Coille Na Borgie North and Coille Na Borgie South present slightly different cases (see Figure 7.29). Paths 1 to both sites each offer sea previews as well as exhibiting a gradual increase in sea affordance during the last leg of their approaches, starting from approximately 260m and 220m, respectively. However, during the last 70–70m of the paths, sea affordance begins to diminish again. Despite these reductions in sea affordance values, these sites are considered as offering revelatory views for two reasons. First, the sea views found at the sites are effectively hidden from the observer for significant parts of the journey. This is especially the case at Coille Na Borgie North, where sea views are well-hidden for the length of the 1.5km journey with the only exceptions being two previews, occurring at 1260m and 720m. Second, and furthermore, the monuments themselves measure approximately 60m (Coille Na Borgie North) and 75m (Coille Na Borgie South). Therefore, it is possible that, depending on where the GPS coordinates were taken in relation to the monuments, parts of those monuments might be placed in areas where sea affordance has not decreased.

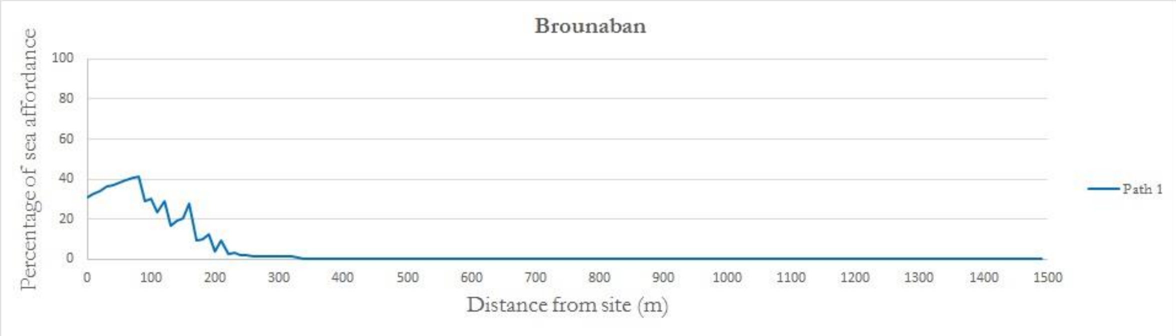

Edderton Hill
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 2

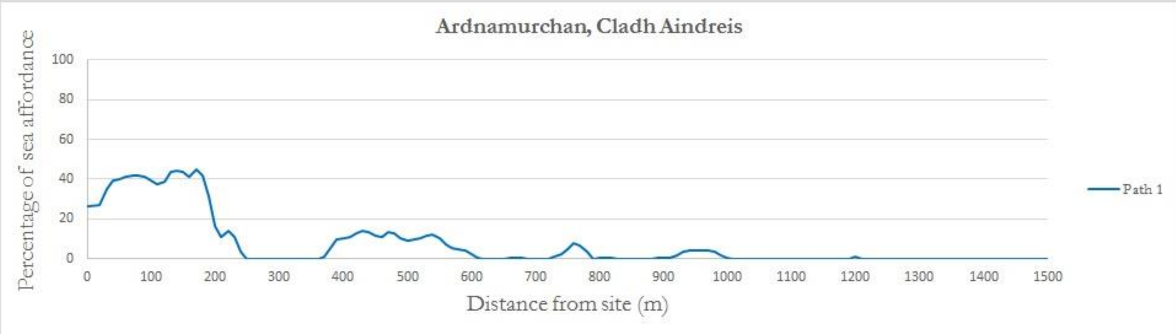

Latheronwheel Long
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1
Path 2

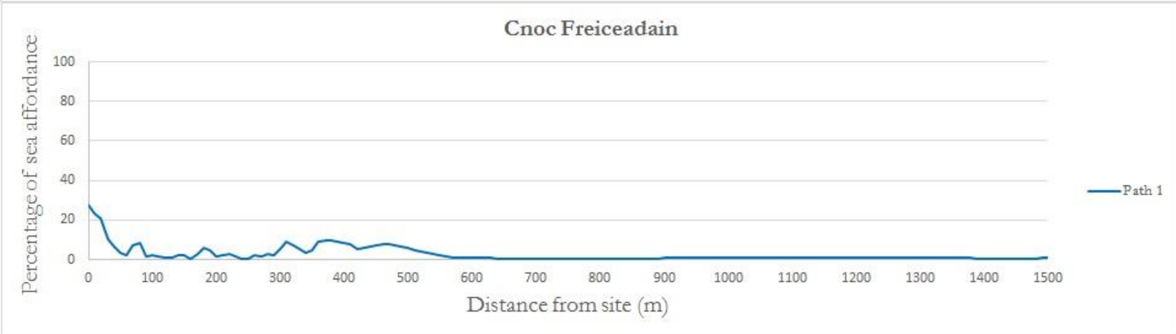

Essich Moor
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1
Path 2

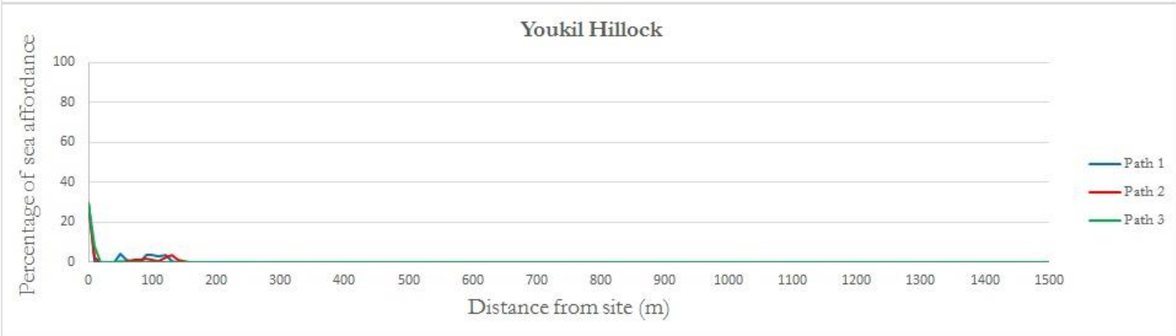

Na Tri Sithean
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1
Path 2


Cooper's Hill
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1
Path 2


Brounaban
Percentage of sea affordance
Distance from site (m)
Path 1

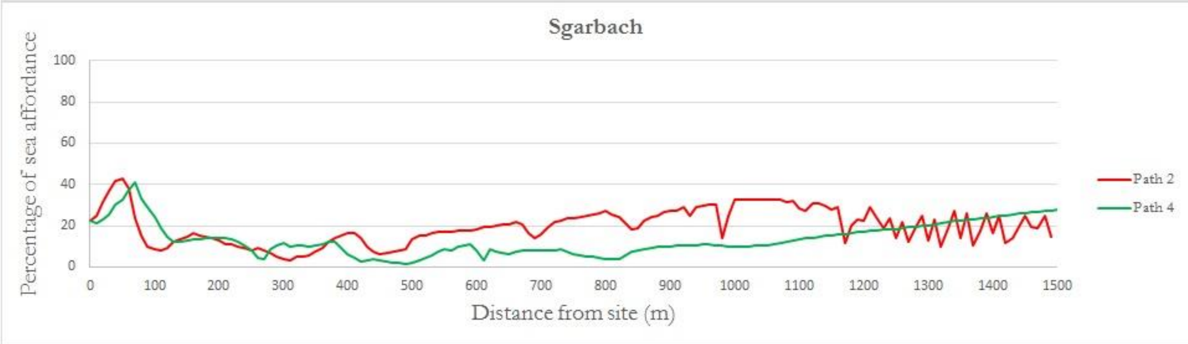

Ardnamurchan, Cladh Aindreis
Percentage of sea affordance
Distance from site (m)
Path 1


Cnoc Freiceadain
Percentage of sea affordance
Distance from site (m)
Path 1


Youkil Hillock
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2
Path 3

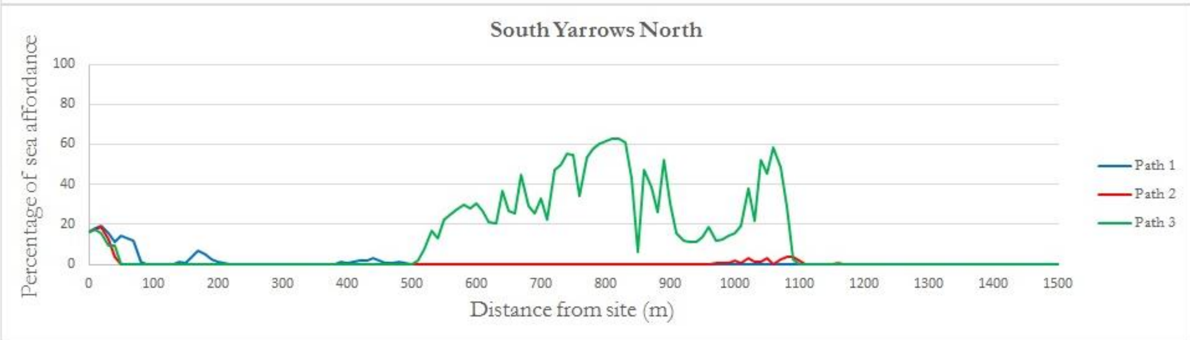

Warehouse South
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2


Skelbo Wood
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1


Sgarbach
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 2
Path 4


Wester Lamington
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 3


South Yarrows South
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1
Path 2
Path 3


South Yarrows North
Percentage of sea affordance
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance from site (m)
Path 1
Path 2
Path 3

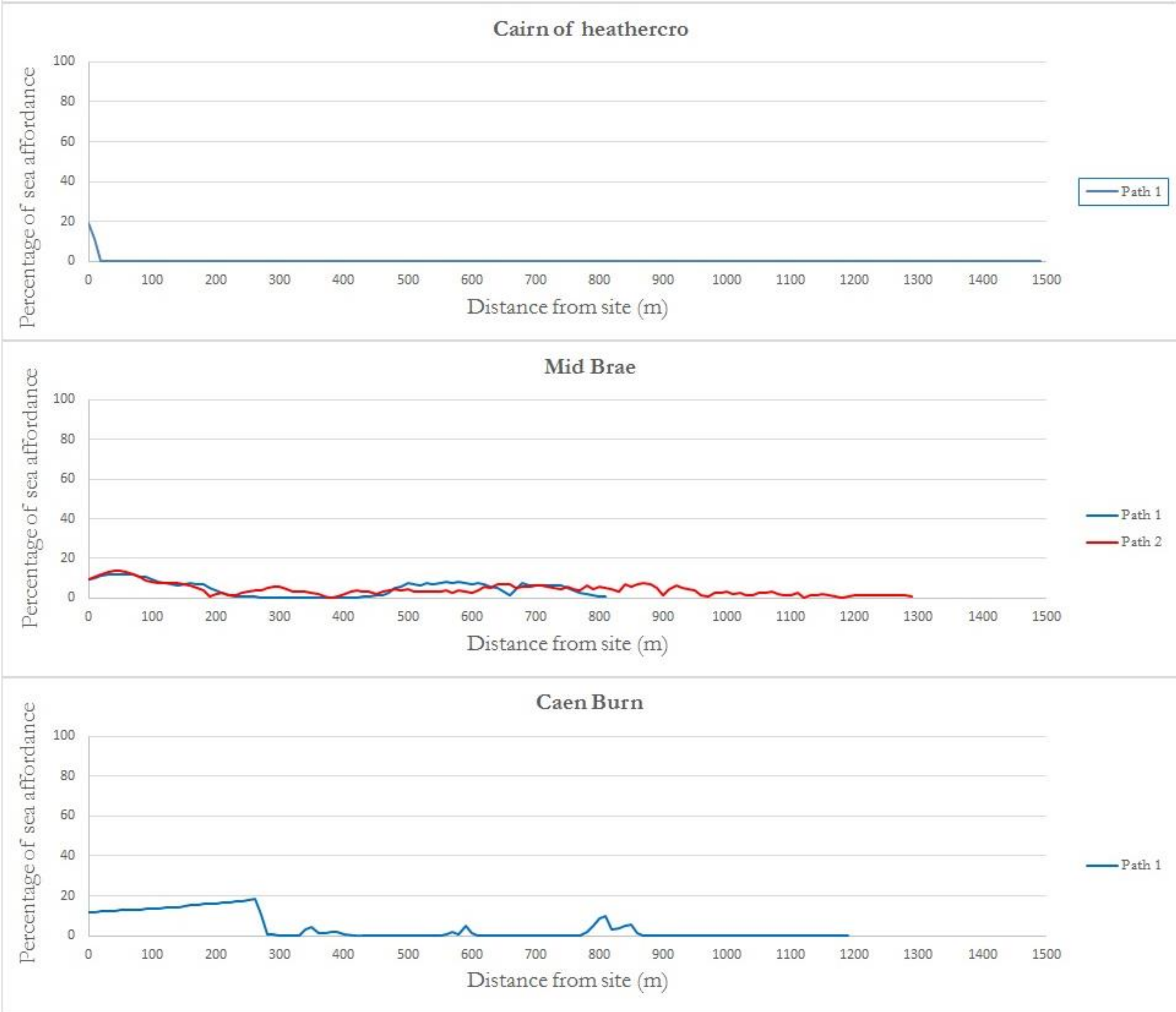
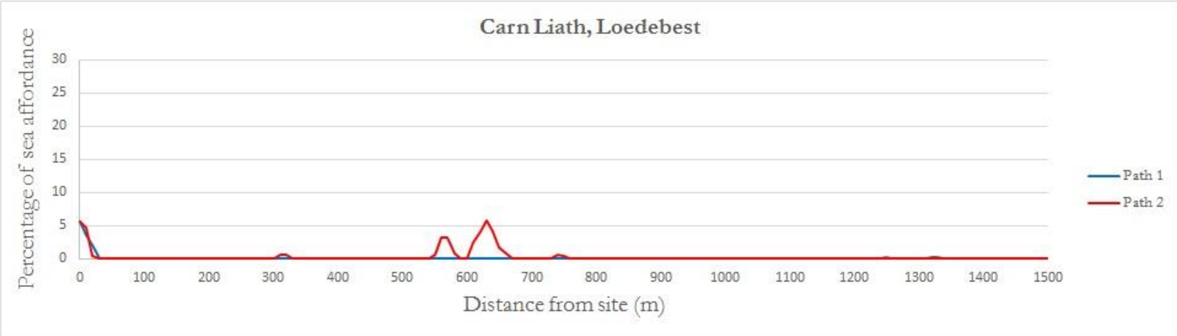
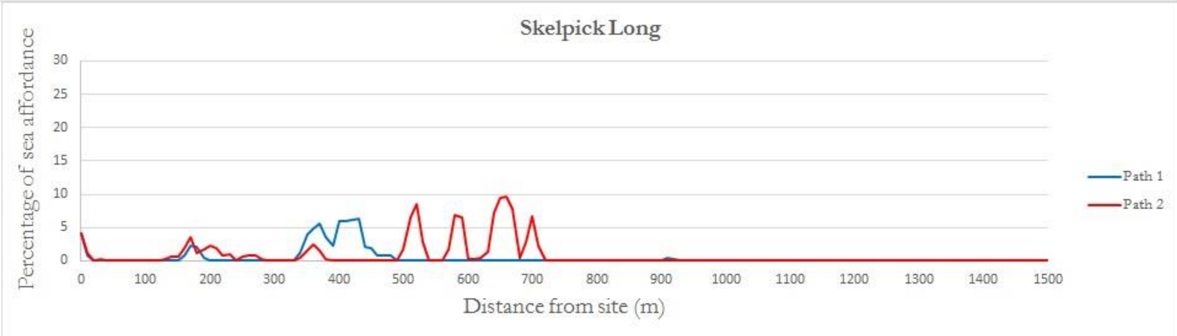
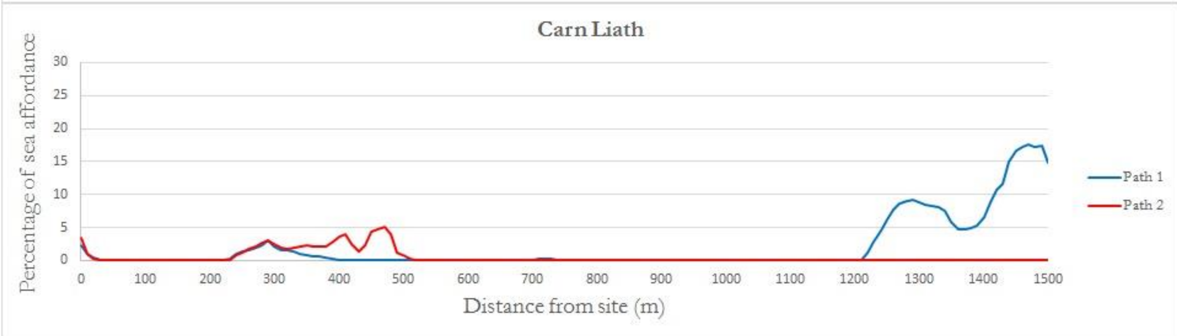


Figure 7.235: Sea affordance profiles of Edderton Hill, Latheronwheel Long, Essich Moor, Na Tri Sithean, Cooper's Hill, Brounaban, Ardnamurchan, Cnoc Freiceadain, Youkil Hillock, Warehouse South Skelbo Wood, Sgarbach, Wester Lamington, South Yarrows South, South Yarrows North, Cairn of Heathercro, Mid Brae and Caen Burn.


Carn Liath, Loedebest
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2


Baillie Hill
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2
Path 3


Skelpick Long
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2


Carn Liath
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2

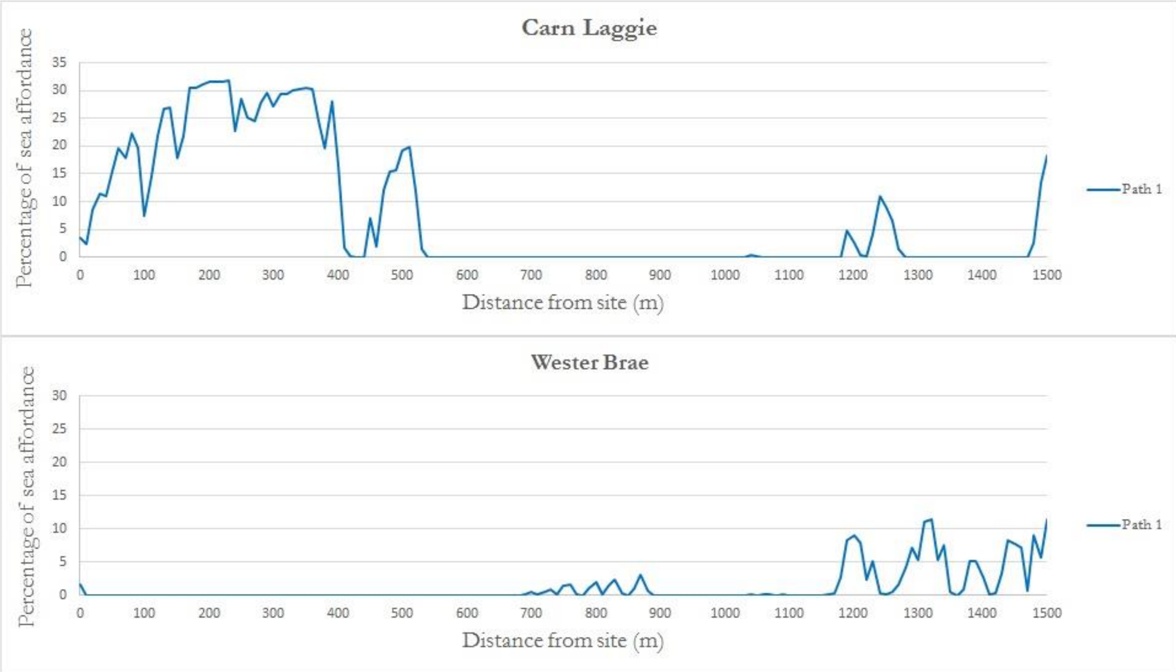


Figure 7.28: Sea affordance profiles of Carn Liath (Loedebest), Baillie Hill, Skelpick Long, Carn Liath, Carn Laggie and Wester Brae.

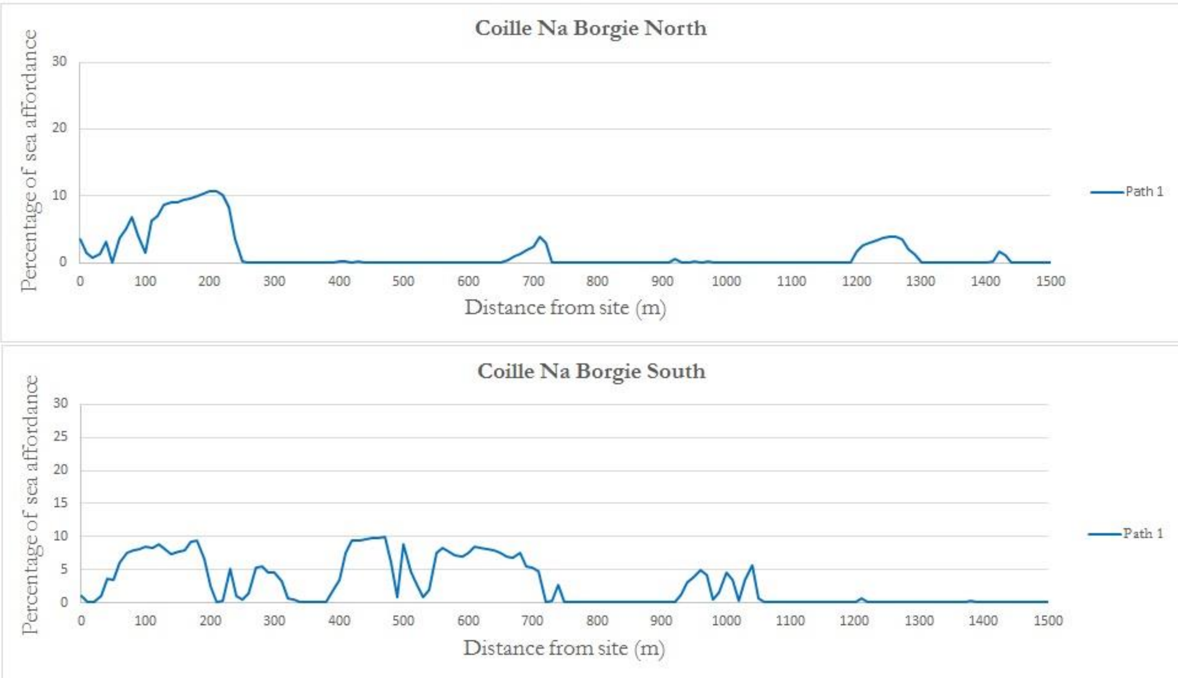


Figure 7.29: Sea affordance profiles of Coille Na Borgie North and Coille Na Borgie South.

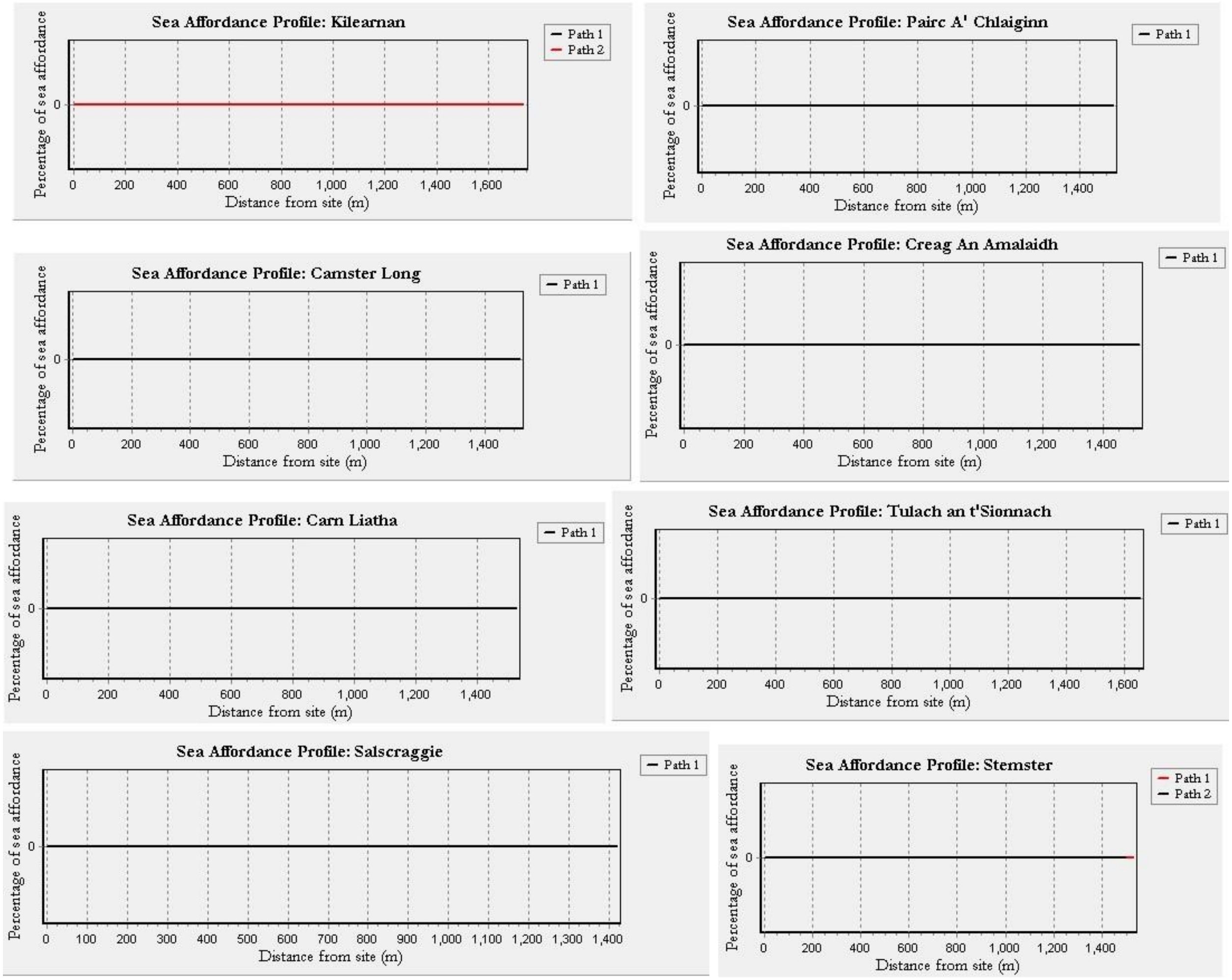


Figure 7.30: Sea affordance profiles of Kilearnan, Camster Long, Cairn Liatha, Stemster and Tulach an t'Sionnach Pairc A' Chlaiginn, Creag An Amalaidh and Salscraggie.

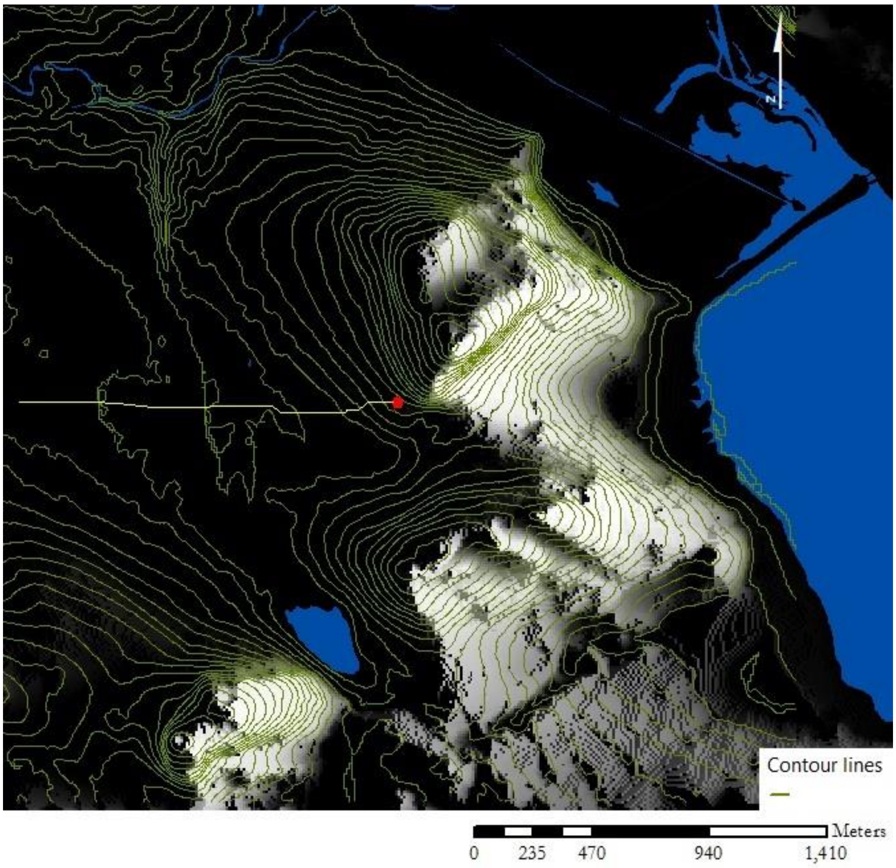


Figure 7.31: Sea affordance surfaces of Creag An Amalaidh (marked in red).
Path 1 leading up to the site is shown in yellow. The contour lines were generated at 10m intervals. This shows that the site and the path are both situated on the side of the mountain that faces away from the sea, and as a result there are no visible sea views from that side.

Investigation of Revelatory Views and Previews with Horizon Panoramas

Horizon panoramas were generated for each of the 26 sites offering revelatory views.[37] It seems that despite a majority of sites having expansive sea views, i.e. sea views that spread out across the horizon, only 5 of the 26 sites offer views that are also substantially prominent in the observer's visual field. These are: Edderton Hill, Latheronwheel Long, Sgarbach, Ardnamurchan and Skelbo Wood, with respective sea views spanning from approximately 306.5–96º, 71.5–201º, 44–201º, 280–7.5º and 349–139.5º (see Figure 7.34). Expansive and moderately prominent sea views are available from Warehouse South, Na Tri Sithean and Cnoc Freiceadain, respectively spanning from approximately 11.5–207º, 270–46º and 273.5–45.5º (see Figure 7.34).[38] It should be noted that the

[37] Edderton Hill, Essich Moor, Latheronwheel Long, Na Tri Sithean, Cooper's Hill, Brounaban, Ardnamurchan, Cnoc Freiceadain, Youkil Hillock, Warehouse South, Skelbo Wood, Sgarbach, Wester Lamington, South Yarrows South, South Yarrows North, Cairn of heathercro, Mid Brae, Caen Burn, Carn Liath (Loedebest), Baillie Hill, Skelpick Long, Carn Liath, Carn Laggie, Wester Brae, Coille Na Borgie North and Coille Na Borgie South.
[38] At Warehouse South, bulk of the sea views spans from 11.5º to 207º. However, there is another very small patch of sea spanning from 219º to 221.5º.

different distances of these sites from the coast may explain why their sea views are either substantially or moderately prominent: the first set of sites is located in close proximity to the sea, while the second set is placed further inland (see Table 7.12).

The Horizon panoramas reveal that an additional ten sites have expansive sea views but only appear as a 'slivers' of sea across the horizon. These sites and the approximate ranges of their sea views are as follows: South Yarrows South 15–96º and 108–135.5º, South Yarrows North 17.5–94º, Mid Brae 310–30º and 40–71º, Wester Lamington 26–73º, 86–109º and 124.5–201º, Brounaban 14–127º, Youkil Hillock 319–24º, Baillie Hill 324.5–329º and 332– 356.5º, Cooper's Hill 305–354.5º and 20.5–25.5º, Essich Moor 357–44º and Cairn of Heathercro 82.5–106º (see Figure 7.35).[39] Some of these sites have significant levels of sea affordance, however, at each of these locations sea views are barely noticeable in the distant horizon. As above, an explanation for this may be the distance of these sites from the coastline, as they are situated further inland (for more details, see Table 7.12). A further example of such an instance is seen in the Horizon panorama for Essich Moor. The sea affordance analysis yielded a value of 56.45% for this site location. Yet, in the visual field, the sea views it offers are hardly noticeable, appearing only as a sliver of sea across the horizon. The disparity between the sea affordance value and sea views found in this case is attributable to the 6.2km distance of this site from the coastline, diminishing the effect of its sea views.

The two sites of Brounaban and Mid Brae are not placed at such distances from the coast, at 2.6km from the nearest shoreline in either case. Yet, at both locations, sea views appear only as slivers of sea that expand across the horizon. These examples illustrate how the prominence of a sea view it is not only dependent on how close a site is to the coastline but also how far that site is from the area of sea that is visible. With standard viewsheds it was possible to determine which parts of the sea are visible from the sites and, subsequently, measure the distance from each site to those nearest areas of visible water. The nearest parts of visible sea from Brounaban and Mid Brae were, then, found at approximately 4km (in the E-SE) and 5m (in the N and NE), respectively. Therefore, the area of sea that was visible from each site location to the observer is, in both cases, considerably far, explaining why sea views only appear as a sliver across the horizon.

[39] At Cooper's Hill, bulk of the sea views spans from approx. 305º to 354.5º and 20.5º to 25.5º but there are miniscule patches of sea views in-between, which is barely recognizable. Similarly, at Wester Lamington bulk of the sea views spans from approx. 26º to 73º, 86º to 109º and 124.5º to 201º but there are minuscule patches of sea views in-between.

Site Name	Distance to the Nearest Coastline (m)
Sgarbach	106
Latheronwheel Long	220
Skelbo Wood	1203
Edderton Hill	639
Ardnamurchan	121
Warehouse South	2353
Na Tri Sithean	3259
Cnoc Freiceadain	3234

Table 7.32: Distance of sites to the nearest coastline.

Site Name	Distance to the Nearest Coastline (km)
South Yarrows South	3.2
South Yarrows North	3.3
Mid Brae	2.6
Wester Lamington	5.1
Brounaban	2.6
Youkil Hillock	4.0
Baillie Hill	5.9
Cooper's Hill	3.2
Cairn of Heathercro	8.8

Table 7.33: Distance of sites to the nearest coastline.

From the Horizon panoramas, the remaining 8 sites of the 26 that are identified as having revelatory views on the basis of sea affordance values appear to offer only narrow views of the sea (see Figure 7.36). These sites and the approximate ranges of their sea views are: Caen Burn 150.5–164°, Carn Liath (Loedebest) 123.5–149°, Coille Na Borgie North 326.5–329°, Coille Na Borgie South 326°, Skelpick Long 330–334°, Carn Liath 101–117.5°, Wester Brae 64–67°, and Carn Laggie 162–174.5°.[40] The Horizon panoramas shown in Figure 7.36 indicate that the sea views at each of these site locations are not only narrow in the visual field, but are also extremely faint if noticeable at all; at six of the eight sites, sea views are impossible to discern with any clarity without magnification of the image. The two exceptions are Caen Burn and Carn Liath (Loedebest), where sea views are clear despite being narrow. However, as those particular sea views are narrow, there is a high potential for them to be obscured either partially or completely

[40] At Wester Brae, there are minuscule patches of visible sea at approximately 40°, 47.5°, 50°, and between 59° and 61.5°.

by vegetation or atmospheric conditions. The views afforded at these eight particular sites do not, then, offer confirmation to the claim that seas views were somehow significant and played a role in enhancing the experience of places where monuments were built.

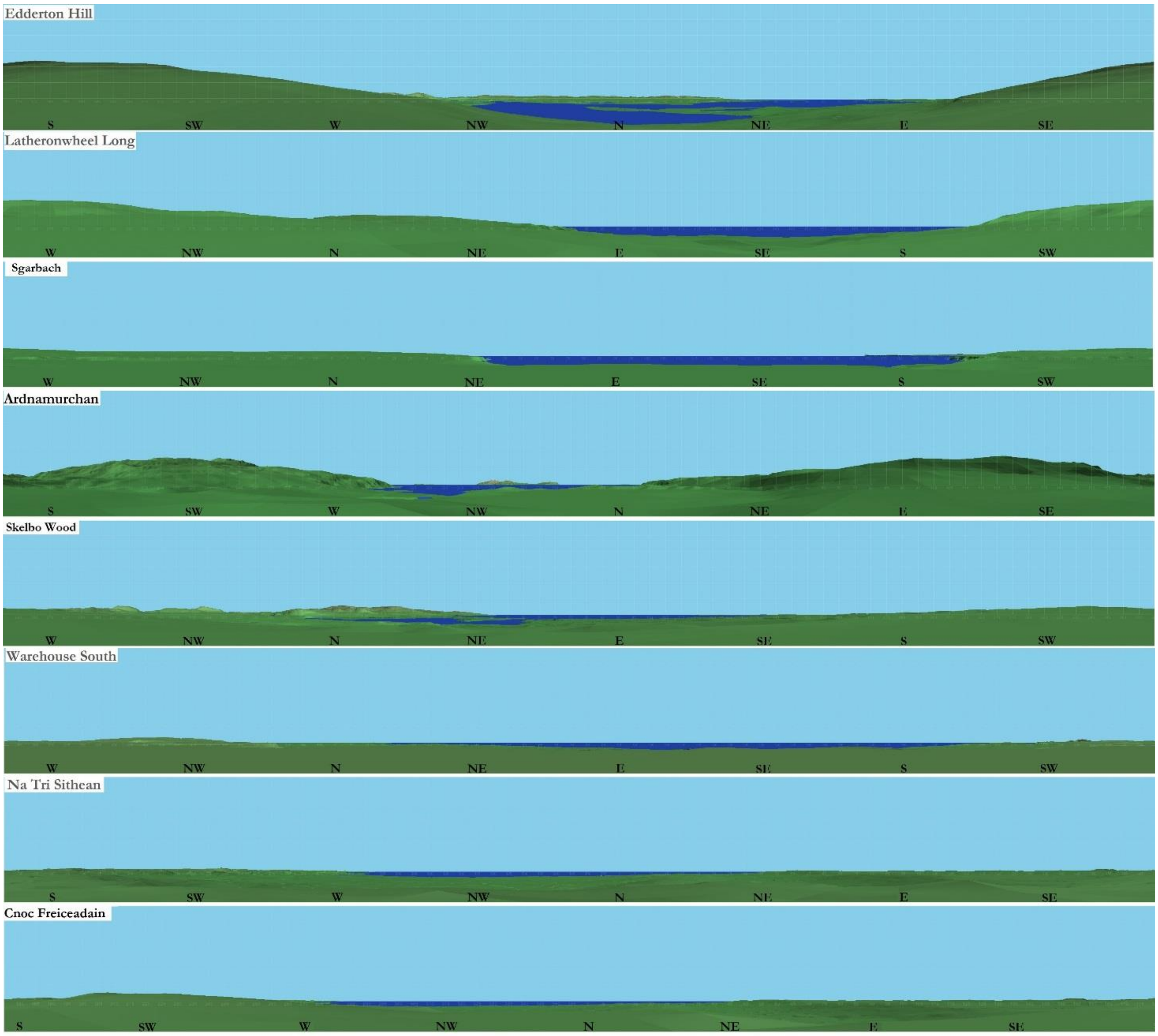


Figure 7.34: Horizon panoramas of Edderton Hill, Latheronwheel Long, Sgarbach, Ardnamurchan, Skelbo Wood, Warehouse South, Na Tri Sithean and Cnoc Freiceadain, displaying 'broad' expansive views of the sea.

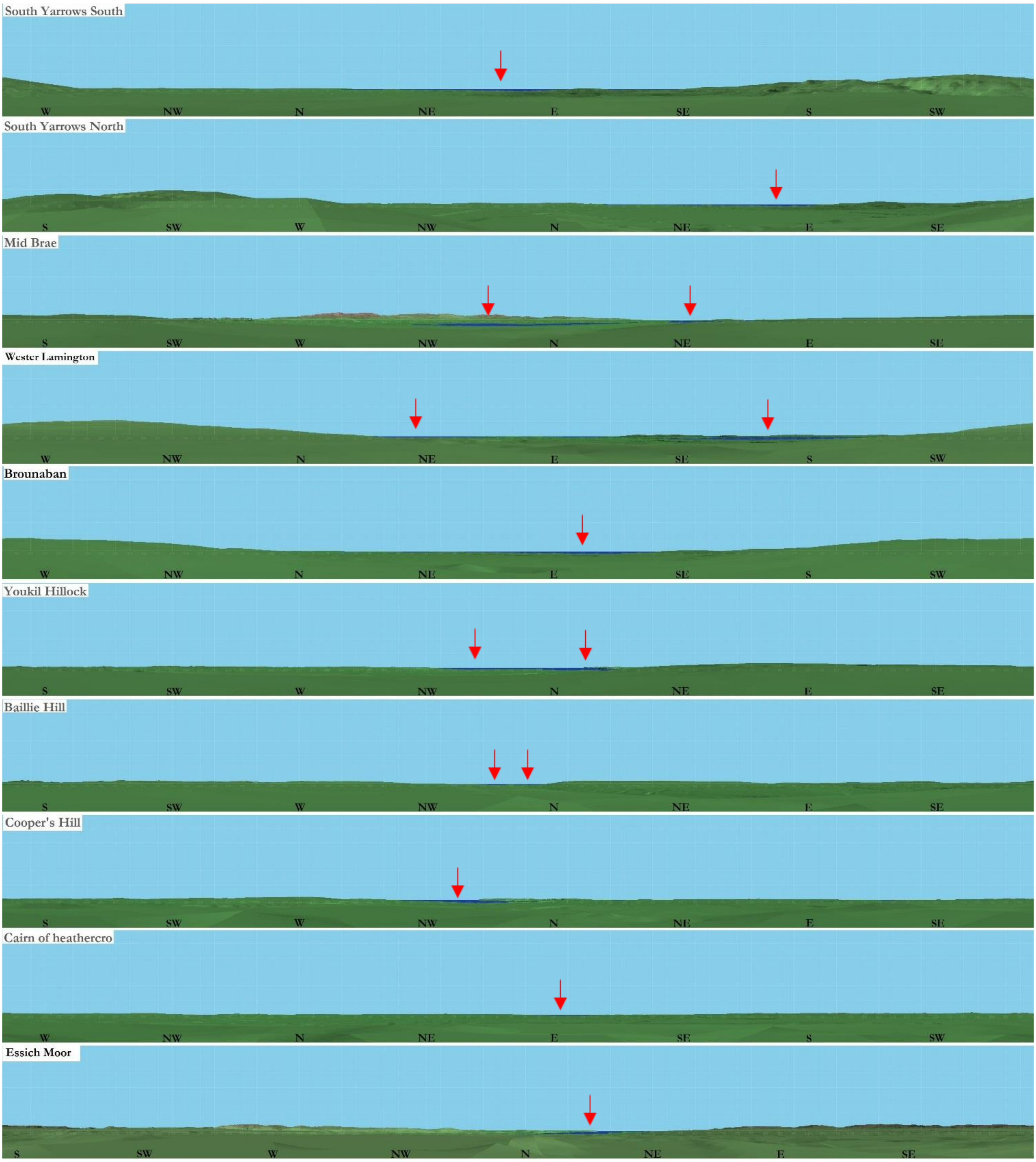


Figure 7.35: Horizon panoramas of South Yarrows South, South Yarrows North, Mid Brae, Wester Lamington, Brounaban, Youkil Hillock, Baillie Hill, Cooper's Hill, Cairn of Heathercro and Essich Moor.

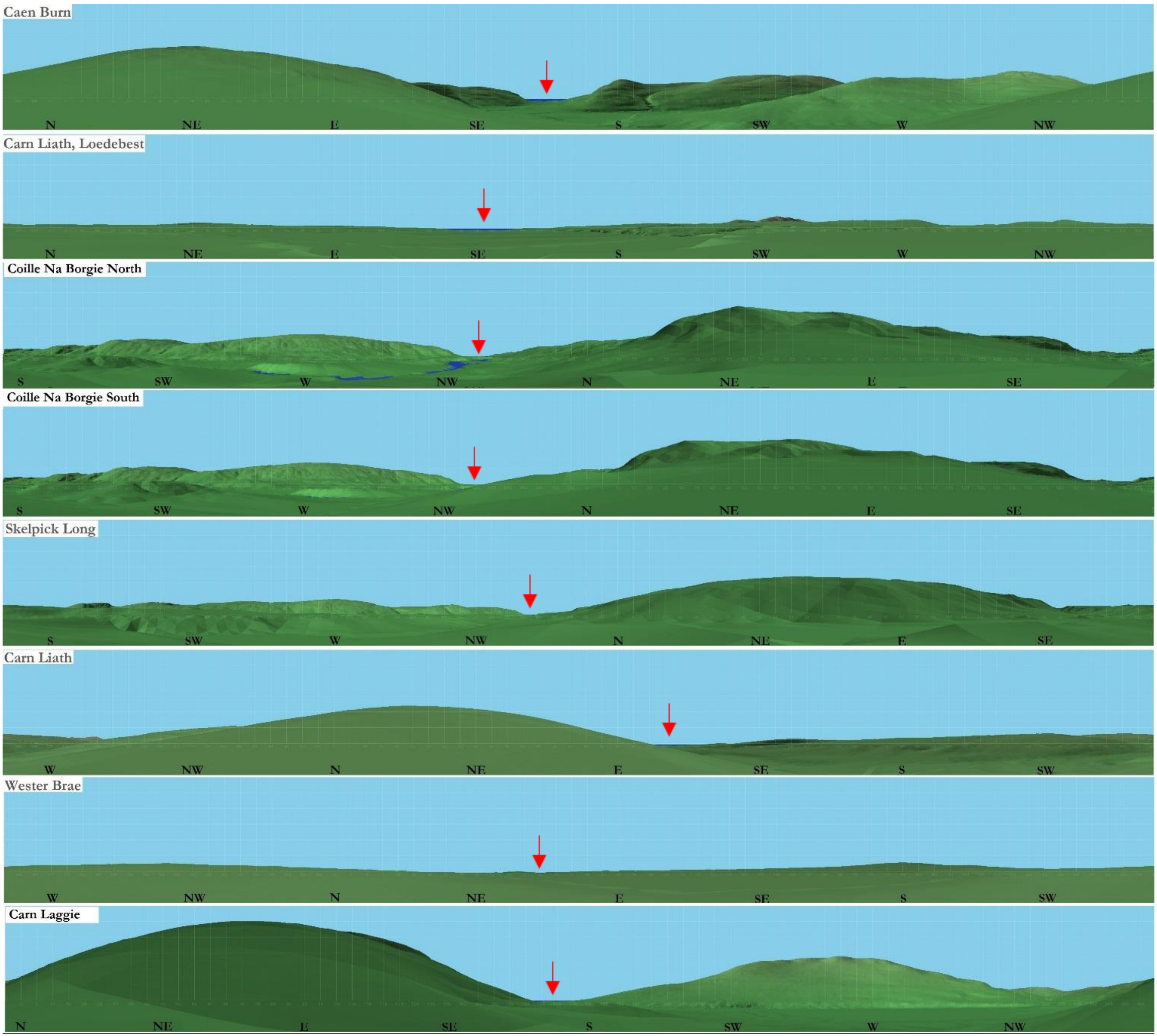


Figure 7.36: Horizon panoramas of Caen Burn, Carn Liath (Loedebest), Coille Na Borgie North, Coille Na Borgie South, Skelpick Long, Carn Liath, Wester Brae and Carn Laggie depicting narrow views of the sea.

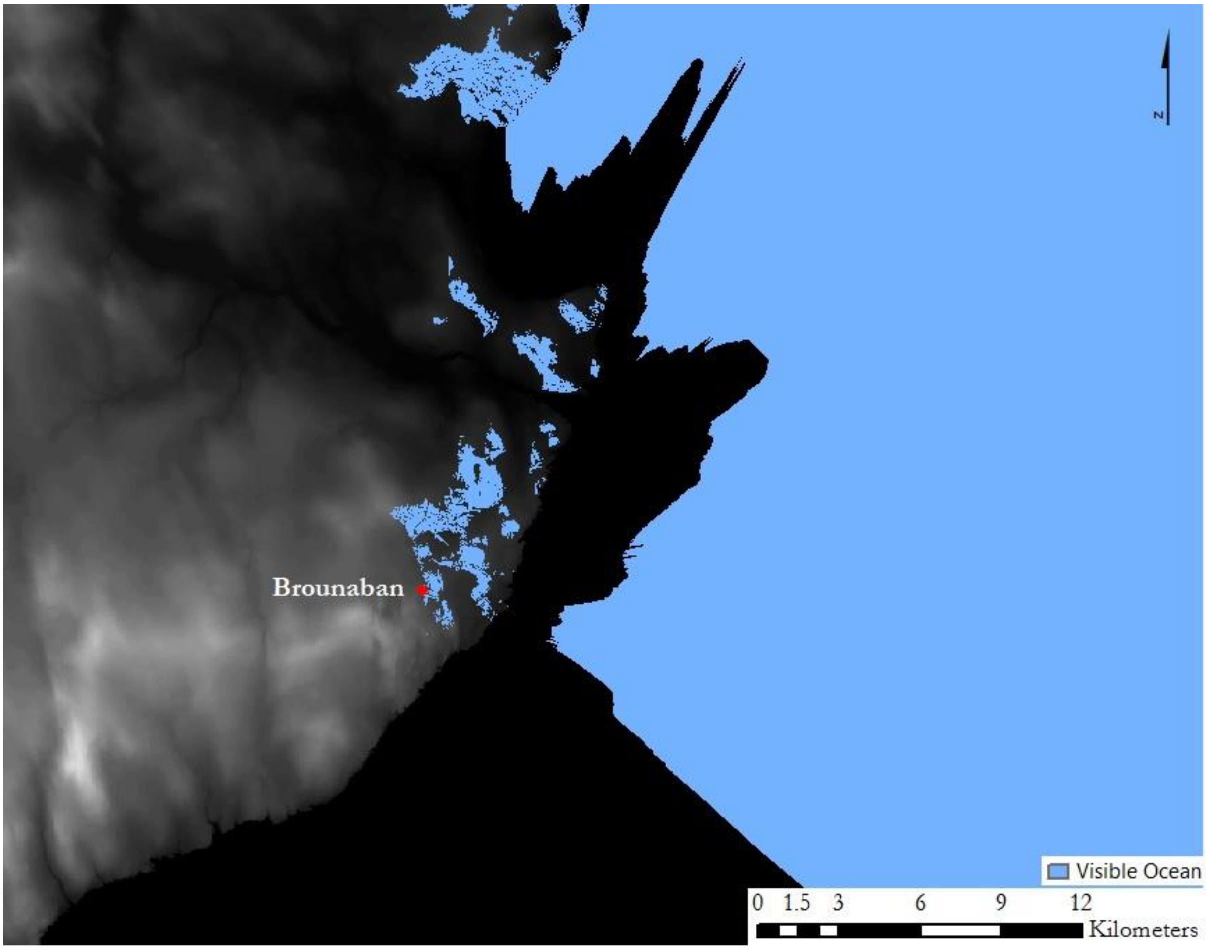


Figure 7.37: Standard viewshed of Brounaban showing the areas of sea visible from that particular location. The sea areas closest and along the coastline are not visible while areas further away only appear as a sliver of sea across the horizon.

The findings of the Horizon panoramas are corroborated by panoramic photographs taken during field surveys, as shown in Figure 7.38. Thirteen of the 26 sites that offer revelatory sea views were able to be visited during fieldwork—unfortunately, due to practical constraints on time, resources, and accessibility (in the case of Wester Lamington, the site was unable to be found) the remaining 13 sites could not be investigated in person. The remaining sites which were visited sites are: Wester Brae, Baillie Hill, Skelpick Long, Essich Moor, Na Tri Sithean, Cnoc Freiceadain, South Yarrows South, South Yarrows North, Brounaban, Caen Burn, Coille Na Borgie North, Coille Na Borgie South and Carn Laggie.

As can be seen in Figures 7.38–41 below, panoramic photographs reveal that sea views can only be seen at Na Tri Sithean, Cnoc Freiceadain, South Yarrows South, South Yarrows North, Brounaban and Caen Burn. At the remaining 7 of the 13 sites (Wester Brae, Baillie Hill, Skelpick Long, Essich Moor, Coille Na Borgie North, Coille Na Borgie South and Carn Laggie) sea views are not visible to the naked-eye, which conforms to the depiction of sea views in the Horizon panoramas for those sites as being present but infinitesimally small. Modern-day constructions and plantation trees further impede the visibility of many of these sea views. In the case of Baillie Hill, however, there are no plantation trees or modern constructions. In this particular case, see views appear to be simply too far away to be apparent to the naked eye. This site is situated 5.9km from the nearest coastline but the nearest parts of the sea that are visible from that location are much further away. At Coille Na Borgie North, sea views could only be identified through the aid of a digital camera (see Figure 7.39), a problem that occurred at several other sites, including Skelpick Long and Coille Na Borgie South. These cases indicate that it would have been impossible for prehistoric builders – without the aid of modern technology – to discern any such sea views.

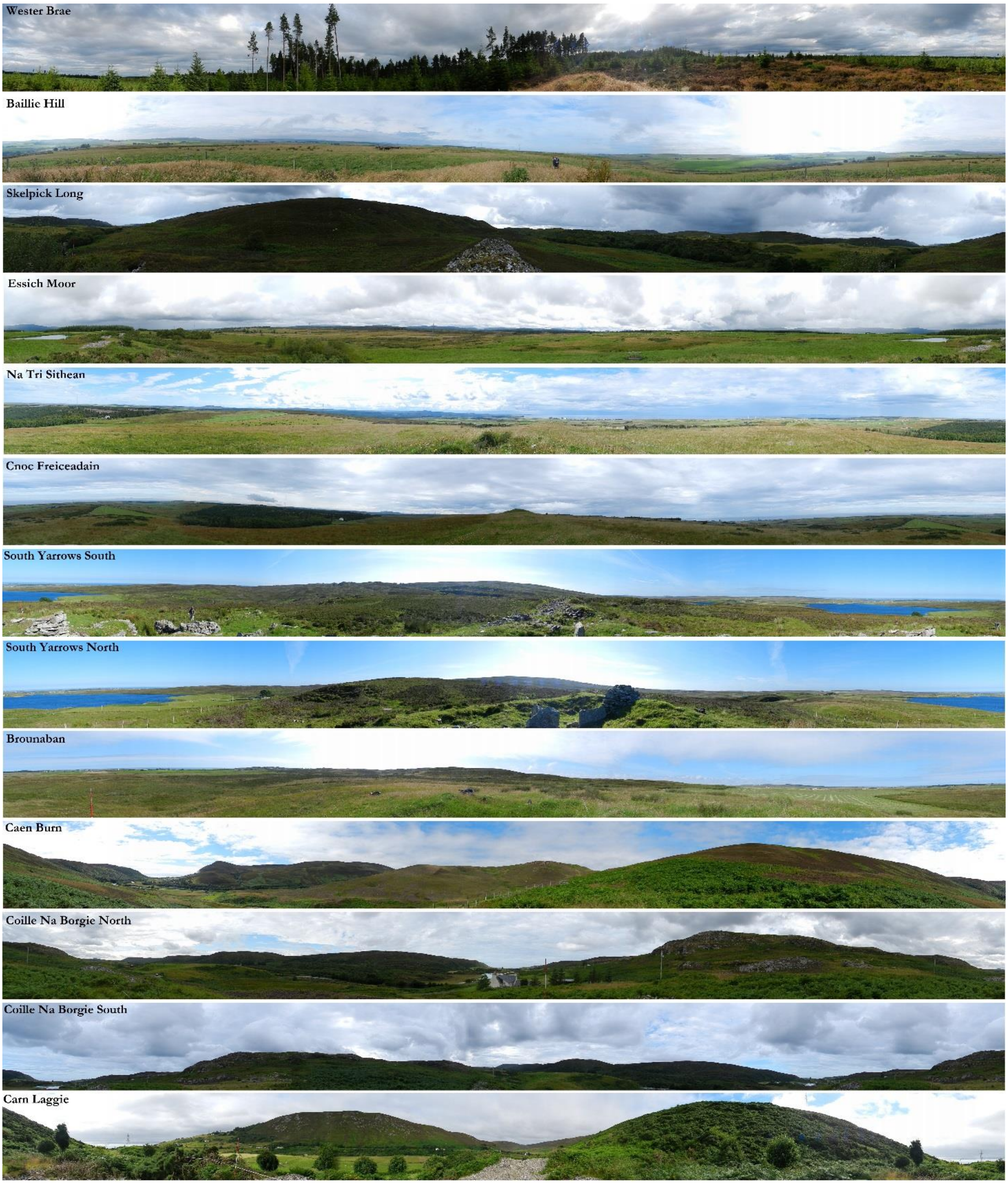


Figure 7.336: Panoramas of Wester Brae, Baillie Hill, Skelpick Long, Essich Moor, Na Tri Sithean, Cnoc Freiceadain, South Yarrows South, South Yarrows North, Brounaban, Caen Burn, Coille Na Borgie North, Coille Na Borgie South and Carn Laggie, taken during field surveys.

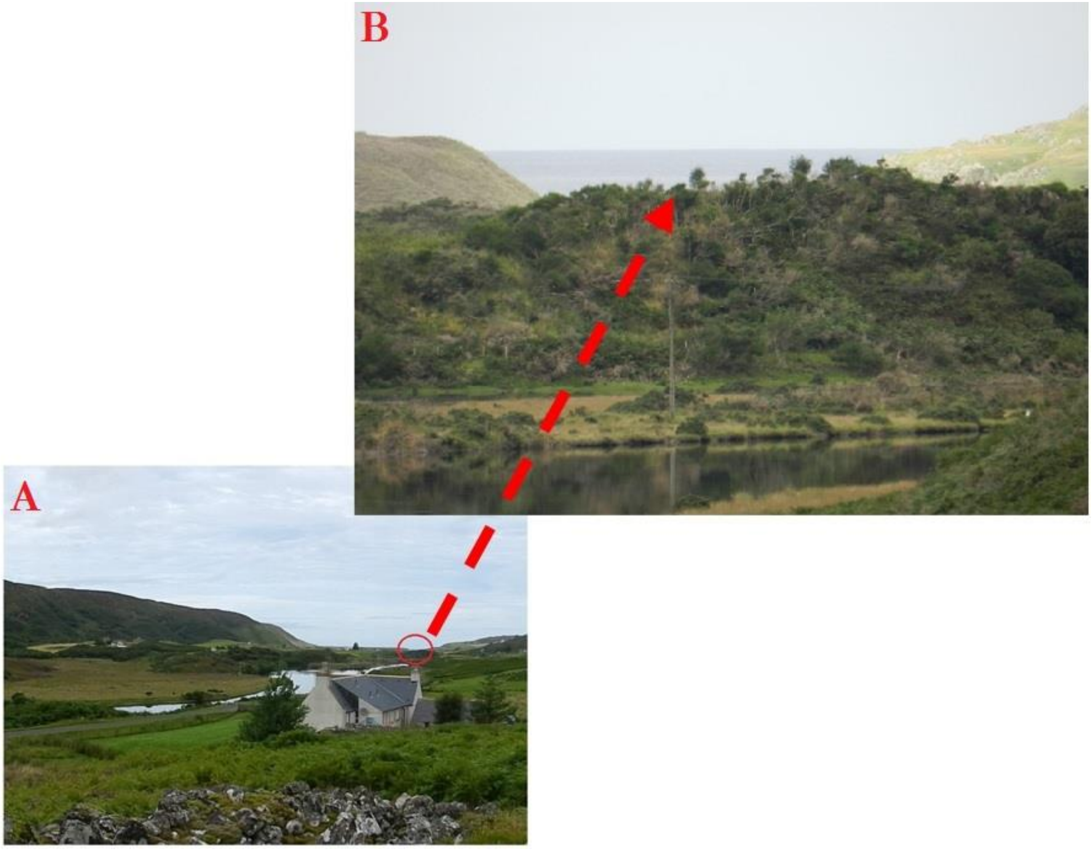


Figure 7.39: Coille Na Borgie North image A: photograph taken from the site location, looking in the direction of the sea areas that are visible (circled here in red). Coille Na Borgie North image B: close up photograph showcasing the sea views in the distant horizon. However, these views are not easily discernible to the naked eye this far from the coast as can be seen from image A.

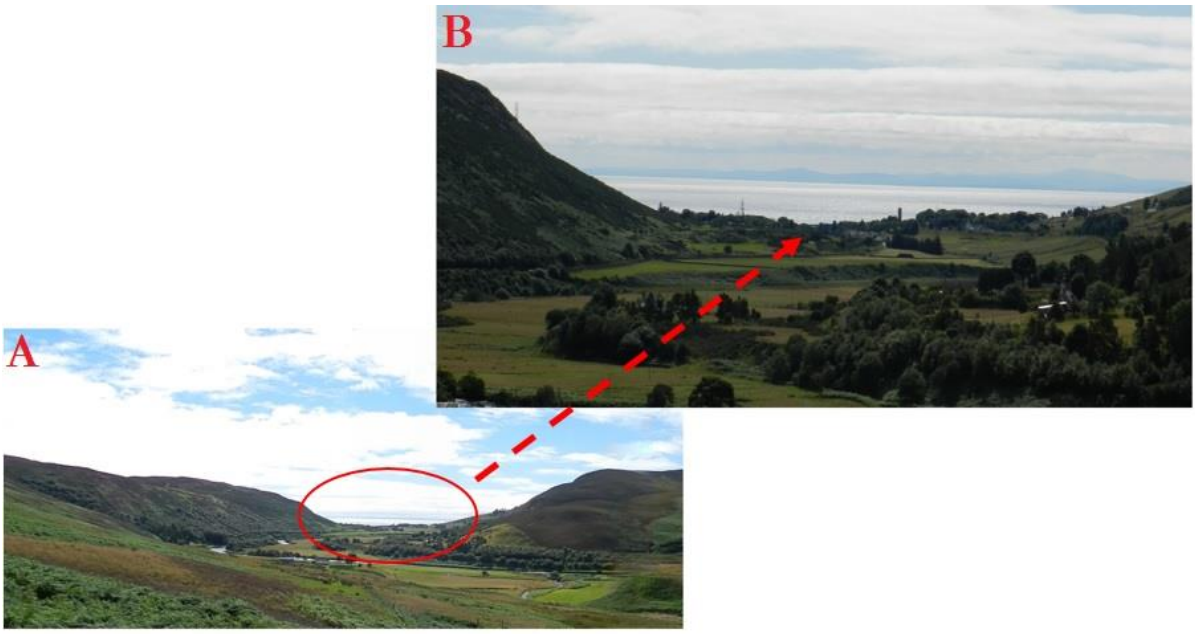


Figure 7.40: Caen Burn image A: photograph taken from the site location, looking in the direction of the sea that is visible (circled here in red). Caen Burn image B: close-up photograph showing the sea views in the distant horizon.

Figure 7.41**:** Sea views across the distant horizon at South Yarrows South, South Yarrows North, Brounaban, Cnoc Freiceadain and Na Tri Sithean.

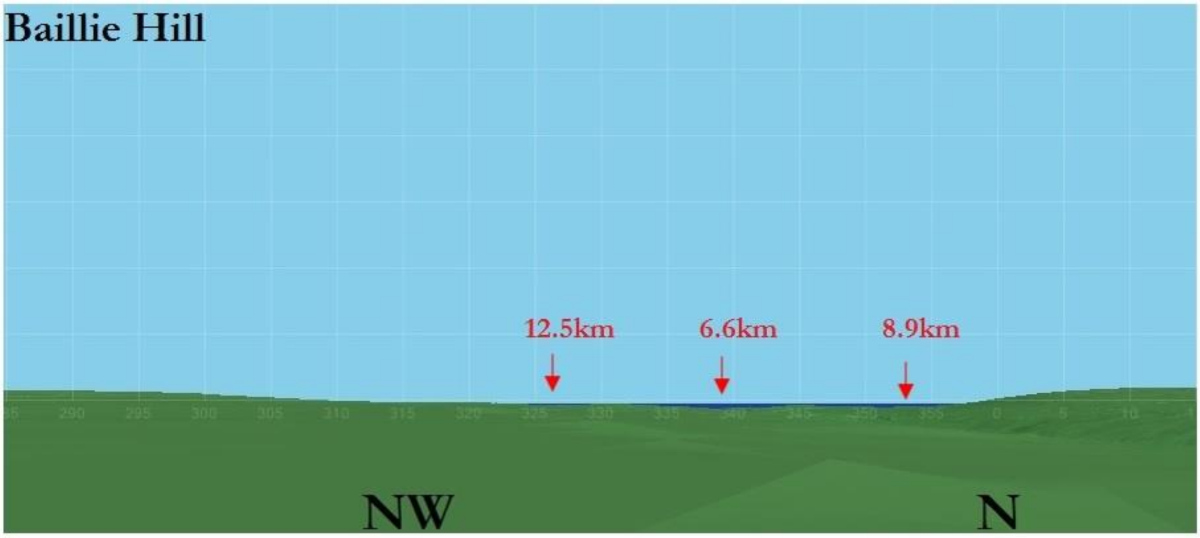


Figure 7.42: Horizon panorama of Baillie Hill showing sea views across the horizon (indicated here with the red arrows) as well as the distance of those areas of sea from the site location.

Comparison of Site Locations and Preview Locations with Horizon Panoramas

As observed earlier in this section, some cases there are locations along the paths to long cairn sites that provide higher sea affordances than the values found at the sites themselves. If the assumption is made that sea views were an important criterion for the placement of these megalithic constructions, this finding raises the question of *why* prehistoric people overlooked these alternative locations. One way to approach this question is to investigate whether and how the sea views at site locations differed, from their respective preview locations. To that end, Horizon panoramas were generated for the cairn locations together with respective preview locations for: Ardnamurchan, Carn Laggie, Caen Burn, Coille Na Borgie North, Coille Na Borgie South, Essich Moor, Mid Brae, Na Tri Sithean, Sgarbach, Skelbo Wood, Warehouse South, South Yarrows North, South Yarrows South, Wester Lamington, Skelpick Long, Brounaban and Carn Liath (Loedebest). These Horizon panoramas are shown in Figure 7.43.

The Ardnamurchan preview location has a sea affordance value of 45%, which is almost double that of the site itself. There, the sea views spans across the horizon from approximately 275–0.5º. This is a similar range to the sea views at the cairn site, which spans from approximately 280–7.5º. While the range of views is slightly larger at the cairn site, Horizon panoramas reveal that the sea views from the preview location occupy a larger area in the observers' visual field, making the latter the better location out of the two, on that count at least. Furthermore, the preview location in this instance also has a comparable elevation to that of the cairn site. Hence, the information examined here does not explain the location chosen by prehistoric builders in this instance.

The Carn Laggie preview location has a sea affordance value of 31.5%, which is almost nine times the value found at the site. There, sea views span 34º, from approximately 166–200º, while sea views from the cairn site span only 13.5º, from approximately 162–174.5º. In this instance, sea views at the site location are barely detectable, whereas the views from the Preview Location A are more prominent while spanning further across the horizon. The place of that preview, therefore, appears to be the more ideal location, however, it should be noted that it is situated at a much higher elevation than the cairn site: Carn Laggie lies at only 29m above sea level, whereas the preview location is situated some 75m higher, at 104m above sea level. Higher elevation might, then, offer some explanation as to why this preview location was disregarded by prehistoric builders. However, such an explanation must also contend with the fact that the modelled pathway also traverses that particular location. On the, perhaps reasonable, assumption that prehistoric people followed this (or a similar) path, then it could be inferred that these prehistoric builders had no major difficulties navigating through mountainous terrains with its varying elevations. Thus, the conundrum of why this location was not chosen instead is reintroduced. There is, then, insufficient information here to account for how the rationale for site placement in this case is consistent with sea views being an important factor for prehistoric builders. Rather, it seems obvious that sea views were not a determining factor in the placement of this particular monument, given that sea views are barely recognizable from the cairn site and that it is likely that they may have been obscured by vegetation and the effects of atmospheric conditions.

Similar observations can be made at and on the path to Caen Burn. Sea views from the cairn site span from approximately 150.5–164º. However, preview locations A and B offer sea views that are more noticeable in the visual field, respectively spanning from approximately 153–173º and 159–188º. At both of these locations, sea views expand further across the horizon compared to those available from the cairn site, and are much more prominent in an observer's visual field. However, as in the preview location for Cairn Laggie described above, these previews are also situated at much higher elevations than their corresponding cairn site, Cairn Burn. Such a relation is also observed at Coille Na Borgie North and Coille Na Borgie South: preview locations for both of these sites offer noticeably greater sea views, in their spans across the horizon and in the space they occupy in an observer's visual field. However, the river that runs alongside the site is only observable from Preview Location A to Coille Na Borgie North, and slightly more of that river appears to be observable from the cairn site (of Coille Na Borgie North—only a relatively small stretch of the river is visible from Coille Na Borgie South). These previews locations are also situated at much higher elevations than their respective cairn sites. Nevertheless, given that both preview locations are situated along the modelled pathways, there is a greatly reduced likelihood that elevation acted as a deterrent from those locations.

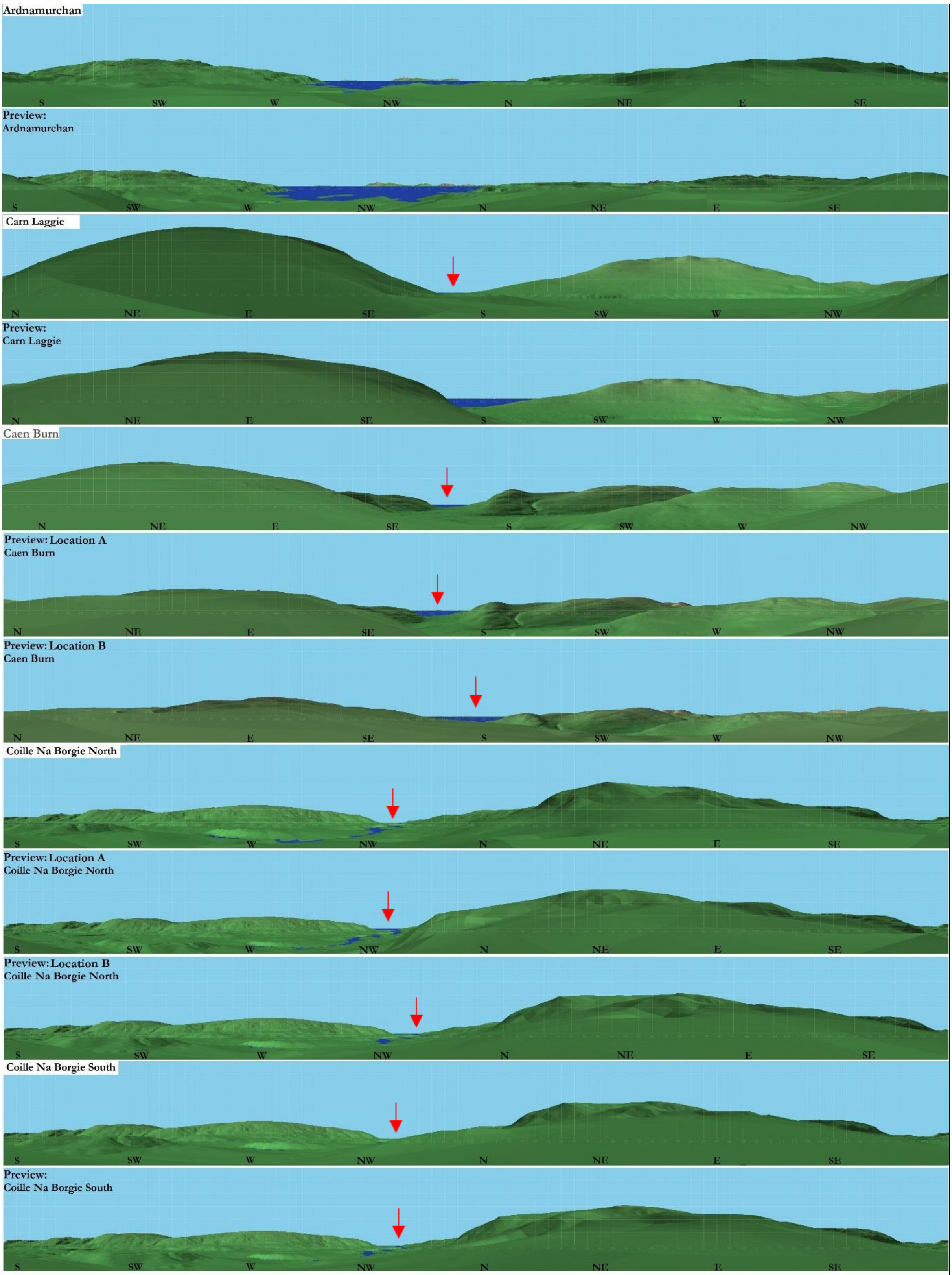
The Horizon panoramas also depict more prominent sea views at corresponding preview locations than are offered at the cairn sites of Skelpick Long, South Yarrows North, South Yarrows South and Wester Lamington. At Skelpick Long, sea views span 4º (from approximately 330–334º), appearing only as a narrow sliver on the horizon, whereas sea affordance at the preview location is roughly twice that of the site's, and views have greater visual presence while spanning twice as far (an additional 4.5º, from approximately 325–333.5º). At South Yarrows North, sea views span 76.5º, from approximately 17.5º–94º, while sea views at the preview location span an additional 23º, from approximately 16–115.5º, and occupy a greater area in an observer's visual field, as would be expected with sea affordance values over 3.5 times than those found at the cairn site. At South Yarrows South sea views are segmented, spanning from approximately 15–96º and 108–135.5º, and although sea views are also segmented at the preview location, sea affordance there is roughly 3.5 times than the value found at the site, and span a total of 54.5º further across the horizon, from approximately 14–134º and 149–192º. At Wester Lamington, sea views span a total of 178º from approximately 26–204º, while being concealed several times by the surrounding hills. The same kind of views, in that they are also concealed in places, are available from both Preview Location A and B, which respectively span from approximately 21–204.5º and 34–194º. However, sea views from both of these preview locations appear to be significantly more prominent in the distant horizon than they are at the cairn location. For each of these five cairn sites, the elevation of the preview locations are comparatively higher. However, as elucidated above, any such higher elevations are unlikely to have deterred prehistoric builders from choosing these specific topographic locations, if it is to be assumed that they followed the routes identified by the pathways modelled here. These findings suggest that some other factor – perhaps a different topographical feature or a proximity to and an accessibility of building materials – may have played a more decisive role in determining where monuments were ultimately to be placed and situated within the landscape.

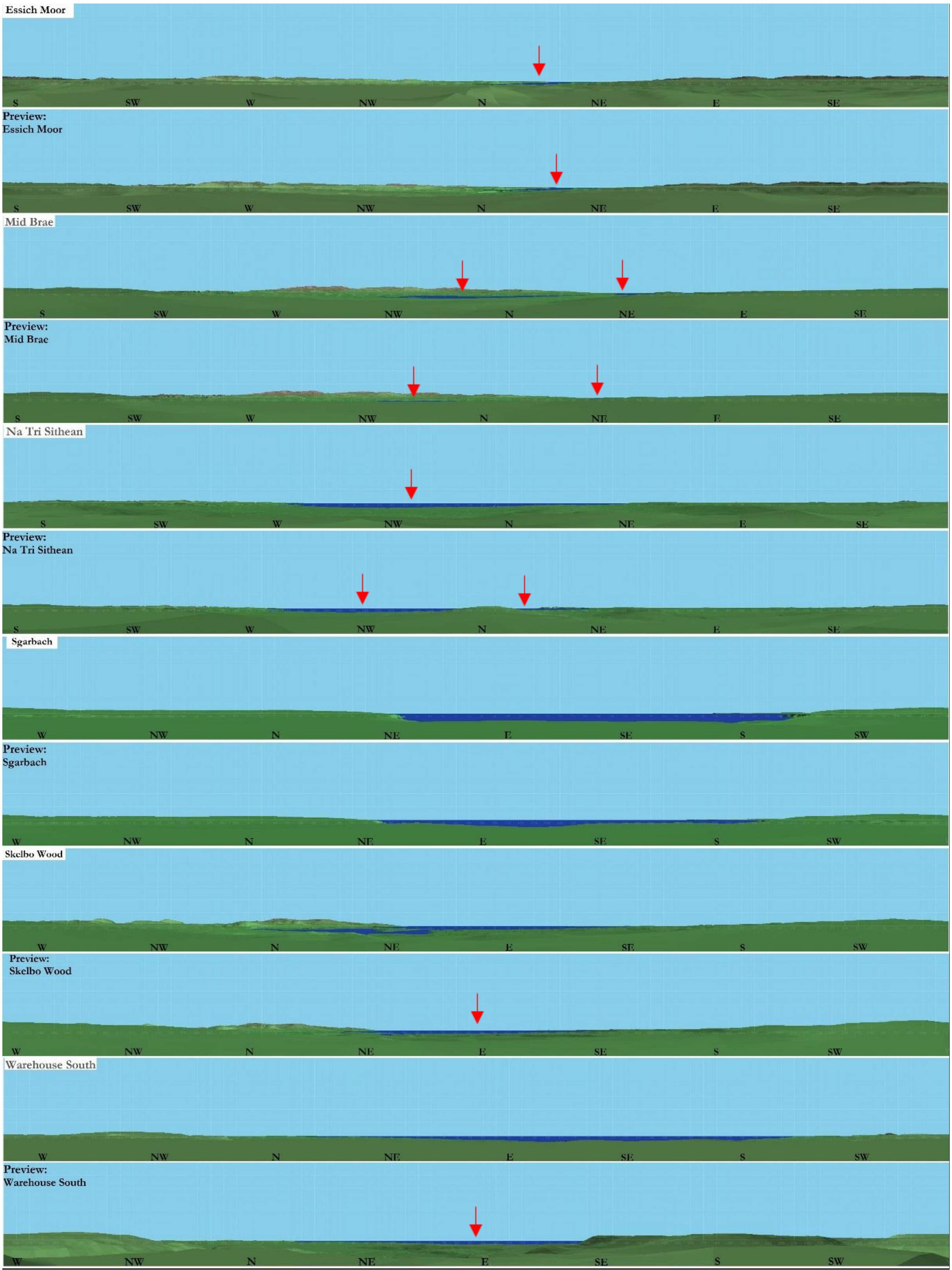
The views available from Brounaban and its Preview Location are comparable, despite the preview location having a slightly higher sea affordance value than the cairn site, and despite the sea views at the preview location spanning across the horizon marginally further, from approximately 14–129º as oppose to 14–127º. Prehistoric builders could, then, have chosen either location and achieved the same outcome in terms of sea views. An observation to the same effect can be made for Essich Moor. Sea views there extend from approximately 357–44º but only occupy a very small area in the observer's visual field. Similarly trivial sea views are also present from the preview location, spanning from approximately 0–45º, with the visible part of the inlet continuing only slightly further inland. Hence, with comparable sea views, in addition to comparable elevations, these findings indicate that other factors governed prehistoric builders' location choice for Essich Moor.

At Mid Brae, sea views are segmented into two parts, spanning from approximately 309.5–30º and 40–71º. This contrasts with the preview location, where some areas of the sea are masked from view by the surrounding hills, so that sea views are in four parts, with the largest area of sea spanning from approximately 319–350º. While this preview location has a slightly higher sea affordance value than what is seen at the cairn site and a lower elevation of 1m, the latter offers markedly more prominent sea views. This result is explained by the relative distance of each location to the areas of sea that are visible from those locations, so that although less sea area is visible from the cairn site, that area takes up more space in the observer's visual field than the greater area of sea that is visible from the preview location. In terms of affording sea views, the site location is, then, more preferable for the construction of this megalithic monument.

This pattern, of cairn locations being the better locations in terms of sea views, is also observed at Sgarbach, Skelbo Wood, Warehouse South, Na Tri Sithean and Carn Liath (Loedebest). Sea views from Sgarbach and its preview location spans from similar ranges, respectively from approximately 44–201º and 46.5–199.5º. While the preview location offers almost double the sea affordance value, the surrounding hills block views of closer areas of sea. Thus, on examination of the Horizon panoramas, it is clear that sea views are more prominent from the site location. At Skelbo Wood, sea views span from approximately 349–139.5º while sea views at the preview location span from approximately 35–142º. Examination of the data reveals that the preview location is not only situated at a slightly higher elevation than the site location, by about 2m, but also offers almost double the value of sea affordance. Yet, as is the case above, the Horizon panoramas reveal that sea views are more prominent at the site location than at the preview location. At Warehouse South, sea views span from approximately 11.5–207º and 219–221.5º while sea views at the preview location span from approximately 14–129º. The sea affordance at the preview location is comparable to that of the site but it is situated at a slightly lower elevation (i.e. 6m lower than the site). The Horizon panorama for this location indicates that surrounding hills block significant parts of the sea that are visible from the cairn site location, making the latter the more ideal location for monument placement in terms of sea views. At Na Tri Sithean, sea views span from approximately 270–46º, while sea views at the Preview Location

Are segmented into two parts spanning from approximately 276–351º and 12.5–42º. The preview location has a marginally higher sea affordance value than the site location but, again, is situated at a slightly lower elevation, by around 4m. It is clear from the Horizon panoramas that the sea views that are available from the cairn site are obscured at the Preview Location By the surrounding hills, making the former the preferable location in terms of sea views. At Carn Liath (Loedebest) sea views span from approximately 123.5–149º while sea views at the preview location spans from approximately 131–152.5º. The preview location is situated 3m higher in elevation and has a comparable sea affordance to the cairn site. A comparison of the Horizon panoramas for these locations reveal that sea views are narrow and appear only as a sliver in the distant horizon. Nevertheless, those views are slightly more prominent at the cairn site location, making it the more ideal location for incorporating sea views.


Ardnamurchan
S SW W NW N NE E SE
Preview:
Ardnamurchan
S SW W NW N NE E SE
Carn Laggie
N NE E SE S SW W NW
Preview:
Carn Laggie
N NE E SE S SW W NW
Caen Burn
N NE E SE S SW W NW
Preview: Location A
Caen Burn
N NE E SE S SW W NW
Preview: Location B
Caen Burn
N NE E SE S SW W NW
Coille Na Borgie North
S SW W NW N NE E SE
Preview: Location A
Coille Na Borgie North
S SW W NW N NE E SE
Preview: Location B
Coille Na Borgie North
S SW W NW N NE E SE
Coille Na Borgie South
S SW W NW N NE E SE
Preview:
Coille Na Borgie South
S SW W NW N NE E SE



Essich Moor
S SW W NW N NE E SE
Preview: Essich Moor
S SW W NW N NE E SE
Mid Brae
S SW W NW N NE E SE
Preview: Mid Brae
S SW W NW N NE E SE
Na Tri Sithean
S SW W NW N NE E SE
Preview: Na Tri Sithean
S SW W NW N NE E SE
Sgarbach
W NW N NE E SE S SW
Preview: Sgarbach
W NW N NE E SE S SW
Skelbo Wood
W NW N NE E SE S SW
Preview: Skelbo Wood
W NW N NE E SE S SW
Warehouse South
W NW N NE E SE S SW
Preview: Warehouse South
W NW N NE E SE S SW

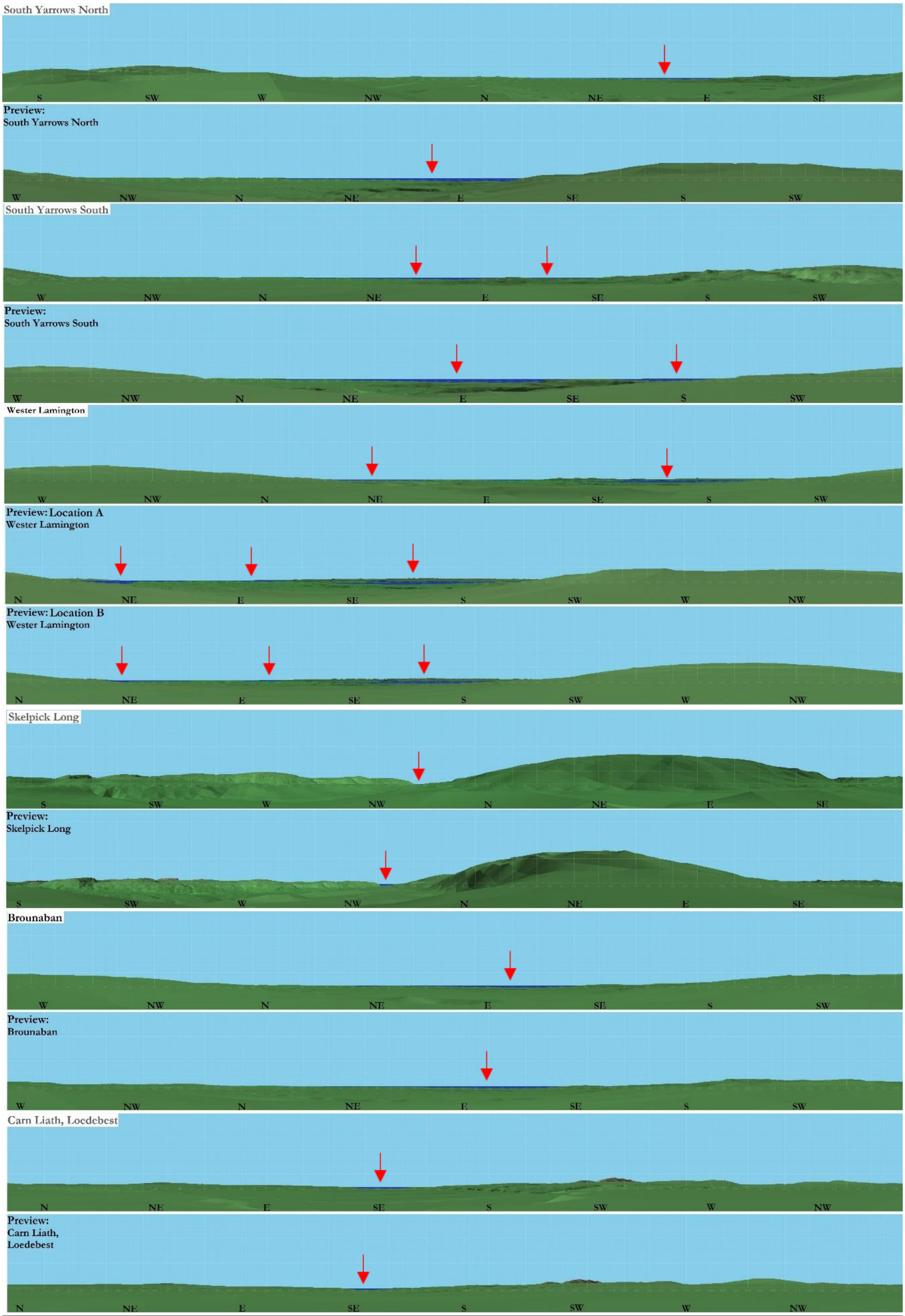


Figure 7.43: Horizon panoramas of Ardnamurchan, Carn Laggie, Caen Burn, Coille Na Borgie North, Coille Na Borgie South, Essich Moor, Mid Brae, Na Tri Sithean, Sgarbach, Skelbo Wood, Warehouse South, South Yarrows

North, South Yarrows South, Wester Lamington, Skelpick Long, Brounaban and Carn Liath (Loedebest) as well as the sea views from the preview locations.
The red arrows indicate sea views.

Considering the Effect of Atmospheric Conditions on Revelatory Views

For each of these 26 site locations that offer revelatory views in the three categories discussed in this section, additional Horizon panoramas were generated to depict the effects of atmospheric conditions often prevalent in the Scottish Highlands, such as haze, mist and fog (see figures below). At each location, visibility was set to the distance at which sea views begin to appear to the observer, so that the distance noted for each panorama indicates how much clearance or visibility is needed before one can observe sea views on the horizon. Take Caen Burn, for instance (see Figure 7.49). From this site location there needs to be, at minimum, 3.5–4km of clear visibility for sea views to become visible to an observer. If visibility is restricted to less than that distance those views are completely obscured from the observer.

As can be seen from Figure 7.44, Horizon panoramas of Edderton Hill, Latheronwheel Long, Sgarbach and Ardnamurchan reveal that even with extremely poor weather conditions, i.e. even when atmospheric clarity is set to 1km, sea views are reasonably recognisable and substantial in the visual field. This further supports the conclusions drawn earlier: that these locations were certainly ideal places to build on, as they not only offer revelatory views to anyone approaching the site from the directions of the modelled pathways but also because those views are not threatened or masked by layers of fog or mist.

At Skelbo Wood, during extremely poor visibility conditions only 55º (from 5–60º) of the 125º of normally available sea views (from 350–115º) will be visible (see Figures 7.34 and 7.46). However, the entire expanse of the vista comes into view when there is 3km of clear visibility. At Warehouse South, sea views come into view at approximately 5km of clear visibility and in the case of Na Tri Sithean and Cnoc Freiceadain sea views come into view at approximately 3km of clear visibility. However, in each of these three cases, it is doubtful if the available views are sufficiently significant to have enhanced the experience of the cairn sites.

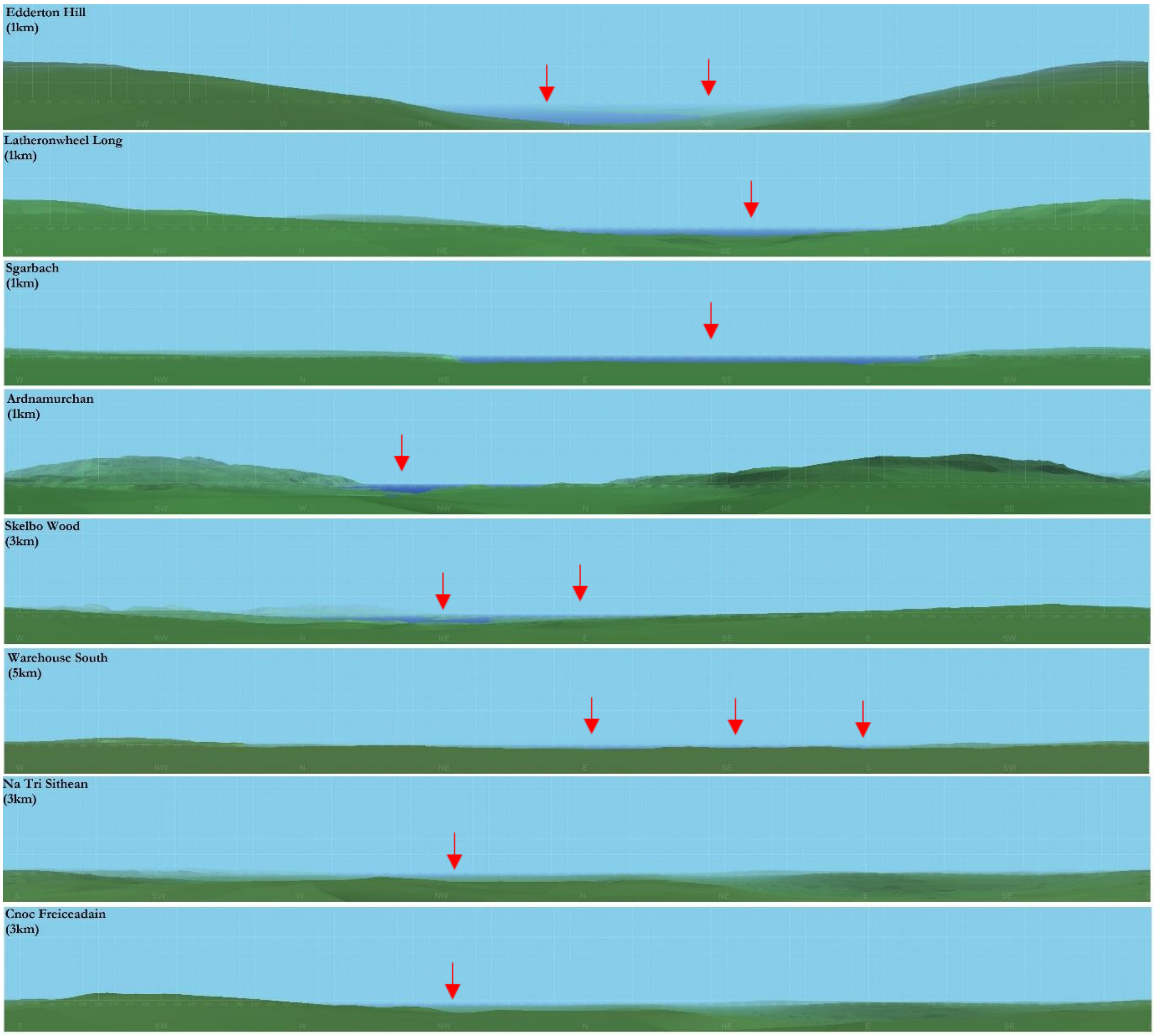


Figure 7.44: Horizon panoramas of Edderton Hill, Latheronwheel Long, Sgarbach, Ardnamurchan, Skelbo Wood, Warehouse South, Na Tri Sithean and Cnoc Freiceadain showing the effects of atmospheric conditions.

Figure 7.45: Sea views from Na Tri Sithean taken during field survey.
This photograph clearly shows the effects of atmospheric conditions such as fog and mist. Sea views are masked by a layer of fog and are not very discernible in the distant horizon.

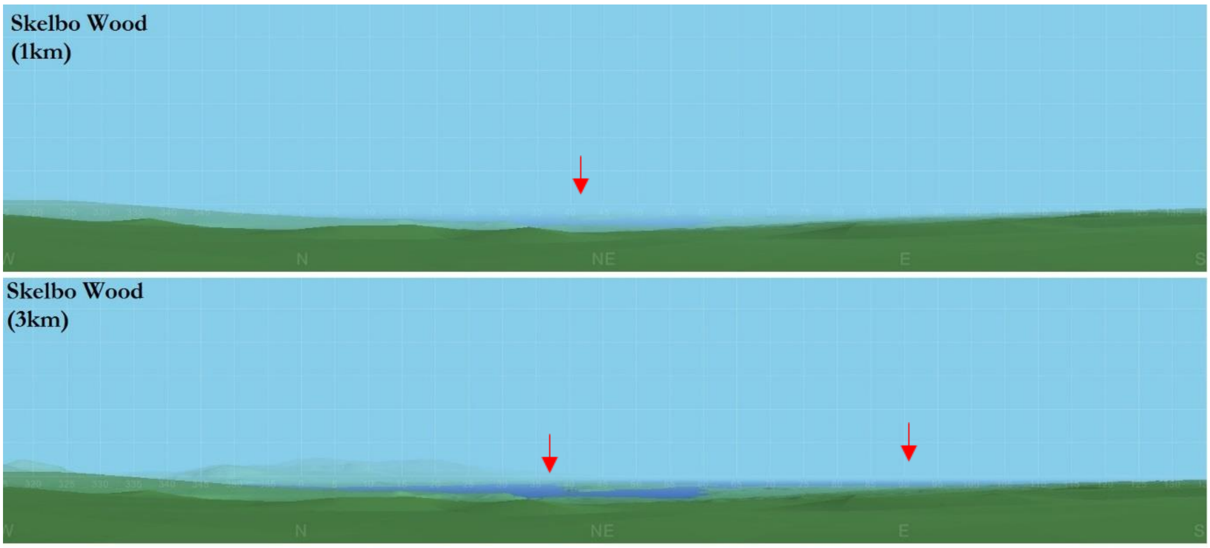


Figure 7.46: Horizon panorama of Skelbo Wood with visibility set to 1km (top) and 3km (bottom).

Similar observations can be made for South Yarrows South, South Yarrows North, Mid Brae, Wester Lamington, Brounaban, Youkil Hillock, Baillie Hill, Cooper's Hill and Cairn of Heathercro (see Figure 7.47). As can be seen in Figure 7.47, sea views only appear when there is clear visibility for a considerable distance; in the cases of South Yarrows South, South Yarrows North, Baillie Hill and Cairn of Heathercro, atmospheric conditions can effectively mask views so that they only become visible under respective clarities of approximately 8km, 10km, 13km, and 25km. Of course, at these four locations, sea views are nominal even under ideal conditions, as shown in Figure 7.47. With the addition of atmospheric conditions, it is highly doubtful that sea views from any of these four locations were sufficient to have made an impact on the experience of these places.

As observed earlier, many of the sites that the sea affordance profiles indicated had revelatory views exhibited expansive sea views across the horizon. However, when atmospheric conditions are simulated with the Horizon panoramas, in most cases it becomes apparent that a significant degree of atmospheric clarity is required before the entire range of sea views are visible. This is observed at Youkil Hillock, Baillie Hill, Mid Brae and Wester Lamington. For instance, with 4km of clarity at Youkil Hillock, an observer will only see 26° (from 354–20°) of the sea views that are otherwise available, the views spanning from approx. 319° to 354° are completely obscured, and only come into view when there is at least 9km of atmospheric clarity (see Figure 7.48). At Baillie Hill, even with 13km of clear visibility an observer will only see patches of the sea between approximately 332–356.5° while sea views ranging between 324.5–329° are completely obscured by fog. This outcome is simply the result of that stretch of sea being further away from the site location so that its visibility is affected to a greater degree by atmospheric deterioration. Similarly, at Mid Brae, only the larger, more prominent portion of the sea views (from approximately 310–30º) are visible under 3km of atmospheric clarity, while the views lying in the NE-ENE direction (from approximately 40–71º) are masked from the observer. At Wester Lamington, sea views are segmented into three distinct parts, all of which are hidden from the observer until there is 4km of clear visibility, when sea views spanning between 124.5–201º begin to appear. However, sea views spanning from 26–73º and 86–109º remain completely masked until visibility reaches a minimum of 9km. Atmospheric conditions, therefore, seriously affect and impede the visibility of sea views from these site locations, which raises substantial doubts as to the import that these views may have held.

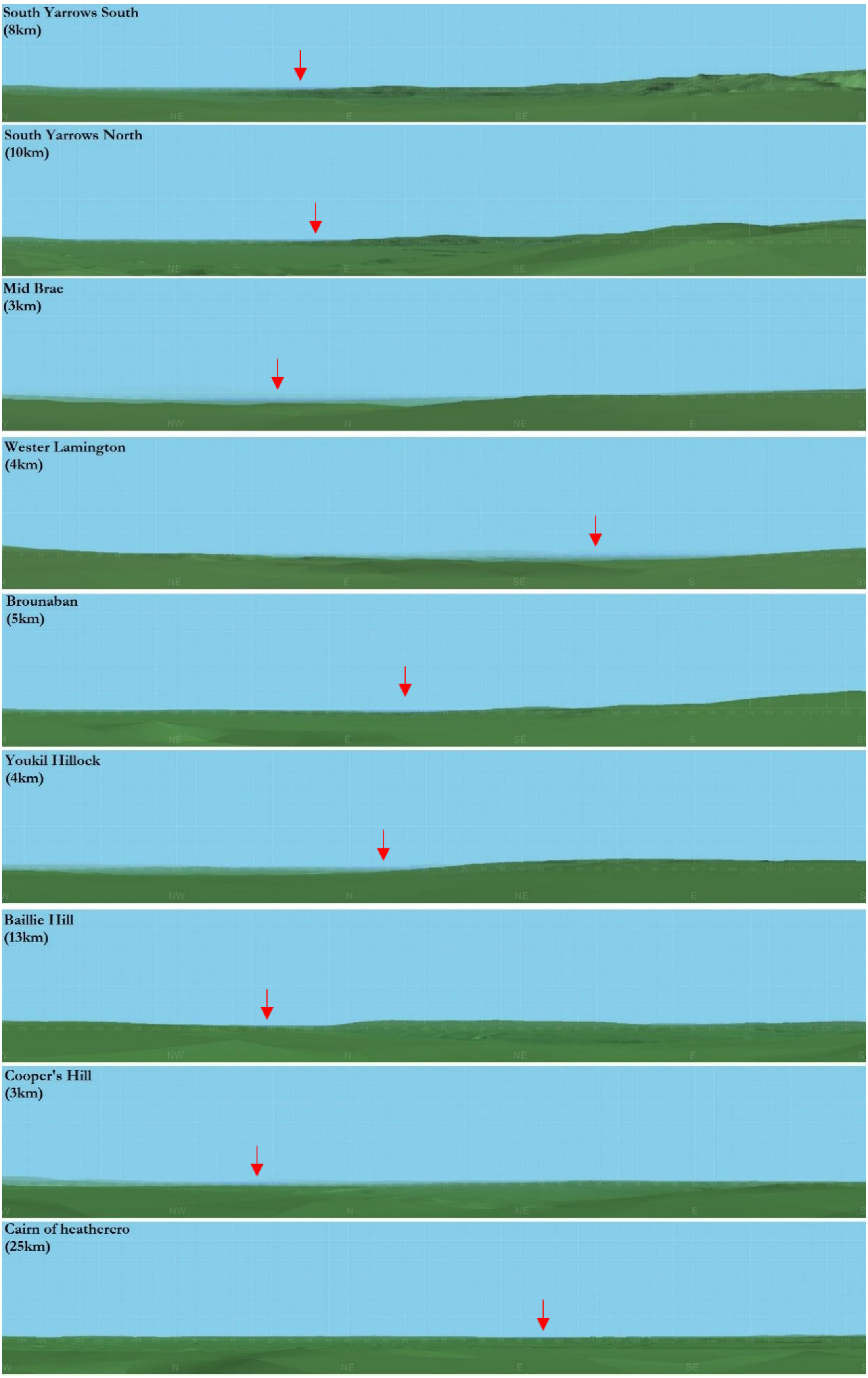


Figure 7.47: Horizon panoramas of South Yarrows South, South Yarrows North, Mid Brae, Wester Lamington, Brounaban, Youkil Hillock, Baillie Hill, Cooper's Hill and Cairn of Heathercro showing the effects of atmospheric conditions.

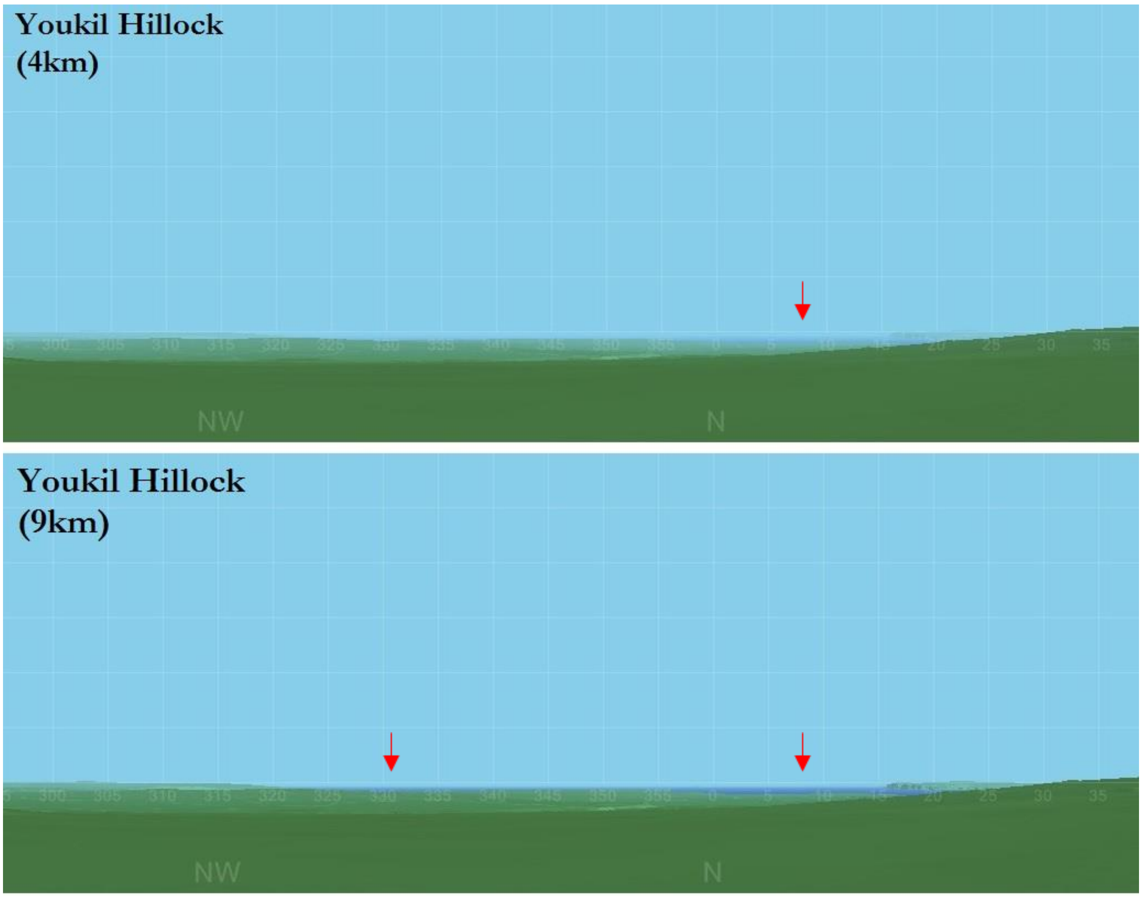
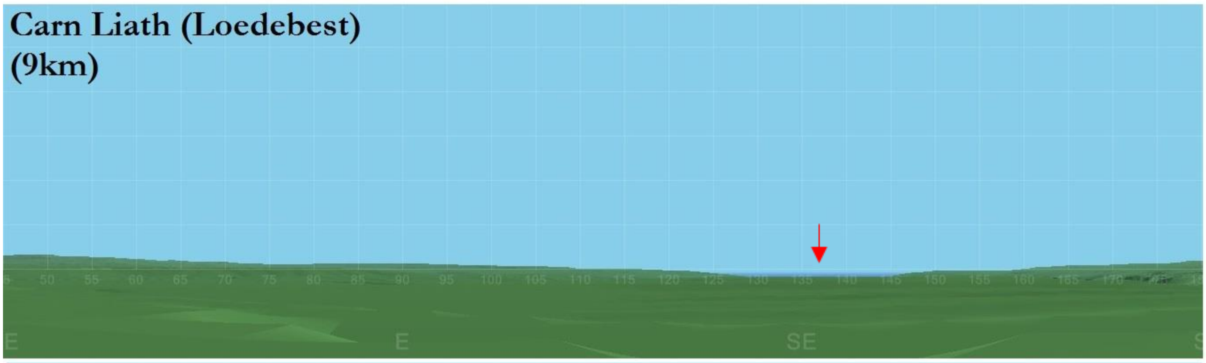
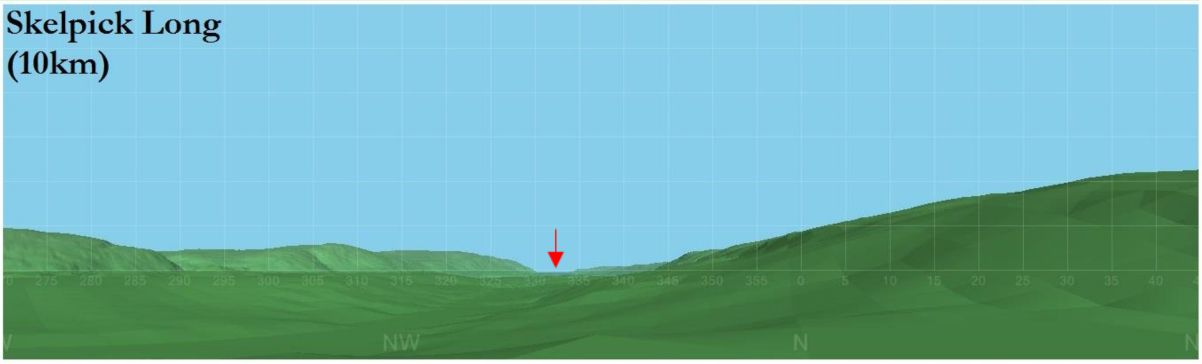
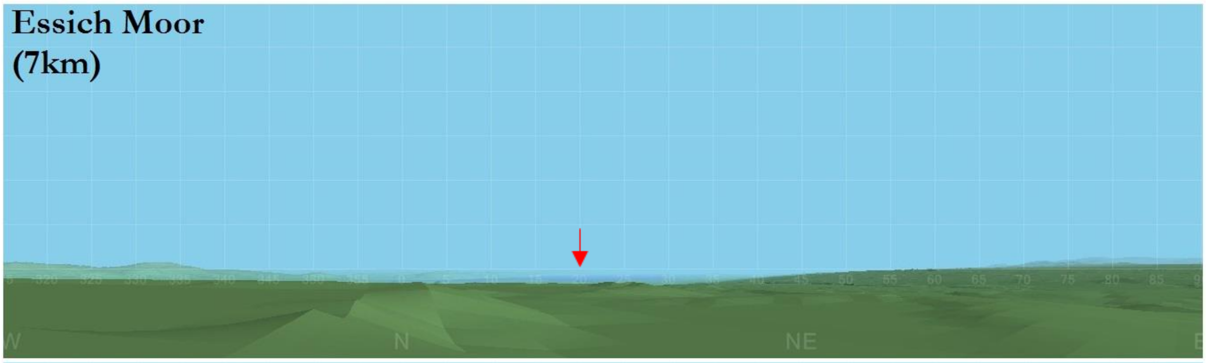


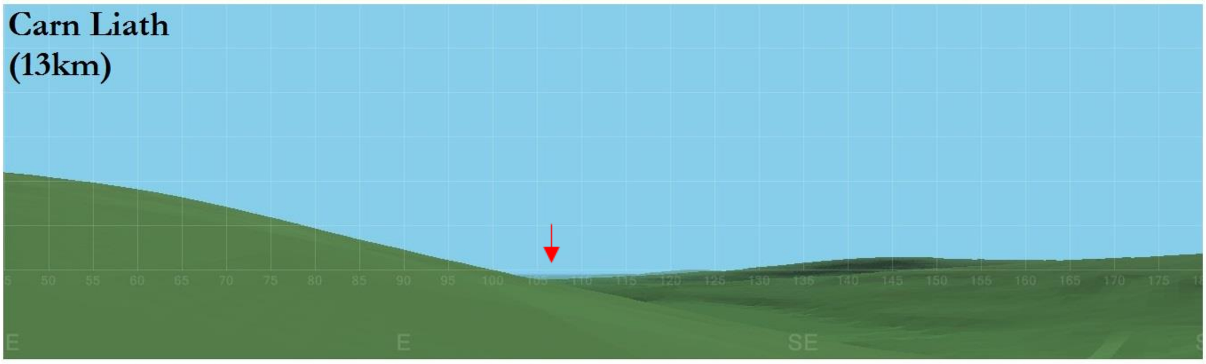
Figure 7.48: Horizon panoramas of Youkil Hillock, with atmospheric clarity set at 4km (top) and 9km (bottom).

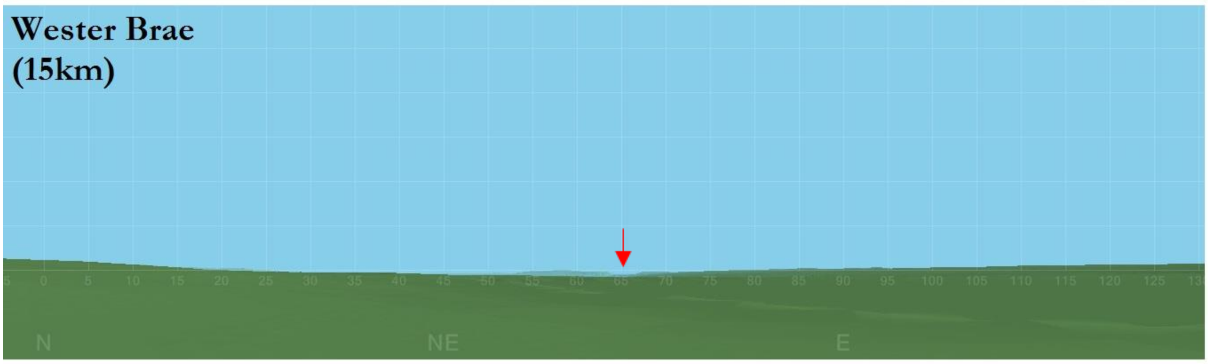
As described in this section, further above, sea affordance profiles indicate that at nine cairn sites, revelatory views consist of narrow strips of sea. These sites are: Caen Burn, Carn Liath (Loedebest), Coille Na Borgie North, Coille Na Borgie South, Skelpick Long, Essich Moor, Carn Liath, Wester Brae and Carn Laggie. When atmospheric conditions were taken into consideration, Horizon panoramas show that the sea views these sites offer could be greatly affected (see Figure 7.49). Moreover, at seven of the nine sites, a significant distance of clear visibility is required before those sea views appear in the observer's visual field. This is especially the case at Wester Brae and Coille Na Borgie South, where sea views only appear when there are respective distances of 15km and 25km of clear visibility, and even then those views are only beginning to come into view and are barely noticeable. An exception here is at Caen Burn, where sea views come into view with just 4km of clear visibility and these sea views appear to be visible to the naked eye. As observed earlier in this section, in a majority of cases, the narrow views offered by these sites are insufficiently prominent in the observer's visual field to have had a significant impact on the experience of these places.


Carn Liath (Loedebest)
(9km)
E
SE


Skelpick Long
(10km)
NW
N


Essich Moor
(7km)
N
NE


Carn Liath
(13km)
E
SE


Wester Brae
(15km)
N
NE
E

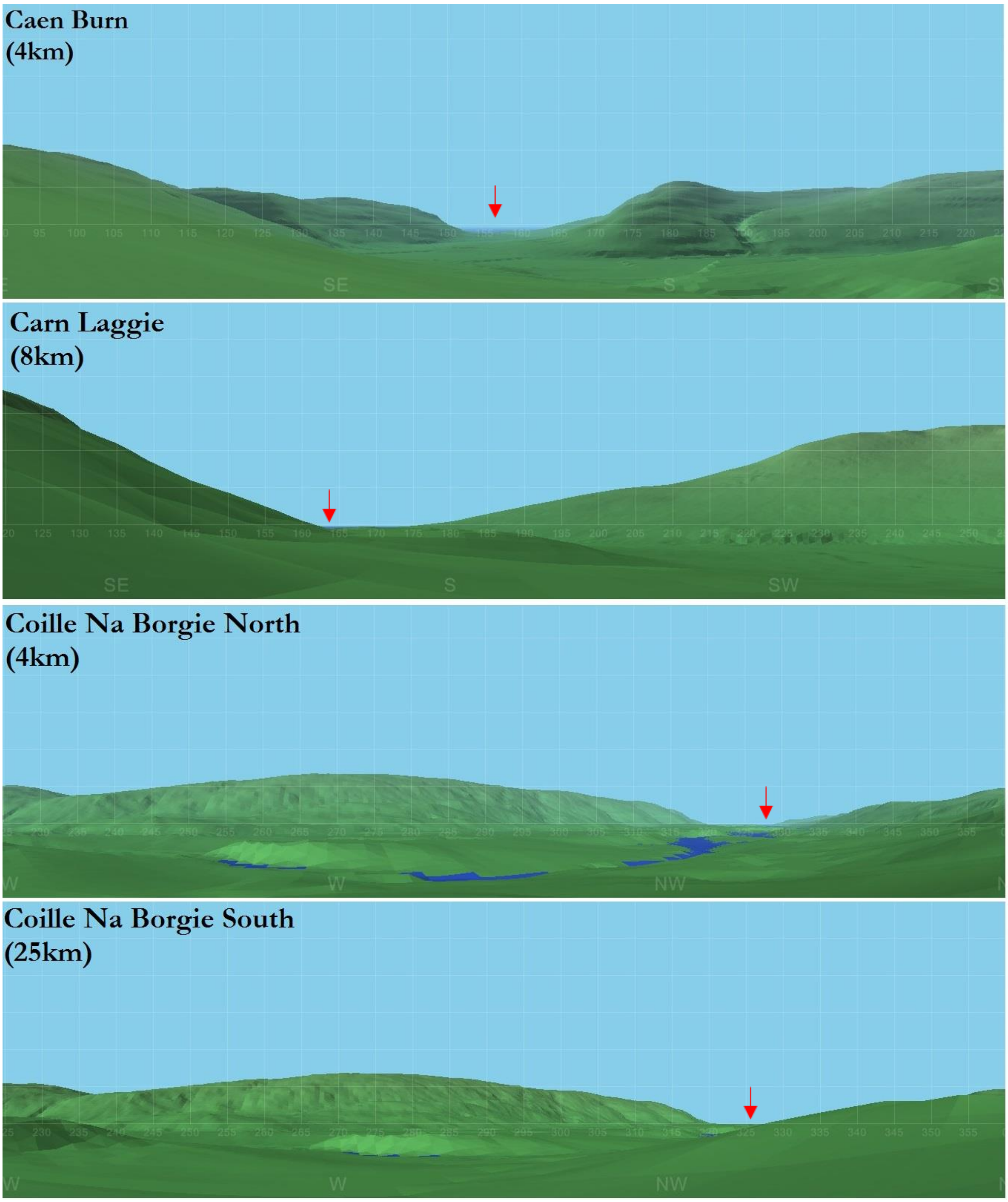


Figure 7.49: Horizon panoramas of Caen Burn, Carn Liath (Loedebest), Coille Na Borgie North, Coille Na Borgie South, Skelpick Long, Essich Moor, Carn Liath, Wester Brae and Carn Laggie showing the effects of atmospheric conditions.
These panoramas were cropped in order to zoom in and focus only on the visible sea area.

Considering the Effect of Atmospheric Conditions on Sea Views from Preview Locations

As described earlier, the pathways to 17 sites offer sea previews. For each preview location, Horizon panoramas were generated to examine the effects of atmospheric conditions on their sea views (see Figure 7.50). The findings indicate that for a majority of the cairn sites and corresponding preview locations discussed here, preview locations appear to have been considerably more ideal than the cairn sites in terms of the sea views available under poor weather conditions. Take, for instance, the preview location for Carn Laggie in comparison to the cairn site. At the Carn Laggie preview location not only are the sea views more prominent but they also only require a distance of 2km clarity to be visible to an observer. On the other hand, a minimum of 8km clarity is required for sea views to be apparent at the site location.

As discussed earlier, in comparison to the Ardnamurchan cairn site, the corresponding preview location offers both a higher sea affordance value and more prominent sea views in the observer's visual field. When atmospheric conditions are taken into consideration, those views do not appear to be greatly affected; even with a distance of only 1km clarity, the vistas from this particular location appear to occupy a significant area in the observer's visual field, thus, confirming that it offers a better location than the cairn site in terms of sea views. A similar observation can be made for the preview location for Coille Na Borgie South. The Horizon panorama indicates that this alternative location affords greater sea views when compared with the site location, by offering relatively expansive sea views, which come into view with a distance of 4km of clear visibility. In comparison, sea views from the site location are barely noticeable, even on a clear day. Moreover, when atmospheric conditions are simulated for the site location, the Horizon panorama shows that for those views to come into the observer's range of sight there needs to be, at minimum, 25km of clear visibility. Even then, those views are hardly recognizable with the naked eye.

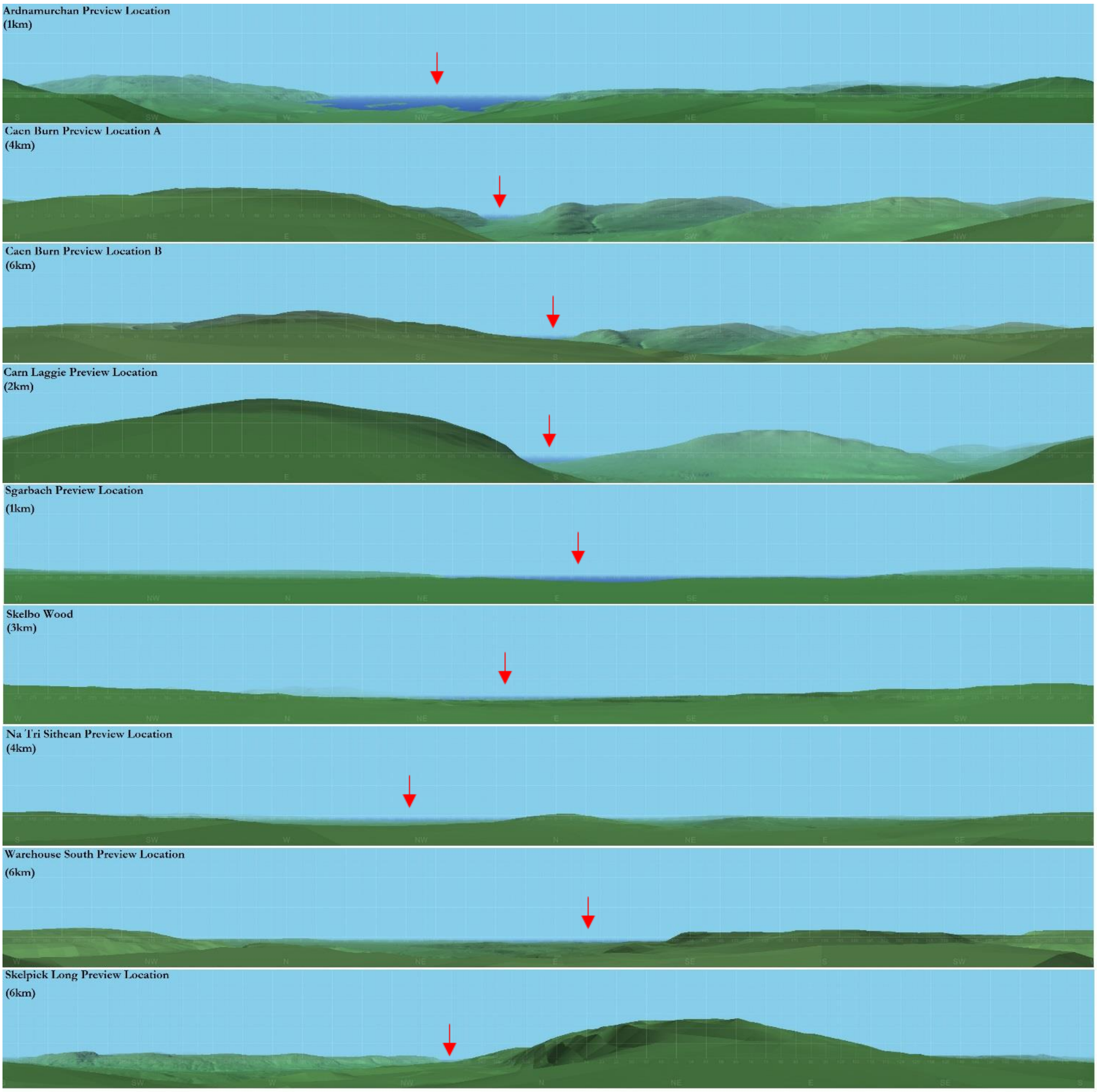
At Caen Burn, a comparison of the Horizon panoramas of Preview Location A and the cairn site reveals that, despite sea views at both sites coming into the observer's visual range at approximately 4km, the sea views are more prominent at the preview location. At Preview Location B, sea views are only slightly greater than those observed at the site as they occupy only a marginally larger area in the visual field. Nevertheless, a greater distance of clear visibility (of approximately 6km) is required for the sea vistas from location B to come into view.

In comparison to the sea views from Coille Na Borgie North, the sea views from Preview Location A encompass a broader area on the horizon. With a distance of 4km clear visibility, those views are strikingly noticeable in the observer's visual field, while sea views are only beginning to appear and are barely recognizable from the cairn site under the same atmospheric conditions. Under clear atmospheric conditions, Coille Na Borgie North Preview Location B offers greater sea views than are available from the cairn site, however, for those vistas to be apparent there needs to be a minimum distance of 15km clear visibility. Location A is, then, the most ideal in terms of sea views. However, as observed earlier, that location is also situated at a much higher elevation than the cairn site. This may have acted as a deterrent to prehistoric builders in some regards, however, Location A is also situated along the modelled pathway, which suggests that they did or could have passed over that location with relative ease to access the cairn site. These considerations, then, raise the question as to why this particular location was disregarded by prehistoric builders, and suggest the possibility and indeed probability that factors other than available sea views attracted prehistoric builders to the site location.

Sea views appear as more prominent from the preview location for South Yarrows North than those available from the cairn site, when atmospheric conditions are simulated. A distance of only 6km of clear visibility is required for the sea views from the preview location to appear, whereas the sea views from site location require 10km of clear visibility. Similar observations are made at the preview locations for South Yarrows South , Wester Lamington and Skelpick Long: in comparison to the respective cairn sites, sea views from these locations are more prominent in the visual field and require lesser distances of clear visibility before they can be seen by an observer. This evidence further supports the conclusions drawn earlier regarding these preview locations, that in terms of sea views, these particular locations are more suited than the corresponding cairn sites for the placement of the respective megalithic constructions.

Further Horizon panoramas reveal that when atmospheric conditions are simulated for Essich Moor and its preview location, there are no noticeable differences between the sea views of the two locations. A similar observation can be made when comparing the sea views available from Brounaban and its preview location.

As described further above, a number of cairn sites offer more prominent sea views than their counterpart preview locations despite the latter holding higher sea affordance values. This may be accounted for by the (smaller) areas of sea visible from such sites being closer to the observer and therefore appearing as larger in the visual field. The conclusions drawn earlier regarding those sites were supported by the further Horizon panoramas that were generated to examine the effects of atmospheric conditions: in these particular cases, site locations are indeed better suited in terms of sea views. An example is the Mid Brae preview location. The findings suggested that sea views from the corresponding cairn site were more prominent in comparison to the sea views observed at the preview location, despite the latter offering a slightly higher sea affordance value. This remains the case when atmospheric conditions are taken into consideration. A comparison of the Horizon panoramas reveal that a distance of 5km of clear visibility is required for sea views to be apparent from the preview location, whereas a 3km distance of clear visibility is sufficient for sea views to be visible from the cairn site. In addition, views from the cairn site appear to be more noticeable across the horizon, despite atmospheric conditions. Similar observations can be made for: Na Tri Sithean preview location, Sgarbach preview location, Skelbo Wood preview location, Warehouse South preview location and Carn Liath (Loedebest) preview location.


Ardnamurchan Preview Location
(1km)
Caen Burn Preview Location A
(4km)
Caen Burn Preview Location B
(6km)
Carn Laggie Preview Location
(2km)
Sgarbach Preview Location
(1km)
Skelbo Wood
(3km)
Na Tri Sithean Preview Location
(4km)
Warehouse South Preview Location
(6km)
Skelpick Long Preview Location
(6km)

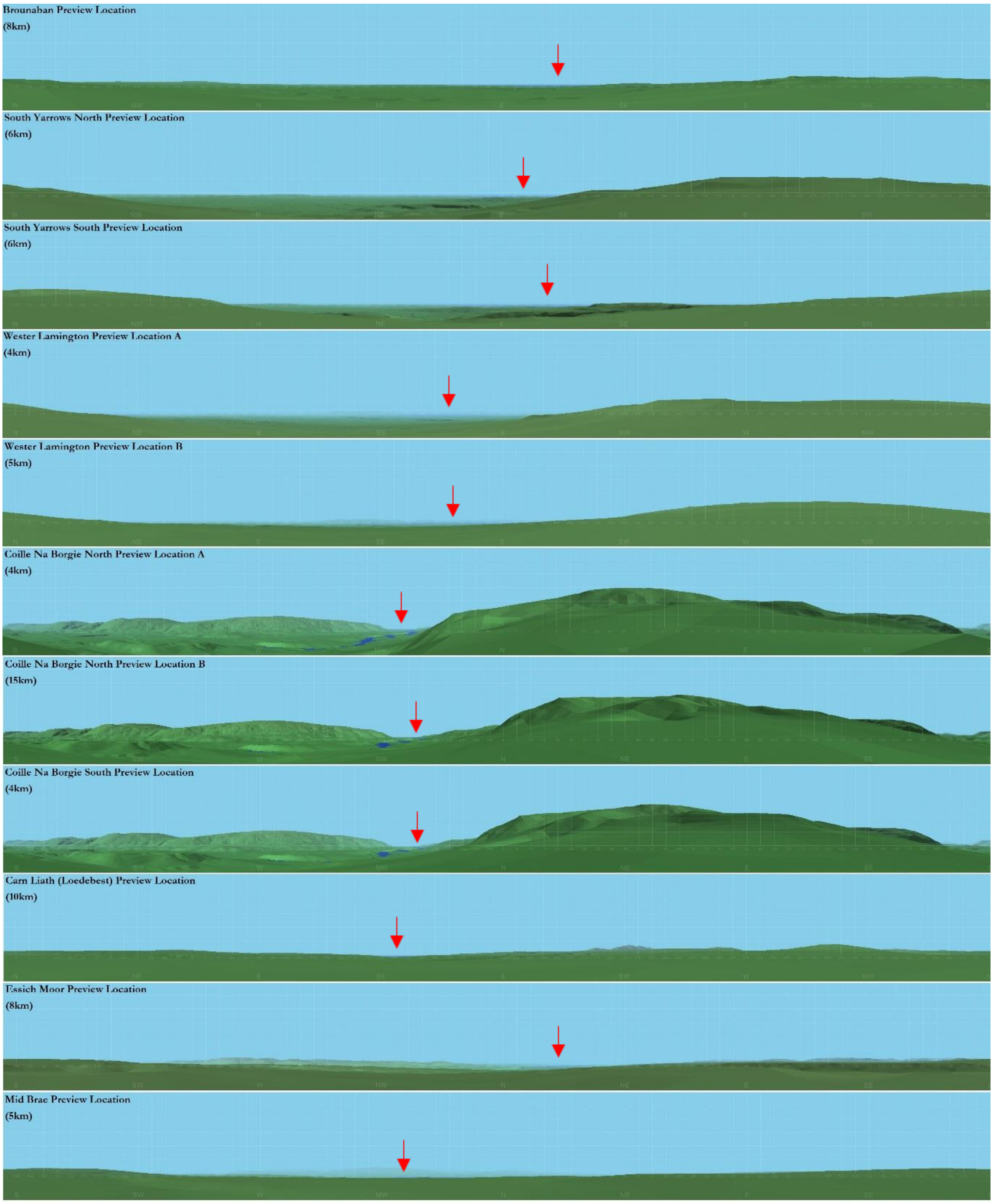


Figure 7.50: Horizon panoramas of preview locations depicting the effects of atmospheric conditions. Ardnamurchan.

7.4 Alignments of Long Cairn Axes, Sea Views and Pathways

Orientation of Cairns Relative to Sea Views

The orientations of the long axes of the sites that offer sea views were compared with the azimuthal ranges of those sea views to determine whether and how they align. Twenty eight of the 29 sites that offer sea views could be examined in this way— it was not possible to survey or obtain a plan for only one such site, Skelbo Wood, which had been insufficiently preserved, and possibly mutilated by forestry and ploughing (see Table 7.14).

Site name	Direction of seaward pathways	Direction of sea views	Orientation of monument long axis	Part of monument approached by pathway(s)
Coille Na Borgie North	Path 1 (NW)	NW–NNE (326.5–29º)	S–N (169–349º)	proximal end
Coille Na Borgie South	Path 1 (NW)	NW (326º)	S–N (168–348º)	proximal end
Skelpick Long	Path 1 (NNW) Path 2 (NNW)	NNW (330–334º)	SE–NW (139–319º)	distal end
Cnoc Freiceadain	Path 1 (N)	W–NE (273.5–45.5º)	NNE– SSW (33.5–213.5º)	proximal end
Na Tri Sithean	Paths 1, 2 (N)	W–NE (270–46º)	ESE– WNW (113–293º)	proximal end
Baillie Hill	Path 1 (NNW) Path 2 (NW) Path 3 (N)	NW–NNW (324.5–329º) NNW–N (332–356.5º)	SSE–NNW (153–333º)	proximal end
Youkil Hillock	Path 1 (NW) Path 2 (N) Path 3 (NE)	NW–NNE (319–24º)	S–N (175–355º)	proximal end
Cooper's Hill	Path 1 (N) Path 2 (NW)	NW–N (305–354.5º) NNE (20.5–25.5º)	SE–NW (131–311º)	proximal end
Cairn of Heathercro	Path 1 (E)	E–ESE (82.5–106º)	NE–SW (41–221º)	proximal end
Sgarbach, Auckingill	Path 2 (S) Path 4 (SE)	NE–SSW (44–201º)	NNE–SSW (18–198º)	distal end
South Yarrows North (Yarhouse)	Path 1 (SSE) Path 2 (ESE) Path 3 (E)	NNE–E (17.5–94º)	E–W (81–261º)	Path 1: side/proximal end (uncertain) Path 2: side/proximal end (uncertain) Path 3: distal end

South Yarrows South (Yarhouse)	Path 1 (S) Path 2 (SE) Path 3 (N)	NNE–E (15–96º) ESE–SE (108–135.5º)	E–W (87–267º)	Path 1: side/proximal end (uncertain) Path 2: side/proximal end/distal end (uncertain) Path 3: proximal end
Warehouse South	Path 1 (SE) Path 2 (SE)	NNE–SSW (11.5–207º)	NE–SW (42.5–222.5º)	proximal end
Brounaban	Path 1 (SE)	NNE–SE (14–127º)	E–W (82.5–262.5º)	side
Latheronwheel Long	Path 1 (ESE) Path 2 (S)	ENE–SSW (71.5–201º)	NNE–SSW (26–206º)	proximal end
Carn Liath, Loedebest	Path 1 (SE) Path 2 (SE)	ESE–SSE (123.5–149º)	ENE–WSW (70–250º)	Path 1: side/distal end (uncertain) Path 2: proximal end
Caen Burn	Path 1 (S)	SSE (150.5–164º)	ESE–WNW (118.5–298.5º)	side
Carn Laggie	Path 1 (SSW)	SSE–S (162–174.5º)	SSE–NNW (158–338º)	side
Skelbo Wood	Path 1 (NE)	N–SE (349–139.5º)	N/A	N/A
Wester Lamington	Path 3 (SE)	NNE–ENE (26–73º) E–ESE (86–109º) SE–SSW (124.5–201º)	SE–NW (132–312º)	distal end (uncertain)
Carn Liath	Path 1 (ESE) Path 2 (ESE)	E–ESE (101–117.5º)	NE–SW (56–236º)	Path 1: side/proximal end (uncertain) Path 2: side/proximal end (uncertain)
Edderton Hill	Path 2 (E)	NW–E (306.5–96º)	ESE–WNW (114–294º)	side
Mid Brae	Path 1 (N) Path 2 (NE)	NW–NNE (310–30º) NE–ENE (40–71º)	ENE–WSW (68–248º)	Path 1: side Path 2: proximal end
Wester Brae	Path 1 (N)	ENE (64–67º)	ENE–WSW (66–246º)	distal end/side (uncertain)
Essich Moor (Carn Glas)	Path 1 (ENE) Path 2 (NE)	N–NE (357–44º)	N–S (9–189º)	proximal end
Ardnamurchan, Cladh Aindreis	Path 1 (W)	W–N (280–7.5º)	SE–NW (134–314º)	proximal end
Kinrive West	Path 1 (SE) Path 2 (SW)	ENE–SW (67–218)	NE–SW (44–224)	Path 1: distal end/side (uncertain) Path 2: proximal end
Woodhead Long	Path 1 (NE)	NE–ENE (34–66)	E–W (84–264)	proximal end/distal end (uncertain)
Caen Burn North	Path 1 (E)	SSE (145–149	NE–SW (56–256)	distal end/side (uncertain)

Table 7.14: Long cairn, pathway and sea view orientations.

Fifteen of the 28 sites hold direct axis-alignments with sea views. These sites are: Cnoc Freiceadian, Na Tri Sithean, Baillie Hill, Youkil Hillock, Cooper's Hill, Sgarbach, South Yarrows North, South Yarrows South, Warehouse South, Brounaban, Wester Lamington, Mid Brae, Wester Brae, Essich Moor and Ardnamurchan. At eight more sites, cairn long axes form indirect or general axis-alignments with the direction of sea views (see Chapter 4, Section 6 for these terms). These sites are: Latheronwheel Long, Carn Laggie, Skelpick Long, Coille Na Borgie North, Coille Na Borgie South, Edderton Hill, Kinrive West, and Woodhead Long. For example, Carn Laggie's long axis runs SSE–NNW (158–338º) but its sea views only extend between SSE–S (162–174.5º), so that the S end of the monument is indirectly aligned with those views. At Skelpick Long, the long axis runs SE–NW (139–319º) but narrow sea views in the NW range between 330–334º. Thus, the cairn's long axis is aligned in the general direction of the sea views, being askew of those views by 11º.

Sixteen instances of side-alignments between cairn axes and sea views are also observed in this region. Twelve of these occur alongside axis-alignments, so that at least one form of alignment was found at a total of 27 of the 28 sites with sea views (and available plans with which to determine alignments). Both direct side-alignments and direct axis-alignments are present at: Cnoc Freiceadain, Na Tri Sithean, Warehouse South, Wester Lamington, and Mid Brae. Direct side-alignments are seen alongside indirect or general axis-alignments at: Sgarbach, Edderton Hill, Latheronwheel Long, and Kinrive West. Cooper's Hill forms a direct axis-alignment alongside a general side-alignment with one of the two ranges of sea views available from its location, and a similar arrangement of factors is seen at South Yarrows South (Yarhouse). Brounaban forms a direct axis-alignment but has a general side-alignment. The four instances of side-alignments that occur without the presence of axis-alignments are seen at: Caen Burn North, Carn Liath, Carn Liath (Loedebest), and Cairn of Heathercro. These are all alignments with relatively narrow views, and Cairn Liath is the only site of these four with a direct side-alignment.

Orientation of Pathways Relative to Sea Views and Monuments

Out of a total of 48 seaward pathways that lead to 29 sites, 42 paths to 26 sites formed a 'direct line of sight' with the sea, thus framing the respective monuments against a backdrop of the sea for people arriving at the sites.[41] The six exceptions are: Path 1 to Caen Burn, Path 1 to Carn Laggie, Path 1 to South Yarrows South, Path 1 to South Yarrows North, Path 1 to Wester Brae, and Path 1 to Caern Burn North. Despite approaching monuments in a seaward direction, these paths do not form a direct line-of-sight with the directions of sea views.

On examination of the direction of these pathways relative to monument orientations, it was revealed that a majority of sites had paths that approach monuments towards their proximal ends (see Table 7.14). However, there were some variations. In the case of Cooper's Hill, Path 2 approaches the proximal end in alignment with the cairn's long axis (see Figure 7.52),[42] yet Path 1 approaches the proximal end from an oblique angle, from the side of the monument. This pathway is distinct from those that approach a site more directly and in alignment with a cairn's long axis. Further examples of variations are seen at Latheronwheel Long; Path 1 approaches the proximal end at an angle of nearly 90º from the monument's long axis, while Path 2 approaches the proximal end at an angle that is closer to 45º from the monument's long axis (see Figure 7.51). More paths that approach sites from oblique angles are seen at Coille Na Borgie North, Coille Na Borgie South and Cairn of Heathercro (see Figures 7.53 and 7.54).

In several cases, poor monument preservation led to difficulty in determining how pathways approach and access a cairn structure, whether from its side, or its proximal or distal end. These pathways are classified as 'uncertain'. Only three sites have paths that could be identified as approaching the monuments towards their distal ends, these are: Paths 1 and 2 to Sgarbach, Path 3 to South Yarrows North, and Paths 1 and 2 to Skelpick Long. A similarly small number of pathways could be identified as approaching monuments towards their sides. These are: Path 1 to Mid Brae, Path 2 to Edderton Hill, Path 1 to Carn Laggie, Path 1 to Caen Burn and Path 1 to Brounaban.

In some cases, an axis-alignment was found to hold between pathways, monuments, and sea views, with paths forming either a proximal–distal sightline or a distal–proximal sightline with the sea. Proximal–distal sightlines were found at six sites: on Path 1 to Cnoc Freiceadain, Paths 1, 2 and 3 to Baillie Hill, Paths 1 and 2 to Youkil Hillock, Path 2 to Cooper's Hill, Path 2 to Mid Brae and Path 1 to Ardnamurchan. Distal–proximal sightlines were found at two sites: on Path 2 to

[41] As noted in Section 7.3, 44 of 90 paths considered in this region offer some form of revelatory view, and these occur at 26 sites. To determine the incidence of alignment between paths and sea views at the long cairn sites in this region, those 44 paths were examined alongside the 4 paths to the 3 sites that offer non-revelatory sea views.

[42] Pathways that approach proximal ends at roughly 45º to the monument's long axis: Path 1 to Cnoc Freiceadain, Path 2 to Baillie Hill, Paths 1 and 3 to Youkil Hillock, Path 1 to Cooper's Hill, Path 1 to Ardnamurchan and Paths 1 and 2 to Essich moor. Pathways that approach the proximal ends at 90º to the monument's long axis: Paths 1 and 2 to Warehouse South, and Path 2 to Carn Liath (Loedebest).

Sgarbach, and Path 3 to South Yarrows North. A further sightline was also found on Path 3 to Wester Lamington, although there is some degree of uncertainty as to which end of the monument this path approaches and, thus, whether it has a proximal–distal sightline or distal–proximal sightline.[43] At ten sites in this region, paths approach monuments towards their side in a way that creates a sideway sightline. These are: Paths 1 and 2 to Na Tri Sithean, Path 4 to Sgarbach, Path 1 to South Yarrows North, Path 3 to South Yarrows South, Paths 1 and 2 to Warehouse South, Path 1 to Latheronwheel Long, Paths 1 and 2 to Carn Liath (Loedebest), Paths 1 and 2 to Carn Liath, Path 1 to Mid Brae, Path 1 to Kinrive West. No such paths were confirmed to approach monuments towards the side of the cairn structures. Thus, at least one form of sightline was found at each of 16 cairn sites, out of a total of 28 sites that offer sea views in this region.

[43] At Wester Lamington, it is hard to determine from the survey drawing which end is the proximal end and which end is the distal end.

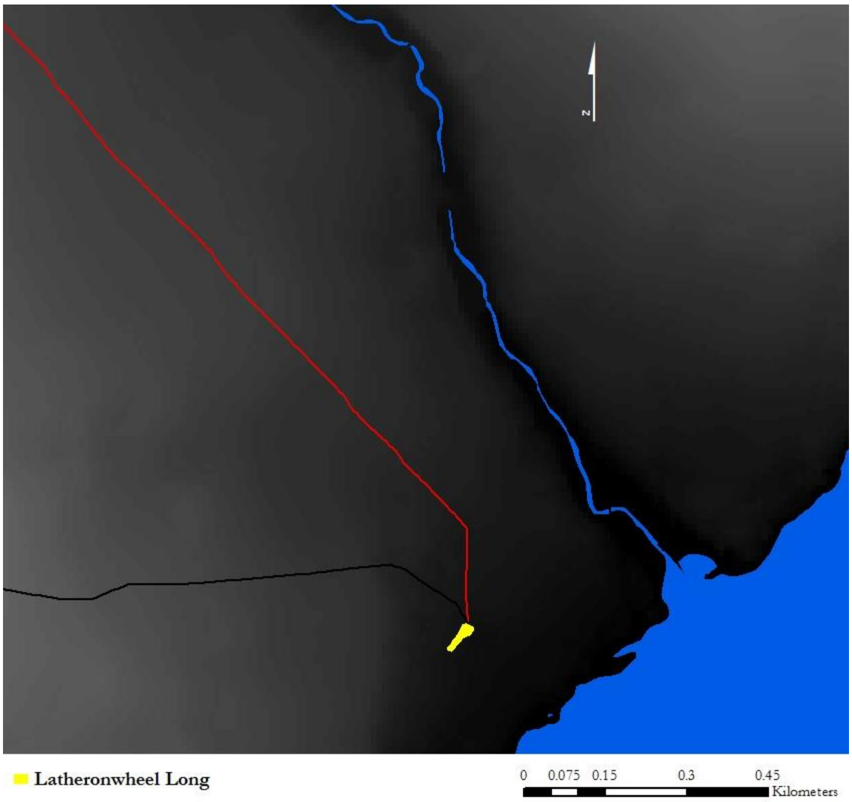


Figure 7.537: Path 1 (black) and 2 (red) to Latheronwheel. Paths 1 and 2 approach the proximal end at approximately 90º and 45º to the monument's long axis, respectively.

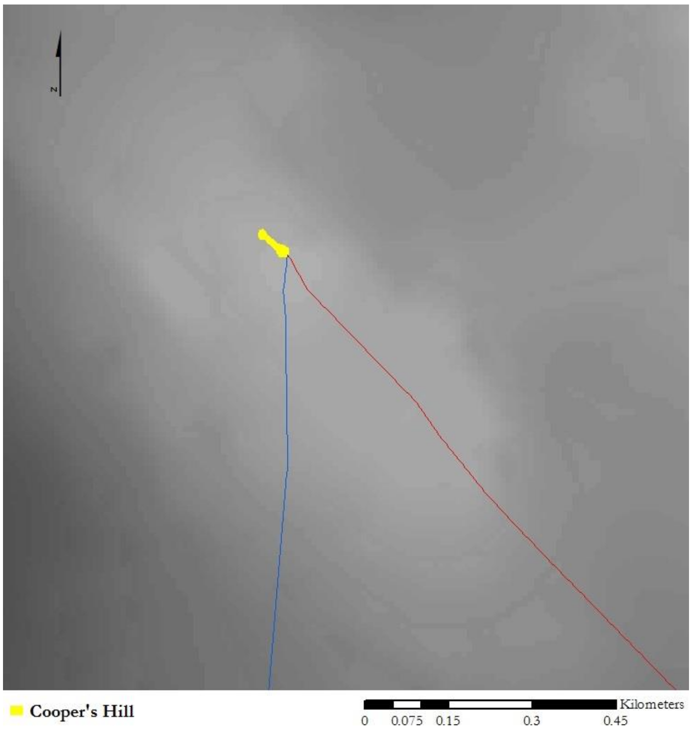


Figure 7.52: Path 2 (red) to Cooper' Hill. Path 2 approaches the proximal end in alignment with the monument's long axis, while Path 1 (blue) approaches from approximately 45º to the monument's long axis.

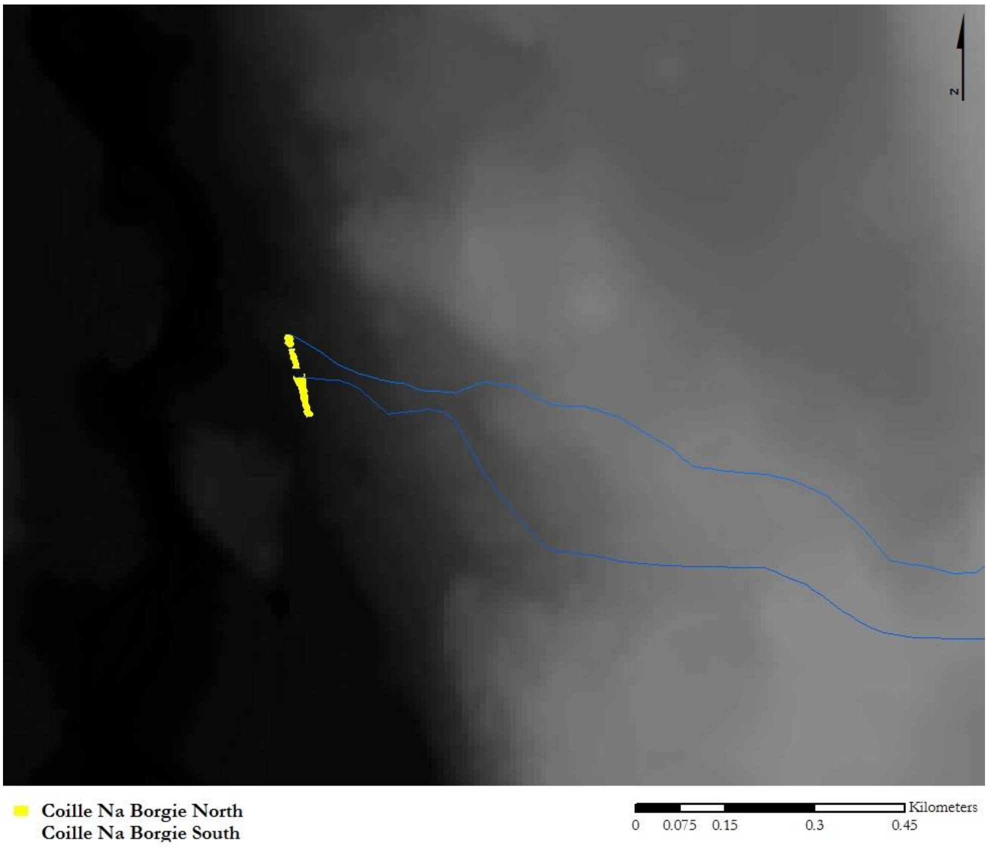


Figure 7.53: The Paths to Coille Na Borgie North and Coille Na Borgie South.
Both paths approach the monuments' proximal ends from an oblique angle.

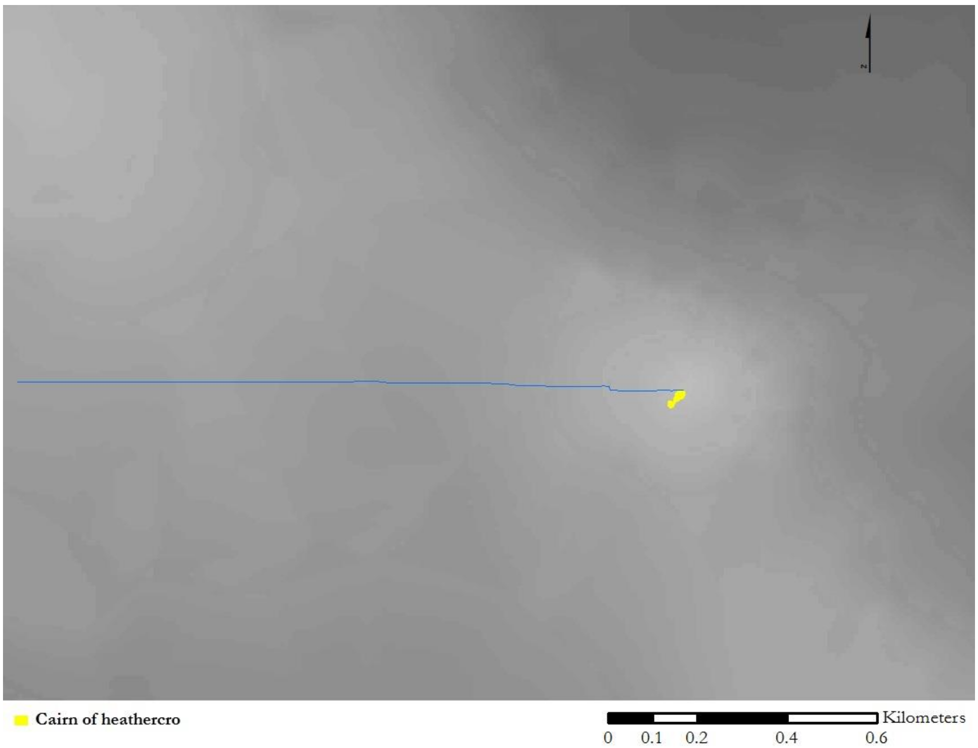


Figure 7.54: Path 1 to Cairn of Heathercro.
Path 1 approaches the monument's proximal end from an oblique angle, at roughly 45º to the monument's long axis.

7.5 Summary

Containing a large group of monuments that share in common a loosely defined set of characteristics while also being placed in relative proximity to the coastline, the Highlands presents an interesting opportunity to test the hypothesis considered here, of whether the long cairns of Scotland were placed so as to reference the sea. As discussed in 7.1, statistical consideration of the sites and their surrounding landscape contexts revealed that, taken as a collective, these long cairns were not placed in locations unique to their surrounds in terms of sea views. On consideration, this may not be altogether surprising given that many monuments offered either no or nominal sea views and that, despite their proximity to the shoreline, sea views could often be rare in their surroundings.

There were mixed results for the second and third stages of the study, which considered sites and their surrounds on an individual and qualitative basis. As described in 7.2 and 7.3, there are locations in proximity to some sites and along the pathways to some sites that offer greater sea views and which seem to have been suitable locations in terms of distance from where monuments are placed, elevation, and ease of access for prehistoric peoples. In many other instances, cairn sites were also revealed to be the among most ideal locations in terms of both sea views generally and revelatory views more specifically, which is consistent with prehistoric people actively seeking out such locations and preferring them. Taken together, these results indicate that the prehistoric people of the Highlands had a preference for being able to reference the sea with monument-construction, but that such a preference was only one factor among possibly a number of other factors that they may have considered for site selection.

A degree of confirmation that prehistoric peoples had an interest in the sea was found in the final stages of the investigation conducted. Of the 47 long cairns considered in this region, the sea affordance analysis and generated affordance profiles indicated that 26 had offered revelatory views of the sea. After further interrogation of these views, using Horizon panoramas, some were revealed to be too narrow or unnoticeable to be regarded as holding significance. However, there were also a significant number of noticeable sea views, some of which were either substantially or moderately prominent. It was also found that 21 sites have an alignment with the sea (direct, indirect or general) incorporating the orientation of a cairn's long axis in relation to the direction of its sea views, as well as the angle of the paths that approach the site, relative to the cairn's long axis and sea view. In addition to the 16 of 28 sites with sea views that demonstrate at least one form of sightline, these features, and the number of cairn sites that hold them, indicate that the prehistoric people of the Highlands may have held a significant level of interest in the sea, and especially so when sea views are available in a given area.

Chapter 8: Analysis of the Long Cairns of Aberdeenshire

Aberdeenshire holds a relatively modest amount of long cairns in proximity to the North Sea. However, the region presents an area of particular interest due to one particular aspect of its topography. Much of the area is covered by relatively high plateaus that offer views that extend for some distance out to sea. Hence, the areas where sea views are available reach further inland than is often the case in the other regions of Scotland. This feature of Aberdeenshire's landscape arguably makes more likely that the sea held some significance to the prehistoric people who once inhabited it, and, therefore, makes this region highly important for testing the hypothesis that prehistoric monuments and long cairns, in particular, were placed so as to reference the sea.

The long cairns of Aberdeenshire were, therefore, investigated to determine whether they reference the North Sea (sea) in any of the three ways described in Chapter 4, Section 5. First, sites were assessed in terms of their affordance of sea views, to determine whether their locations are either typical or unique in that respect in the landscapes in which they are situated. This was conducted both quantitatively, in terms of the statistical consideration of the sites as a collective as discussed in Section 1, and in terms of a qualitative consideration of their landscape contexts on a site by site basis, as discussed in Section 2. Second, as described in Section 3, sites were assessed to determine whether they offer 'revelatory views' of the sea, as dependent on the pathways from which these monuments were likely to have been approached and whether sea views are obscured to observers on their approach. Third, the details of sea views and revelatory views, where present at long cairn sites, were compiled and considered in Section 4, alongside the orientation of their long axes relative both to the sea and to the pathways that may have been used to approach them.

8.1 Sea Affordance Surfaces and Statistical Considerations

There are 18 long cairns in the 6,313km² region of Aberdeenshire (see Figure 8.1 for the site distribution map).[44] Of these 18 cairns, half are located at over 10km away from the shoreline and are placed too far inland for the sea affordance analysis to be conducted. The nine remaining sites were treated as suitable for consideration of sea affordance. These sites are: Longcairn, Hill of Foulzie, Cairn Catto, Blackhill Wood, Longman Hill, Bruxie Hill, Gourdon, Stirling Cairn and

[44] Unless otherwise noted, all cairn sites in this chapter refer to monuments within the council area of Aberdeenshire.

Hillhead Plantation.[45] As can be seen from the distribution map of considered sites (Figure 8.2), there are two modestly sized and distinct clusters of sites, and two further sites that are in isolation from each other and the rest. While sea affordance surfaces generated for other regions analysed in this study were often able to include multiple sites or site-clusters, reducing processing time, due to the distance of sites in Aberdeenshire from each other, even within site-clusters, surfaces for seven of the nine sites needed to be generated in isolation, with only one site per surface. This led the region to be sub-divided into eight micro-regions or sectors. It took a total of 35 days (837hrs) to process all the required sea affordance viewsheds. The percentage of sea affordance for each of the nine sites was then extracted using the methodology described in Chapter 4, Section 3 (for a detailed summary of these findings see Table 8.1).

[45] The sites not included in the analysis and their distance from the nearest coastline are: Finzean 29.2km, Glenshee 22.6km, Blue Cairn 40.9km, Newton Hill 23.6km, Balnacraig 42.1km, Stot Hill 33km, Upper Tillygarmond 25.5km, Midmill 15.1km, and Knapperty Hillock 15.8km.

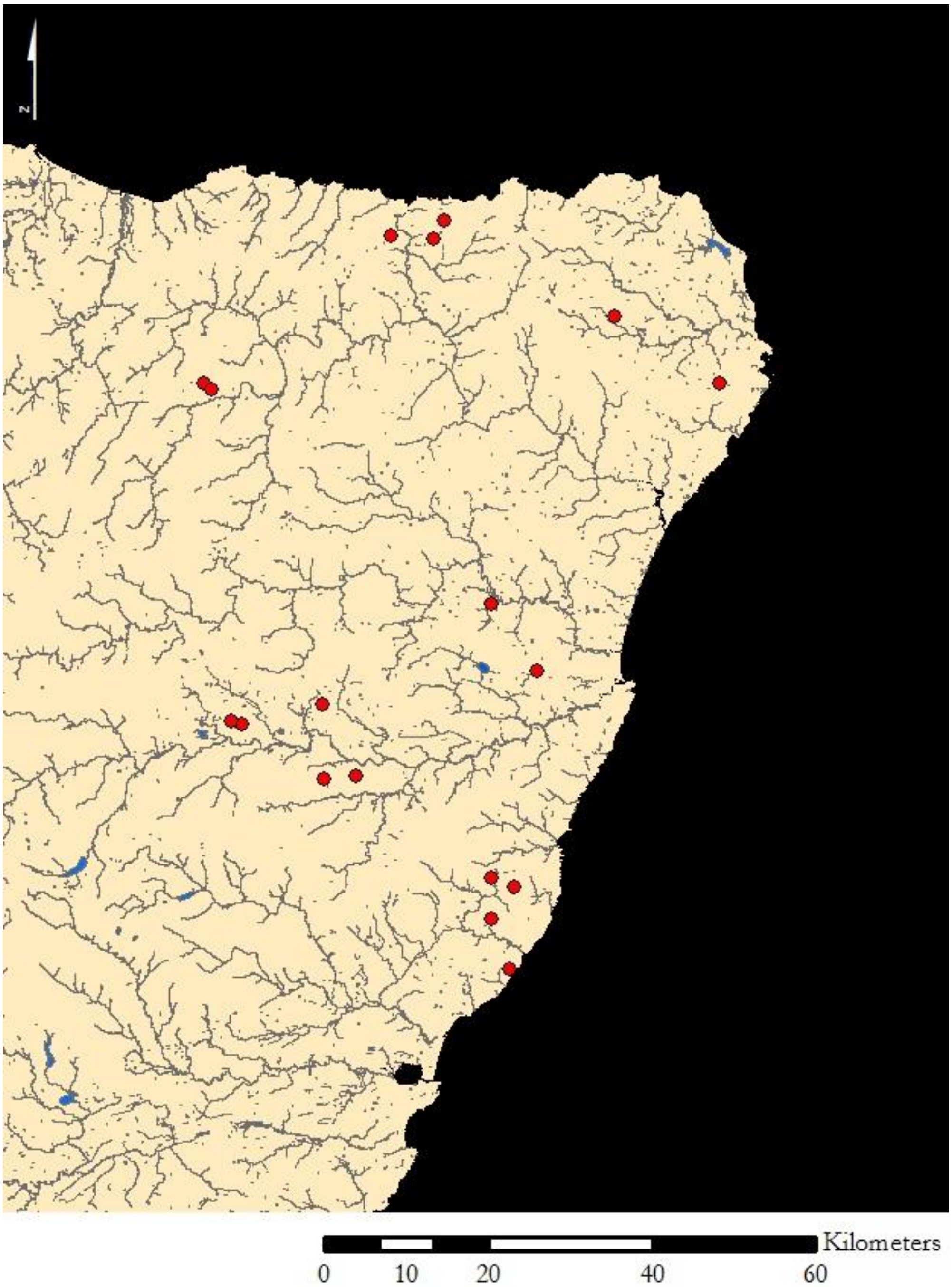


Figure 8.38: Aberdeenshire site distribution map.

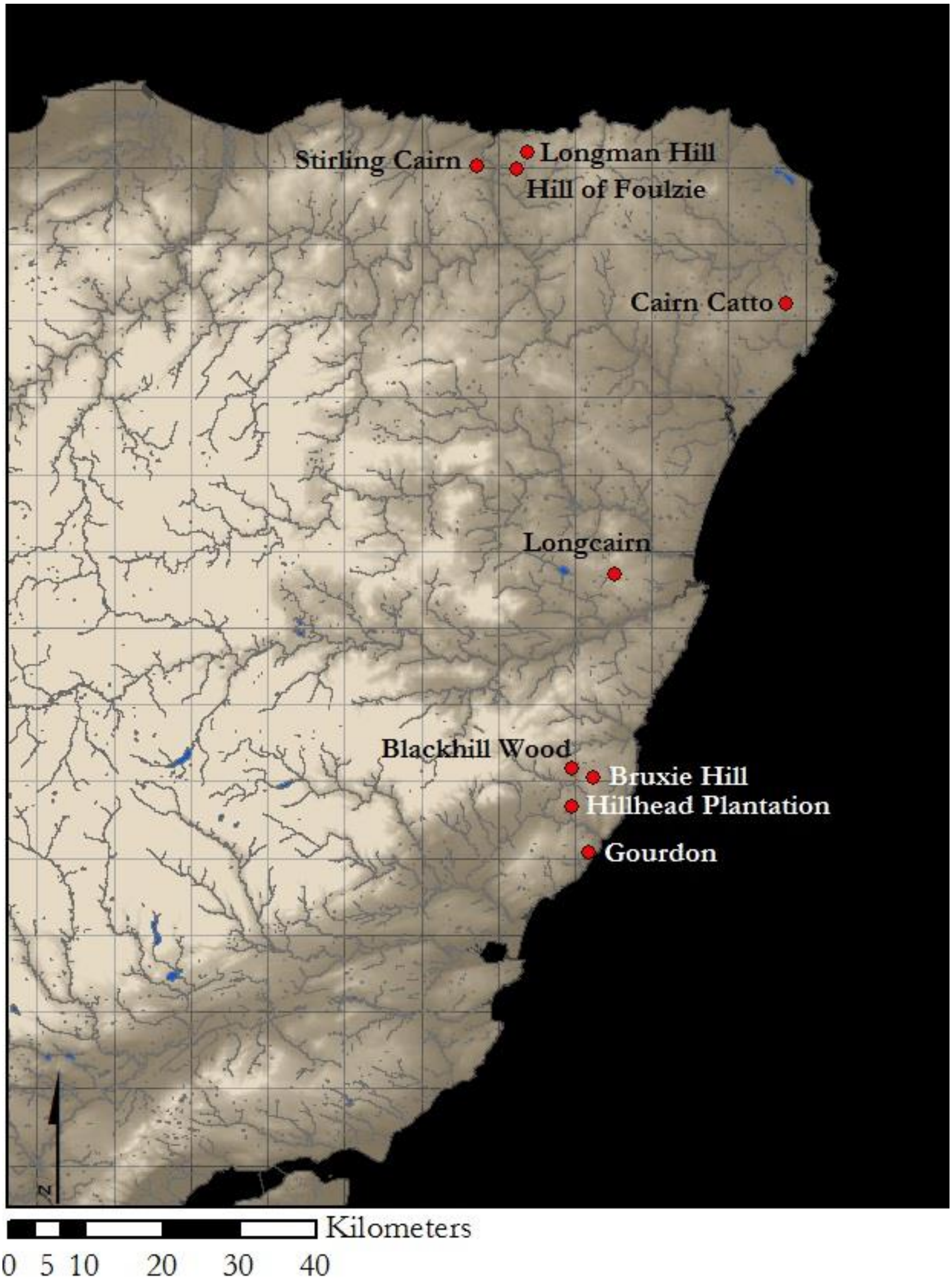


Figure 8.2: Aberdeenshire distribution map of sites considered for sea affordance analysis.

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	Sea Affordance %
1	Hill of Foulzie	132	1129.39	4520.73	10.47
2	Stirling Cairn	145	1022.38	2689.07	57.50
3	Longman Hill	146	1391.62	2423.27	20.23
4	Cairn Catto	82	709.65	4934.34	0.00
5	Longcairn	152	1087.27	8392.56	0.00
6	Blackhill Wood	105	771.01	8122.67	0.00
7	Bruxie Hill	198	469.51	5165.99	26.52
8	Gourdon	136	1010.15	528.09	28.92
9	Hillhead Plantation	171	284.65	5567.64	0.00

Table 8.1: Results of sea affordance analysis.

Consideration of Sites and Verification of Sea Affordance Analysis

As is shown in Table 8.1, the sea affordance analysis yields values of 0% for four sites. For two of those sites, the results of this analysis do not match the results of a standard viewshed. The greatest discrepancy is in the case of Hillhead Plantation. On consideration of photographs taken during fieldwork, it is clear that sea views are available from Hillhead Plantation (see Figure 8.3). These views are also accurately represented by the Horizon panorama, below (Figure 8.4).

Figure 8.3: Close-up of a photograph of Hillhead Plantation taken during site survey, showing sea views in the SE.

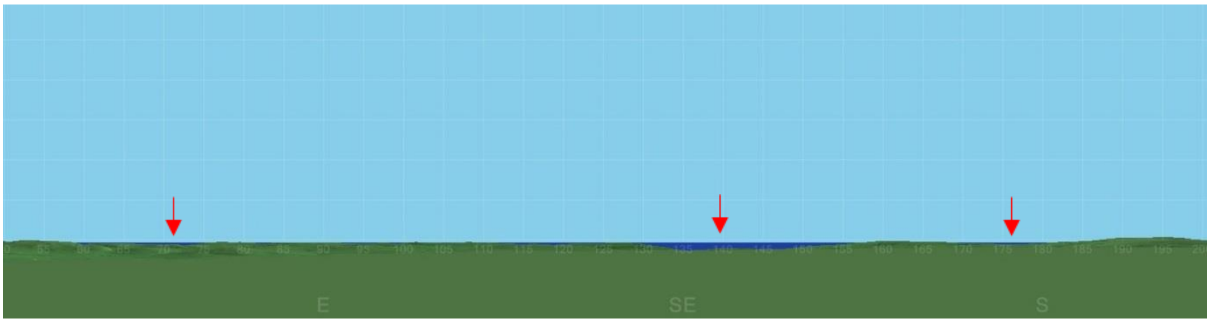


Figure 8.4: The Horizon profile of Hillhead Plantation shows sea views on the distant horizon. The red arrows indicate sea views.

The standard viewshed analysis reveals that the nearest, visible areas of sea are much further away from the coastline than is usually the case in the regions of Scotland considered in this thesis (see Figure 8.5). This explains the discrepancy between the standard viewshed and sea affordance outputs: at approximately 6km from the shore, those areas of sea are not included within the limited 3km buffer of sea from the coast that is used to generate the sea affordance maps (see Chapter 4, Section 3 for more details). Out of all the sites investigated in this thesis through sea affordance analysis, the 3km buffer only produced a false negative of this kind for the site of Hillhead Plantation. As described below, in cases where areas of sea that might be visible are also at great distances from a site, the prevailing finding is that they appear as infinitesimal and almost, if not, impossible to detect with the naked eye. Therefore, it is highly unlikely that limitations posed by the 3km buffer affect in any significant way the conclusions drawn in this thesis.

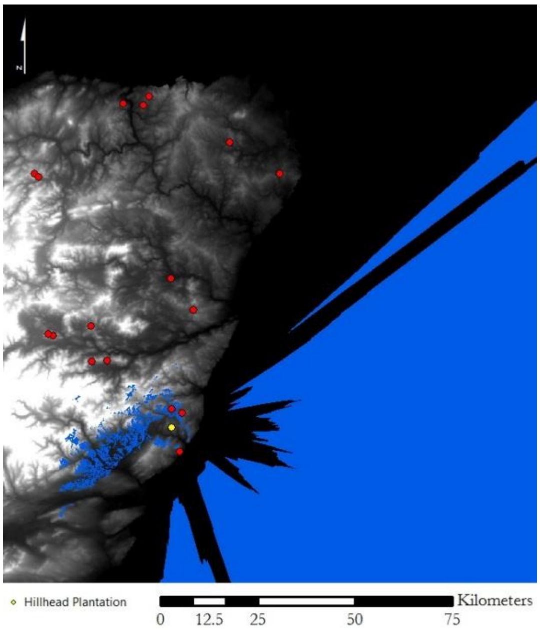


Figure 8.5: A standard viewshed showing the parts of the landscape and seascape that are visible from Hillhead Plantation (marked here in blue).

Cairn Catto presents a different case from what is seen at Hillhead Plantation. The sea affordance analysis also yields a value of 0% for Cairn Catto and, contrary to that result, a standard viewshed analysis depicts sea views from that location. However, as shown in Figure 8.6 below, the nearest areas of visible sea are at extreme distances from Cairn Catto: 17.5km in the north, and 20.3km in the south. The effect of these distances is that those areas of sea occupy infinitesimal areas in the observers' visual field. As is demonstrated both in photographs taken during field surveying and the generated Horizon panorama, those areas of sea are simply too far away to be seen from the location of the site (see Figures 8.7 and 8.8).

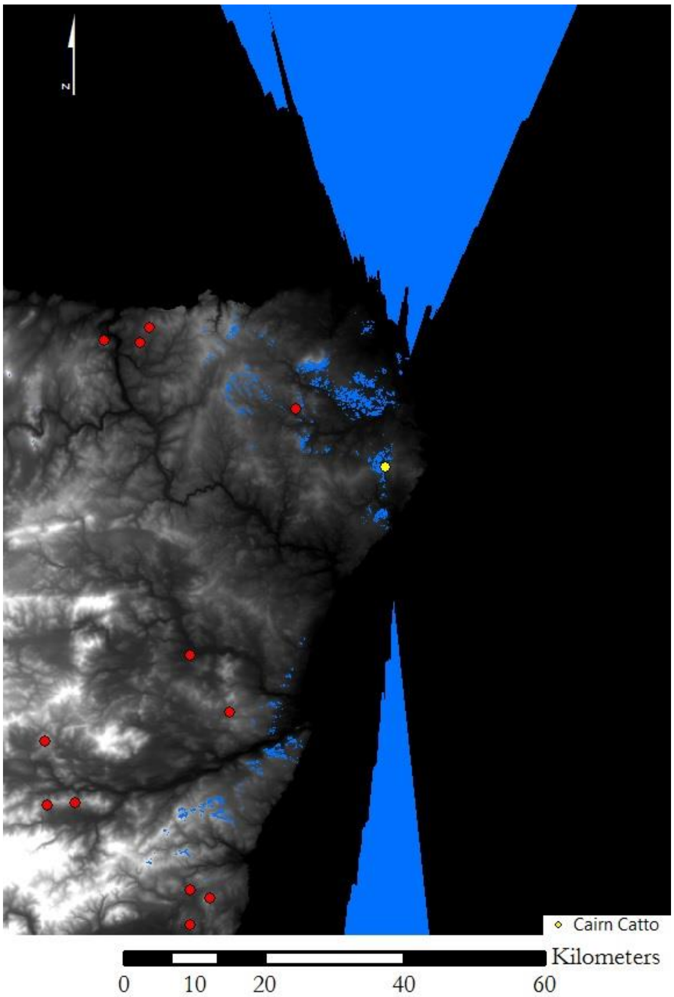


Figure 8.6: A standard viewshed showing the parts of the landscape and seascape that are visible from Cairn Catto (in blue).

Figure 8.7: Photograph of Cairn Catto taken during site survey shows no apparent sea views.

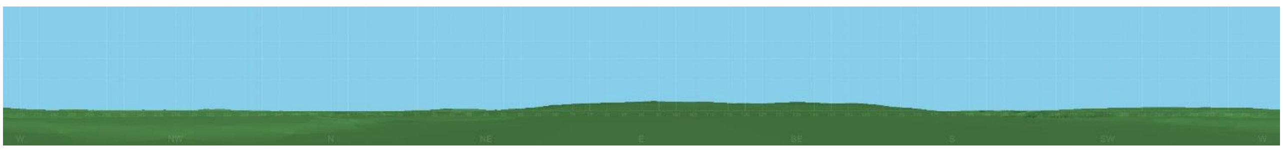


Figure 8.8: The Horizon panorama of Cairn Catto shows no sea views in the north or south directions.

The same explanation accounts for discrepancies observed between Horizon panoramas and standard viewshed outputs for several of the inland sites that were excluded from the sea affordance analysis. As noted earlier, half of the 18 long cairns in Aberdeenshire were not considered as suitable for sea affordance analysis as they are situated too far from the coast.

However, a cursory examination via standard viewsheds reveals that sea views are, in principle, available from six of those excluded sites. These are: Glenshee, Blue Cairn, Newton Hill, Stot Hill, Upper Tillygarmond and Knapperty Hillock (see Figures 8.9–11). As with both Hillhead Plantation and Cain Catto, because the areas of sea that are visible from those site locations are beyond a 3km distance from the shore, none of those sites' sea views would be represented by a sea affordance analysis, if conducted. Such an outcome would not, however, signify a defect in the methodology used here, since all of those areas of sea are, in actuality, invisible to the observer's naked eye due to their sheer distances from the location in question. Photographs taken during field surveys confirm this finding, although they are of limited utility due to certain obstructions to the otherwise visible horizon that would not have been present in the same way during prehistoric times (see Figures 8.12 and 8.13).

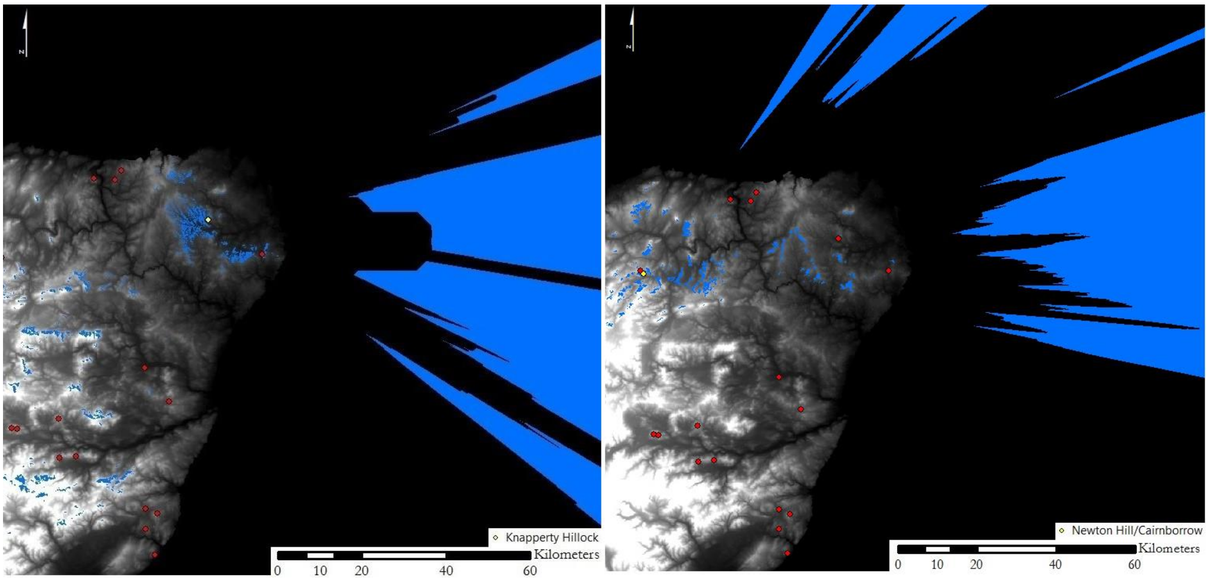


Figure 8.9: A standard viewshed showing the parts of the landscape and seascape that are visible from Knapperty Hillock (left) and Newton Hill (right).
The nearest areas of sea that are visible from Knapperty Hillock are located 35.6km from that site, in an easterly direction, while the nearest areas of sea visible from Newton Hill are 40.5km from that site, in a NE direction.

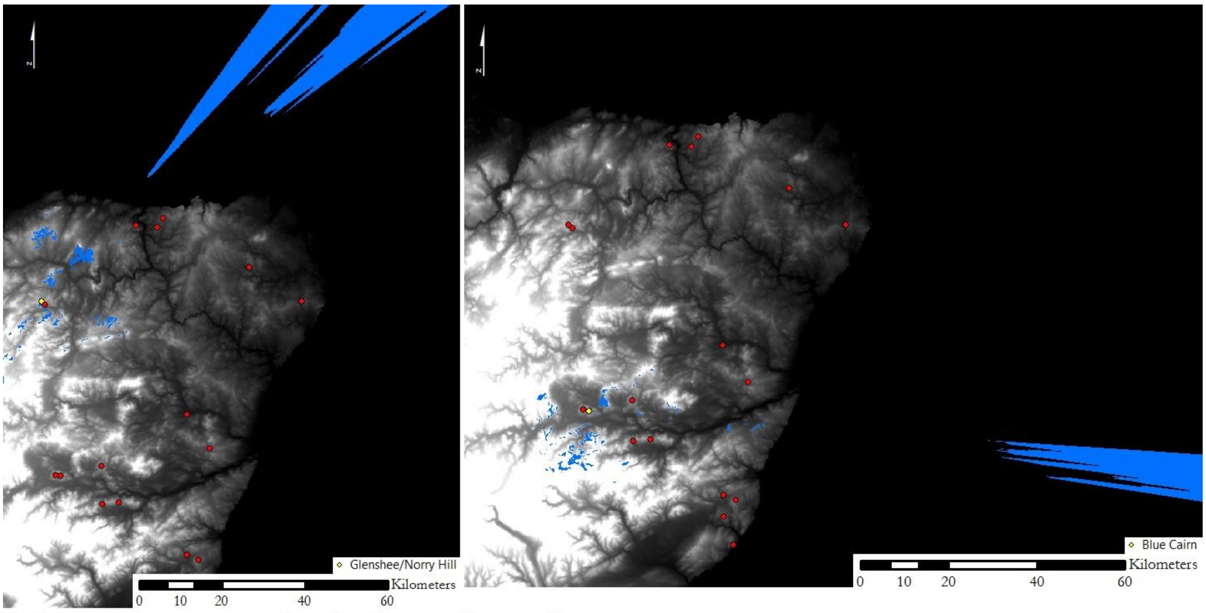


Figure 8.390: A standard viewshed showing the parts of the landscape and seascape that are visible from Glenshee (left) and Blue Cairn (right).
The nearest areas of sea that are visible from Glenshee are located 39.6km from that site, in a NE direction, while the nearest areas of sea that are visible from Blue Cairn are 95.3km from that site, in an easterly direction.

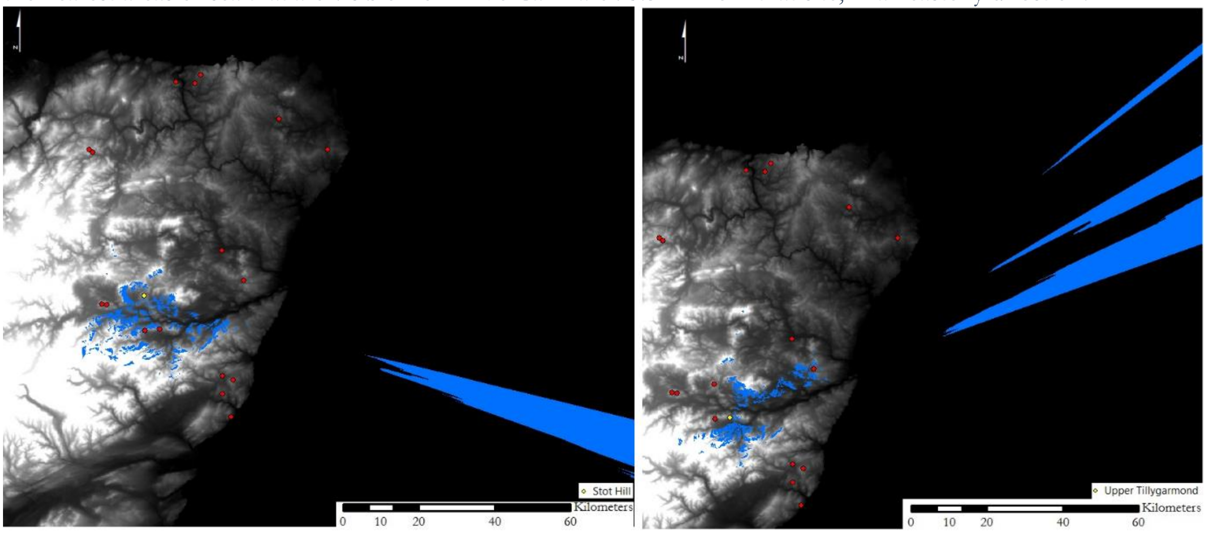


Figure 8.40: A standard viewshed showing the parts of the landscape and seascape that are visible from Stot Hill (left) and Upper Tillygarmond (right).
The nearest areas of sea that are, in principle, visible from Stot Hill are located 62.1km from that site, in a ESE direction, while the nearest areas of sea that are visible from Upper Tillygarmond are 61.5km from that site in an ENE direction.

Figure 8.412: The panoramas of Knapperty Hillock (above) and Glenshee (below) show no visible sea in the distant horizon (photographs taken during field surveys).

Figure 8.423: The panorama of Blue Cairn (photograph taken during field surveys).

As mentioned above, aside from Cairn Catto and Hillhead Plantation, there were two sites with sea affordance values of 0%: Longcairn and Blackhill Wood. These sites are located at the greatest distances from the coastline, at over 8km in both cases. Standard viewshed analyses confirm the accuracy of sea affordance value of 0% as neither site is placed in a topographic location that affords sea views (see Figures 8.14 and 8.15). Moreover, an examination of the immediate areas surrounding these sites, with radii of 1.5km, reveals that the Blackhill Wood is situated in a location that was completely devoid of sea views (see Figure 8.16); the nearest location with sea views is approximately 2.1km away (in a NNE direction) and has sea affordance values of only 7.7%. In the case of Longcairn, 95.9% of the area immediately surrounding the site offers very little or no sea views, with sea affordance values ranging only from 0–5% (see Figure 8.18). Approximately 1.3% of the area investigated within a 1.5km radius of the site offers significant sea views, with sea affordance values ranging from 40–50%. As will be discussed in the following section (8.2), these views are only a very short distance from where the site is situated. For instance, approximately 534.5m, in a NE direction, there is a small area that offers sea affordances ranging from 40–60%. A second larger area, also with high sea affordance values, lies just 1.5km from the site, again in a NE direction (see Figure 8.18).

The remaining five sites are placed in locations of the landscape that offer sea views. Of these, the most noteworthy is Stirling Cairn, with a sea affordance value of 57.5%. Gourdon, Bruxie Hill and Longman Hill all fall in the 20–30% range, with respective sea affordances of 28.9%, 26.5% and 20.2%. With a sea affordance value of 10.5%, Hill of Foulzie seems to be the only site to be built in an area of comparatively low sea affordance. However, a closer examination of the area inside a 1.5km radius of that site reveals that it is placed on the only topographic location that affords any sea views at all. This is a considerable finding as only a very minor percentage of that landscape offers sea views despite being only 4.5km away from the nearest coastline (see Figure 8.19). This may suggest intentionality by prehistoric builders, as they appear to have found some of the only sea views that were are available, when they were available.

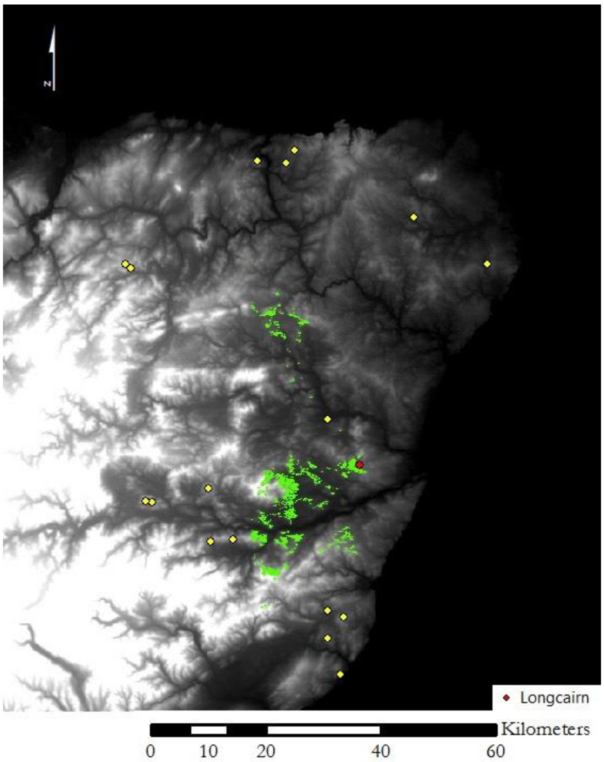


Figure 8.434: A standard viewshed showing the parts of the landscape and seascape that are visible from Longcairn (indicated here in green).

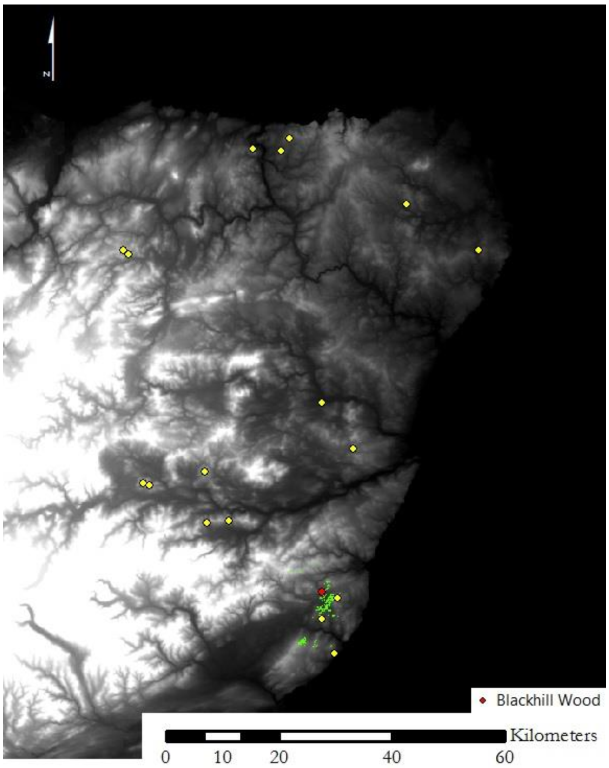


Figure 8.445: A standard viewshed showing the parts of the landscape and seascape that are visible from Blackhill Wood (indicated here in green).

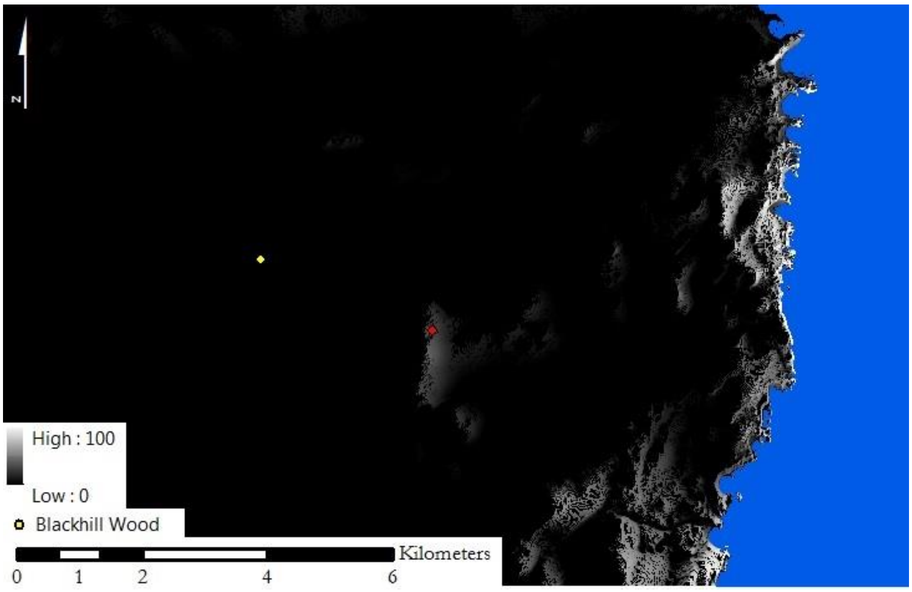


Figure 8.456: Sea affordance surface for Blackhill Wood (0%), indicating a complete absence of sea views in the immediate vicinity of the site.

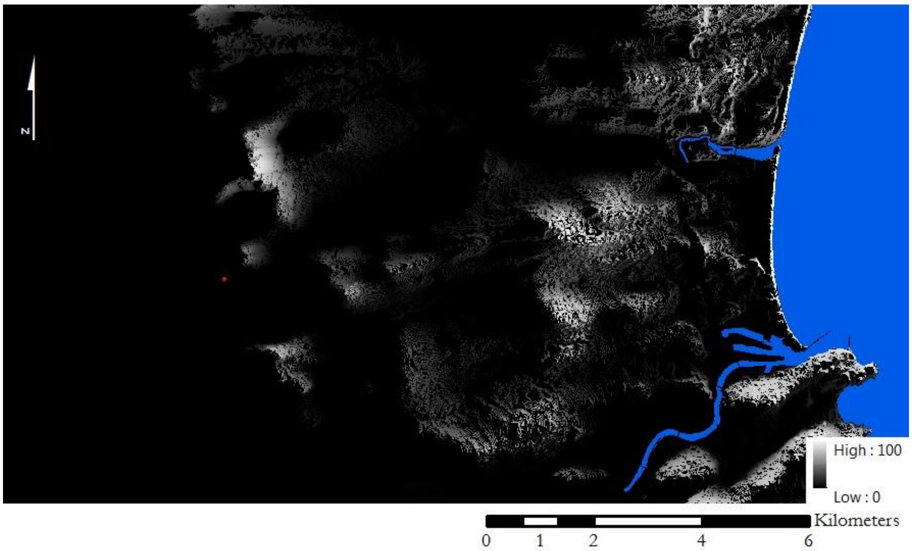


Figure 8.467: Sea affordance surface for Longcairn, indicating available sea views in the immediate vicinity of the site.

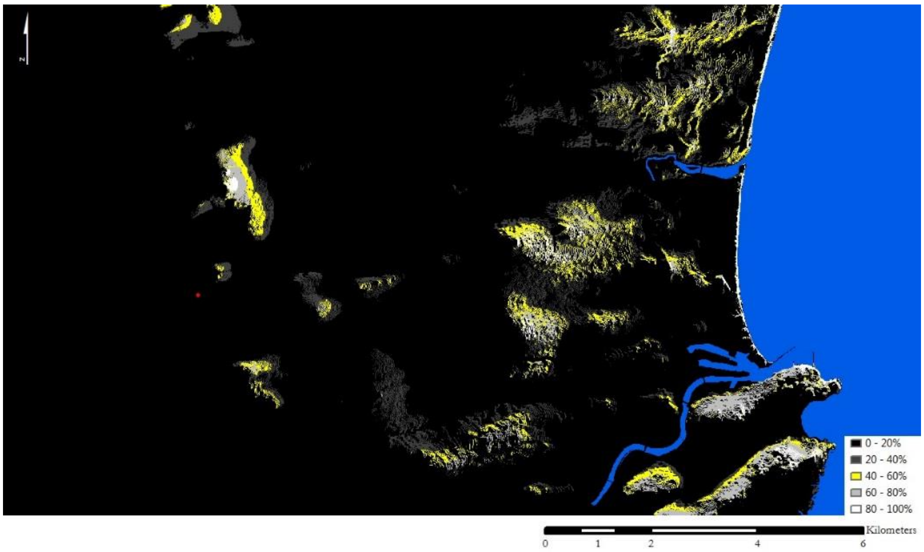


Figure 8.478: Sea affordance surface for Longcairn displaying the high sea affordance zones in the immediate vicinity of the site.
Areas that offers sea affordances ranging from 40-60% are highlighted in yellow.

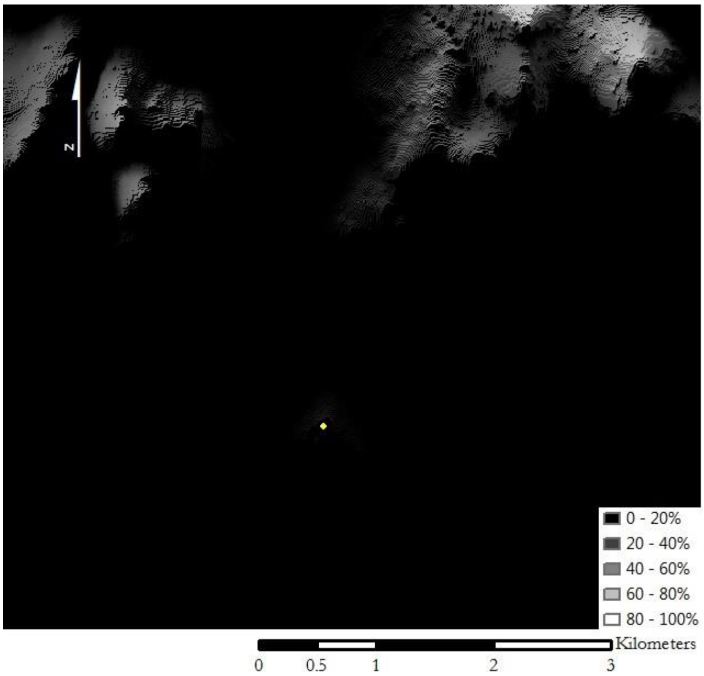


Figure 8.489: Sea affordance surface for Hill of Foulzie indicating a lack of sea views in the immediate vicinity of the site.

Statistical Considerations

Due to the anomalous result of the sea affordance analysis in the case of Hillhead Plantation, that site was excluded from the statistical analysis. Eight sites remained to be considered in the study area. A chi-square significant test was used to determine whether the remaining eight long cairns were placed in locations that have higher or lower sea affordance values than could expected from a random distribution in the landscape. As was the case with other regions, first, a 500m radius around each site was tested. Due to the nature of the sea affordance percentages found in the landscape of Aberdeenshire, the data were reclassified into only two percentage categories: 0–10 and 10–100%. As can be seen from Table 8.2, where the results are summarized, the test yielded a chi-square value of 13.3 and a p-value of 0.004. Given that the standard probability distribution function resulted in a p-value of less than 0.05, the test does suggest that there is a statistically significant difference between the site locations and what could be expected from a random distribution.

	Label (% categories)	Observed	Expected	Chi-Square Values
Aberdeenshire	1 (0-10)	3	6	1.041666667
	2 (10-100)	5	1	12.25
				13.29166667
			p-value =	**0.004046495**

Table 8.10: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results suggest significant differences between the observed values (site locations) and expected values (random locations).

This finding does not necessarily mean that sea affordance was a significant factor at every single site, but rather that when all eight sites are considered as a collective, there is an indication that prehistoric people may have deliberately selected specific locations to construct these megalithic cairns. There is, however, some question regarding the validity of these results, given that the small number of sites taken into consideration can only provide such indications with a relatively low level of confidence. Therefore, it was deemed necessary and desirable to analyse each site location on a case by case basis to determine the extent to which the views they offer are unique in their surrounding landscapes. In doing so, it was possible to more meaningfully address the question of whether such views are abundant in sites' immediate vicinities or whether prehistoric builders may have achieved them with relative difficulty.

Sea affordance surfaces were reclassified into the following percentage categories: 10–20, 20–40, 40–60 and 60–100. As described in the preceding chapters, pixels counts were then taken for the total areas falling within each category, within a 500m buffer of each site. Those counts were then used to determine the percentage of the total tested land area in each category. The results of this investigation are summarized in Table 8.3.

Sea Affordance % Categories	Hill of Foulzie	Stirling Cairn	Longman Hill	Cairn Catto	Longcairn	Blackhill Wood	Bruxie Hill	Gourdon
1 - (0-10)	98	43.7	40.7	**100**	**99.5**	**100**	62.2	30.9
2 - (10-20)	**2**	25.1	37.9	0	0.3	0	20.9	8.8
3 - (20-40)	0	16	**20.5**	0	0.2	0	**16.9**	**14.5**
4 - (40-60)	0	**10.5**	1	0	0	0	0	10.9
5 - (60-100)	0	4.8	0	0	0	0	0	34.9

Table 8.3: The percentage of the total tested land area (0.8 km^2, or a 500m radius) which falls into each of the sea affordance categories. Percentages in bold indicate the categories into which the sites fall in each case.

The results show that four of the eight sites were placed in topographic locations that were unique in comparison to their immediate surrounding areas. In these instances, only a small fraction of those areas offered similar sea affordances to those seen at the site locations. At Stirling Cairn, the sea affordance is 57.5%, falling in the 40–60% category. Table 8.3 shows that a large percentage of the immediately surrounding area offers very low levels of sea affordance: 68.8% of the area offers sea affordances that range between 0–20% while only 4.8% of the land offers higher sea affordances than that of the site location. A similar observation is made at Longman Hill. A large fraction, or 78.6%, of the area immediately surrounding the site appears to lie at the lowest end of the sea affordance spectrum (the 0–20% sea affordance category) while only 1% falls in the higher (40–60%) sea affordance range. At Bruxie Hill, the sea affordance value is 26.5% while a substantial proportion of the tested area falls in the lowest sea affordance category of 0–10%. Finally, at Hill of Foulzie, 98% of the tested area falls into the lowest category of sea affordance spectrum. Only 2% of the immediate area has sea views in the same category as that of the site. These results suggest that there is both a distinct possibility and a reasonable probability that prehistoric people may have actively sought topographic locations that were unique, in terms of sea views, for the placement of their monuments.

With a sea affordance value of 28.9%, Gourdon falls in the mid-range sea affordance category of 20–40%. Its surrounding landscape is heterogeneously distributed among the various sea affordance categories, with the site's immediate vicinity being divided equally between the lowest and highest ends of the sea affordance spectrum; 30.9% of the tested area falls in the 0–10% sea affordance category while 34.9% of the tested area falls the highest sea affordance category of 60–100%. Despite the sea views from Gourdon being the most impressive out of the sites in this region, as seen in the following section, these values do not indicate that prehistoric people intentionally sought out that location; although it is nevertheless possible that they did. In the cases of Cairn Catto and Blackhill Wood, both of the tested areas (0.8 km^2) fell into the lowest sea affordance percentage category of 0–10%. This result was also found for Longcairn, with the exception of nominal levels of higher sea affordances being detected in other percentage categories.

In order to verify these and the above findings, the 500m buffer of land tested around each site was increased to 1500m. Table 8.4 shows how the sea affordances are distributed across the landscape within this larger radius around sites. As can be seen, the observed results are stable, despite the change in area under consideration.

Sea Affordance % Categories	Hill of Foulzie	Stirling Cairn	Longman Hill	Cairn Catto	Longcairn	Blackhill Wood	Bruxie Hill	Gourdon
1 (0-10)	99.78	90.75	68.86	**98.13**	**97.29**	**100.00**	91.30	36.00
2 (10-20)	**0.22**	4.39	13.52	1.35	1.58	0.00	5.26	7.28
3 (20-40)	0.00	3.45	**13.78**	0.53	1.00	0.00	**3.45**	**17.03**
4 (40-60)	0.00	**1.10**	2.50	0.00	0.13	0.00	0.00	16.70
5 (60-100)	0.00	0.30	1.33	0.00	0.00	0.00	0.00	22.98

Table 8.4: The percentage of the total tested land area (7.1 km^2 or 1.5km radius) which falls into each of the sea affordance categories. Percentages in bold indicate the categories into which the sites fall in each case.

8.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones

In this section and the next, sites are considered on an individual and qualitative basis to determine whether and how they reference the bodies of water they sit beside. As in previous chapters, sites and their surrounds are examined on the assumption that prehistoric builders held a preference for incorporating sea views. Alternative candidates for site placement were selected, each one affording noticeably greater sea affordance values when compared with where monuments were placed. It is determined on the basis of elevation and proximity to cairn sites whether those locations may have been viable alternatives and, therefore, whether cairn sites were the best available for monument placement, in terms of sea views and such practical considerations. This process involves examining Horizon panoramas of site locations and alternative locations to determine what kinds of sea views are available and whether those views are accurately represented by sea affordance values.

Initial Analysis of Sites with Horizon Panoramas

Horizon panoramas were generated for each of the 18 long cairns in Aberdeenshire. These reveal that sea views are not available from any of the nine sites excluded from the sea affordance analysis (see Figures 8.20 and 8.21). The Horizon panoramas confirm the findings of the sea affordance analyses for eight of the nine remaining sites; Hillhead Plantation was the single exception, and was addressed in the preceding section. The results show that six of those sites (including Hillhead Planation) offer sea views (see Figure 8.22). These sites and the approximate ranges of their sea views are as follows: Gourdon 43.5–219.5º, Stirling Cairn 301–60º, Bruxie Hill 37–162.5º, Longman Hill 288–15º, Hill of Foulzie 300.5–14º and Hillhead Plantation, which offers segmented views (between 59–75º, 81.5–83.5º, 92–100º, 112–125º, 128–166.5º and 169–180.5º).

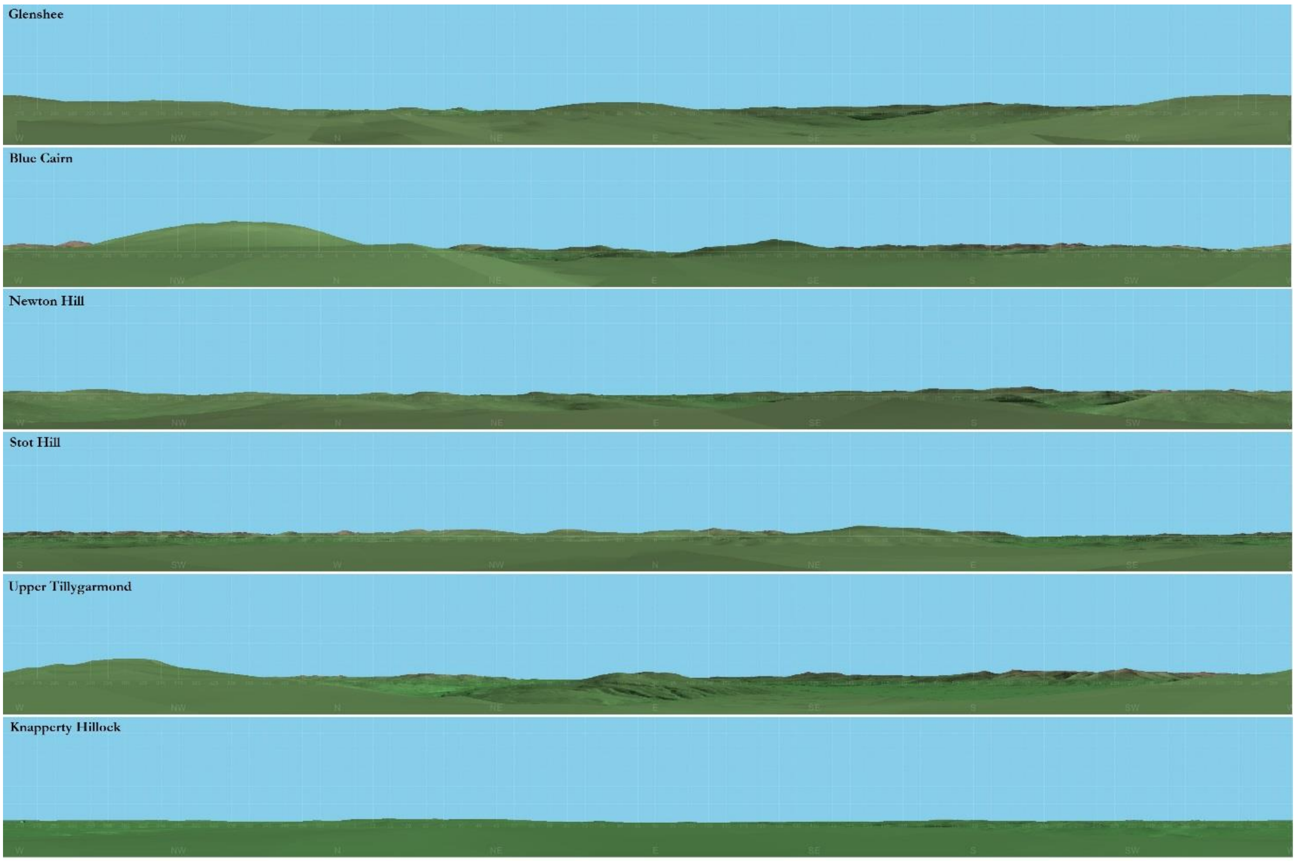


Figure 8.20: The Horizon profiles of Glenshee, Blue Cairn, Newton Hill, Stot Hill, Upper Tillygarmond and Knapperty Hillock, which show no visible sea in the distant horizon. These are six of the nine sites excluded from the sea affordance analysis.

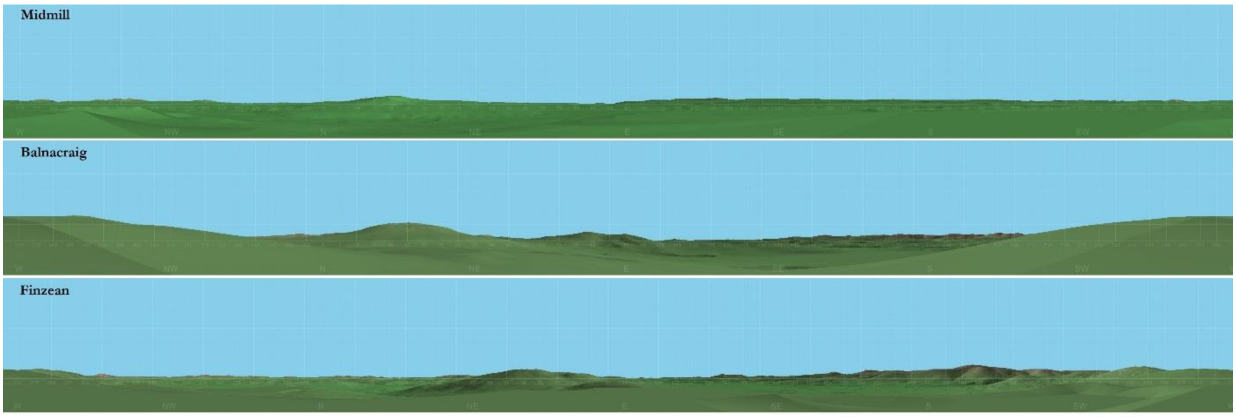


Figure 8.21: The Horizon profiles of the remaining sites excluded from the sea affordance analysis: Midmill, Balnacraig and Finzean. The profiles indicate that no sea views are available from these sites.

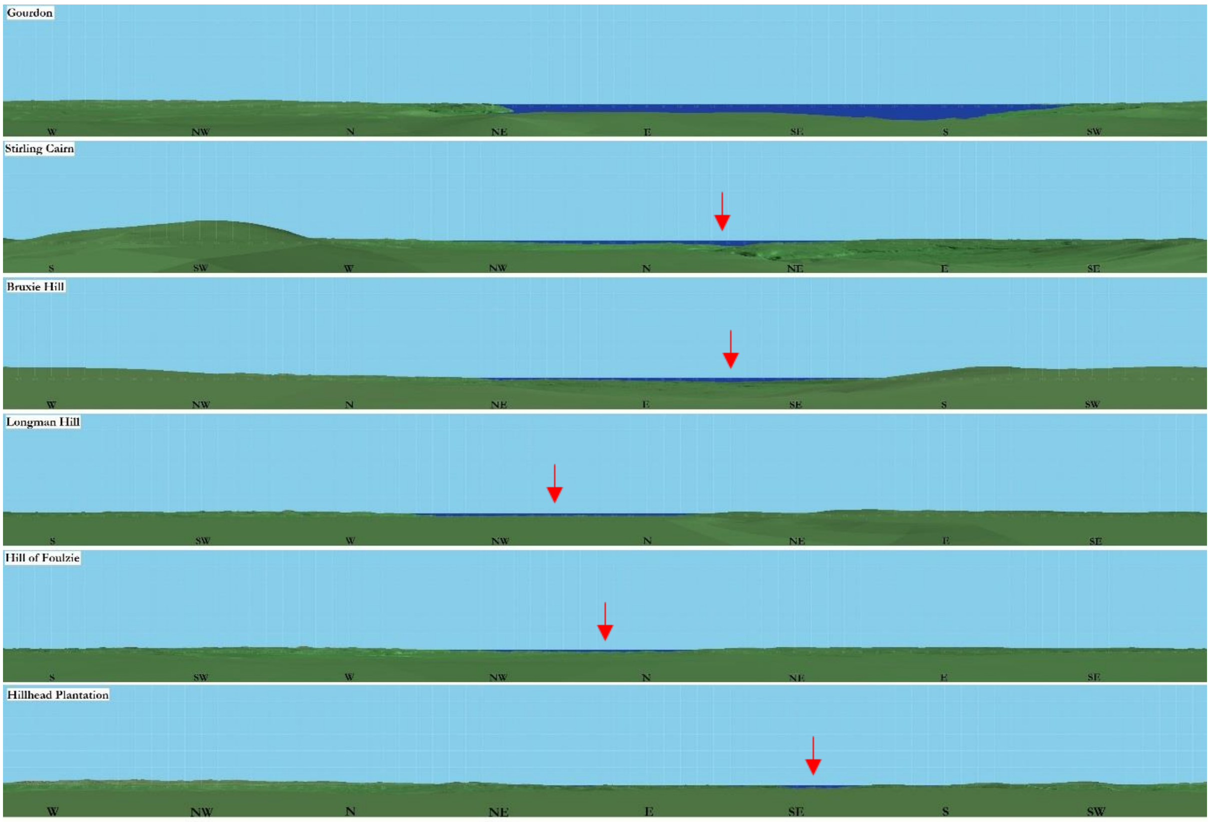


Figure 8.22: Horizon panoramas of Gourdon, Stirling Cairn, Bruxie Hill, Longman Hill, Hill of Foulzie and Hillhead Plantation showing expansive views of the sea.

Despite a majority of these sea views having ranges that expand across the horizon, they lack significance or prominence in three of the six cases, appearing only as slivers of sea in the distance (see Figure 8.22 for panoramas for Longman Hill, Hill of Foulzie and Hillhead Plantation). As will be explored below, there is some question as to whether such views would be visible when the effects of vegetation and poor atmospheric conditions are accounted for. At Hillhead Plantation, for instance, the sea views are expansive, yet they are also faint and nearly unnoticeable.

It may be impossible to see them with the naked eye except for the relatively narrow strip of sea that is not partially obscured by the surrounding hilly terrain. That area of visible sea ranges from approximately 128–166.5º, which is considerably narrower when compared with the sea views observed from other site locations (see Figures 8.23 and 8.24 below for photographs taken during field survey).

Figure 8.23: Panoramas of Hillhead Plantation taken during field visit.
The red arrow indicates the narrow view of the sea ranging from 128–166.5º.

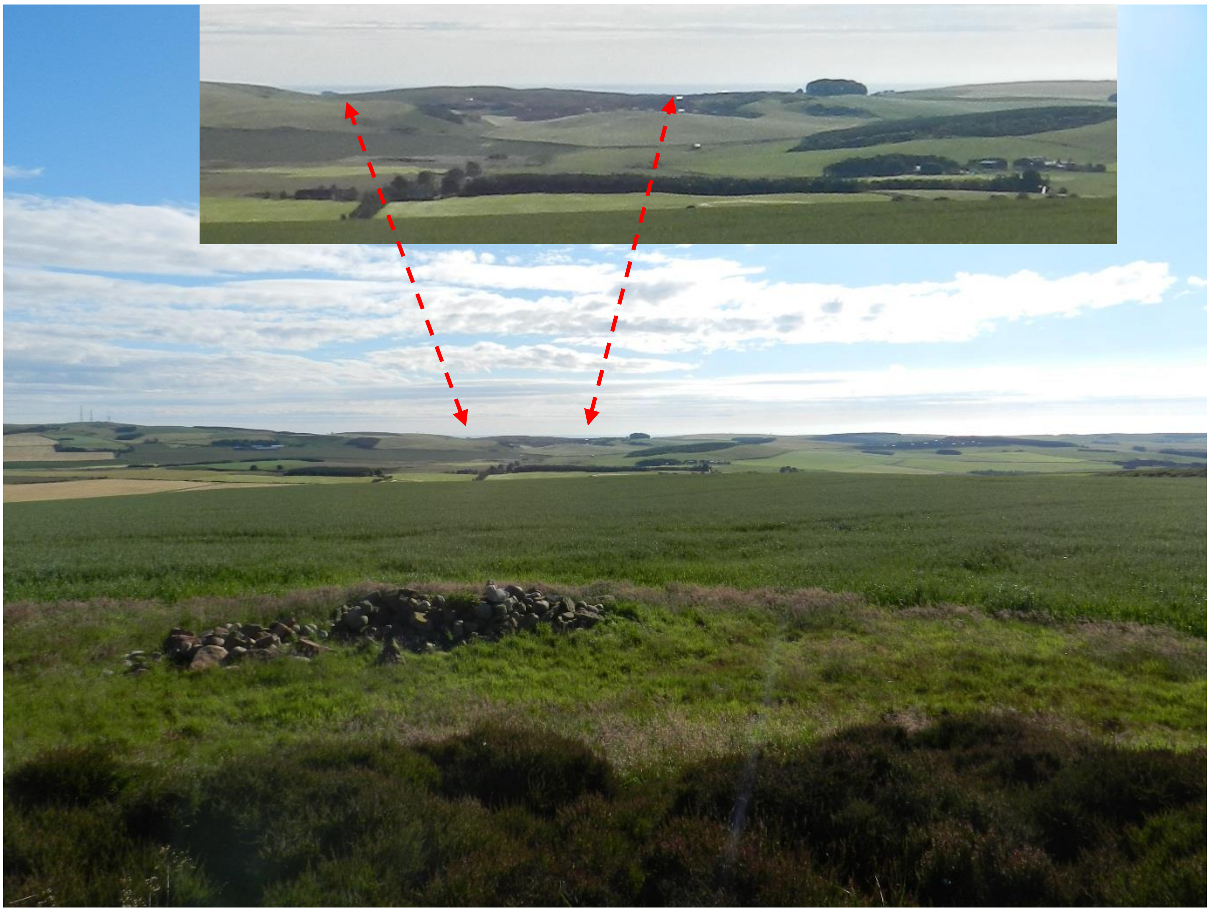


Figure 8.24: Hillhead Plantation, photograph taken during field visit.
Red arrows indicate parts of the sea that are visible in the distant horizon. Insert image: zoomed into the image to show the visible sea more clearly.

The Horizon panoramas for Stirling Cairn and Gourdon reveal more substantial sea views. Those views are not, however, proportionately represented by the sea affordance analysis, which yielded a values of 57.5% for Stirling Cairn and 28.9% for Gourdon. On the basis of those values alone it might, for example, be expected that the sea views from Stirling Cairn are more prominent than those available from Gourdon. Yet, as seen in Figures 8.25 and 8.26, a comparison of the Horizon panoramas reveals that this is not the case. There are two reasons for this discrepancy. The first is the different distances of each site from the coastline: Gourdon is situated just a few hundred meters from the shoreline while Stirling Cairn lies around 2.7km away. The same amount of sea area at the same distance from the shore will, therefore, appear as smaller from Stirling Cairn than it does from Gourdon, since Stirling Cairn lies at a greater distance from the shore. The second reason for this discrepancy arises from the methodological limitation of the 3km buffer of sea area that is used to generate the sea affordance surfaces. A standard viewshed reveals two pieces of information: first, much of the sea area that is visible from Gourdon lies outside the 3km buffer; and second, only a small amount of the sea area that is inside the buffer is also visible from that location. This is contrasted with the output of a standard viewshed from Stirling Cairn, which clearly shows that much of the sea area inside the 3km is visible from that location. Hence, despite how their sea views appear to the observer, the sea affordance value found at Stirling Cairn, as derived from the amount of visible sea area from inside the 3km buffer, is higher than the sea affordance value found at Gourdon.

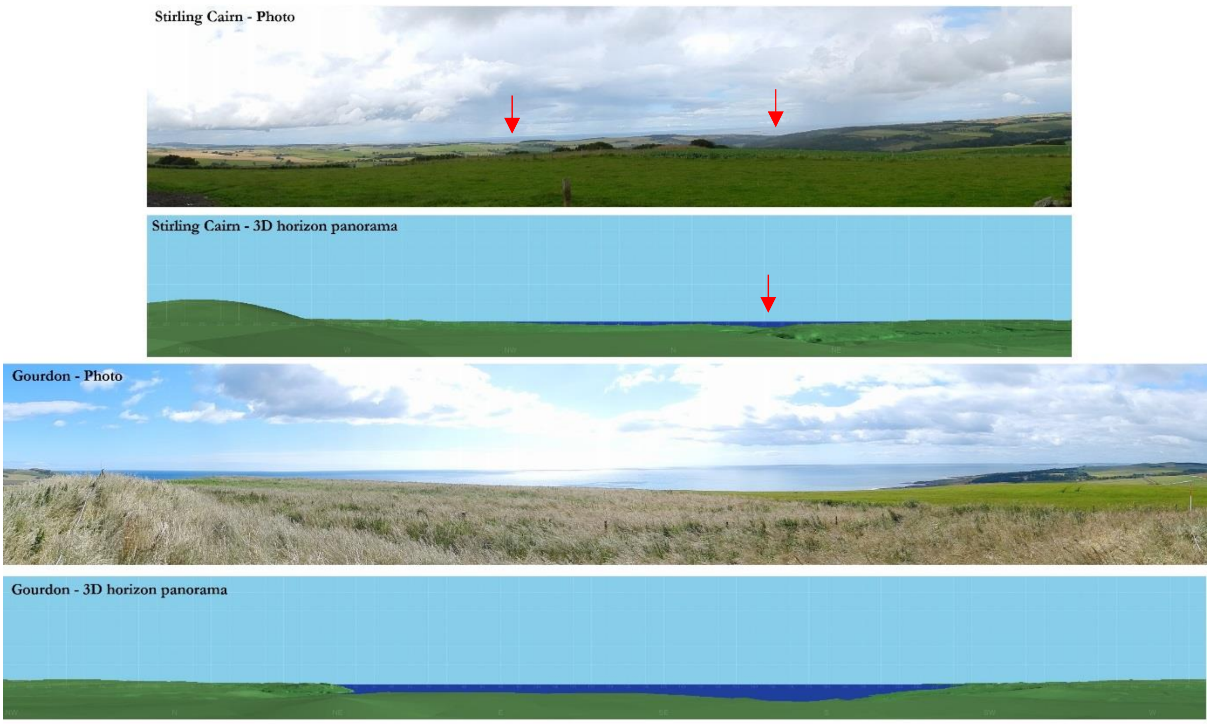


Figure 8.25: Sea views from the sites of Stirling Cairn and Gourdon.
For comparative purposes, both the Horizon panoramas as well as the photos taken from each of the site locations are shown above. As can be seen from both, sea views are more prominent at Gourdon.

Figure 8.26: Sea views from the sites of Stirling Cairn (above) and Gourdon (below).
Photographs taken during field visits. At Gourdon, sea views appear closer to the observer, as the site located just 528m away from the nearest coastline, whereas sea views at Stirling Cairn appear to be further away.

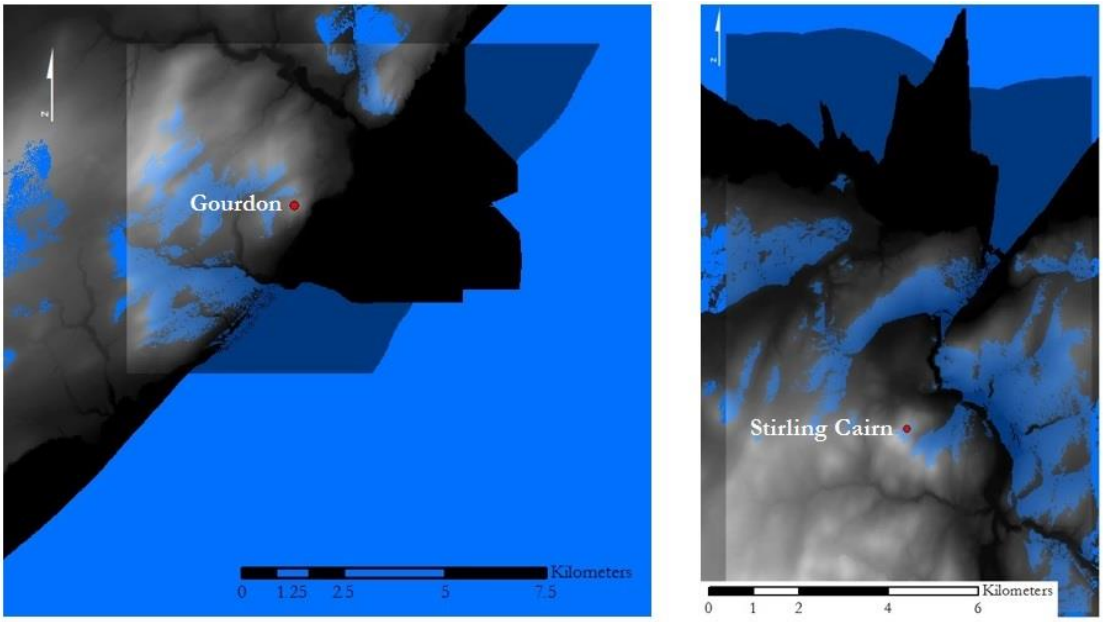


Figure 8.27: Superimposed viewshed and the DEM with the 3km buffer out to sea at Gourdon and Stirling Cairn. The dark blue areas represent the parts of the sea which were visible and that were captured by the buffer used to define the tested area.

Effects of Atmospheric Conditions on Sea Views from Cairn Sites

As seen from the Horizon panoramas above, at a majority of the site locations sea views appear only as slivers across the distant horizon. Such faint views are particularly vulnerable to atmospheric deterioration. Therefore, further Horizon panoramas were generated in order to model the impact of atmospheric conditions. As with previous chapters, this enabled determinations to be made regarding the minimum level of visibility required for sea views to be available at each location. Results are shown in Figures 8.28 and 8.29.

The Horizon panoramas reveal that from Bruxie Hill, some of the sea views between E and SE appear in approximately 5km of visibility, but a minimum of 8km visibility is required before views in the NE direction will be apparent. Similarly, at Stirling cairn, sea views begin to appear with approximately 3km visibility but the full range of sea views are only revealed when visibility reaches at least 6km. At Hillhead Plantation, sea views become evident in a minimum of 8km of visibility but only in the small expanse that ranges from approximately 130.5–151º. The full ranges of sea views that might be available from this location only appear when there is at least 30km of visibility. Hence, under usual conditions there are no sea views from approximately 59–75º, 81.5–83.5º, 92–100º, 112–125º and 169–180.5º (see Figure 8.29). At Hill of Foulzie, sea views appear across the horizon when there is approximately 8km of visibility (see Figure 8.28). At Longman Hill, with even 20km of visibility, sea views are barely noticeable and even then only a very small patch of water to the north is visible. Moreover, there needs to be 35km of visibility for the entire range of sea views to appear, which expand from approximately 288–15º (see Figure 8.28). Even then, however, it is questionable whether those areas of sea would be visible to the naked eye from Longman Hill, which is especially doubtful when the impacts of vegetation are also taken into consideration. The site of Gourdon presents an exception in these regards. Sea views from that location not only spread out across the horizon but also have depth, making them visually prominent, and even with poor visibility, sea views remain salient (see Figure 8.28).

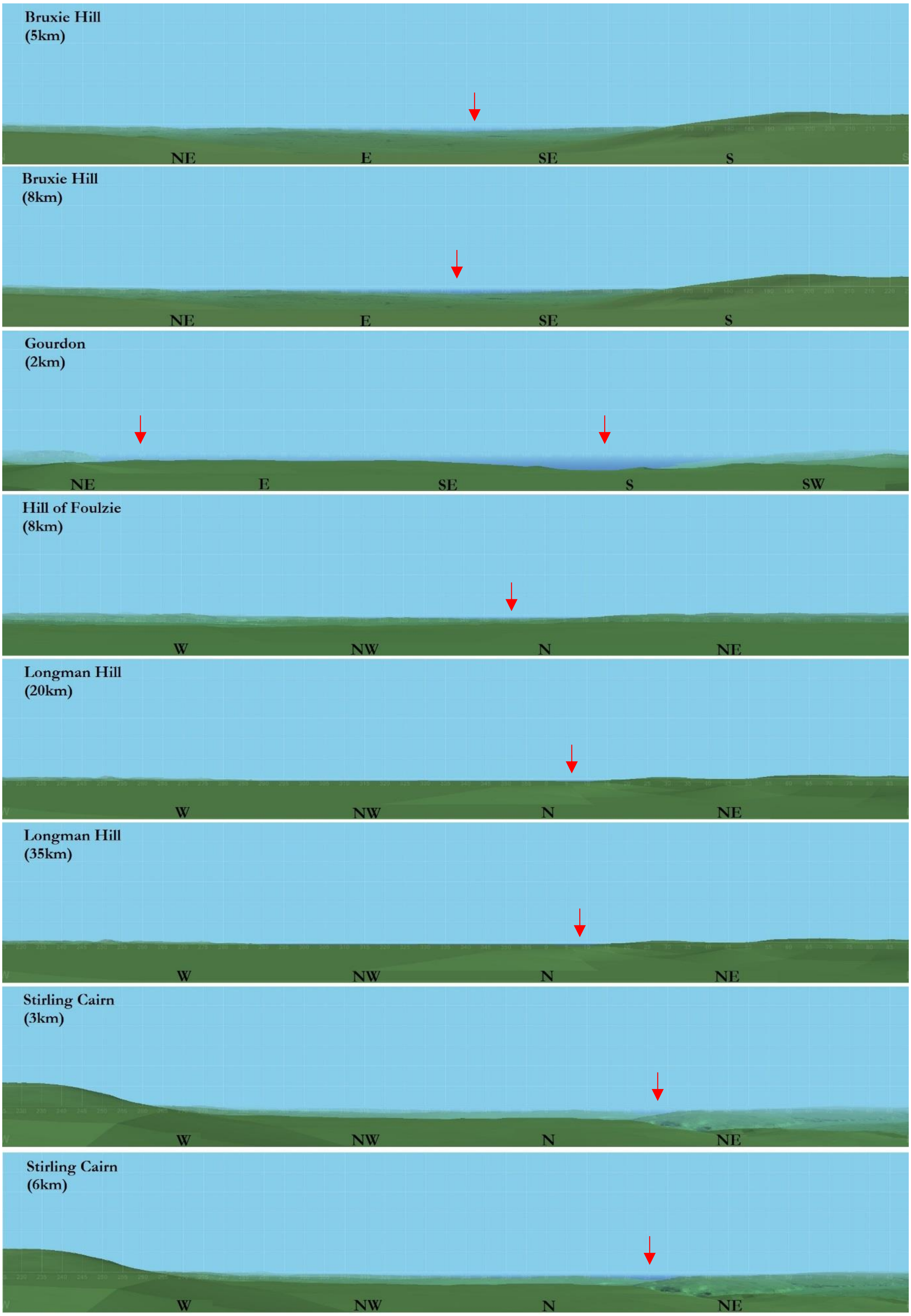


Figure 8.28: Horizon panoramas of Bruxie Hill, Gourdon, Hill of Foulzie, Longman Hill and Stirling Cairn showing the effects of atmospheric conditions.

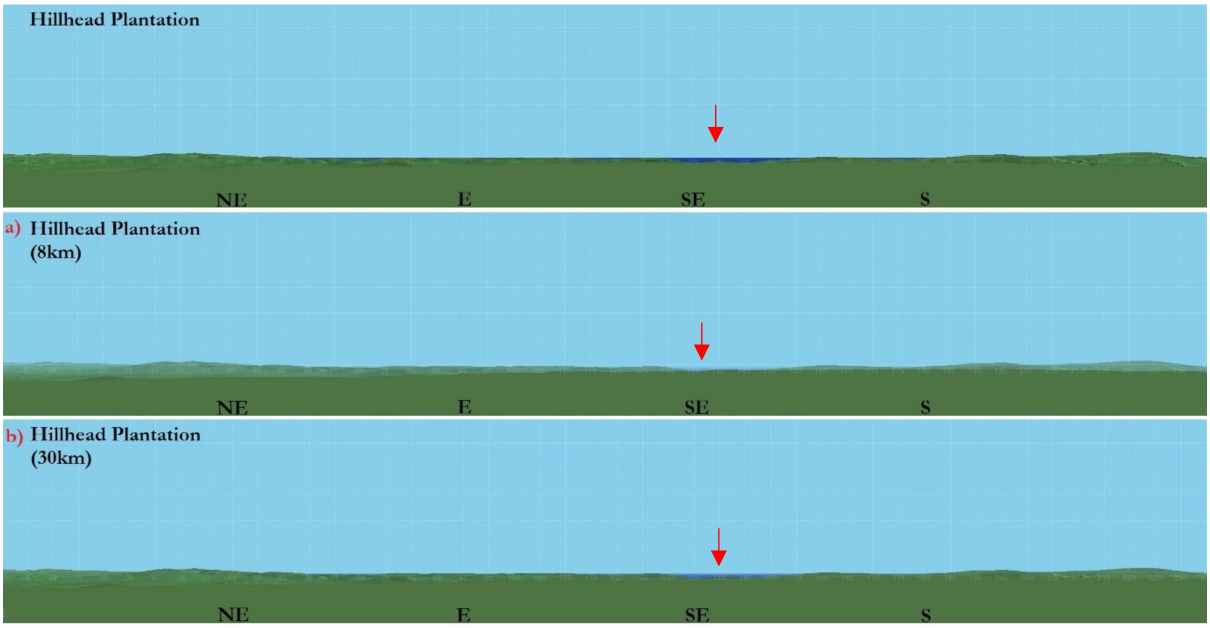


Figure 8.29: Horizon panoramas of Hillhead Plantation showing the effects of atmospheric conditions.

Investigation of Alternative Locations that offer Higher Sea Affordance Values

As discussed above, the long cairns of Aberdeenshire offer a varied range of sea views, many of which are insubstantial. Despite this finding, it may still be possible that the prehistoric people of this region had a preference for incorporating sea views, whether or not such a preference was always fulfilled. To provide grounds for either confirming or denying this notion, the areas surrounding these cairn sites were assessed to determine whether there are better locations in terms of sea views within the sites' vicinities. Thus, potential 'alternative locations' were selected on the basis of their sea affordance values and were examined to determine whether they may have presented as suitable locations for site placement.

An investigation of the sea affordance surfaces reveals that some of the sites discussed above are placed in locations that have substantially greater sea affordances nearby (see Table 8.5, below). Some specific locations that afford noticeably greater sea views were selected and compared with where the monuments were ultimately placed. However, consideration of those locations reveals that not all may have been viable options. In some instances, they are placed at substantial distances from their corresponding cairn sites and are also situated at much higher elevations. At Blackhill Wood, for instance, the cairn site is placed in a topographic location that affords 0% sea affordance. As mentioned in the previous section, the immediate area surrounding this site also offers zero sea views. The nearest sea views are 2.2km away, and they are only available from a much higher elevation than that of the site (see Figure 8.31). Similar examples are seen at Longman Hill Location B, Longcairn Location B and Cairn Catto Location A (see Figures 8.32 and 8.33).

Longcairn Location A and Stirling Cairn Location A present different cases. These alternative locations are each found in extreme proximity to their corresponding cairn sites but are situated at much higher elevations: Stirling Cairn Location A is situated 88m higher than Stirling Cairn, and Longcairn Location A is 47m higher in elevation than Longcairn (see Table 8.5 and Figure 8.34). The same pattern is observed at Bruxie Hill Location A, but the converse scenario is apparent at Bruxie Hill Location B, which is at a much lower elevation than Bruxie Hill but is placed much further away, at approximately 1km from the cairn site. In these instances, the evidence suggests that distance from otherwise desired locations and problems of accessibility associated with higher elevations may have been countervailing factors that prevented prehistoric people from selecting the respective alternative locations with higher sea affordance values.

Not all of the alternative locations identified posed these problems. The most notable cases are Gourdon Location A, Longman Hill Location A and Hill of Foulzie Location A. Gourdon Location A is situated just 156m away from its corresponding cairn site (Gourdon) in an ESE direction. The sea affordance is significantly higher, reaching a value of 98.9%, almost three-and-half times the value found at Gourdon (see Figures 8.30). This alternative location is situated at 13m lower in elevation than the cairn site, and is only a very short distance from where the monument sits. A similar observation is made at Longman Hill Location A, which is located only a very short distance of 217m away from the corresponding cairn site of Longman Hill, in a NW direction (see Figures 8.31). This alternative location has a significantly higher sea affordance value of 41.7%, which is double that of the cairn site (20.2%); the elevation is also lower, by 9m. At Hill of Foulzie Location A, situated just 25m from the corresponding cairn site in a northerly direction, the sea affordance reaches 15.5%, which is an increase in affordance of 5%. In each of these three cases (Gourdon Location A, Longman Hill Location A and Hill of Foulzie Location A) the alternative locations offer better sea affordance values, have elevations that are comparable to, if not lower than, the corresponding cairn locations, and are located in extreme proximity to those cairn sites. In terms of these factors, it is arguable that these high sea affordance locations may have presented ideal areas for monument placement if their builders intended to incorporate sea views. However, as has been seen thus far, sea affordance values can only be used as a guide or proxy for sea views and do not always provide an accurate representation. The views from these locations will, therefore, be examined further through the aid of Horizon panoramas to determine whether offer greater sea views than the sites they correspond to.

Site Name	Site elevation (m)	Nearby high sea affordance locations	Elevation at this new location (m)	Distance away from the site (m)	Directionality of this location	Sea Affordance (%)
Longcairn	152	Location A	199	524	NE	44.77
	152	Location B	183	2200	ESE	66.50
Gourdon	136	Location A	123	156	ESE	98.9
Hill of Foulzie	132	Location A	132	25	N	15.5
Stirling Cairn	86	Location A	174	282	SW	73.61
Longman Hill	146	Location A	137	216.89	NW	41.66
	146	Location B	157	1530	NE	71.01
Blackhill Wood	105	Location A	223	2155	NNE	7.40
Bruxie Hill	198	Location A	215	366	SSW	36.18
	198	Location B	137	3400	SE	48.61
Cairn Catto	82	Location A	110	997	ENE	28.56

Table 8.5: Comparison of available sea affordances between site locations and their immediate surroundings.

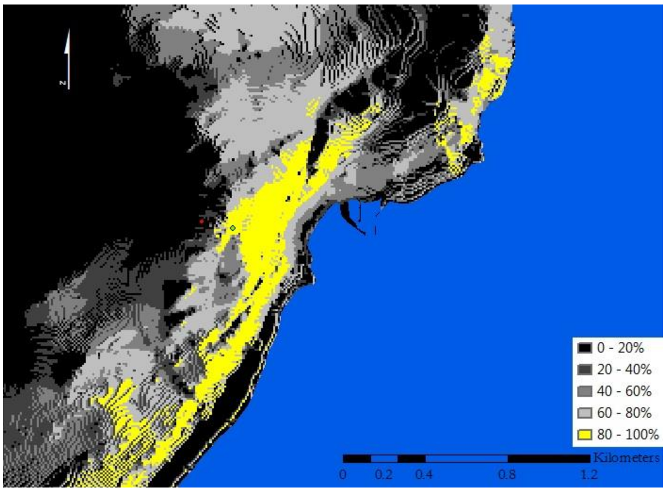


Figure 8.30: Sea affordance surface for Gourdon (28.92%) displaying the high sea affordance zones in the immediate vicinity of the site.

Figure 8.31: Sea affordance surfaces for Blackhill Wood (0%), displaying the high sea affordance zones in the immediate vicinity of the site.

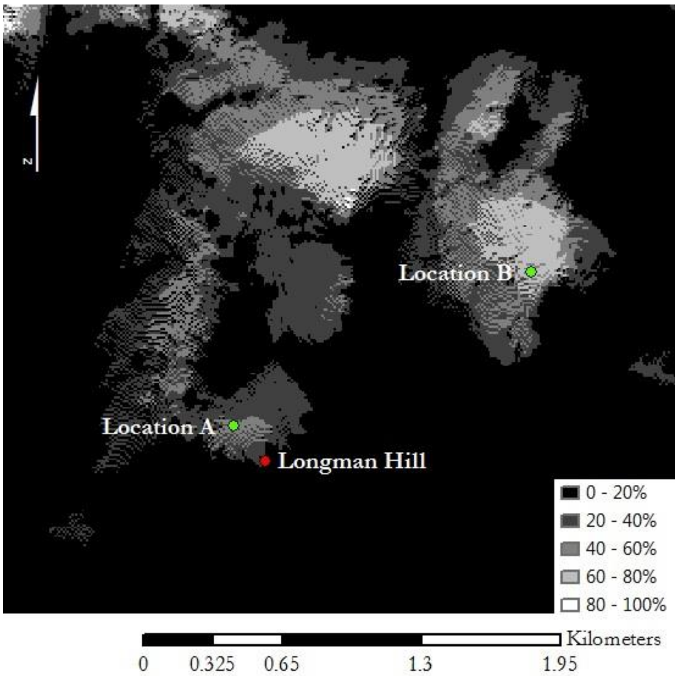


Figure 8.32: Sea affordance surfaces for Longman Hill (20.23%), displaying the high sea affordance zones in the immediate vicinity of the site.

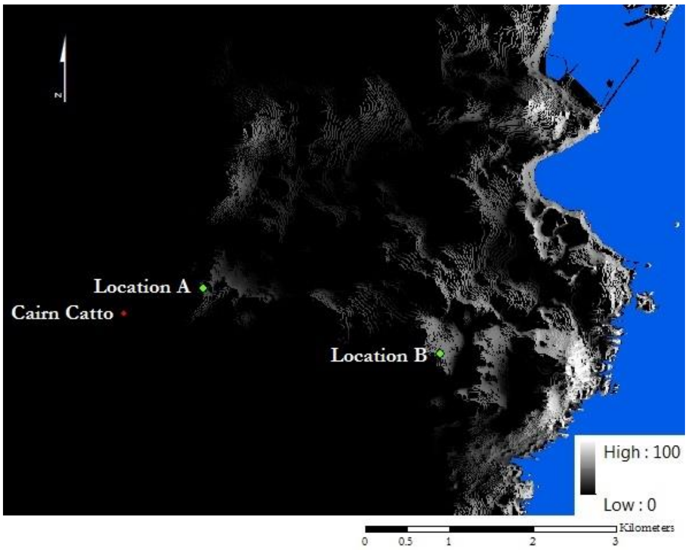


Figure 8.33: Sea affordance surfaces for Cairn Catto (0%), displaying the high sea affordance zones in the immediate vicinity of the site.

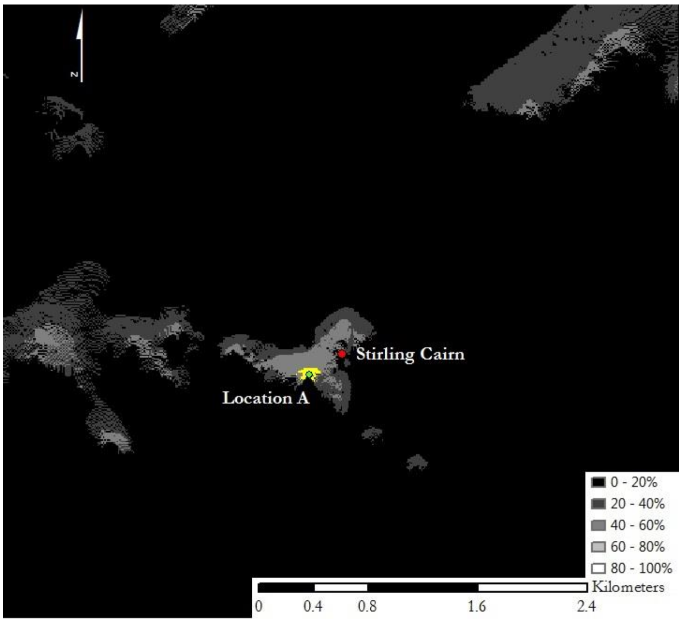


Figure 8.34: Sea affordance surfaces for Stirling Cairn (57.50%), displaying the high sea affordance zones in the immediate vicinity of the site.

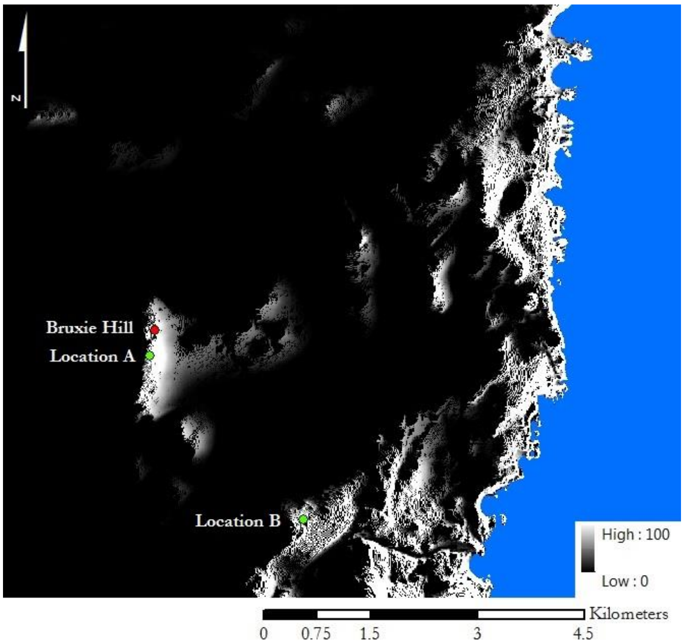


Figure 8.35: Sea affordance surfaces for Bruxie Hill (26.52%), displaying the high sea affordance zones in the immediate vicinity of the site.

Investigation of Alternative Locations using Horizon Panoramas

To shed light on the significance of the high sea affordance zones identified above, Horizon panoramas were generated so that the sea views they offer could be compared to the views from the corresponding cairn sites. This investigation was carried out for alternative locations in all high sea affordance zones that are situated at elevations and distances that were considered not too much higher or far from the corresponding site locations. It was not possible to identify any alternative location in the vicinity of Hillhead Plantation that held sea affordance values over 0%. Outputs of Horizon panoramas for site locations and alternative locations are shown below, in Figure 8.36.

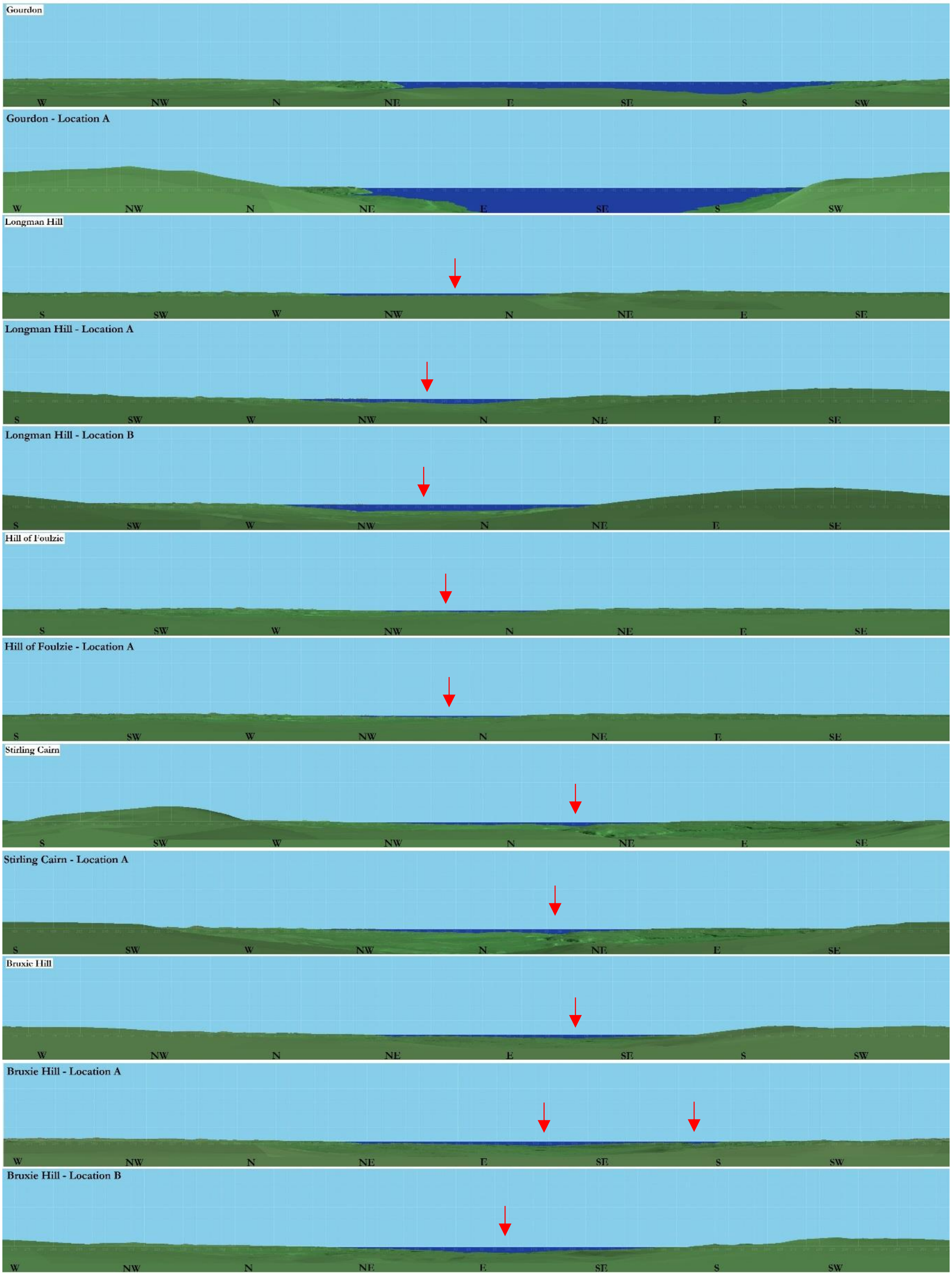


Figure 8.36: Horizon panoramas of Gourdon, Longman Hill, Hill of Foulzie, Stirling Cairn and Bruxie Hill as well as the high sea affordance zones nearby to these sites, identified in Table 8.5.
The red arrows indicate sea views. Note that some alternative locations are included here that are not discussed in the text as they are situated at either great distances from or significantly higher elevations than the cairn sites that they correspond to.

The results show that, at Gourdon, sea views span from approximately 43.5–219.5º and at Gourdon Location A, sea views span from approximately 39–214º. While these views are largely equivalent in terms of their ranges, the sea views from Location A – which achieve a sea affordance value of 98.9% – appear as more prominent and as occupying a substantially greater space in the observer's visual field, due to its extreme proximity to the coast. This alternative location may, therefore, have been ideal for site placement, that is, if prehistoric people intended to achieve a striking backdrop of the seascape.

As noted above, Longman Hill holds a sea affordance value of 20.2%, and the Horizon panorama for that location shows sea views expanding as a thin sliver across the horizon, from approximately 288–15º. However, a few of the surrounding areas offer substantially greater sea affordance values, such as Longman Hill Location A which reaches 41.7%. The Horizon panoramas confirm that this sea affordance value accurately represents the sea views in this case as proportionately greater than what is offered at the cairn site. The sea views from Location A span a comparable range, from approximately 287.5–19º, but occupy a significantly larger area of the observer's visual field. Therefore, at only 217m away and situated at a much lower elevation, alternative Location A may have been better suited for the placement of this cairn.

As described earlier, Bruxie Hill has a sea affordance of 26.5% with sea views spanning from approximately 37–162.5º, and taking up a relatively small space in the observer's visual field largely due to the site's 5.2km distance from the nearest coastline. Alternative location A has a sea affordance values of 36.2%. The Horizon panorama for Location A shows that sea views expand across the horizon from approximately 34.7–196º, with hills in the distance concealing a small area of sea, between 182–190.5º. Therefore, sea views from this location span further across the horizon than those from the cairn site, but also appear to be segmented. However, it should be noted that those areas of higher sea affordance at and around Location A cover only a very small percentage of the site's immediate surroundings. It is, then, possible that any patches of land with better sea views than those of the site may have been difficult for prehistoric people to locate. As the cairn site may, therefore, represent of an example of sea views being reasonably optimized, it arguably presents an example prehistoric builders' referencing the sea with monument placement.

The sea affordance value of Hill of Foulzie is 10.5%. Sea views from that site appear as a sliver across the horizon, spanning from approximately 300.5–14º. The sea affordance analysis yielded a value of 15.5% for the alternative location, A. Despite this increase in sea affordance, the Horizon panorama for that location shows sea views spanning an almost identical range, from approximately 300–14.5º, and occupying the same space in the observer's visual field. With comparable elevations and being only a short distance from each other, either location appears to be ideal for the placement of the cairn.

Stirling Cairn has a sea affordance value of 57.5%. The Horizon panorama for that site shows that sea views from there only appear as a sliver across the horizon, although they span for some distance, from approximately 301–60º. The alternative location, A, has a higher sea affordance value of 73.6%. The sea views it offers are comparable to the cairn site's, expanding from approximately 296.5–63.5º, and occupying slightly more area in the observer's visual field. Despite the increase in sea affordance values, these differences between locations are marginal and may not have been discernible. Therefore, as is the case above for Hill of Foulzie, either location may have been equally suitable.

The evidence, therefore, seems to suggest that while Gourdon Location A and Longman Hill Location A presented ideal locations for the placement of cairn sites in terms of achieving sea views, the remaining alternative locations held comparable sea views with those of their corresponding cairn sites and did not present better landscape choices in that regard. In those instances, whether or not prehistoric people chose the existing cairn sites or alternative locations, it appears that there would have been no overall and discernible differences to the aesthetic outcomes they achieved.

Considering the Effect of Atmospheric Conditions

The sea views available from the alternative locations considered above are re-examined here with Horizon panoramas to assess the effects of atmospheric deterioration on the sea views they offer (see Figures 8.37). The re-generated panoramas reveal that, for a vast majority of these alternative sites, much shorter distances of atmospheric clarity are required for sea views to appear when compared with the corresponding cairn sites. For instance, as seen above (in Figure 8.28), the Horizon panoramas for Longman Hill reveal that a minimum of 20km visibility is required before sea views will appear. However, for sea views to appear from Longman Hill Location A a mere distance of approximately 3km visibility is required, and even under such conditions the views it offers are more prominent than those observed from the cairn site. Similarly, Horizon panoramas for Bruxie Hill Location A reveal that sea views begin to appear at approximately 4km, with the full range of sea views across the horizon being visible with approximately 6km of clear visibility. However, there needs to be a minimum 8km of clear visibility for the sea views to appear at Bruxie Hill. At Gourdon Location A, sea views are prominent even during extremely poor weather conditions; with only 1km of clear visibility sea views still occupy a significant area in the observer's visual field. Sea views are not quite as prominent from Gourdon, however, where a minimum of 2km visibility is required before they appear. These findings show that sea views were consistently clear and, thus, more prominent at the alternative locations. If incorporating sea views were an integral part of choosing topographic locations at which to place these megalithic constructions, purely based on the evidence here, it is arguable that these alternative locations were better suited for cairn placement. The only two exceptions are Hill of Foulzie and Stirling Cairn. In those cases, the observed differences with the corresponding cairn sites are marginal at best. For instance, at Hill of Foulzie Location A, sea views are barely noticeable, even with 8km of atmospheric clarity. This is also the case at Hill of Foulzie. A similar observation is made at Stirling Cairn, such that the sea views available from both the cairn site and the alternative locations are comparable even under deteriorated atmospheric conditions.

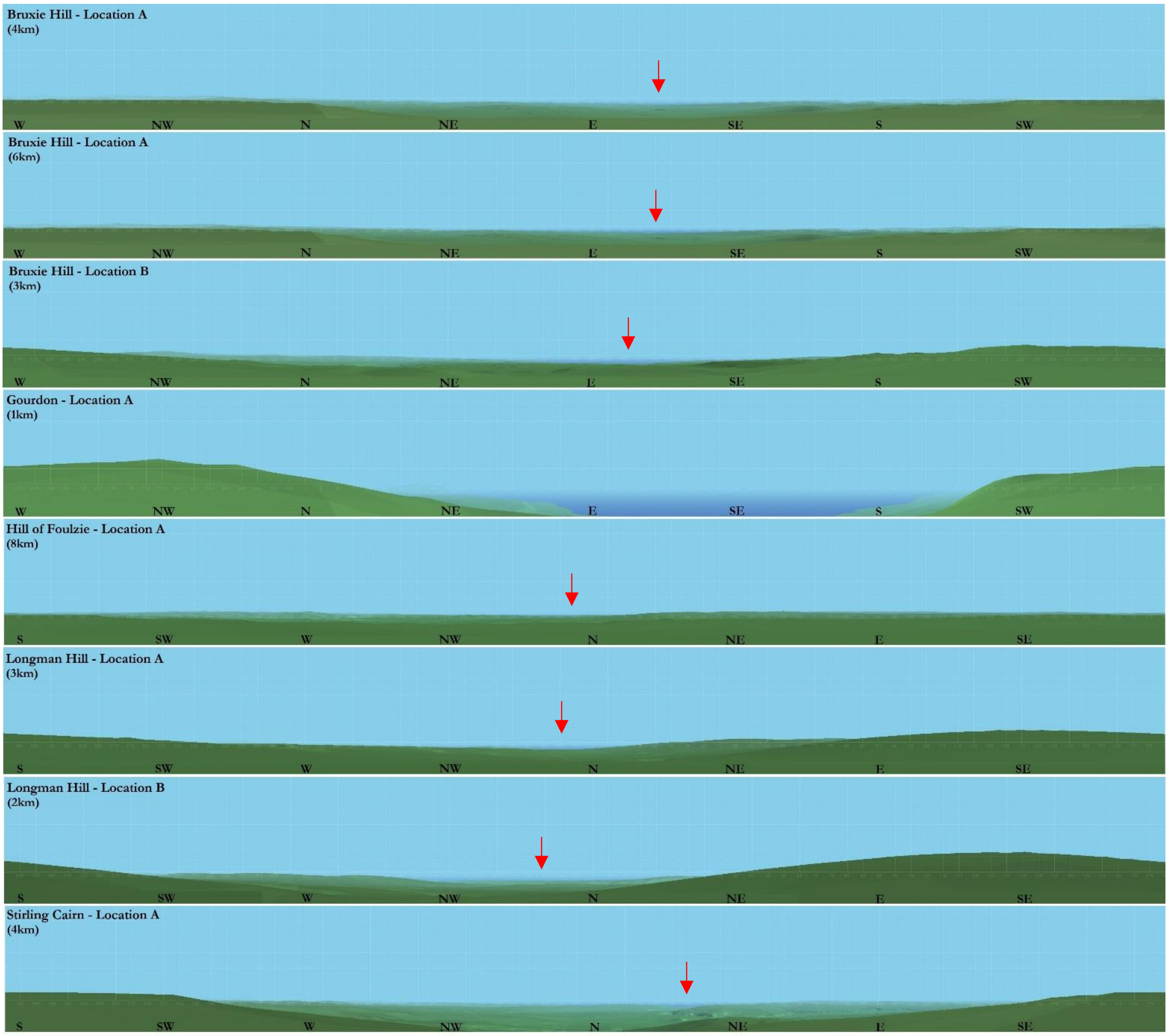


Figure 8.37: Horizon panoramas displaying the effects of atmospheric conditions on the sea views available from Bruxie Hill location A, Bruxie Hill Location B, Gourdon location A, Hill of Foulzie Location A, Longman Hill location A, Longman location B and Stirling Cairn location A.

Note that some alternative locations are included here that are not discussed in the text as they are situated at either great distances from or significantly higher elevations than the cairn sites that they correspond to.

8.3 Testing for Revelatory Views

Using travel corridors in conjunction with the sea affordance surfaces, sea affordance profiles were drawn for each of the nine sites considered in the region of Aberdeenshire. Twenty pathways were initially identified as having the potential to offer revelatory views, in that they approach cairn sites from a seaward direction. An examination of those profiles indicates that only 13 pathways offer revelatory views upon arrival at the site and that, out of the 9 sites considered, these are restricted to 5 of the 6 sites that offer sea views (see Table 8.6 and Figure 8.38, below). These pathways are categorized into three overlapping types, as defined by the differing degrees that the final view of the sea is hidden and then revealed. Pathways can, then, offer: first, sudden and dramatic revelatory views of the sea; second, gradually revealed views; and third, 'previews' of the sea leading up to the final view that is available at the cairn site.

Based on the above categorization, Paths 1 and 2 to Bruxie Hill offer a dramatic reveal with a sudden uptick in the sea affordance profile in the final stages of approach to the site. In both cases, sea views are completely obscured from the viewer until the viewer is approximately 150m from reaching the site, at which point there is a dramatic increase in sea affordance, reaching a value of 26.5% at the location of the site. Path 3, on the other hand, seems to provide numerous 'previews' of sea along most of length of the journey that ranges from approximately 1110m to 420m, with one preview, at 460m, reaching as high as 36%. Thereafter, sea affordance drops dramatically to 0%, and stays almost unchanged until 170m from the site where it gradually increases, reaching a value of 26.5% upon arrival.

Path 1 to Longman Hill can also be characterised as offering a dramatic and sudden revelatory view. The sea affordance starts to increase on this path at approximately 250m from the site, reaching its maximum of 20.2% upon arrival. As with the two paths mentioned above, this case also arguably provides a particularly convincing dramatic and sudden revelatory view, due to the sea views being hidden from the viewer throughout the length of the journey to the site only to be revealed around the last 200m.

The sea affordance profiles for Path 2 to Longman Hill and both paths to Hill of Foulzie (Paths 1 and 2) show more gradual increases in sea affordance. As a result, the observer is exposed to sea views for some distance before reaching the site. This is especially the case on Path 2 to Longman Hill, where, at approximately 600m from the site, sea affordance gradually starts to increase from 3.5% to reach its maximum of 20.9% at 40m. Both paths to Hill of Foulzie show a gradual increase in sea affordances, respectively starting from approximately 640m and 990m. Both

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	General Direction of all paths drawn in	Paths that offer 'revelatory' views	Sea Affordance %
1	Hill of Foulzie	132	1129.39	4520.73	Path 1 (NW); Path 2 (N)	Path 1 (NW); Path 2 (N)	10.47
2	Stirling Cairn	145	1022.38	2689.07	Path 1 (NW); Path 2 (N); Path 3 (NE)	Path 1 (NW); Path 2 (N)	57.50
3	Longman Hill	146	1391.62	2423.27	Path 1 (NNE); Path 2 (E)	Path 1 (NNE); Path 2 (E)	20.23
4	Cairn Catto	82	709.65	4934.34	Path 1 (ESE)	No	0.00
5	Longcairn	152	1087.27	8392.56	Path 1 (SE); Path 2 (E)	No	0.00
6	Blackhill Wood	105	771.01	8122.67	Path 1 (ENE)	No	0.00
7	Bruxie Hill	198	469.51	5165.99	Path 1 (SE); Path 2 (ENE); Path 3 (NE)	Path 1 (SE); Path 2 (ENE); Path 3 (NE)	26.52
8	Gourdon	136	1010.15	528.09	Path 1 (SW); Path 2 (S); Path 3 (SSE); Path 4 (ESE); Path 5 (NE)	Path 2 (S); Path 3 (SSE); Path 4 (ESE); Path 5	28.92
9	Hillhead Plantation	171	284.65	5567.64	Path 1 (SE)	No	0.00

Table 8.6: Sites and pathways offering revelatory views.

of these pathways have a sudden decrease in sea affordance at 50–60m from the site, dropping to approximately 0.9%. The profiles for these pathways then show a sudden increase in sea affordance, reaching a maximum value of 10.5% at the site location. The sea affordance profile for Path 1 may qualify as a case of a gradual revelatory view, however, it is doubtful that Path 2 is capable of achieving the same effect, given that sea views are present along the pathway for such a distance (of around 1km). A further factor that must be considered in analysing the significance of these paths to Hill of Foulzie is that the maximum sea affordance value achieved at this site is particularly low, so that increases in values upon approach to the site may be relatively trivial.

At Stirling Cairn, three paths were identified as having the potential to offer revelatory views; however, only Paths 1 and 2 offers convincing cases while Path 3 offers sea views along the entire length of the journey and, therefore, does not offer revelatory views. Both Paths 1 and 2 offer dramatic reveals, with a sudden uptick in the sea affordance value starting from, respectively, approximately 30m and 40m from the site, reaching a maximum of 57.5 % at the site. In the case of Path 1, sea views are well hidden from the observer until 290m from the site, at which point an the observer may be aware of minor sea views in comparison to those available at the site. The profile for Path 2 reveals that an observer had a sea preview before reaching the site, which starts from approximately 440m. At that point, the sea affordance values increase, reaching as high as 49.3% at the 320m point before dropping at around 230m away from the cairn site. The sea affordance values of this sea preview are comparable to the values of the final sea views that are available at the site location. In order to see if and how these views differ from each other and to determine which location might be preferable in terms of sea views, Horizon panoramas were generated for each of these locations (See Figure 8.40 for display of Location A).

The profiles for Gourdon indicate that Paths 2, 3, 4 and 5, offer revelatory views. Path 1 offers sea views along the entire length of the journey and therefore does not offer revelatory views. The sea affordance profile indicates higher sea affordances throughout most of that pathway. On the basis of the sea affordance values, Paths 2 and 5 do not present convincing cases of revelatory views to the same extent as Paths 3 and 4. In the first instance, Path 2 offers numerous sea previews that have higher sea affordance values than what are achieved at the cairn site. For instance, at 450m, sea affordance reaches as high as 71.4%, almost two-and-half times the value found at the site. There is, of course, every chance that these percentages do not translate to the same kinds of differences in terms of sea views and how they appear in an observer's visual field. For that reason, the significance of such previews has been investigated and is addressed below with the generation of Horizon panoramas. Path 5 to Gourdon also offers sea previews throughout the 1.5km journey to the site. However, the sea affordance decreases gradually from 39.2– 2.6% between 650–70m before dramatically increasing to a value of 28.9% at the cairn site. The presence of such previews may act to diminish the impact of any final reveal of the sea to persons approaching. Hence, both Paths 2 and 5 are treated here as not in the same category of convincingly sudden and dramatic revelatory views as Paths 3 and 4. In both of these cases (Paths 3 and 4), sea views are effectively concealed for the length of the respective journeys until just before reaching Gourdon—with very minor exceptions to that concealment between 850–650m from the site.

In summary, 10 of the 13 paths appear to be convincing cases of revelatory views. These are: Paths 3 and 4 to Gourdon, Paths 1 and 2 to Stirling Cairn, Path 1 to Hill of Foulzie, Paths 1 and 2 to Longman Hill and Paths 1, 2 and 3 to Bruxie Hill. The other three pathways, Paths 2 and 5 to Gourdon and Path 2 of Hill of Foulzie, are unpersuasive cases of revelatory views. In addition, further analysis of the sea affordance profiles reveals that there are no sea affordance values available anywhere along the pathways to Blackhill Wood, Longcairn and Cairn Catto (see Figure 8.40).

Figure 8.38: Sea affordance profiles of Stirling Cairn, Gourdon, Bruxie Hill, Longman Hill and Hill of Foulzie.

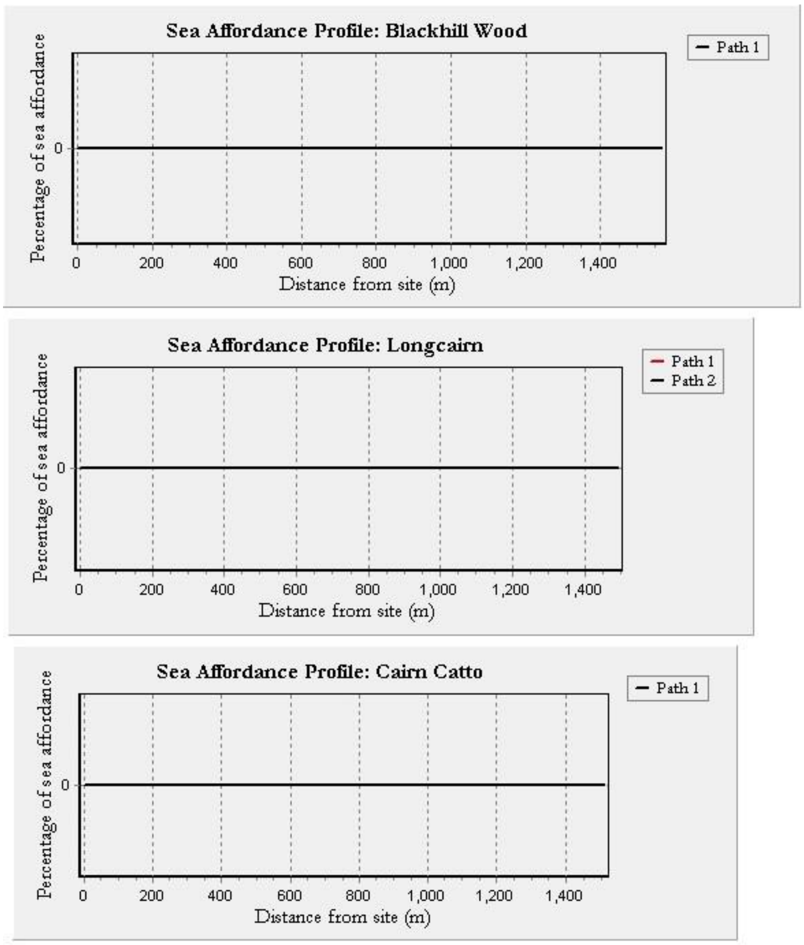


Figure 8.39: Sea affordance profiles of Blackhill Wood, Longcairn and Cairn Catto.

Investigation of Previews with Horizon Panoramas

As discussed in earlier chapters, the presence of sea previews on the paths to monuments raises several questions. Do sea previews spoil or enhance the effects of final views offered at cairn sites? Moreover, where sea previews are comparable with or superior to the sea views offered at the corresponding cairn sites, why were those preview locations not chosen instead for monument placement? These question are considered here through the use of Horizon panoramas to investigate the sea views offered at preview locations and how they compare with those offered from the corresponding cairn sites (see Figure 8.40.).

As detailed above, sea previews are offered on Path 1 to Stirling Cairn, Path 3 to Bruxie Hill and Path 2 to Gourdon. Preview locations on the respective paths to Bruxie Hill and Gourdon hold higher sea affordance values than those observed at the corresponding cairn sites. The preview location on the path to Stirling Cairn holds a comparable although slightly lower sea affordance value than that of the cairn site.

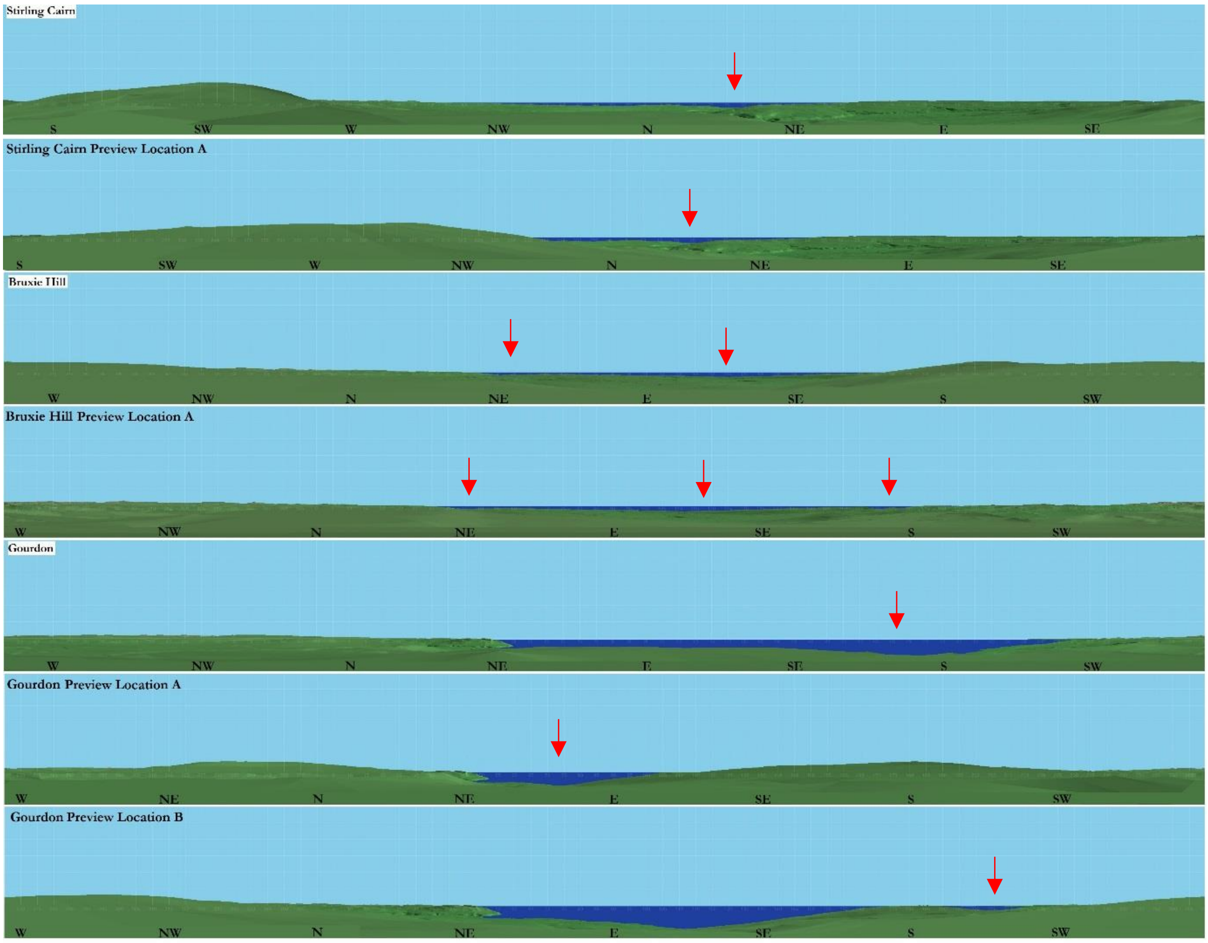


Figure 8.40: Horizon panoramas of Stirling Cairn, Bruxie Hill and Gourdon together with sea views at preview locations.
The red arrows indicate sea views.

The sea affordance profile shows that Stirling Cairn Preview Location A has a sea affordance value of 49.3%, which is a little under the value found at the cairn site. Sea views from this preview location span across the horizon from approximately 336.2–60º. From the cairn site, sea views span from approximately 301–60º. In both cases, sea views appear as slivers across the distant horizon. On examination , it appears that sea views are, then, broader from the site location; but, from the preview location, they occupy slightly more space in the observer's visual field. Nevertheless, these differences are so minute that there is some question as to whether they are at all noticeable.

At 36%, the sea affordance value of Bruxie Hill Preview Location A is significantly higher than the value of 26.5% found at the cairn site. Sea views from the preview location span across the horizon from approximately 34.7–184º, with a small patch of sea between 190–196º. These views are more expansive than those available at the cairn site, which span from approximately 37–162.5º. The sea views from the preview location also appear to be more prominent in comparison to the views observed from the cairn site, suggesting that the preview location would have been better suited in that regard.

Two key locations on Path 2 to Gourdon were identified as offering previews, therefore, two separate Horizon panoramas were generated. Preview Location A has a sea affordance of 42.2% and offers sea views that span from approximately 46–104º. Preview Location B holds a sea affordance value of 71.4%, with sea views that span from approximately 46–174º, and a further patch of sea in view between 190–216º. Neither of these sea views compare with the breadth of the views offered at Gourdon, which expand across the horizon from approximately 43.5–219.5º. However, the preview from Location B occupies a greater space in the observer's visual field than the views from the other two locations.

Considering the Effect of Atmospheric Conditions on Sea Previews

For each of these four preview locations identified above, Horizon panoramas were regenerated to examine the effects of atmospheric conditions on the available sea views. These findings are shown below in Figure 8.41.

At Bruxie Hill Preview Location A, sea views begin to appear with approximately 4km of visibility, and the entire range of sea views is revealed when visibility reaches 7km. When atmospheric conditions are taken into consideration, a comparison of the sea views from the cairn site and the preview location shows that sea views come into view marginally sooner at the preview location. Also, the sea views are visually more noticeable from there than they are from the site, even when a layer of fog hovers over the horizon. This finding suggests that the Preview Location A was more ideal for cairn placement in terms of sea views.

When atmospheric conditions are taken into consideration in comparing Stirling Cairn and Stirling Cairn Preview Location A, it appears that sea views from the latter are more reliably observable in different weather. From the regenerated Horizona panoramas, it is evident that the sea views available from both of these locations only begin to appear when there is a minimum visibility of 3km. However, at Preview Location A, the sea views are more prominent in the visual field to the extent that almost the entire expanse of available sea views appears with 5km of visibility. Yet, with 6km of visibility, it is not yet possible to see the full range of sea views from the cairn site.

The sea views from both of the Gourdon preview locations, A and B, are apparent even under very poor visibility conditions. With only 1km of visibility, sea views from both preview locations start to appear across the horizon; and, at Preview Location B, quite a substantial area of sea is visible, expanding from 50–145º. However, the smaller patch of sea views that are otherwise available from Preview Location B (from 190–216º) are obscured by atmospheric deterioration, and only appear if there is between 3–4km of clear visibility. Nevertheless, a consideration of differing atmospheric conditions suggests this preview location may have been preferable to the cairn site in terms of sea views, for their noticeability even during poor conditions.

As noted earlier, the considerations taken up here and above raise the question of why prehistoric people did not choose to construct their monuments on preview locations such as Gourdon Preview Location B, where their sea views seem to be greater. There are a number of plausible explanations. Prehistoric people may have intentionally disregarded such locations, for the sake of other qualities or attributes apparent at cairn sites; or there may have been overriding factors that deterred prehistoric builders from using the preview locations.

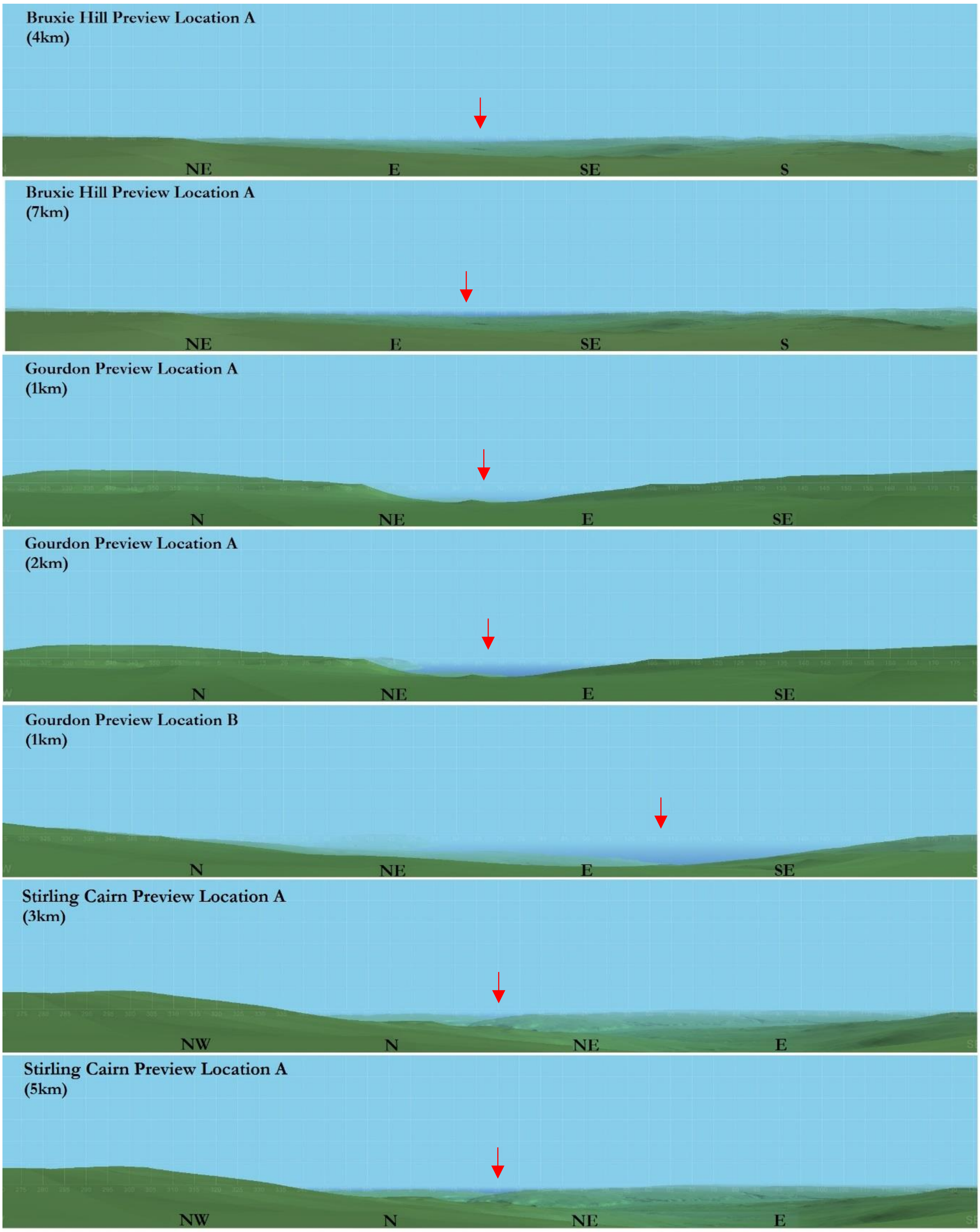


Figure 8.41: Horizon panoramas of Bruxie Hill preview Location A, Gourdon preview Location A, Gourdon preview Location B and Stirling Cairn preview Location A, displaying sea views with the effects of atmospheric conditions. Red arrows indicate where the sea views are.

8.4 Alignments of Long Cairns' Axes, Sea Views and Pathways

Orientation of Cairns Relative to Sea Views

Of the nine sites investigated in this region, the orientations of only seven could be examined, as it was not possible to acquire site plans for Blackhill Wood or Hill of Foulzie (which were destroyed by 1902 as a result of agriculture). Two further sites, Cairn Catto and Longcairn, did not offer sea views and, hence, their orientations were not relevant to this particular aspect of the study. The results show that all the remaining five sites' long axes form axis-alignments with the azimuthal direction of sea views (see Table 8.7). At Stirling Cairn, Bruxie Hill, Gourdon and Hillhead Plantation, these axis-alignments are direct, while Longman Hill holds an indirect axis-alignment. At Bruxie Hill, sea views span across the horizon from approximately NE–SSE (37–162.5º), while the cairn's long axis is oriented from ENE–WSW (77.5–257.5º). This means that the long axis coincides with the range of the sea views such that the cairn aligns with or points in the direction of those sea views. Specifically, the monument's distal end in the ENE faces the sea. Similar observations are made at Stirling Cairn and Hillhead Plantation: Stirling Cairn's distal end aligns directly with its sea views, and Hillhead Plantation's proximal end aligns directly with its sea views.

Site name	**Direction of seaward pathways**	**Direction of sea views**	**Orientation of monument long axis**	**Part of monument approached by pathway(s)**
Hill of Foulzie	Path 1 (NW) Path 2 (N)	WNW–NNE (300.5–14º)	N/A	N/A
Stirling Cairn	Path 1 (NW) Path 2 (N) Path 3 (NE)	WNW–ENE (301–60º)	S–N (170–350º)	proximal end
Longman Hill	Path 1 (NNE) Path 2 (E)	WNW–NNE (288–15º)	NNE–SSW (18.5–198.5º)	Path 1: proximal end Path 2: distal end
Cairn Catto	Path 1 (ESE)	N/A	ESE–WNW (115–295º)	distal end
Longcairn	Path 1 (SE) Path 2 (E)	N/A	ESE–WNW (105–285º)	distal end
Blackhill Wood	Path 1 (ENE)	N/A	N/A	N/A
Bruxie Hill	Path 1 (SE) Path 2 (ENE) Path 3 (NE)	NE–SSE (37–162.5º)	ENE–WSW (77.5–257.5º)	proximal end

Gourdon	Path 1 (SW) Path 2 (S) Path 3 (SSE) Path 4 (ESE) Path 5 (NE)	NE–SW (43.5–219.5º)	NE–SW (51–231º)	Path 1: proximal end Path 2: proximal end/side (uncertain) Path 3: side Path 4: distal end/side (uncertain) Path 5: distal end
Hillhead Plantation	Path 1 (SE)	ENE (59–75º) E (81.5–83.5º) E (92–100º) ESE (112–125º) ESE–SSE (128–166.5º) S (169–180.5º)	ENE–WSW (69–249º)	uncertain

Table 8.7: Long cairn, pathway and sea view orientations.

A slightly different situation is observed at Gourdon, which is placed parallel to wide sea views that span from approximately NE–SW (43.5–219.5º). While the monument's proximal end points to the NE (51º) and aligns directly with sea views, the monument's distal end is only slightly out of alignment with, or points slightly to the side of, the same panoramic stretch of sea. Nevertheless, in pointing to the SW (231º), the distal end matches the general direction of the sea views despite not forming a direct alignment with the azimuthal range of those sea views; the monument is askew by 11.5º. Also of interest is the site of Longman Hill. Its proximal end points NNE (18.5º) and is indirectly aligned with the range of sea views that span from WNW–NNE (288–15º).

All five long cairns were also found to hold side-alignments with sea views. These side-alignments were: direct at Gourdon and Hillhead Plantation; indirect at Longman Hill, being askew by 0.5º; and, general at Stirling Cairn and Bruxie Hill, which were respectively askew by 10º and 15º. Of note here is that while Longman Hill holds both an axis-alignment and a side-alignment, neither alignments are direct. Although Hillhead Plantation holds both a direct axis-alignment and a direct side-alignment, the most prominent sea views run parallel with the cairn's long axis.

Orientation of Pathways Relative to Sea Views and Monuments

Sixteen seaward paths were identified as approaching the five sites in this study region that offer sea views and for which there were available site plans for determining the orientations of cairn structures. A comparison of the orientations of these pathways with the orientations of sea views reveals that 15 of the 16 pathways form a direct line of sight with sea views. In each case, people travelling along these pathways would find the respective monuments framed against a sea backdrop upon their approach to the sites. The only exception is Path 2 to Longman Hill, where the path approaches the site in an easterly direction but sea views range across the horizon from WNW–NNE (288–15º). Therefore, in that particular instance, the path does not directly align with sea views, despite approaching seaward.

Eight of the 16 pathways, to four of the five sites, approach cairns towards their proximal ends. These are: Paths 1, 2 and 3 to Stirling Cairn; Path 1 to Longman Hill; Paths 1, 2 and 3 to Bruxie Hill; and, Path 1 to Gourdan. In three cases, the pathways approach the proximal ends from the side of the monuments, at an approximate angle of 45º to monuments' long axes. This is observed at Path 1 and 3 to Bruxie Hill and Path 1 to Stirling Cairn (see Figure 8.42). At Longman Hill, Path 1 approaches from the side of the monument towards its proximal end at an angle perpendicular to the cairn's long axis (see Figure 8.43). Path 2 to Bruxie Hill, Path 2 to Stirling Cairn, and Path 1 to Gourdan also approach monuments towards their proximal ends, however, they do so more directly and in alignment with the monuments' long axes.

Comparing the angle of approach with the orientation of monuments' long axes revealed that only two sites had paths approaching monuments towards their distal ends. This is observed at Path 2 to Longman Hill and Path 5 to Gourdon. In both instances, the paths approach the respective sites directly and in alignment with the monuments' long axes (see Figure 8.43 and 8.44). Path 3 to Gourdon approaches the monument towards its side while Paths 2 and 4 are categorized as 'uncertain' (Figure 8.44). This is because Path 2 to Gourdon could have easily been used to approach the monument towards either its proximal end or to its side, and Path 4 to Gourdon could have been used to approach the site towards either its distal end or its side.

Drawing together this information, it is apparent that at four sites alignments held between the pathways, monuments and sea views to form sightlines. Path 2 to Longman Hill and Path 5 to Gourdon align with the respective cairns' long axes to form distal–proximal sightlines with sea views in the distant horizon. Path 2 to Bruxie Hill and Path 2 to Stirling Cairn align with the respective cairns' long axes to form proximal–distal sightlines with sea views. Sideway sightlines were found at two sites, on Paths 3 and 4 to Gourdon, and Path 1 to Bruxie Hill. Path 3 to Gourdon was the only of these paths to approach a monument towards the side of its structure. Most but not all criteria were met for a sideway sightline on Path 1 to Hillhead Plantation: due to the low elevation of the path relative to the height of the monument and the hill on which it rests, the cairn body obscures sea views for observers approaching the site.

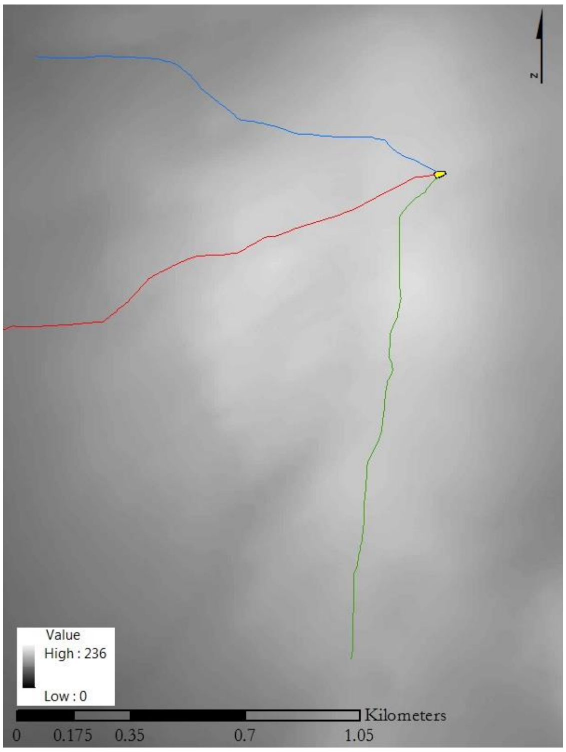


Figure 8.42: Paths 1 and 3 to Bruxie Hill. Paths 1 (blue) and 3 (green) approach at approximately 45º to the monument's long axis while Path 2 (red) approaches the proximal end in alignment with the monument's long axis.

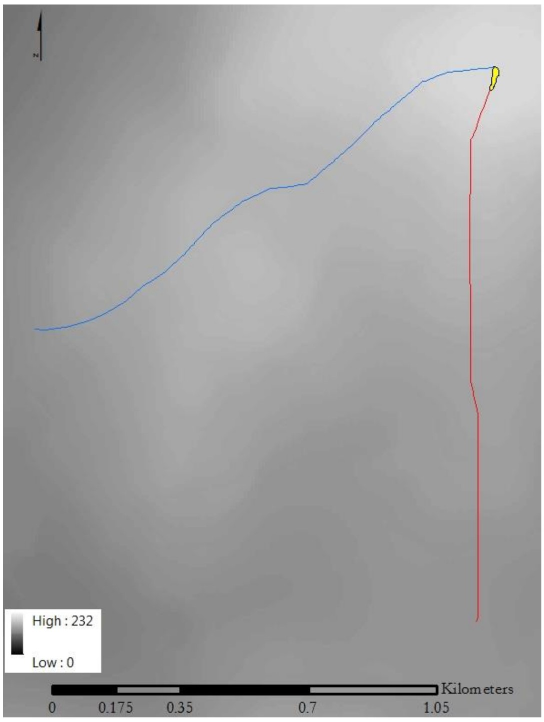


Figure 8.43: Paths 1 (blue) and 2 (red) of Longman Hill. Path 1 approaches the proximal end at approximately 90º to the monument's long axis, while Path 2 (red) approaches the distal end in alignment with the monument's long axis.

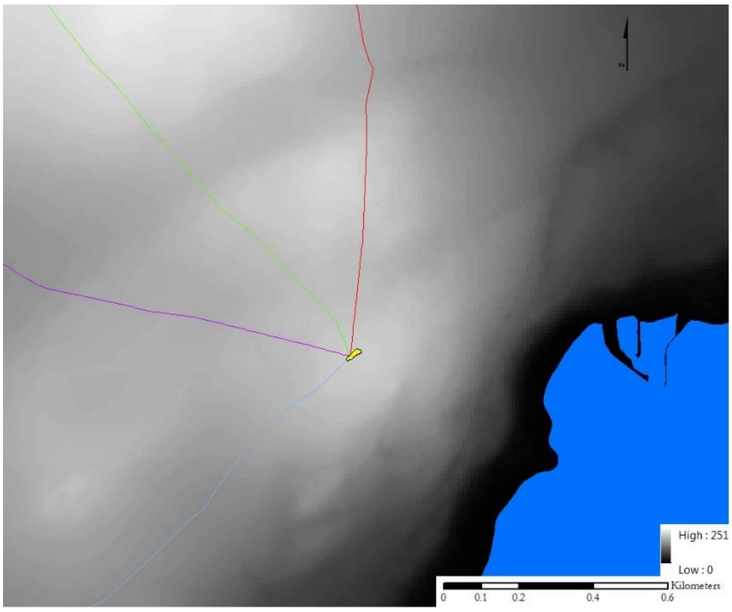


Figure 8.44: Paths 2, 3, 4 and 5 of Gourdon. Path 5 (indicated here in blue) approaches the distal end in alignment with the monument's long axis.

8.5 Summary

There was a very modest sample of long cairns placed in sufficient proximity to the sea in Aberdeenshire to be considered relevant to the study conducted here. However, the investigation of that region proved to be fruitful. Statistical considerations established that the long cairns examined are placed in locations unique for their surroundings in terms of sea views. While too much confidence cannot be placed in such results, given the small size of the sample analysed, they at least provide a positive indication that prehistoric people may have been likely to have held a preference for referencing the sea in their monument placement.

The qualitative investigation of the long cairns in this region provided further evidence to support and confirm the results of the statistical analyses. Barring a small number of exceptions, it was found that the sea views available from cairn locations—as could be modelled from Horizon panoramas—were usually the best available, or equal best, in their surrounding landscapes. To be sure, under atmospheric deterioration some alternative locations offered more robust or reliable sea vistas; however, the presence of the small number of such locations found in this region does not, on its own, establish that prehistoric builders were uninterested in sea views, even if such a possibility remains. To the contrary, the analysis of the areas surrounding Longcairn, Cairn Catto and Blackhill Wood revealed that there were no available locations with sea views anywhere in their immediate vicinities that were also at comparable elevations. Moreover, in analysing cairn sites for revelatory views, the majority of the evidence supported the notion that the prehistoric people of Aberdeenshire referenced the sea in their monument construction, when such views were available. This finding was confirmed a third time in considering the alignments of long cairn axes and the pathways that approach the monuments, together with the relative orientation of sea views, whereby four of five sites were found to demonstrate at least one form of sightline.

Chapter 9: Analysis of the Long Cairns of the Isle of Arran

The Isle of Arran, North Ayrshire, presents a unique area that holds several characteristics that are of particular interest for this study. It holds 12 long cairns in a relatively small area, most within some proximity to the coast. As they are situated within the confined area of the island, these cairns were likely to have been built by peoples belonging to a common culture, which in theory may make it more likely to identify distinct trends and traditions in their construction. Furthermore, as a relatively small island, sea views are more common on Arran than they in other regions of Scotland. Therefore, it was of interest to examine how prehistoric people related to the sea in the construction of their monuments in this area, and to determine whether any such trends could be identified. The long cairns of Arran, therefore, investigated to determine whether they reference the Firth of Clyde (sea), where the isle is situated, in any of the following three ways. First, sites were assessed in terms of their affordance of sea views, to determine whether their locations are either typical or unique in that respect in the landscapes in which they are situated. This was conducted both quantitatively, in terms of the statistical consideration of the sites as a collective as discussed in Section 1, and in terms of a qualitative consideration of their landscape contexts on a site-by-site basis, as discussed in Section 2. Second, as described in Section 3, sites were assessed to determine whether they offer 'revelatory views' of the sea, as dependent on the pathways from which these monuments were likely to have been approached and whether sea views are obscured to observers on their approach. Third, the details of sea views and revelatory views, where present at long cairn sites, were compiled and considered in Section 4, alongside the orientation of their long axes relative both to the sea and to the pathways that may have been used to approach them.

9.1 Sea Affordance Surfaces and Statistical Considerations

There are 12 long cairns in the Isle of Arran, all of which are situated less than 6km from the coast, and half are at a distance of less than 1km (for site distribution map see Figure 9.1).[46] At these relatively small distances from the sea, all sites were considered relevant to the sea affordance analysis.[47] As can be seen from the site distribution map (Figure 9.1), majority of these sites appear

[46] The site of Clachaig is described as being oval in shape, but has been included in this study since it is described by Henshal (1972) as a possible long cairn.
[47] Unless otherwise noted, all cairn sites in this chapter refer to monuments within the council area of North Ayrshire.

to be placed in isolation from one another, the only exception being the three-site cluster found in the island's southeast side, which comprises Torr an Loisgte, Giant's Graves North and Giant's Graves South. At roughly 432km², the island of Arran is sizable. Thus, given the distance of sites from each other, it was necessary to process the relevant areas in nine different micro-regions or sectors. It took 16 days (280 hours) to process all the required sea affordance viewshed maps. The percentage of sea affordance for each of the 12 sites were then extracted using the methodology described in Chapter 4, Section (see Table 9.1).

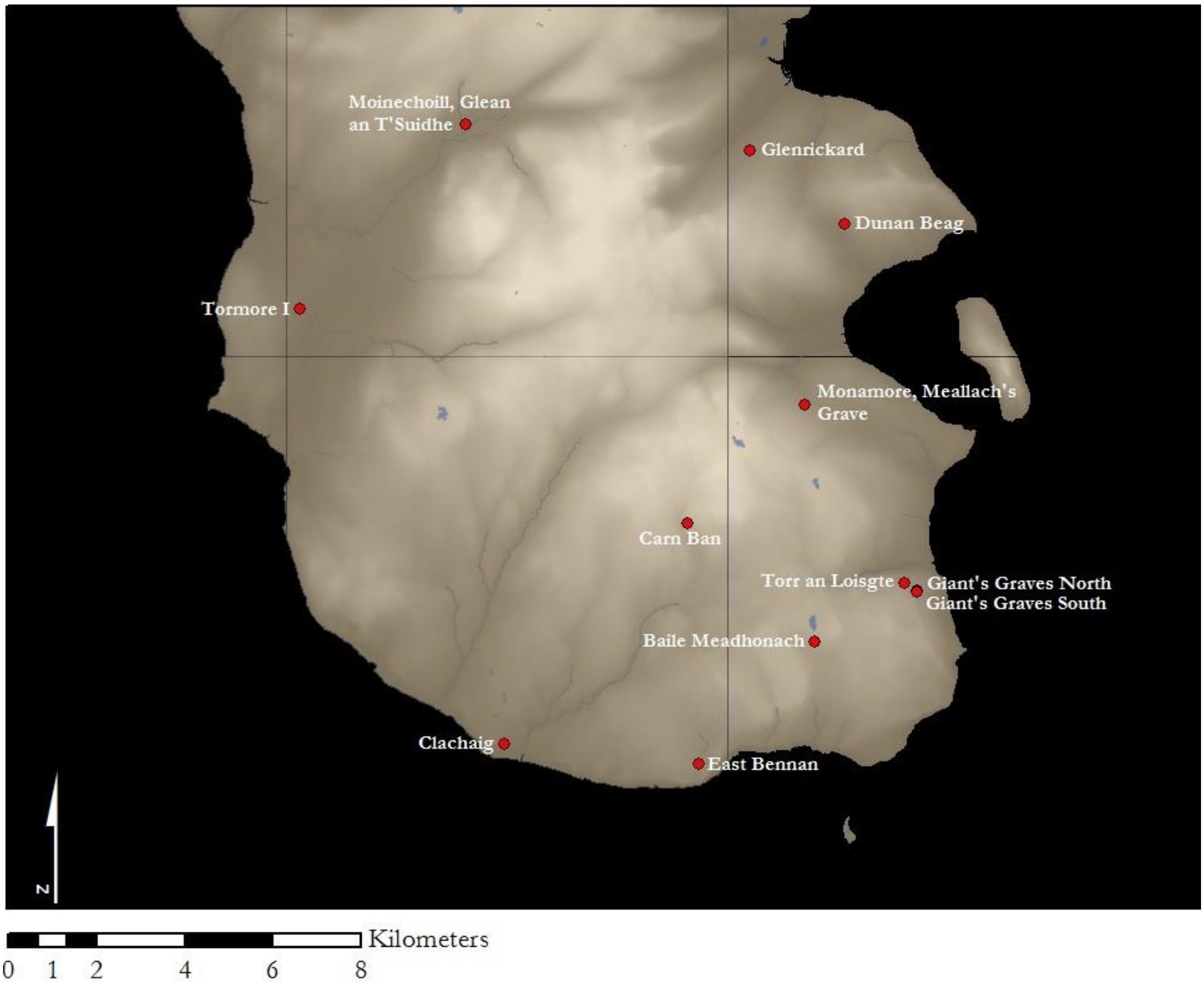


Figure 9.49: Site Distribution Map.

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	General Direction of all paths drawn in	Paths that offer 'revelatory' views	Sea Affordance %
1	Clachaig	22	468.06	295.73	Path 1 (SW); Path 2 (SSW); Path 3 (SSE)	Path 1 (SW)	68.86
2	East Bennan	93	265.67	422.43	Path 1 (S/SSE)	Path 1 (S/SSE)	11.77
3	Tormore I	31	357.09	1840.68	Path 1 (S)	No	0.00
4	Carn Ban	272	1838.19	5306.54	Path 1 (SSW)	No	2.89
5	, Glean an T'Suidhe	71	82.77	4847.99	Path 1 (SW)	No	0.00
6	Monamore, Meallach's Grave	129	888.00	1575.64	Path 1 (ESE); Path 2 (NNE)	No	5.34
7	Baile Meadhonach	213	275.15	2358.02	Path 1(SSE)	Path 1 (SSE)	27.58
8	Torr an Loisgte	144	358.59	780.17	Path 1 (E)	Path 1 (E)	31.95
9	Giant's Graves North	132	492.53	643.03	Path 1 (E)	Path 1 (E)	60.68
10	Giant's Graves South	130	474.88	655.78	Path 1 (E)	Path 1 (E)	74.25
11	Dunan Beag	102	1021.24	1331.99	Path 1 (SE); Path 2 (SSE)	Path 1; Path 2 (SSE)	8.19
12	Glenrickard	91	459.70	1696.97	Path 1 (NE)	Path 1 (NE)	6.51

Table 9.1: Results of sea affordance analysis.

Consideration of Sites and Verification of Sea Affordance Analysis

Standard viewsheds and Horizon panoramas were used to verify results in terms of whether sea affordance values accurately represent the sea views available from each of the 12 site locations. The sea affordance analysis resulted in a value of 0% for Tormore I, although a standard viewshed analysis revealed that sea views may be or are in principle available from that location; the closest area of visible sea lies at 13km from the site, and the majority of visible sea lies at a distance of

29km (see Figure 9.2). Upon inspection of the Horizon panorama for that location, it appeared that a very faint sliver of sea may be visible at the particular azimuth that sea views are shown on the standard viewshed analysis (see Figures 9.3 and 9.4). For that reason, the sea affordance viewshed was considered as unreliable in this instance, and the site and its surroundings were not considered for further analysis.

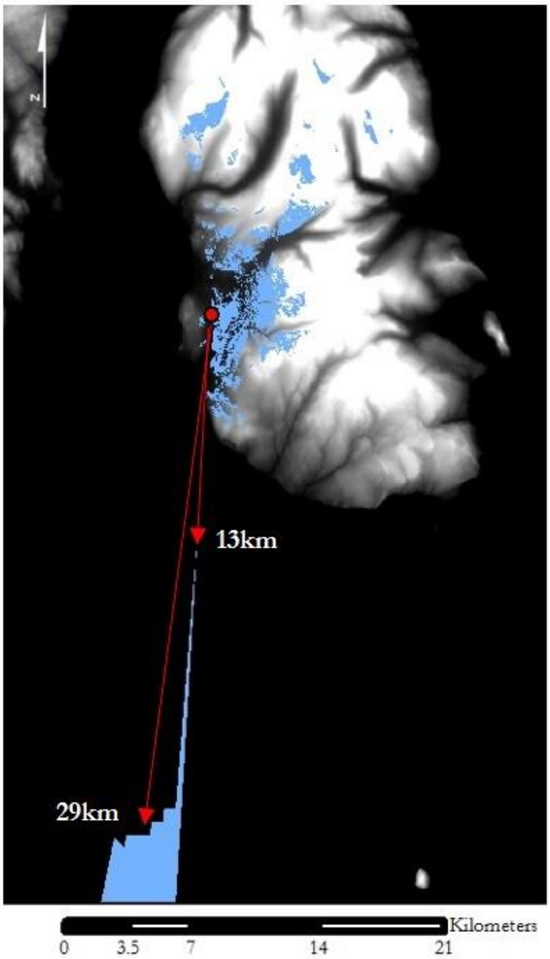


Figure 9.2: Standard viewshed displaying parts of the landscape and seascape that are visible from Tormore I.
The nearest sea views are located approximately 13km away, in a southerly direction.

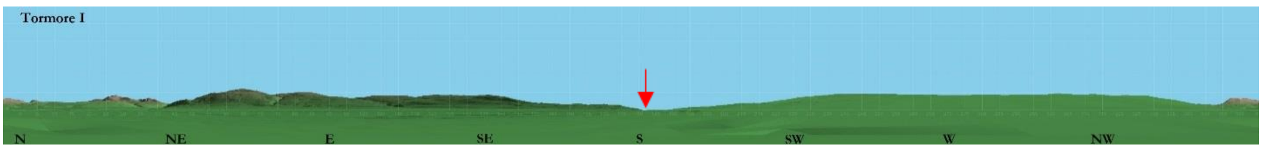


Figure 9.3: The Horizon profile of Tormore I. Sea views are, in principle, visible in the distant horizon but are not clear in this profile.
The red arrow indicates the location where this sea view may be.

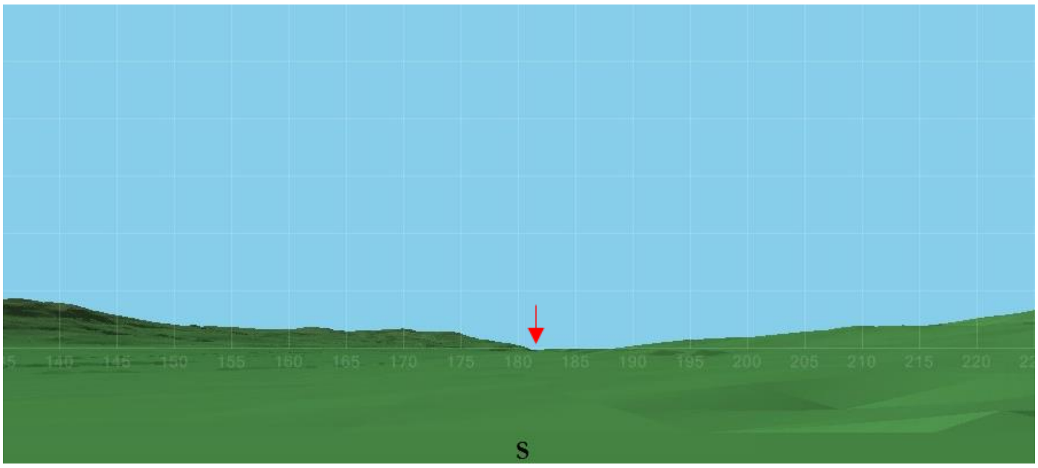


Figure 9.4: A close-up image of the Horizon panorama of Tormore I.
Even under magnification, the sea view remains barely if at all noticeable. The red arrow indicates the sea view.

Carn Ban presents a second case where discrepancies are observed between affordance values and standard viewshed results. The location affords long-distance sea views due to its high elevation, while the surrounding hilly landscape obscures areas of sea lying in close proximity to the coastline. These factors explain the sea affordance value of 2.89%, which seems low for the sea views depicted in the Horizon panorama (see Figure 9.5).

Figure 9.5: The Horizon panorama for Carn Ban, shows the visible sea in the distant horizon, indicated here by the red arrows.

At the remaining site locations, standard viewsheds and Horizon panoramas support the results of the sea affordance analysis as providing accurate representations. Of the ten other sites, only one, Moinechoill, Glean an T'Suidhe, offers no sea views (for the Horizon panorama for this site, see Figure 9.6). An examination of its immediately surrounding area, extending to a radius of 1.5km, shows that Moinechoill is situated in a location that has sea affordance values of 0% and is likely to be devoid of any sea views (see Figure 9.7).

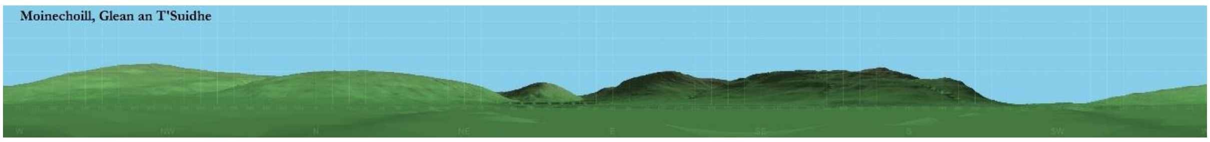


Figure 9.6: The Horizon profile for Moinechoill shows no visible sea in the distant horizon.

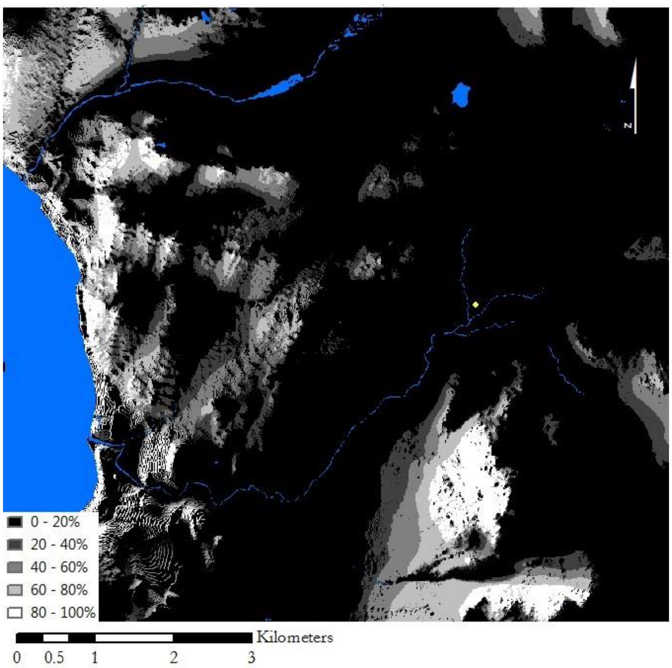


Figure 9.7: Sea affordance surface for Moinechoill (yellow), displaying a complete absence of sea affordance values in the immediate vicinity of the site.

The sea affordance maps show that half of the sites considered are built in topographic locations that offer high sea affordance values. Of significance are three sites that have high sea affordance values, of over 60%. These are Giant's Graves South, Clachaig and Giant's Graves North, with respective sea affordance values of 74.2%, 68.9% and 60.7%. The sites of Torr an Loisgte and Baile Meadhonach, fall in the mid-range sea affordance values, of 31.9% and 27.6%, respectively. In comparison, very marginal sea affordances are found for the remaining five sites, East Bennan, Dunan Beag, Glenrickard, Monamore and Carn Ban (see Table 9.1).

Statistical Considerations

12 long cairns were identified in the island of Arran. However, only 11 sites were considered for the statistical analysis. The site of Tormore I, was not included in this analysis for the reasons outlined above. A chi-square significant test was carried out to ascertain whether these 11 sites are placed in topographic locations that have more or less sea affordance than one would expect randomly. A 500m radius around each site was tested by reclassifying the interpolated sea affordance surfaces into the eight percentage categories of 0–5, 5–10, 10–20, 20–30, 30–40, 40–

60, 60–80 and 80–100. As presented in Table 9.2 below, the statistical test yielded a chi-square value of 7.791 and a p-value of 0.932. With the standard probability distribution function resulting in a p-value greater than 0.05, the analysis suggests that there are no statistically significant differences between the sea affordance values of the site locations and what could be expected from a random distribution of sites in the landscape. Two sample KS tests were also carried out for these 11 sites. The results confirm the findings of the chi-square significance test as indicating no significant differences from random distribution.

	Label (% categories)	Observed	Expected	Chi-Square Values
North Ayrshire	1 (0-5)	2	6	2.042
	2 (5-10)	3	1	2.25
	3 (10-20)	1	1	0.25
	4 (20-30)	1	1	0.25
	5 (30-40)	1	1	0.25
	6 (40-60)	0	1	0.25
	7 (60-80)	3	1	2.25
	8 (80-100)	0	1	0.25
				7.792
			p-value =	**0.932**

Table 9.2: Comparison of the observed and expected values, showing the chi-square values and the p-value. Results suggest no significant differences between the observed values (site locations) and expected values (random locations).

A sample of 11 is small for statistical analysis and may be insufficient to ground confident inferences about the sites as a collective. Therefore, it was deemed necessary to analyse sites on an individual basis, in terms of whether they are placed in unique locations for their surrounding landscapes. To this end, the surfaces were reclassified into the sea affordance percentage categories of 0–10, 10–20, 20–40, 40–60 and 60– 100. Pixel counts were taken for the land areas falling in these categories within a 500m radius of each site, making it possible to determine the percentage of the total tested land area in each category. The results are summarized below, in Table 9.3.

Sea Affordance % Categories	Torr an Loisgte	Giant's Graves North	Giant's Graves South	Dunan Beag	Carn Ban	East Bennan	Monamore	Clachaig
1 - (0-10)	34.5	13.1	13.2	**68.3**	**64.5**	46.6	**57.1**	34.9
2 - (10-20)	15.4	9.4	9.5	28.6	14	**11.4**	10.3	2.6
3 - (20-40)	**28.4**	21.5	19.6	3	21.5	17.1	12.9	15.2
4 - (40-60)	10.2	15.6	15.2	0.2	0.064	9.9	14.5	22.8
5 - (60-100)	11.5	**40.3**	**42.6**	0	0	15	5.4	**24.5**

Sea Affordance % Categories	Glenrickard	Baile Meadhonach	Moinechoill
1 - (0-10)	**76.3**	62	**100**
2 - (10-20)	20.9	9.4	0
3 - (20-40)	2.8	**15.4**	0
4 - (40-60)	0	11.2	0
5 - (60-100)	0	2	0

Table 9.11: The percentage of the total tested land area (0.8 km^2, or a 500m radius) which fell into each of the sea affordance categories.
Percentages in bold are the categories that the cairn sites fall into.

The results show that in most cases a large percentage of the tested area falls into only one sea affordance percentage category. Take, for instance, the site of Dunan Beag: 68.3% of the area within the tested 500m radius of the site falls in the lowest sea affordance category of 0–10%, and the cairn site also falls into that category. Similar observations can be made for Carn Ban, Monamore and Glenrickard, where those cairn sites together with the majority of the tested areas (of 64.5%, 57.1% and 76.3%, respectively) fall within the 0–10% category. A similar situation is seen in the area that surrounds Moinechoill, however, in that case there are no positive sea affordance values anywhere within the 0.8 km^2 test area—meaning that the entire tested area with the cairn site falls in the 0–10% category. The cairn sites in each of these five cases are not, then, placed in locations unique for their surrounding landscapes.

Only a handful of sites seem to be placed in areas that exhibit heterogeneous distributions among the various sea affordance categories. Examples include, Torr an Loisgte and Clachaig. The sea affordance value at Torr an Loisgte falls in the 20–40% category, at 31.9%. Although the area surrounding this site is varied, in that it offers locations with varying sea affordances, a substantial proportion of that area exhibits values similar to those of the cairn site. A similar observation can be made for Clachaig. With a sea affordance value of 68.9%, that site falls within the highest category but, as can be seen from Table 9.4, 24.5% of the tested area also offers similar values.

Interestingly, Giant's Graves North and Giant's Graves South both appear to be placed in a landscape that offers a heterogeneous distribution of sea affordances. However, a large percentage of the tested area around those sites, as well as the sites themselves, falls into a single category, which also happens to be the category of the highest range of sea affordance (60–100%). Therefore, the analysis conducted here reveals that none of those four site locations are unique in the landscapes they lie in. Despite their sea affordance values, the placement of these monuments could, then, have just as easily been achieved through random acts as opposed to deliberate choices. Of course, such a stipulation does not exclude as a possibility that sea views were valued by and were important to prehistoric builders. However, since such views were readily available, these results suggest that the location-choice for monuments may ultimately have been dependent other factors. There may have been many such reasons why a particular location was chosen, including: proximity to settlement sites or other burial sites, proximity routeways and other key features of the landscapes such as hills or mountains or other bodies of water that may have held some symbolic significance, and access to building materials and other resources.

The only two sites that appear to have been built in unique locations in terms of sea views are Baile Meadhonach and East Bennan. Baile Meadhonach has a sea affordance value of 27.6% and thus falls in the 20–40% sea affordance category. However, as can be seen from the above table, only 15.4% of the tested land area around that site offers similar sea affordance values. A similar observation is made at East Bennan, which has a sea affordance value of 11.8% and thus falls in the second lowest sea affordance category of 10–20%. As is the case at Baile Meadhonach, only 11.4%, a small amount of the tested land area around that site, offers similar sea affordance values. It is, therefore, arguable that in these two instances, the sea views observed are unique for their surrounding areas.

In order to verify these and the above findings, the 500m buffer of land tested around each site was increased to 1500m. Results are presented in Table 9.4 below. In most cases, this seemed to lead to the same findings, however, different results were obtained for the areas surrounding some sites. In the cases of Giant's Graves North, Giant's Graves South and Monamore, a substantial percentage of the tested areas still comprised similar sea affordance values to those of the cairn site. Increasing the tested buffer zone also seems to have had no significant impact on distribution of sea affordance values in the areas surrounding the locations of East Bennan and Baile Meadhonach, which still appear to be placed in locations that were unique.

Sea Affordance % Categories	Torr an Loisgte	Giant's Graves North	Giant's Graves South	Dunan Beag	Carn Ban	East Bennan	Monamore	Clachaig
1 - (0-10)	33.67	33.21	33.63	**39.75**	**54.51**	43.70	**38.03**	41.23
2 - (10-20)	10.48	11.06	11.15	20.24	15.53	**11.84**	12.87	8.18
3 - (20-40)	**15.39**	14.78	14.67	19.82	20.86	15.89	22.85	24.27
4 - (40-60)	9.68	8.89	8.62	20.03	8.59	10.48	13.57	15.51
5 - (60-100)	30.77	**32.06**	**31.93**	0.16	0.51	18.10	12.69	**10.82**

Sea Affordance % Categories	Glenrickard	Baile Meadhonach	Moinechoill
1 - (0-10)	**31.17**	81.31	**92.80**
2 - (10-20)	19.83	4.06	2.70
3 - (20-40)	33.34	**5.97**	2.70
4 - (40-60)	14.81	4.68	1.31
5 - (60-100)	0.86	3.98	0.50

Table 9.4: The percentage of the total tested land area (7.1 km^2 or 1.5km radius) which fell into each of the sea affordance categories.
Percentages in bold are the categories that the cairn sites fall into.

However, when an increased buffer of land was tested around Baile Meadhonach, the majority of the area was found to hold sea affordance values of 0%. This meant that the sea affordance value of the cairn site is rare in that wider landscape context, with only 6% of the area in the sea affordance category of 20–40% (Table 9.3). The larger areas tested around a number of other locations revealed that their landscape contexts are more heterogeneous that could be seen under the smaller 500m buffer. The most notable of examples of these sites are Moinechoill, Glenrickard and Dunan Beag. The first test, examining only the 500m radius around Glenrickard, revealed that no locations in its immediate vicinity offered sea affordances ranging from 40–100%. However, under the larger buffer of the second test, 14.8% of the surrounding area was found to offer sea affordance values falling in the 40–60% category and 1% of that area fell into the highest sea affordance category ranging between 60–100%. Moreover, while 24.5% of the 500m area surrounding Clachaig was in the same category of sea affordance as the cairn site, that number dropped to 10.8% when the larger area was considered. This outcome reveals that the sea affordance values seen at the cairn site are not as common as was previously indicated. To the contrary, 41.2% of the larger area has sea affordances that fall in the lowest category of 0–10%, making the cairn location distinct from much of its surrounds. From these results, it is therefore arguable that rather than achieving the sea views offered at that site by chance, megalithic builders may likely have had to search the landscape to achieve those or similar outcomes. However, it should be noted that such cases are exceptions to the general trend, which exhibited no markedly significant differences between the results of the tests of the different sized areas. At a majority of the sites, a relatively substantial portion of the tested areas offer sea affordance values that are comparable to the values obtained for the cairn sites, such that prehistoric builders could have placed those constructions in a large number of available places and achieved similar outcomes.

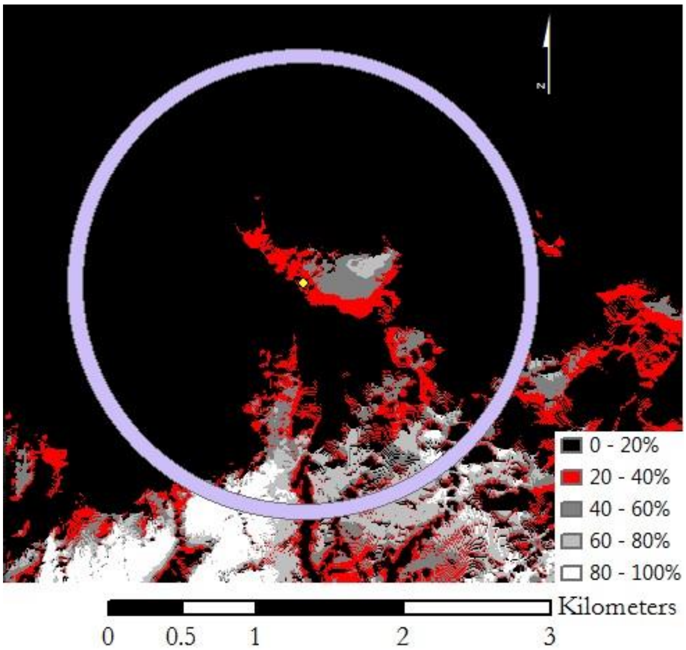


Figure 9.8: The 1.5km radius around Baile Meadhonach that was tested. Highlighted in red is the land area that falls in the 20-40% sea affordance category.
As can be seen here, only a small proportion of the tested area has similar affordances to that of the site.

9.2 Qualitative Investigation of Long Cairn Sites and High Sea Affordance Zones

The statistical analyses described in the previous section provide an initial and general assessment of whether the long cairns of Arran offer unique sea views, and whether prehistoric peoples are likely to have chosen their locations deliberately for their affordance of such views. As outcome of those analyses was that, taken as a collective, there is little reason to suppose that those monuments were placed with sea views as a primary or overriding factor in the minds and motivations of prehistoric people: sea views are prevalent in Arran, and from the considerations taken into account it is likely that other factors, which were described earlier, ultimately influenced and determined location choice. Such a notion does not, however, exclude the possibility that sea views were important to prehistoric people in a given instance. Moreover, since the sites and their locations and surrounds were considered predominantly on the basis of sea affordance values which can be misrepresentative, there is every possibility that crucial details were missed. For these reasons, in this and the following section, site locations and the sea views available from their surrounding landscapes are considered on a qualitative basis, through the use of Horizon panoramas and standard viewshed analyses, to establish whether or not there is reason to suppose that these monuments were placed in such a way so as to reference the sea.

The first step in the qualitative component of this investigation was to generate Horizon panoramas for the purpose of understanding what kinds of views are offered at the cairn sites under consideration. As discussed in the previous section, Moinechoill offers no sea views, and the views from Tormore I are so infinitesimal that they are likely to be imperceptible even to persons that are aware that there could be views in the direction of the sea. These sites were excluded from the initial phase of this investigation. It was found that of the remaining ten sites, five are placed in locations that offer narrow views of the sea. As shown in Figure 9.9 below, these sites and the approximate ranges of their sea views are as follows: Dunan Beag 135–174º, East Bennan 159–211º, Baile Meadhonach 138–184º, Glenrickard 10.5–45º and Carn Ban 150.5–156º and 167–197º. The other five sites are placed in topographic locations that offer expansive sea views that extend across the horizon. As shown in Figure 9.10 below, these sites and the approximate ranges of their sea views are as follows: Giant's Graves North 359–7.5º and 13.5–154º, Giant's Graves South 20–147º, Clachaig 108–251º, and Torr an Loisgte 0.5–12º, 15–115º, and 135.5–140º. Monamore stands apart from the other sites with expansive sea views in that the views it offers views, from approximately 34–60º and 87–111º, that are not prominent and occupy only a minute area or sliver in the observer's visual field.

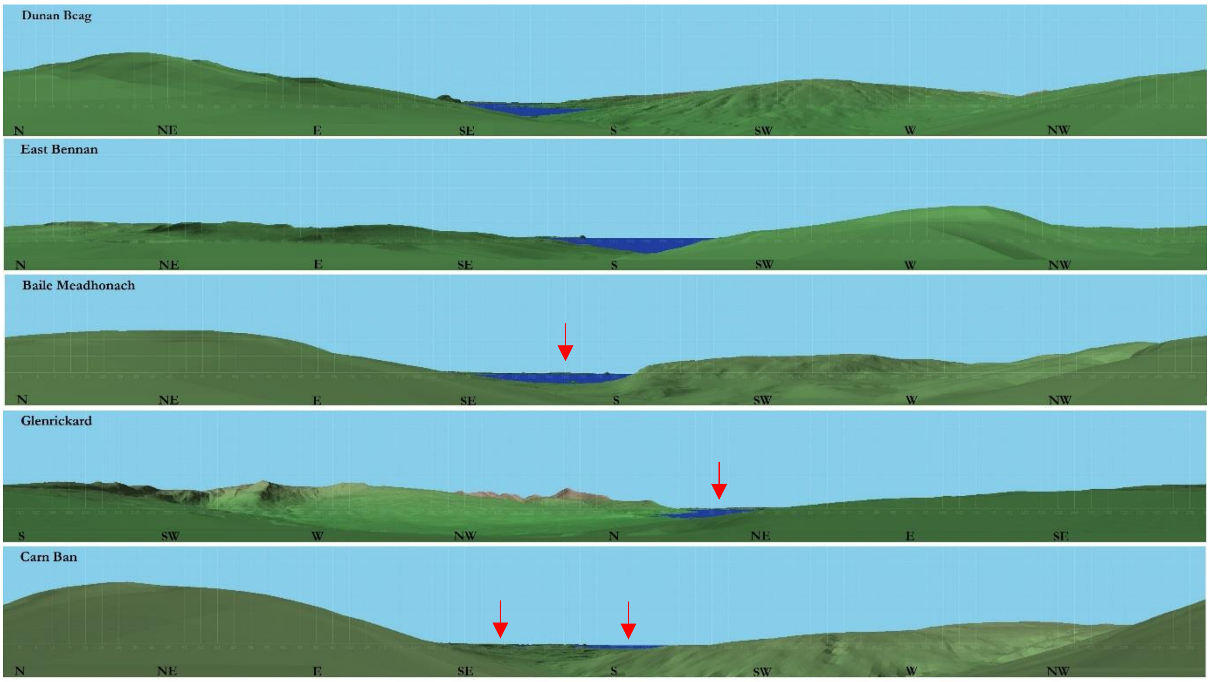


Figure 9.9: Horizon panoramas of Dunan Beag, East Bennan, Baile Meadhonach, Glenrickard and Carn Ban displaying narrow views of the sea.

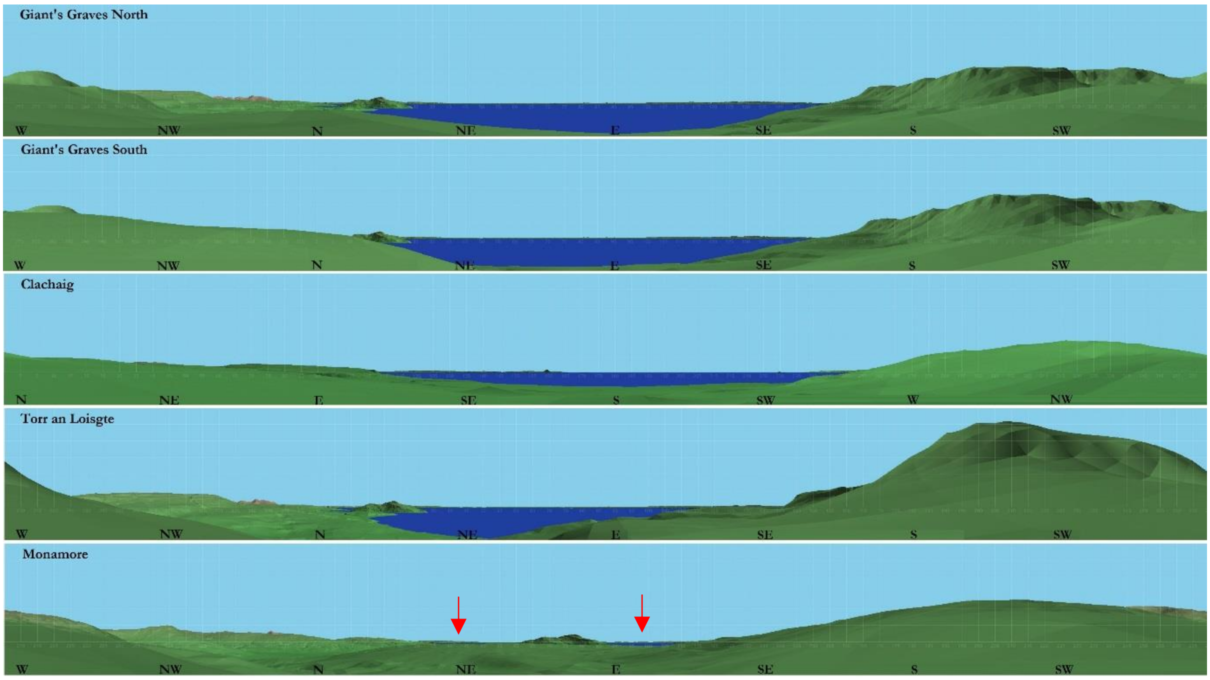


Figure 9.500: Horizon panoramas of Giant's Graves North, Giant's Graves South, Clachaig, Torr an Loisgte and Monamore displaying expansive views of the sea.

Additional Horizon panoramas were generated in order to see how these sea views would have been effected by atmospheric conditions such as haze, mist and fog. As shown in Figure 9.11, four of the five sites that are placed in locations that offer narrow views of the sea do not appear to be detrimentally affected by atmospheric conditions. Take, for instance, the sites of Dunan Beag and East Bennan: even with only 1km of visibility, sea views are reasonably noticeable in the distant horizon. Similarly, at Baile Meadhonach and Glenrickard, sea views appear in the visual range respectively with approximately 2km and 1km of visibility. Can Ban presents the only exception of these five sites, where a minimum visibility of 8km is required for sea views to appear to an observer. However, under those conditions, only the stretch from 167–197º is noticeable, and the area of sea between 150.5–156º remains obscured until visibility reaches 17km (see Figure 9.11). These outcomes demonstrate that the effects of low to moderate atmospheric deterioration on the sea views from this site can lead it to being highly unlikely that they are detectable to an observer—an outcome which is only further established when the effects of vegetation growth on visibility are also taken into consideration.

A similar pattern is observed with the five site locations that offer expansive sea views (see Figure 9.12). Four of the five sites offer both prominent and expansive sea views and do not appear to be adversely affected by atmospheric conditions: the full range of available views appear with under 1km of visibility at Giant's Graves North, Giant's Graves South, Clachaig and Torr an Loisgte. However, at Monamore, a minimum of 5km visibility is needed for sea views to appear to the observer, and even then only a small patch of sea, from E (87º) to ESE (111º), is visible, which under those conditions is barely noticeable in the distant horizon. At minimum, there needs to be visibility for 17km for the entire range of sea views, especially those expanding from approximately NE (34º) to ENE (60º) to come into view. Once again, as is the case at Carn Ban, it is highly questionable if these sea views would have been noticeable to an observer if any atmospheric conditions such as fog and haze lingered on the horizon.

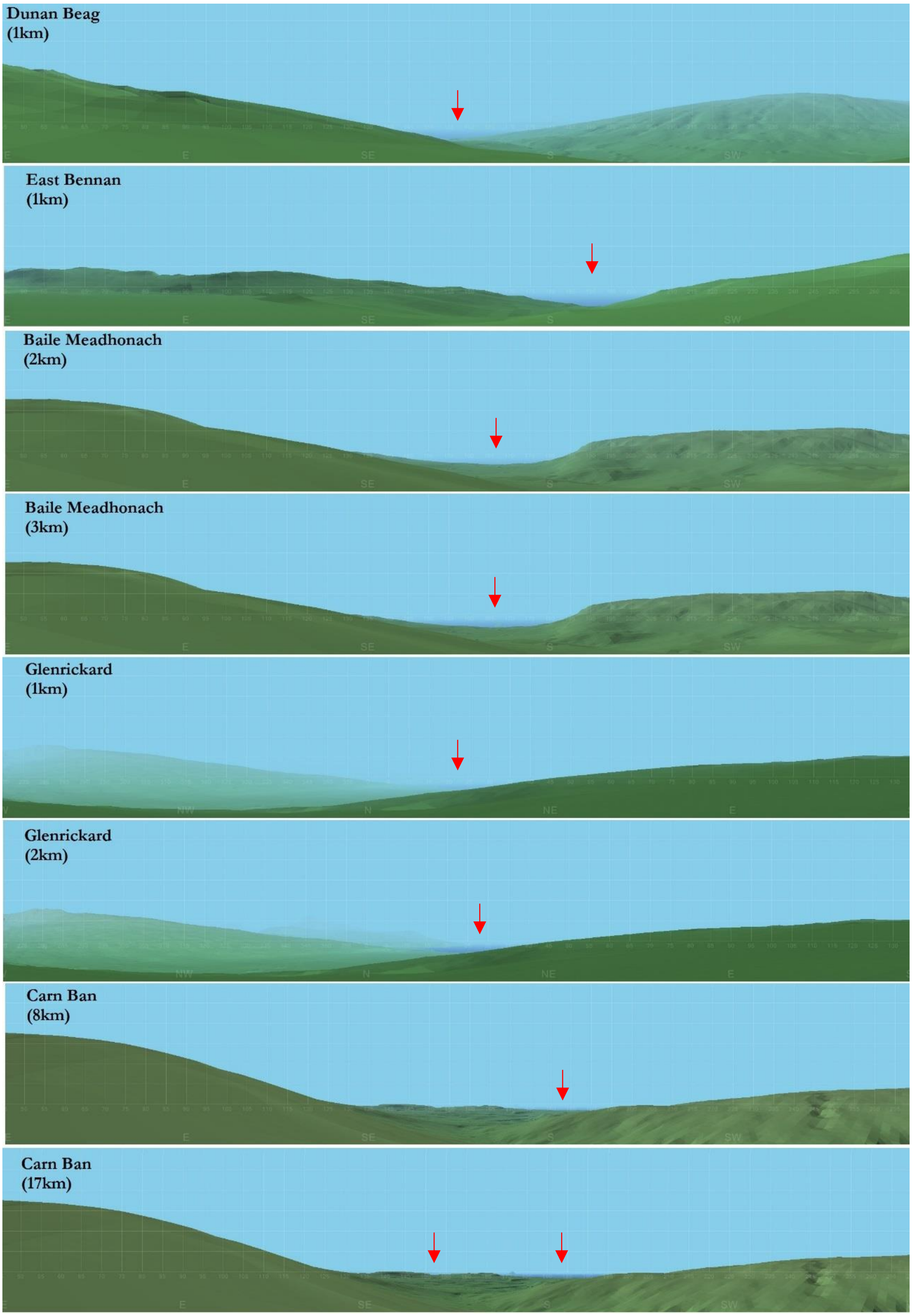


Figure 9.511: Horizon panoramas for Dunan Beag, East Bennan, Baile Meadhonach, Glenrickard and Carn Ban displaying the effects of atmospheric conditions.

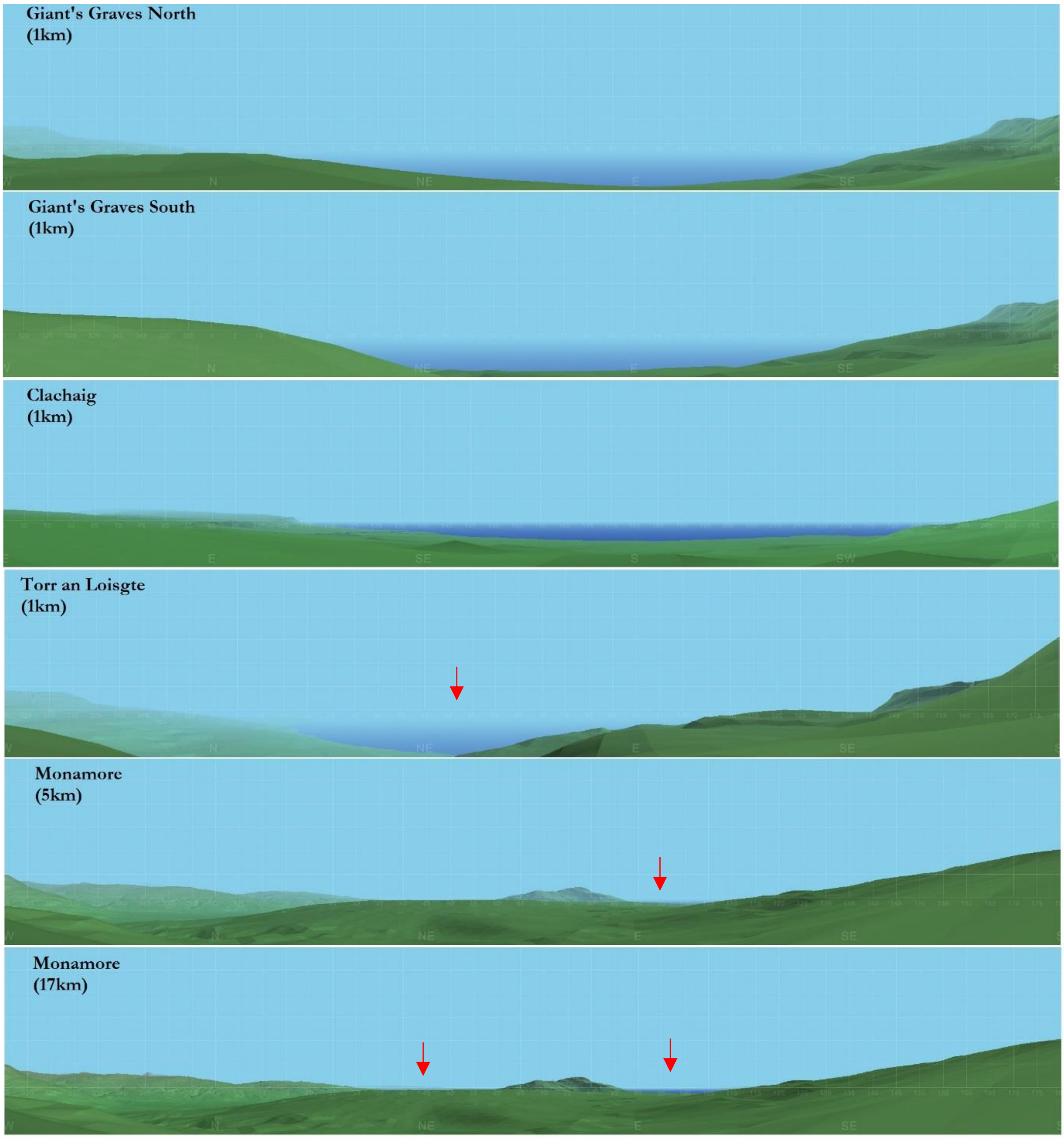


Figure 9.522: Horizon panoramas of Giant's Graves North, Giant's Graves South, Clachaig, Torr an Loisgte and Monamore displaying the effects of atmospheric conditions.

Investigation of Alternative Locations that Offer Higher Sea Affordance Values

As with earlier chapters, to test the hypothesis that the prehistoric people of Scotland, and in this case Arran, sought to (or did) reference the sea with their monument construction, the landscapes surrounding the long cairns under consideration were examined to determine whether there are better locations in terms of sea views that were passed over for monument placement. An investigation of the sea affordance surfaces revealed that, with the exception of Tormore I and Moinechoill, each cairn site is placed in an area where there are considerably better sea affordance values available in nearby areas. The most notable of these locations, with higher sea affordance values were selected and compared with where the monuments were ultimately placed (results are summarized below in Table 9.5).

Site Name	Site elevation (m)	Nearby high sea affordance locations	Elevation at this new location (m)	Distance away from the site (m)	Directionality of this location	Sea Affordance (%)
Baile Meadhonach	213	Location A	232	1200	SSW	81.98
		Location B	255	429	E	60.20
Torr an Loisgte	144	Location A	161	87.31	S	81.17
		Location B	152	44.20	S	61.54
		Location C	125	352.95	ESE	93.46
Giant's Graves North	132	Location A	125	75.44	NNE	93.46
		Location B	109	245.43	SE	92.57
Giant's Graves South	130	Location A	125	101.78	NNE	93.46
		Location B	109	220.59	SE	92.57
Monamore	129	Location A	256	1300	WNW	80.87
		Location B	160	132.91	SSW	42.72
Dunan Beag	102	Location A	228	560.10	NNE	42.50
		Location B	154	240.73	ENE	21.07
Clachaig	22	Location A	18	212.56	SW	94.49
Carn Ban	272	Location A	373	1400	WNW	68.78
		Location B	330	633.95	W	45.97
East Bennan	93	Location A	83	558	SSW	82.67
		Location B	91	291.8	SSE	65.98
Glenrickard	91	Location A	195	1400	NW	60.69
		Location B	73	1200	NE	40.55

Table 9.5: Comparison of available sea affordances between site locations and the alternative locations in their surroundings.

On first assessment of these alternative locations, it may appear that there are an abundance of places with sea affordance values that are many times greater than those seen at cairn sites. However, many such locations may have been unsuitable for cairn placement due to having higher elevations than the cairn sites they correspond to, which would likely impede accessibility. Such locations may also have been unsuitable due to their distances from the cairn sites, which may mean that they are also at distances from otherwise desired locations that cairn sites may be in proximity with. This is seen in a number of cases where the alternative locations with significantly higher sea affordance values have both considerably higher elevation values than their corresponding cairn sites and are placed at some distance from the latter. Four such cases are: Baile Meadhonach Location A, Monomore location A, Glenrickard Location A and Carn Ban Location A (see Figures 9.13 and 9.14).

Of course, either elevation or distance alone may have been sufficient to deter prehistoric peoples from using such locations. Take, for instance, the cairn site Glenrickard (see Figure 9.13), which has a sea affordance value of 6.5%. The sea affordance value of Glenrickard Location B is roughly six times that figure. While Location B is situated at a much lower elevation than the cairn site, and may therefore have been more easily accessible, it is also at some distance, approximately 1.2km away. That distance may, then, have discouraged prehistoric builders from building on or around Location B, in spite of its easier accessibility and the greater sea views that may have been on offer. A further example is Monomore Location B (see Figure 9.14), which lies at a short distance of 133m from the corresponding cairn site, where there are numerous high sea affordance zones, falling in the range of 40–60%, almost eight times the value found at the site. Monomore Location B is, however, situated at a much higher elevation than Monomore, the corresponding cairn site, which may impeded access and deterred prehistoric builders from using that location and the greater sea views it offers. Similar findings of significantly higher elevations in high sea affordance zones are made for Dunan Beag Locations A and B, Baile Meadhonach Location B and Torr an Loisgte Location A (see Figure 9.13 for examples).

Monomore Location A, which holds sea affordance values of 80.9% in comparison to the meagre 5.3% seen at its corresponding cairn site, presents a different sort of example altogether. This alternative high sea affordance zone is approximately 1.3km away from the cairn and is situated 127m higher in elevation. While that distance and that elevation might be taken as sufficient explanation for why prehistoric peoples neglected the location and its higher affordance values, such an explanation cannot be taken at face value when it is considered that the location is also situated on a major route to the existing cairn site, as is modelled by the pathways considered in Section 3. It seems that prehistoric builders may, then, have likely been both aware of the sea views offered at that location, and been able to traverse the landscape to access it (see Figure 9.14).

Such speculation aside, however, there are a number of alternative locations with high sea affordance values which are neither at great distances from their corresponding cairn sites nor at comparatively higher elevations. The most notable cases are Torr an Loisgte Location C, Giant's Graves North Locations A and B, Giant's Graves South Locations A and B, Clachaig Location A, and East Bennan Locations A and B. At Torr an Loisgte, the sea affordance is 31.9%, but at Location C, which is situated just 352.9m away, the sea affordance value is significantly higher, reaching 93.5%. At Giant's Graves South, Locations A and B are both located less than 250m away from the corresponding cairn site and yet have higher sea affordances. Similar observations are made at Clachaig and Giant's Graves North. Giant's Graves North Location A is only 75m from Giant's Graves North, but offers 50% more sea affordance than the latter. Moreover, both alternative locations to East Bennan offer considerably higher sea affordances than the cairn site, particularly so in the case of Location A, which reaches values of 82.67% at 558m from the site. All of these high sea affordance zones were evidently disregarded by prehistoric builders, which may cast some doubt on the notion that the cairns of Arran were placed deliberately to reference the sea.

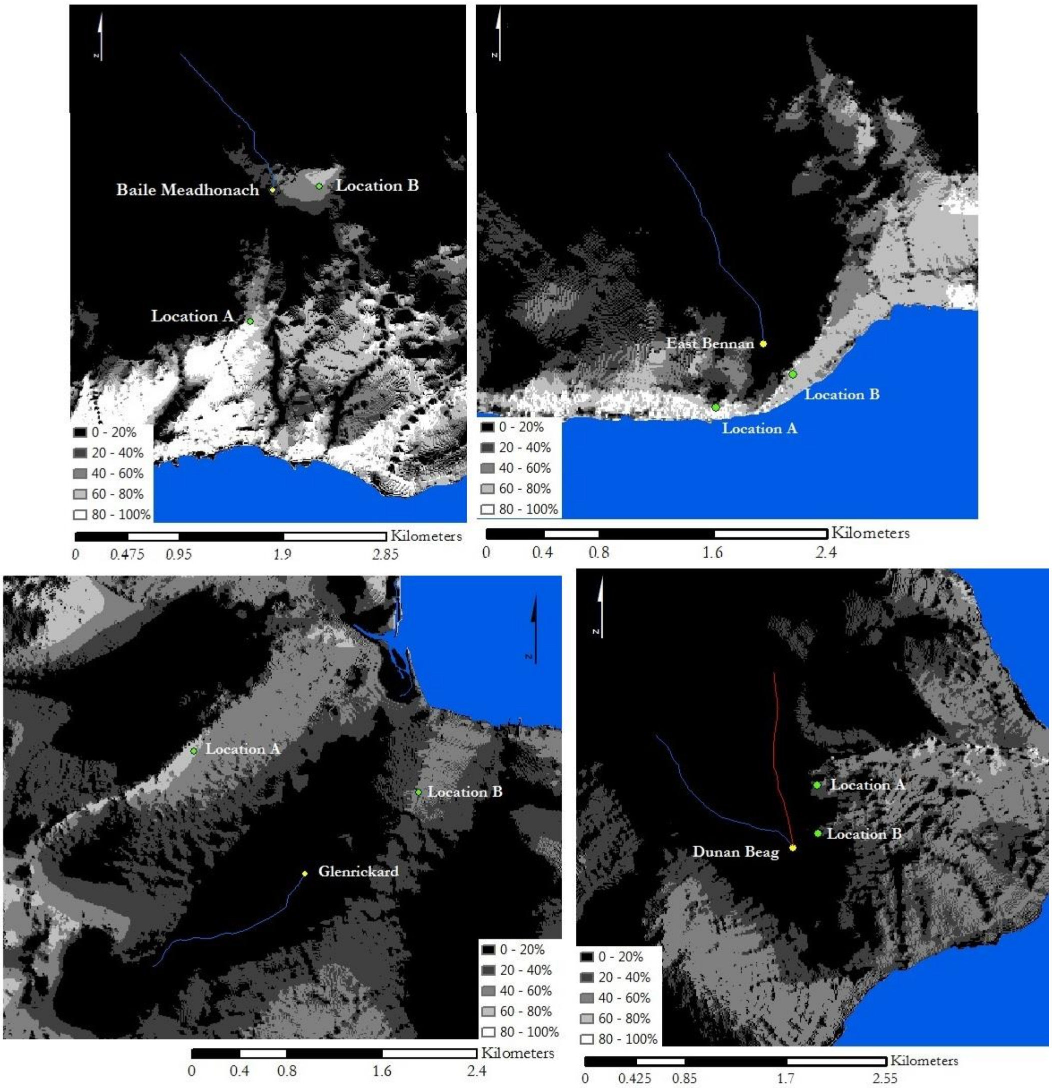


Figure 9.533: Sea affordance surfaces of Baile Meadhonach, East Bennan, Glenrickard and Dunan Beag, displaying the high sea affordance zones in the immediate vicinity of the sites.

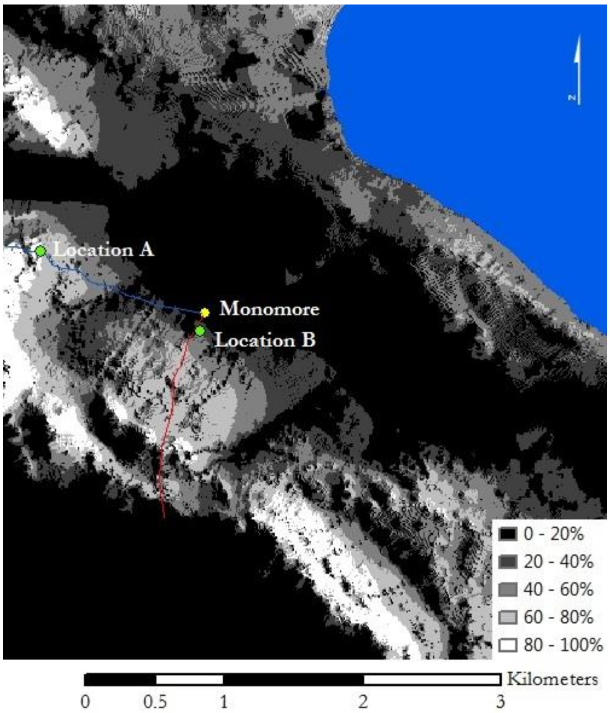


Figure 9.544: Sea affordance surface of Monomore, displaying the high sea affordance zones in the immediate vicinity of the site.

Investigation of Alternative Locations using Horizon Panoramas

To shed light on the significance of the high sea affordance zones identified above, Horizon panoramas were generated so that the sea views they offer could be compared to the views from the corresponding cairn sites (see Figures 9.15 and 9.16).

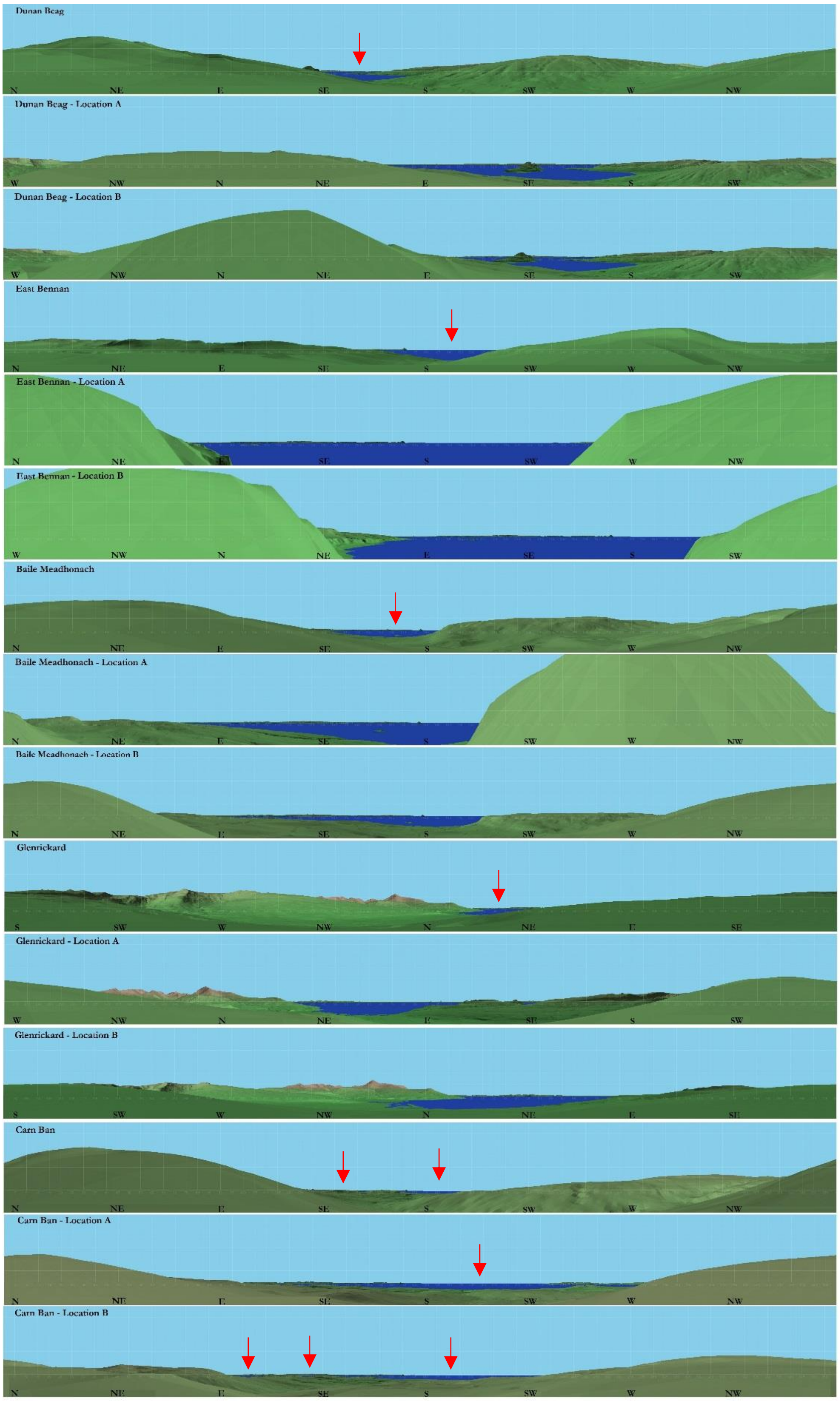


Figure 9.15: Horizon panoramas for Dunan Beag, East Bennan, Baile Meadhonach, Glenrickard and Carn Ban as well as the high sea affordance zones nearby to these sites, identified in Table 9.2.
Red arrows indicate sea views.

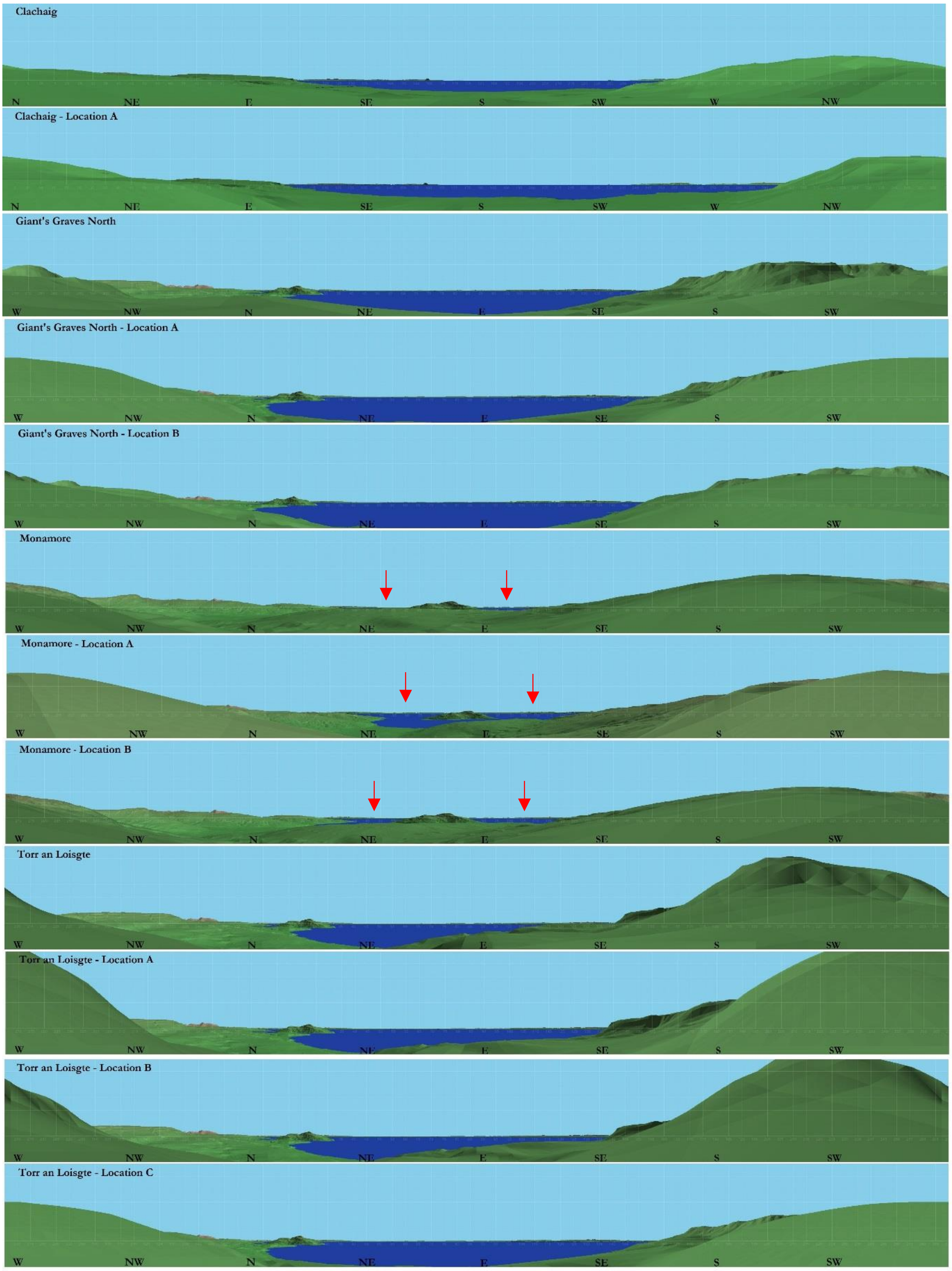


Figure 9.55: Horizon panoramas of Giant's Graves North, Clachaig, Monamore and Torr an Loisgte and the nearby high sea affordance zones (alternative locations) identified in Table 9.2.

Sea views from East Bennan span a considerable range from approximately 159–211º, yet this is much narrower in comparison to either of the ranges of sea views observable from Locations A and B, from approximately 76–253º and 54–210.5º, respectively (see Figure 9.15). The sea views from these alternative locations expand further across the horizon and are also more prominent than those available from the cairn site. Hence, according to the criteria considered here, either of these two alternative locations may have been ideal to build on, that is, if megalithic builders had intended to achieve large vistas of the sea. The evidence in this case seems to suggest that if the monument was moved a few hundred meters to either the SSE or the SSW, then the narrower views of the sea from the existing cairn site would have been lost and replaced with broader and prominent views. Perhaps one explanation for the narrow sea views from this cairn site is that the monument's builders had intended to achieve precisely that kind of view; as described in Chapter 2, Section 1, Cummings and Whittle (2004, p. 82) suggest such a possibility when discussing a similar set of monuments in Wales where they suppose that a view of a smaller area of the sea may symbolise the diminishing use of coastal resources in the lives of prehistoric people. Such a theory might, perhaps, explain why the expansive sea views readily available near East Bennan were overlooked and why the cairn was placed in a location that offers narrow sea views, which are nevertheless still prominent in an observer's visual field.

As mentioned above, four sites are placed in locations that offer expansive and prominent sea views. These sites are: Clachaig, Torr an Loisgte, Giant's Graves North and Giant's Graves South—Monamore also offers expansive sea views but they only appear as a microscopic sliver across the distant horizon. At Clachaig, sea views span from approximately 108–251º, while at the alternative to that site, Location A, sea views span from approximately 104–295º. Location A offers broader and greater sea views, as is shown in Figure 9.16, and is situated at a lower elevation than the cairn site, and only a short distance away. Hence, that alternative location may have been better suited for the placement of the cairn, in terms of sea views. Nevertheless, given that the cairn site already offers a substantial degree of sea views, it is plausible to suppose that those views were sufficient for intended purposes. At Giant's Graves North, sea views span from approximately 359–7.5º and 13.5–154º, and sea views from Giant's Grave South span from approximately 20–147º (see Figure 9.10). These cairns are placed in extreme proximity to each other and may, therefore, be described as a pair of cairns. This means that the alternative locations for Giant's Graves North, A and B, may be treated as alternative to both of those cairns (Giant's Graves North and Giant's Graves South), and are therefore compared with each one here. Sea views from Locations A and B are in similarly wide range, respectively expanding from approximately 0–155º, and 359–152.5º. Although the sea views offered from these alternative locations appear as marginally broader and as slightly magnified in the visual field, they are comparable to those that are seen from the cairn site (see Figure 9.16). As with the alternative locations to Clachaig, both of these alternative locations (for Giant's Graves North and South) are situated at lower elevations than their corresponding pair of cairn sites, particularly so at Location B. These two locations are also only a short distance from those cairn sites. These details raise the question of why either of these locations were not selected, and suggest that other factors ultimately influenced the placing of these monuments within the landscape.

From Torr an Loisgte, it appears as though significant sections of sea are almost visible, but views of those areas are ultimately blocked by the hilly landscape in the distance (see Figure 9.16). The most visually prominent portion of the sea spans from 15–115º, and on either side of that expanse there are two very faint and thin slivers, extending from 0.5–12º and 135.5–140º. At 81.17% and 61.54% respectively, locations A and B have far greater sea affordance values than the 31.9% found at the cairn site. Despite these differences, sea views from all those locations are somewhat comparable, although they extend slightly further across the horizon to the SE, revealing the section of sea at around 125º that was obscured from view (from the cairn site). Those locations are situated at somewhat higher elevations than the cairn site (at 17m and 8m above the cairn site, respectively, see Table 9.5). However, there is a further location, C, that is at both a lower elevation than the cairn and at a distance of only 353m. At that location, not only do the sea views expand even further across the horizon, from approximately 0–155º, but they are also more prominent, occupying a much greater area in the observer's visual field. Much more of the nearby sea area is visible from that location, which is represented in its sea affordance value of 93.5%. This high value is largely attributable to three factors. First, the area of sea inside the buffer is largely contained within an inlet that is visible from these locations. Second, Location C is situated at a lower elevation than Locations A, B and the cairn site. This means that the nearest areas of sea that were obscured from each of the other locations are visible from Location C. The angle of the view from Location C out onto the inlet is the third factor leading its particularly high sea affordance value: the views from there are not obscured as they are at the cairn site, or as they are at Locations A and B. That Location C was not selected by prehistoric builders for monument placement may be attributable to the same explanation described above in the case of Clachaig: the cairn site already offers substantially prominent sea views, and such views may have sufficed for builders' purposes.

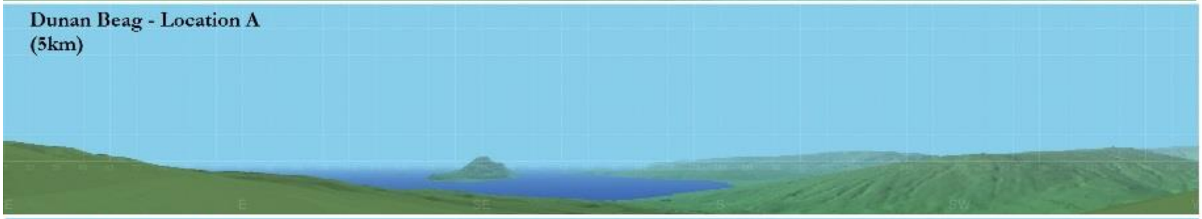
Despite the sea views from Monamore spanning from approximately 34–60º and 87–111º, they appear only as a faint sliver across the horizon (see Figure 9.16). This is not surprising given that the site has a sea affordance value of 5.3% and is at some distance from the coast so that the nearest areas of visible sea, in the NE and SE, are approximately 5.7km and 12km away, respectively. The sea views from Location A span from 36.5–129º, while the sea views from Location B are segmented by a hill (from 60–84.5º) so that they span from approximately 24.5–60º and 84.5–119.5º. In comparison to the views from the cairn site, both of these alternative locations offer sea views that are broader and more prominent visually. However, those locations are situated at much higher elevations and at some distance from the site.

Considering the Effect of Atmospheric Conditions

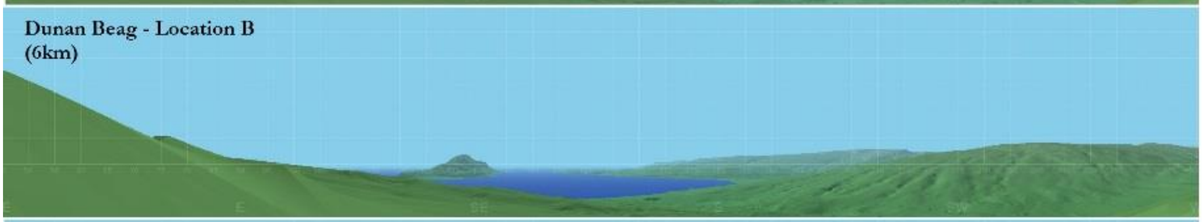
To model atmospheric conditions, Horizon panoramas were generated to examine the sea views available from the alternative locations described above, namely: East Bennan Locations A and B, Giant's Graves North Locations A and B, Clachaig Locations A, Torr an Loisgte Locations A, B and C and Monamore Locations A and B (see Figures 9.17 and 9.18).

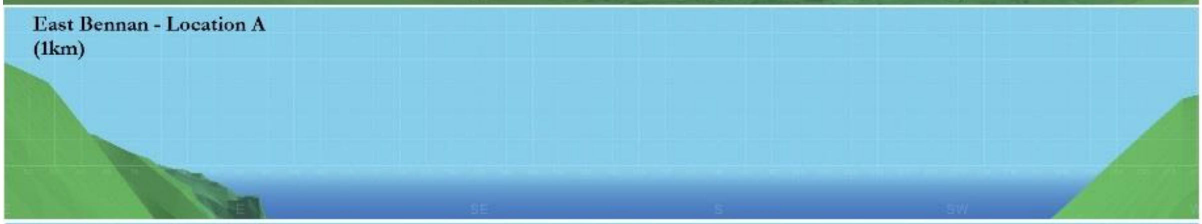
The results of this step of the analysis reveal that, at most of the alternative locations, sea views appear to the observer with a short distance of atmospheric clarity. At Clachaig Location A, for instance, atmospheric conditions do not appear to have an impact on the sea views in any considerable way. The only two locations where sea views appear to be adversely affected by atmospheric conditions are the alternative locations for Monamore, and those views are only moderately affected. At Monamore Location A, some of the sea views from that might be available under clear conditions appear with 2km of visibility. These views range from approximately 45–95º. The full range of sea views, from 45–129º, appear when visibility reaches 3km. A similar observation can be made at Monamore Location B, where the full range of available sea views only comes into view when there is approximately 3km or more of atmospheric clarity. The sea views from both of these locations are, however, revealed to be much more stable under atmospheric conditions than those of the cairn site, which require 17km of atmospheric clarity to appear.


Dunan Beag - Location A
(2km)

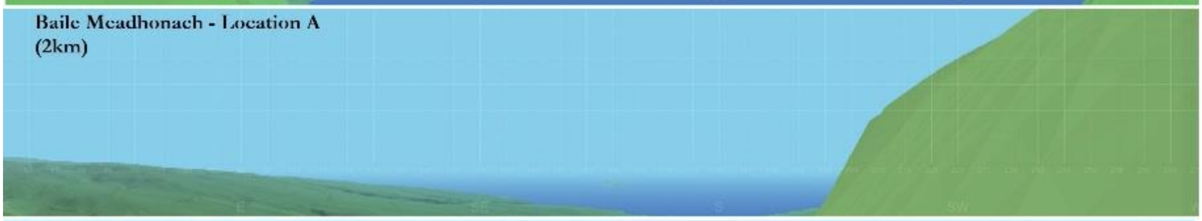

Dunan Beag - Location A
(5km)


Dunan Beag - Location B
(2km)


Dunan Beag - Location B
(6km)


East Bennan - Location A
(1km)


East Bennan - Location B
(1km)


Baile Meadhonach - Location A
(2km)


Baile Meadhonach - Location B
(2km)

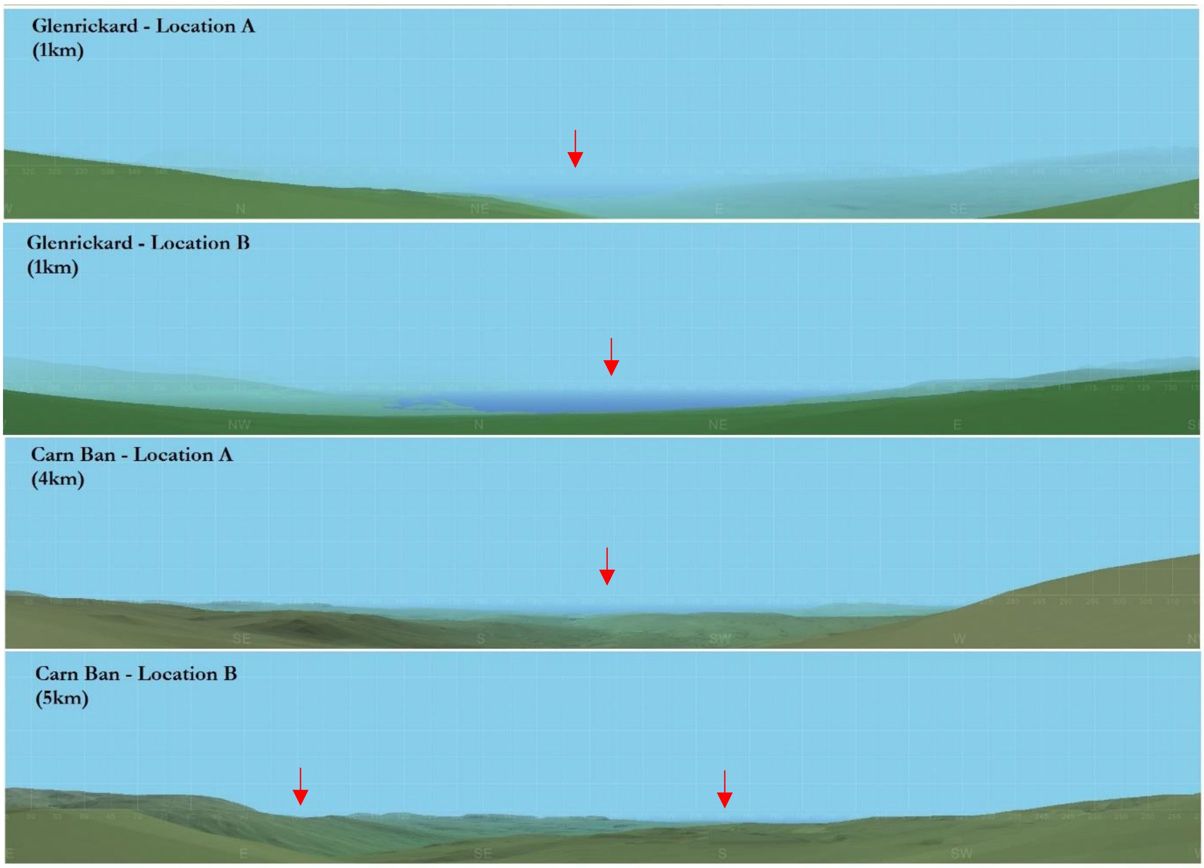


Figure 9.567: Horizon panoramas for alternative locations for Dunan Beag, East Bennan, Baile, Meadhonach, Glenrickard and Carn Ban displaying the effects of atmospheric conditions.
See Figure 9.11, for Horizon panoramas of cairn sites showing atmospheric conditions. Note that some alternative locations are included here that are not discussed in the text as they are situated at either great distances from or significantly higher elevations than the cairn sites that they correspond to.

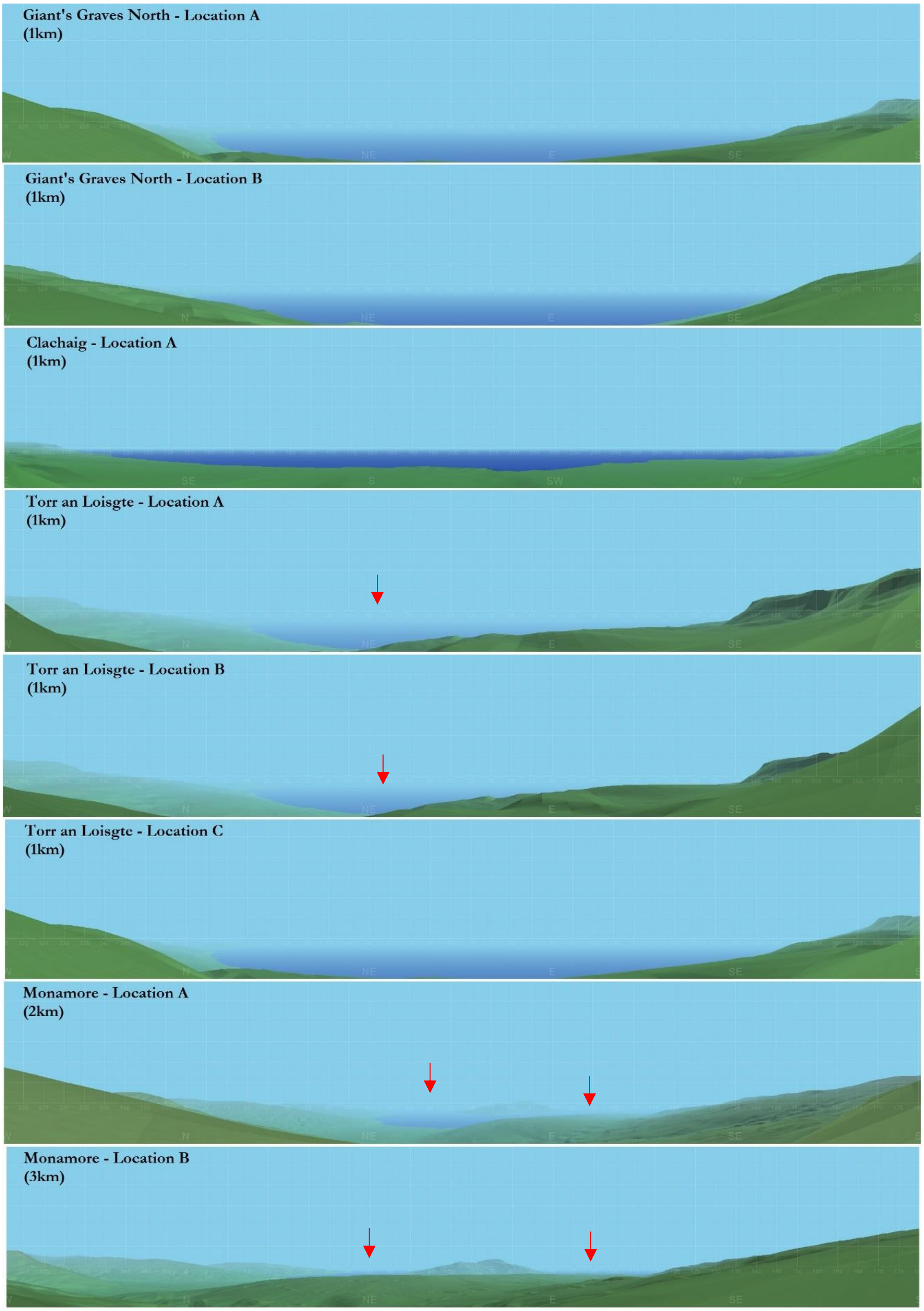


Figure 9.578: Horizon panoramas for the alternative locations for the Giant's Graves North, Clachaig, Torr an Loisgte and Monamore displaying the effects of atmospheric conditions.
Red arrows indicate sea views. See Figure 9.16, for Horizon panoramas of cairn sites showing atmospheric conditions. Note that some alternative locations are included here that are not discussed in the text as they are situated at either great distances from or significantly higher elevations than the cairn sites that they correspond to.

9.3 Testing for Revelatory Views

Using travel corridors in conjunction with the sea affordance surfaces, profiles were drawn for each of the 11 sites considered here.[48] All sites had pathways approaching them in a seaward direction, and in that respect all sites were treated as having the potential of offering revelatory views. A total of 15 pathways were identified. An examination of the profiles revealed that 9 of those paths offer revelatory views, and that those were restricted to 8 of the 11 sites (the results are summarized in Table 9.6). These pathways are categorized into three overlapping types, as defined by the differing degrees that the final view of the sea is hidden and then revealed. Pathways can, then, offer: first, sudden and dramatic revelatory views (of the sea); second, gradual and slowly revealed views; and third, 'previews' of the sea leading up to the final view that is available at the cairn site.

[48] As described in 10.1, Tormore I was excluded from this particular analysis because the sea affordance values at the site location and its immediate surroundings were treated as unreliable, which was a consequence of the limitation set by the 3km buffer used to generate the sea affordance surface, see Chapter 4, Section 3 for further discussion.

Site ID	Site Name	Site Elevation (m)	Distance to the Nearest Body of Water (m)	Distance to the Nearest Coastline (m)	General Direction of all paths drawn in	Paths that offer 'revelatory' views	Sea Affordance %
1	Clachaig	22	468.06	295.73	Path 1 (SW); Path 2 (SSW); Path 3 (SSE)	Path 1 (SW)	68.86
2	East Bennan	93	265.67	422.43	Path 1 (S/SSE)	Path 1 (S/SSE)	11.77
3	Tormore I	31	357.09	1840.68	Path 1 (S)	No	0.00
4	Carn Ban	272	1838.19	5306.54	Path 1 (SSW)	No	2.89
5	, Glean an T'Suidhe	71	82.77	4847.99	Path 1 (SW)	No	0.00
6	Monamore, Meallach's Grave	129	888.00	1575.64	Path 1 (ESE); Path 2 (NNE)	No	5.34
7	Baile Meadhonach	213	275.15	2358.02	Path 1(SSE)	Path 1 (SSE)	27.58
8	Torr an Loisgte	144	358.59	780.17	Path 1 (E)	Path 1 (E)	31.95
9	Giant's Graves North	132	492.53	643.03	Path 1 (E)	Path 1 (E)	60.68
10	Giant's Graves South	130	474.88	655.78	Path 1 (E)	Path 1 (E)	74.25
11	Dunan Beag	102	1021.24	1331.99	Path 1 (SE); Path 2 (SSE)	Path 1; Path 2 (SSE)	8.19
12	Glenrickard	91	459.70	1696.97	Path 1 (NE)	Path 1 (NE)	6.51

Table 9.6: Results of sea affordance analysis.

On the basis of this categorization, six pathways offer dramatic and sudden reveals during the last legs of their journeys (see Figure 9.19). These are: Path 1 to Giant's Graves South, Path 1 to Giant's Graves North, Path 1 to Torr an Loisgte, Path 1 to Baile Meadhonach, Path 1 to East Bennan and Path 1 to Glenrickard. On the paths to Giant's Graves South and Giant's Graves North, there are sudden increases in the sea affordance profiles, starting from approximately 130m from the respective sites, and reaching as high as 79.1%, 30–40m from the site locations. Both graphs, for Giant's Graves South and Giant's Graves North, also show a slight drop in sea affordance after those peaks, with respective decreases of 4.9% and 18.4%. In the case of Giant's

Graves South, the decrease in sea affordance is minimal in that it is unlikely to have had a significant impact on how the available sea views appear in the visual field of an observer. In the case of Path 1 to Giant's Graves North, even though there is a comparatively greater decrease, that path still offers a convincing revelatory view. This is because the sea views are effectively masked from the observer from 200–100m, with sea affordance jumping from 0% at 130m to 60.7% at the site location (0m).

A similar observation can be made regarding the path to Torr an Loisgte (see Figure 9.19), where sea views are hidden from the observer for a significant distance before a sudden and dramatic reveal. At approximately 110m, there is a spike in the sea affordance profile that reaches 74.8% only 70m from the site. As seen in the paths to Giant's Graves North and Giant's Graves South, on the path to Torr an Loisgte, there is a decrease in sea affordance after the sea views are initially revealed at 70m. However, what is different about this example is that the sea affordance values on this path drop to 31.9% at the location of the site, which is a considerable decrease of 42.9%. The path to Baile Meadhonach also exhibits a significant decrease in sea affordance values (Figure 9.19), but not to the same pronounced extent as the path to Torr an Loisgte. Sea views on the path to Baile Meadhonach are completely obscured until the viewer is approximately 290m from reaching the site, at which point there is a dramatic increase in sea affordance, reaching as high as 41% at a point 120m from the site. From there onwards, the sea affordance steadily decreases until the site is reached, where the sea affordance value drops down to 27.6%. To determine how sea views differed as a result of the decreases in sea affordance values seen in these paths, to Torr an Loisgte and to Baile Meadhonach, Horizon panoramas are generated from these locations and then compared with those of the sites.

The sea affordance profile for the path to Glenrickard shows a sudden increase in sea affordance values starting from about 130m and, at 20m from the cairn site, reaching a maximum of 8.2% (Figure 9.19). There is a slight drop of 1.6% in sea affordance before reaching the site. As is the case of Giant's Graves South, it is highly unlikely that such a minimal difference in sea affordance percentages would have translated to a significant effect on the sea area in the observers' visual field. The sea affordance profile for the path to East Bennan indicates a positive increase in sea affordance, of 11.8%, immediately before the cairn site. This path is considered as offering a convincing revelatory view, particularly as sea views are completely concealed until the observer is only 10m from the cairn site (Figure 9.19).

Towards the very end of the journey to sites in five of the six cases described above, there are sudden increases in sea affordance values that are immediately followed with drops in sea affordance—the path to East Brennan is the exception to this trend. As has been noted, all cases can, nevertheless, be considered as persuasive examples of revelatory views, as the relevant sea views are obscured from observers for a considerable distance before they are revealed, regardless of the drop in affordance.

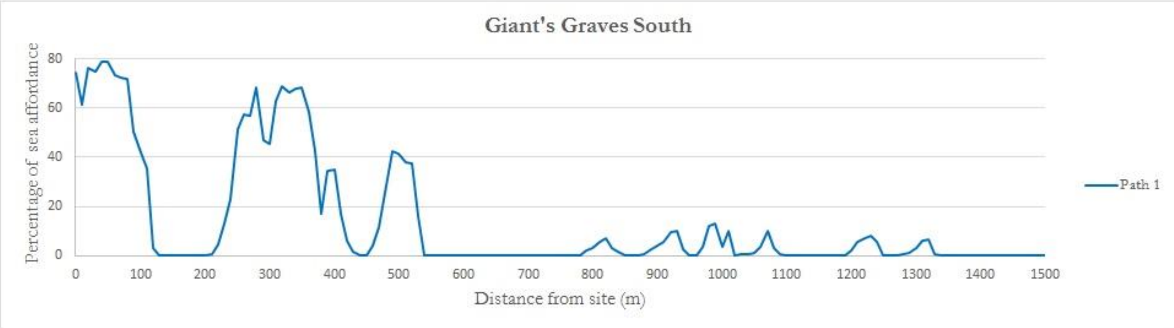
In the cases of Dunan Beag Paths 1 and 2 and Clachaig Path 1, the sea affordance profiles indicate a more gradual increase in values during the last legs of the journeys. On each path to Dunan Beag, sea views are masked for some distance before the points at 780m in Path 1 and 630m in Path 2. Several times before the site is reached, both of these pathways have numerous dips and spikes in the sea affordances before finally dropping to 8.2% at the cairn site. The profile of Path 1 to Clachaig also exhibits sea affordance values at some distance from the site, starting from approximately 580m, increasing gradually from 4.9% and reaching a maximum of 68.9% at the cairn (Figure 9.19).

Many of the paths described above indicate the presence of 'previews', and in many cases they are higher, if not comparable, to the sea affordances found at the cairn sites. Take, for instance, Path 1 to Giant's Graves North, which holds is a significant preview where the sea affordance value reaches as high as 69.7% at approximately 330m from the site. Moreover, on the Path 1 to Torr an Loisgte, there are numerous locations that offer previews of the sea, and at the preview location at 80m from the site the sea affordance reaches 73.5%, which is 2.3 times the value at the location of the cairn. Other previews along that pathway are relatively small in comparison. The sea affordance profiles thus show that, in some instances, prehistoric people were privy to considerable previews of the sea while at other times such views were only fleeting. In an effort to determine whether such previews spoil the effect of any 'dramatic and final reveal' of the sea at a cairn site or enrich it, Horizon panoramas were generated for their locations and compared with those that were generated for the cairn sites, as discussed in the 9.2. The results of that stage of the analysis are detailed further below.

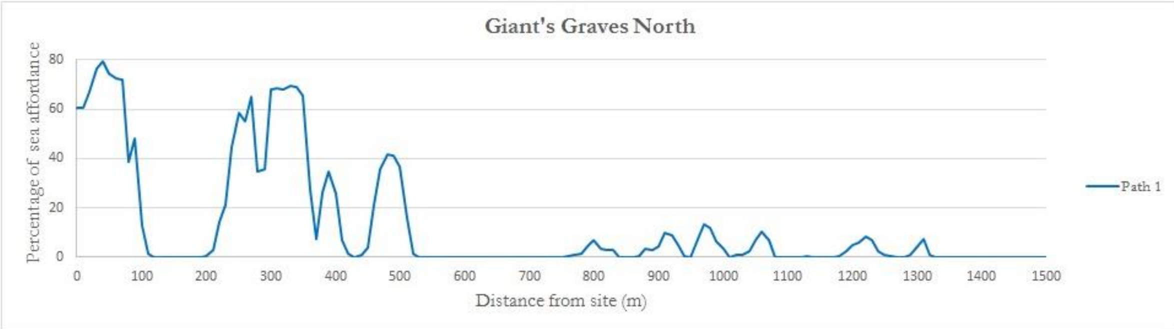
For two further sites, Monomore and Carn Ban, the sea affordance profiles indicate that despite multiple locations along the paths offering considerable sea affordance values, only relatively low and insignificant values are achieved at the cairn sites. In the case of Path 2 to Monomore, sea affordance reaches a value as high as 71.9% at a location 490m from the site. Similarly, at 420m from Carn Ban, sea affordance reaches 39.9%. In both of these instances, these significantly high sea affordances values are found at only short to moderate distances from the respective cairn sites.

In summary, the sea affordance profiles generated for the Isle of Arran show that there are numerous preview locations along the pathways that offer higher sea affordance values than those observed at the cairn sites.[49] These locations pose a problem for the hypothesis that the long cairns of Arran, and Scotland more generally, were placed so as to reference the sea. This is because, if sea views were an integral part of monument construction, these preview locations seem to have been better alternatives for site placement. Moreover, these locations are unlike some of the higher sea affordance zones discussed above, in section 9.2, which may have been rejected due to their higher elevations and distances from cairn sites: preview locations are situated along existing pathways to those sites and are therefore accessible, assuming of course that megalithic builders used these or similar routeways to access their monuments. Yet, preview locations were not preferred, which suggests that other factors played a role in determining where these monuments were to be placed within the landscape.

[49] The only exception to this is the site of Moinechoill, where the sea affordance profile shows values of 0% for the entire length of the pathway (see Figure 9.12).

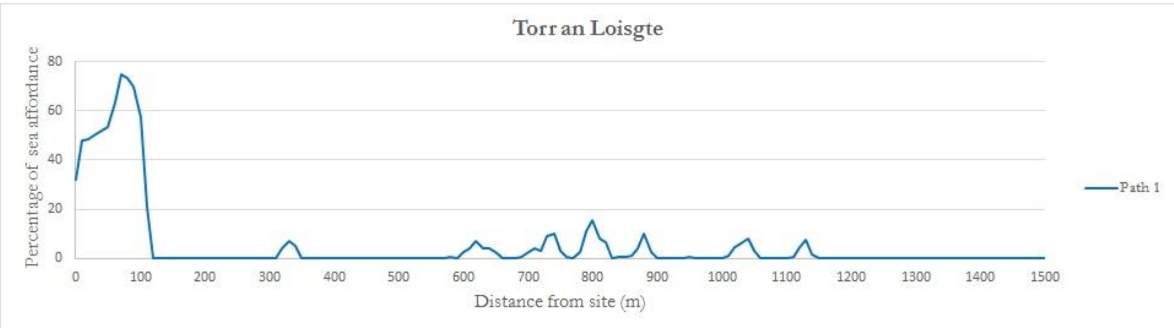


Giant's Graves South
Percentage of sea affordance
Distance from site (m)
Path 1

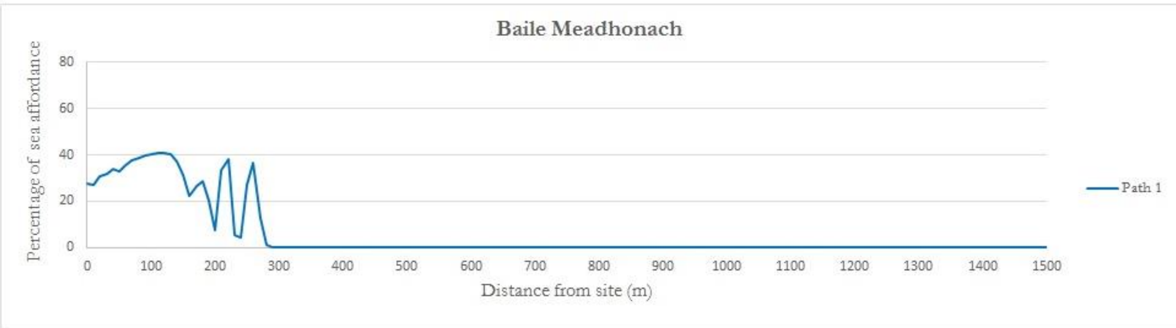


Giant's Graves North
Percentage of sea affordance
Distance from site (m)
Path 1

Clachaig
Percentage of sea affordance
Distance from site (m)
Path 1
Path 2
Path 3



Torr an Loisgte
Percentage of sea affordance
Distance from site (m)
Path 1



Baile Meadhonach
Percentage of sea affordance
Distance from site (m)
Path 1

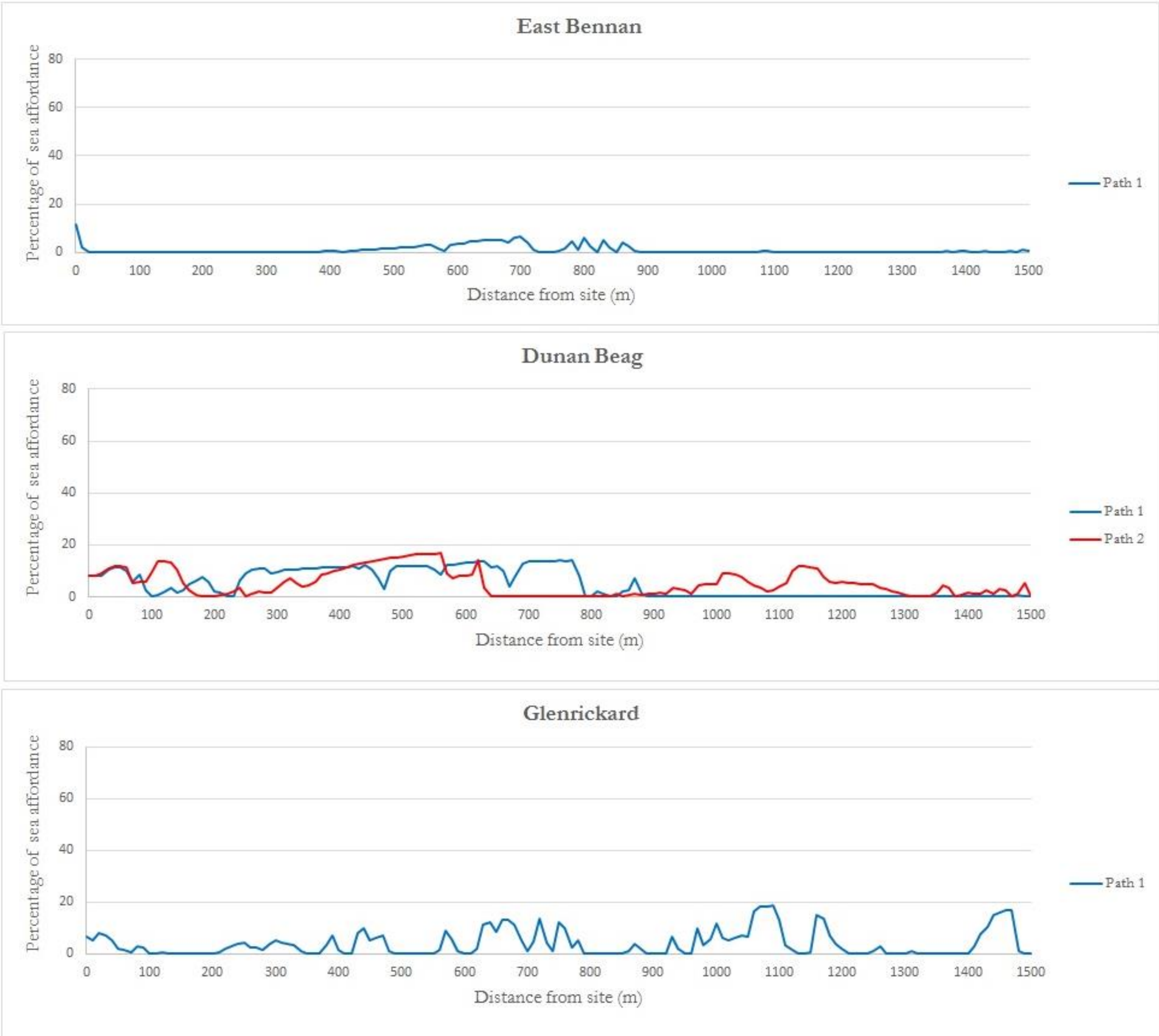


Figure 9.589: Sea affordance profiles of Giant's Graves South, Giant's Graves North, Clachaig, Torr an Loisgte, Baile Meadhonach, East Bennan, Dunan Beag and Glenrickard.

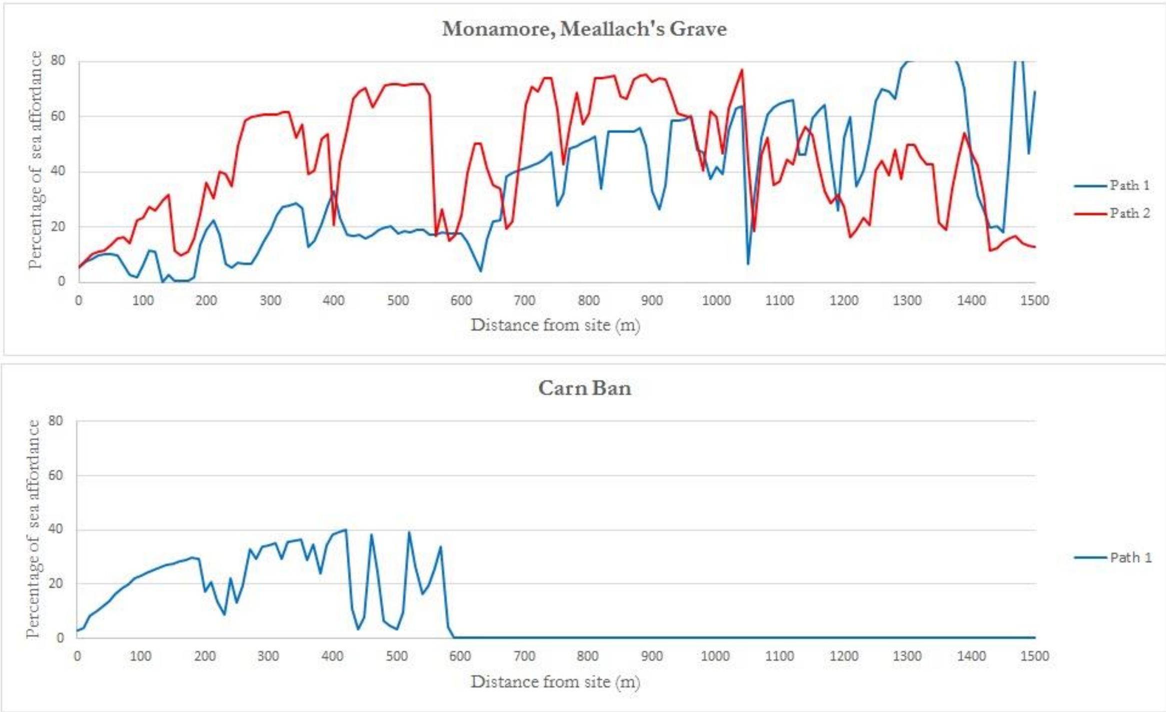


Figure 9.20: Sea affordance profiles of Monamore and Carn Ban.

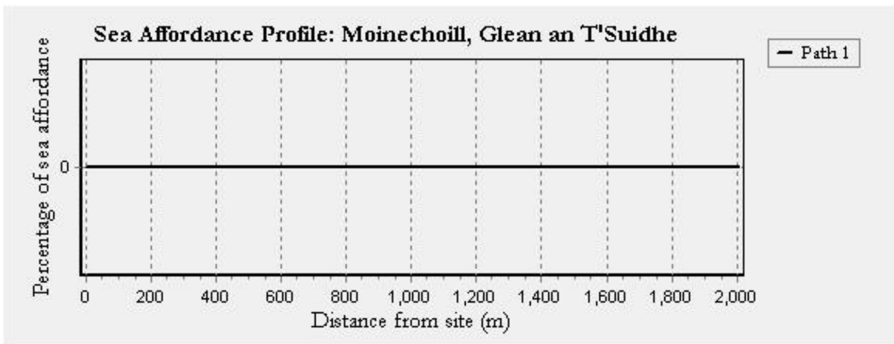


Figure 9.259: Sea affordance profile of Moinechoill, Glean an T'Suidhe.

Investigation of Previews with Horizon Panoramas

To understand whether and how previews of the sea differ from the sea views available from cairn sites, Horizon panoramas were generated and compared for both sets of locations (see Figures 9.24 and 9.25).

East Bennan Preview Location A has a sea affordance value of 6.9%, which is almost half the value found at the corresponding cairn site of East Brennan. The sea views from that preview location span 64º across the horizon, from approximately 121–185º while the views from the cairn site span a comparable 52º, from approximately 159º to 211º. Sea views from the preview location, then, span marginally further across the horizon, but appear only as a faint sliver across the horizon. In comparison, the sea views from the cairn site are considerably more noticeable and prominent even if slightly narrower. In this particular instance, as the preview location only offers a fleeting glimpse of the see, at 700m from the cairn site, it is unlikely to have had any effect to spoil or reduce the impact of the revelatory view from the cairn site. Furthermore, taking into account the impacts of vegetation and atmospheric conditions, there is some question as to whether the sea preview is or was consistently noticeable.

All three preview locations on the paths to Dunan Beag offer slightly higher sea affordances than are found at the cairn site. The Horizon panoramas reveal that the sea views from preview locations A and B range respectively from 135–175º and 119.5–175º. Both of these views, which are along Path 1, are comparable with those that are available at the cairn site. At Preview Location C, sea views span from approximately 125–155º, with another smaller patch of sea, barely visible, between 115.5–119º. Sea views from that particular location appear to be comparatively smaller in the observer's visual field.

At Glenrickard Preview Location A, sea views span from approximately 15–46º, while the views from Preview Location B span from approximately 18.5–49º. A comparison of the Horizon panoramas reveals that these views are comparable with each other and with those available from cairn site, despite being at some distance from each other, at 440m and 720m from the cairn site, respectively, for locations A and B. On the path to this site, prehistoric people seemed to have very similar sea views intermittently, throughout their journey. It is uncertain whether this would spoil the impact that sea views had at the cairn site. This observation also raises the question as to why such alternative locations were not chosen instead, for the placement of the cairn, and suggests that there may have been other qualities at the site location that ultimately attracted prehistoric builders, such as experiential properties with a symbolic significance, or a proximity to settlements, meeting places or building materials.

At Baile Meadhonach Preview Location A, sea views spans from approximately 127–187º and appear to be somewhat more prominent than the views observed from the cairn site, which are narrower, spanning from approximately 138–184º and occupying a slightly smaller area in the observer's visual field. The preview location on the path to Carn Ban also offers greater sea views than are available at the corresponding cairn site. From the preview location, sea views expand from approximately 123–250º and are sufficiently prominent so as to occupy a moderate space in the observer's visual field, while the views from the site appear only as a faint and comparatively narrow sliver of sea. Therefore, in these two cases, respectively, the sea views from the preview locations, from the paths to Baile Meadhonach and Carn Ban, may arguably spoil the effects of the revelatory views available from the two cairn sites. A further possibility is that the preview locations in these instances were disregarded by prehistoric people in favour of narrow views of the sea, perhaps, in reflection of the limited role the sea may have played (Cummings and Whittle 2004, p. 82).

Clachaig has a sea affordance value of 68.9%, with sea views that expand from approximately 108–251º. Three preview locations were chosen to examine how their views compare to those offered at the cairn site. From Path 1, Preview Location A has views that span from 140–227º. Preview locations B and C are found on Path 3 and with views that span from 114.5–288.5º, at Location B, and 114–193º, at Location C. From all three preview locations sea views appear only as slivers across the horizon, without much depth or prominence, although they vary in broadness, with the views from locations A and C spanning much further than the narrow views offered at Location B. It is evident from these comparisons that the sea views from the cairn site location are broader and more noticeable and prominent, occupying a significantly larger area in the observer's visual field.

At Giant's Graves North Preview Location A and Giant's Graves South Preview Location A, sea views respectively span from approximately 5–121º and 6–121º. These views were compared with those from the corresponding cairn sites, which span from approximately 359–7.5º and 15–150º, at Giant's Grave North, and 20–147º, at Giant's Grave South. The Horizon panoramas reveal that sea views are similar in each case. An interesting outcome of the data sets examined (as including the path profiles) is that both preview locations lie at the same short distance from their corresponding cairn sites, at 320m and 330m. This raises the question as to why these particular locations were overlooked, along with other questions such as whether or not the previews they offer could have been intentional, and if so, what may have been their purpose and effect.

Sea views from Monamore appear as a faint sliver, barely noticeable in the distant horizon, from 88–118º, and also present although they are so faint so as to be imperceptible under most if not all conditions, from 35–50º that (as described in 9.2). Both preview locations on the path to that cairn offer sea views that are considerably more prominent in the visual field, spanning in segments from approximately 30–64º and 87.5–113º at Location A, and from approximately 22–125º at Location B. The presence of these locations raise the question as to what led prehistoric people to select the site of Monamore for cairn placement, as the data analysed here excludes the possibility that sea views were a motivating factor in this case.

Torr an Loisgte Preview Location A is another preview that offers more impressive views than the cairn site it corresponds to. It has a sea affordance value of 75.8% and the available sea views span from approximately 359–129º. This stands in contrast to the cairn site, with almost half the sea affordance values, at 39.5%, and segmented sea views, spanning from approximately 0.5–12º, 15–115º and 135.5–140º. The Horizon panoramas show that within some ranges the sea views from the cairn site occupy significant areas of the observer's visual field, however, broader areas of significant views are available from the preview location, to the extent that those views are more impressive. Therefore, in the instances of Monamore and Torr an Loisgte, the respective preview locations offer substantially more noticeable sea views. On the assumption that prehistoric people chose topographic locations to reference the sea and to orchestrate their movement across the landscape to create a revelatory experience, such previews may arguably have detracted from the effects achieved by the cairn sites' revelatory views. However a further possibility which would explain these outcomes is that, as mentioned earlier, it was the intention of prehistoric builders to be able to have a narrow view of the sea at the monument locations.

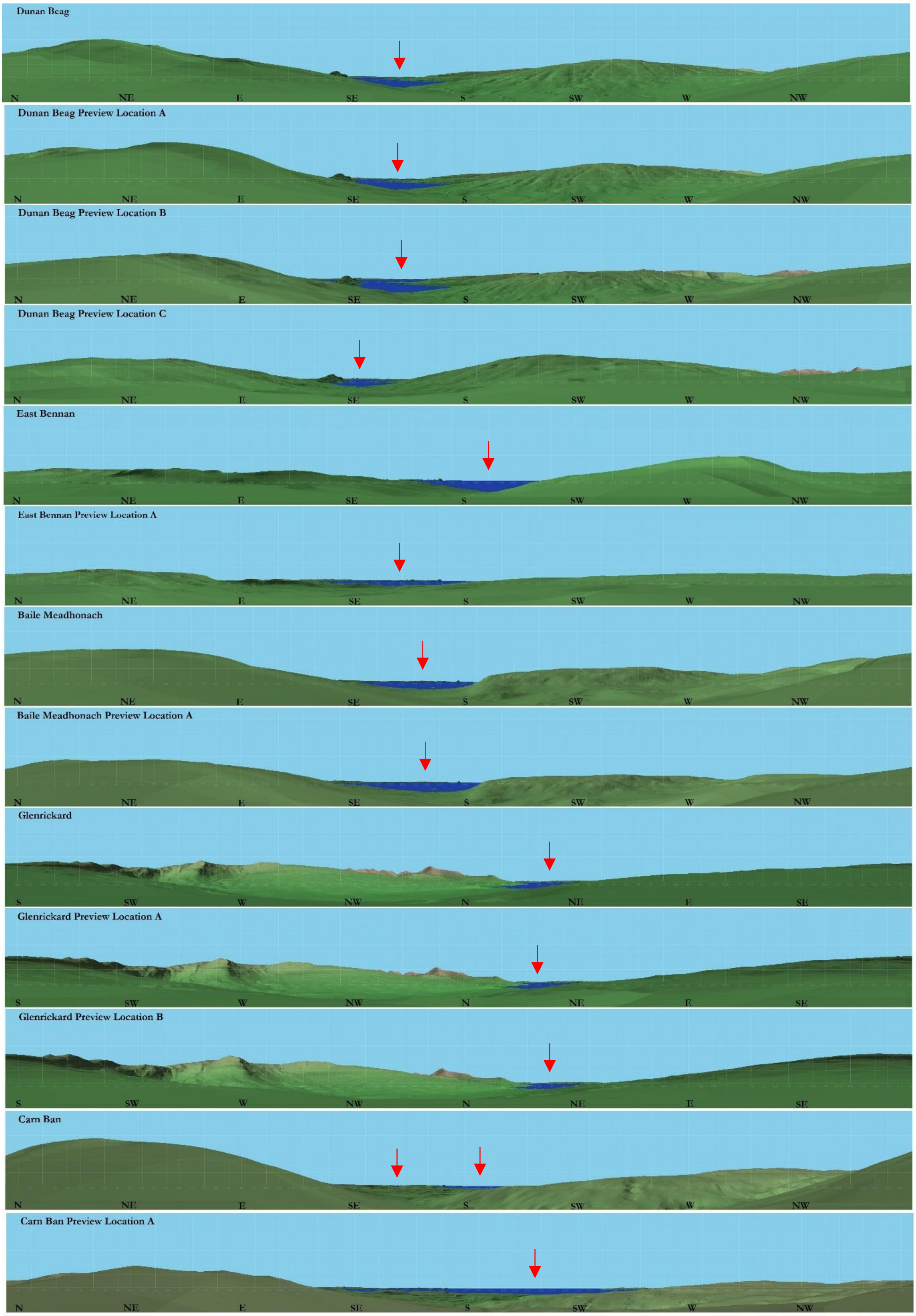


Figure 9.22: Horizon panoramas of sea views for Dunan Beag, East Bennan, Baile Meadhonach, Glenrickard and Carn Ban and respective preview locations.
The red arrows indicate sea views.

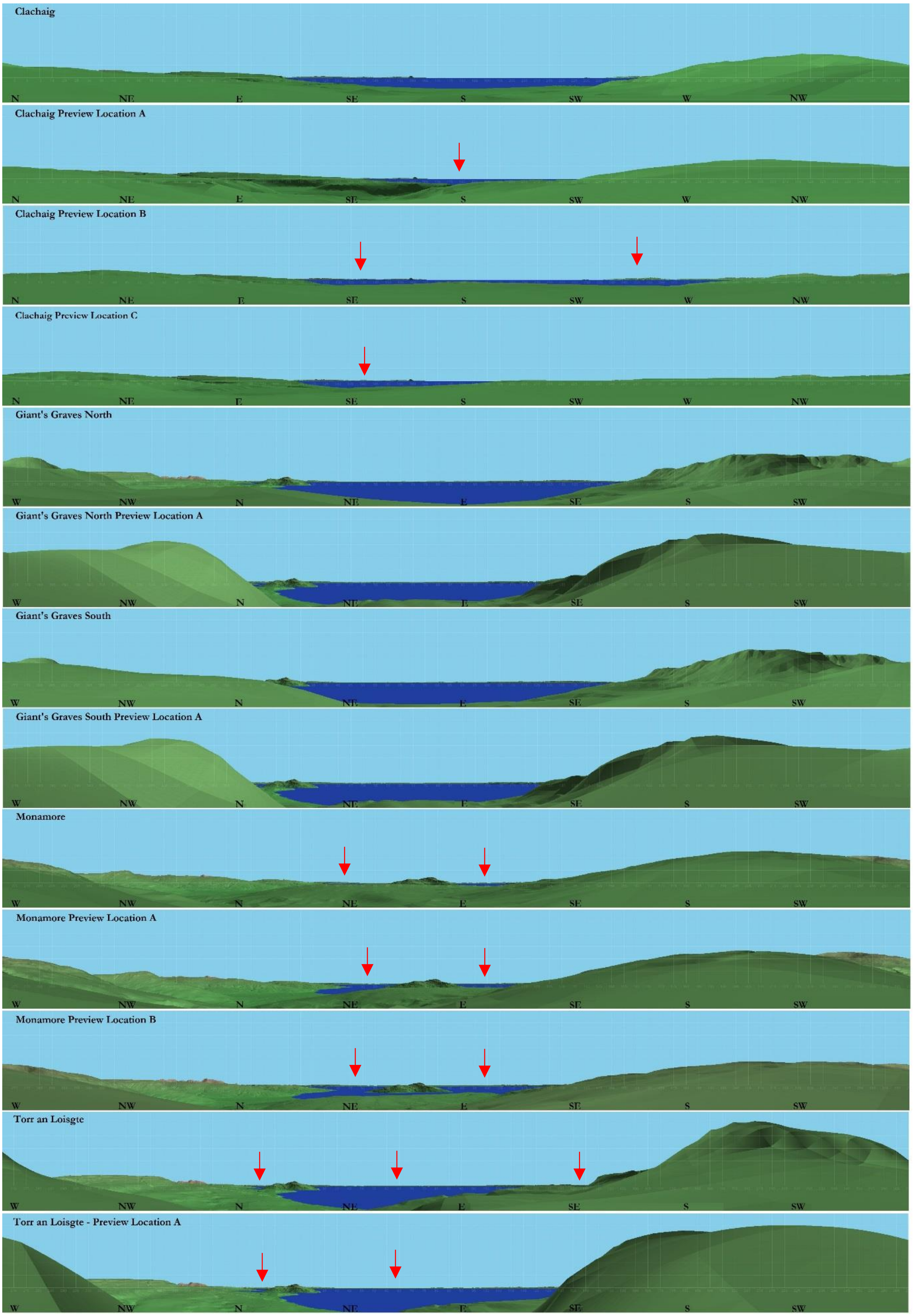


Figure 9.23: Horizon panoramas of sea views for Clachaig, Giant's Graves North, Giant's Graves South, Monamore and Torr an Loisgte and respective preview locations.

Red arrows indicate sea views.

Considering the Effect of Atmospheric Conditions on Revelatory Views and Previews

For each of the preview locations considered above, Horizon panoramas were generated to determine the effects of atmospheric conditions on the available sea views. These findings are shown below, in Figures 9.24 and 9.25.[50]

As described above, the sea views available from the preview sites on the paths to Dunan Beag appear to be comparable with each other and with those from the cairn site under clear atmospheric conditions. This remains to be true to a certain extent when atmospheric deterioration is taken into consideration, as the sea views from Preview Location A and the cairn site both appear when visibility is only 1km, however, the sea views from Preview Location A are shown to be slightly more prominent. Both of those locations offer greater sea views than Preview Location B, under atmospheric deterioration.

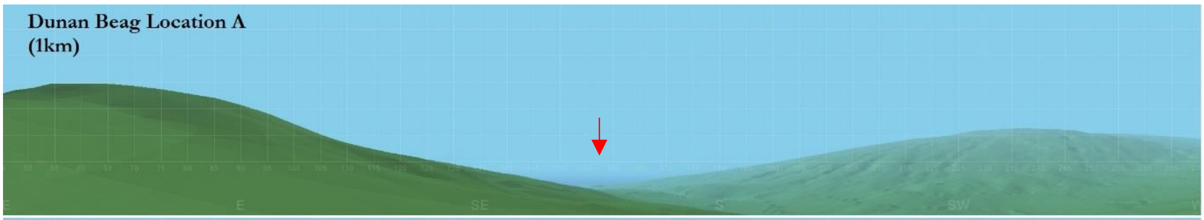
A more pronounced difference between preview location and cairn site can be seen at Carn Ban and the path that approaches it. Sea views from the preview location appear to be considerably more prominent and to range further across the horizon than they do at the cairn site. A substantial portion of the sea comes into view with 4km of atmospheric clarity at Preview Location A, and the full range of sea views are apparent when visibility reaches 9km. This is in stark contrast to the sea views from the cairn site, which require a minimum visibility of 17km for the full range of views to appear. The preview location in this instance, therefore, presents much greater sea views in moderate to poor weather conditions.

Torr an Loisgte and the path that approaches it present a further case where the preview location offers sea views that were revealed to be non-trivially greater under atmospheric conditions. Sea views at both the site location and the preview location are prominent, appearing in the visual range even during extremely poor weather conditions, when there is approximately 1km of clear visibility. However, an examination of the Horizon panoramas shows that sea views are more prominent and occupy a greater area in the observer's visual field at the preview location than they do at the site location. A similar observation is made for Monamore. The full range of sea views from the two preview locations on the path approaching that site not only come into visual range with 2–3km of atmospheric clarity, but they are also prominent under those conditions and occupy a significant area in the visual field. However, the full range of sea views that are

[50] In the cases of Baile Meadhonach and Glenrickard, Horizon panoramas indicate no observable differences between the preview locations and the corresponding cairn sites.

available from the cairn site only start to appear in visual range at approximately 17km of visibility and, as described earlier, even then they are too faint in the distant horizon to be distinctly noticeable. Therefore, in each of these instances, the preview locations are ideal for the placement of these cairns, in that they offer considerably better sea views.

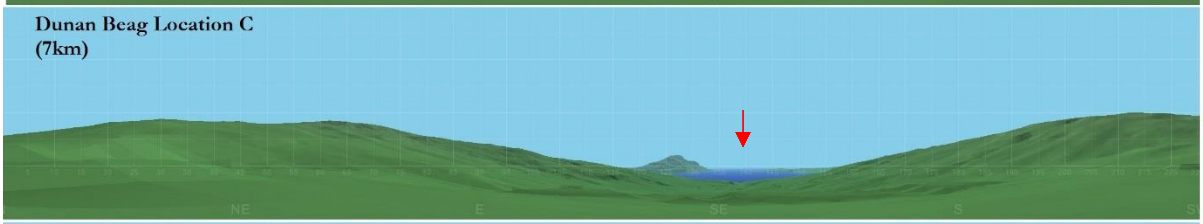
Nevertheless, the reverse is found to be the case at East Bennan, where the sea views from cairn site are prominent and noticeable even during poor weather conditions, requiring visibility of only 1km before they appear. At Preview Location A, a minimum of 3km visibility must be present before sea views are apparent on the horizon, and even then, they are pale in comparison to those offered at the cairn site. Similar observations are also made at Giant's Graves North, Giant's Graves South and Clachaig. In each of these cases, the sea views from the cairn sites come into the visual range for the observer when there is approximately 1km of atmospheric clarity, and appear to be more prominent than the sea views available from the preview locations. These findings suggest that these particular sites were placed in the most ideal locations in terms of their ability to afford sea views.

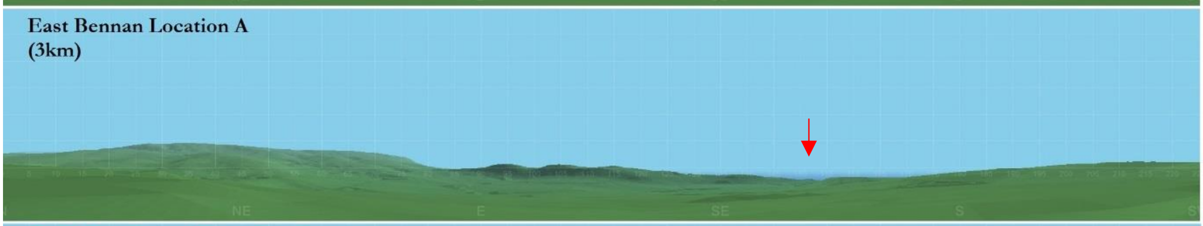

Dunan Beag Location A
(1km)

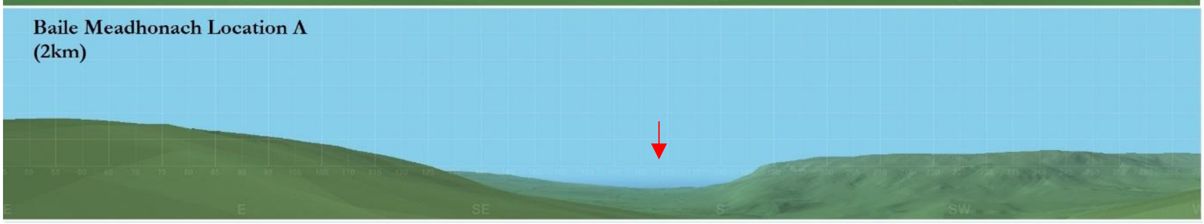

Dunan Beag Location B
(2km)


Dunan Beag Location B
(6km)


Dunan Beag Location C
(2km)


Dunan Beag Location C
(7km)


East Bennan Location A
(3km)


Baile Meadhonach Location A
(2km)

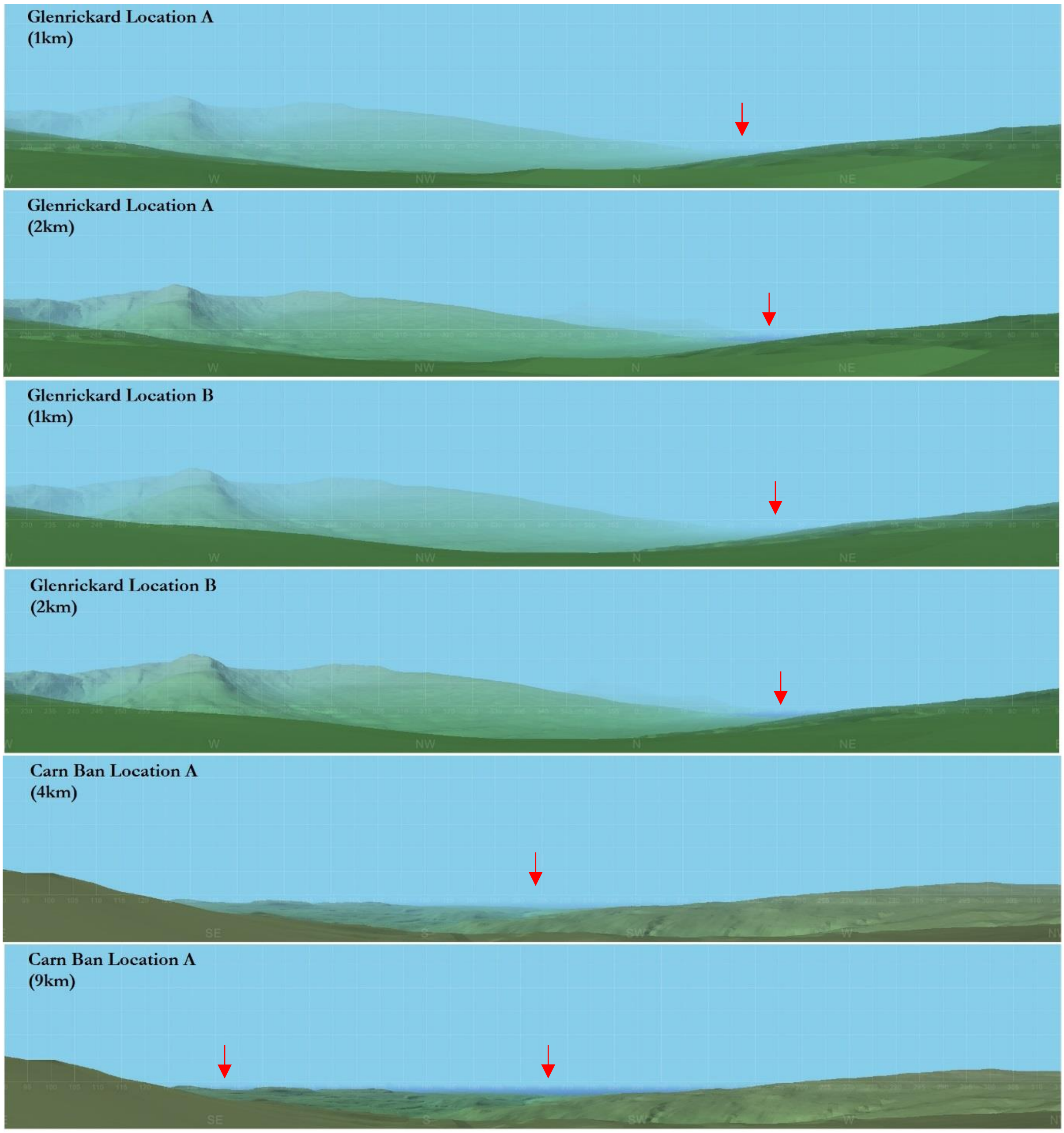


Figure 9.24: Horizon panoramas for the preview locations of Dunan Beag, East Bennan, Baile Meadhonach, Glenrickard and Carn Ban, displaying the effects of atmospheric conditions.
See Figure 9.15, for Horizon panoramas of cairn sites showing atmospheric conditions.

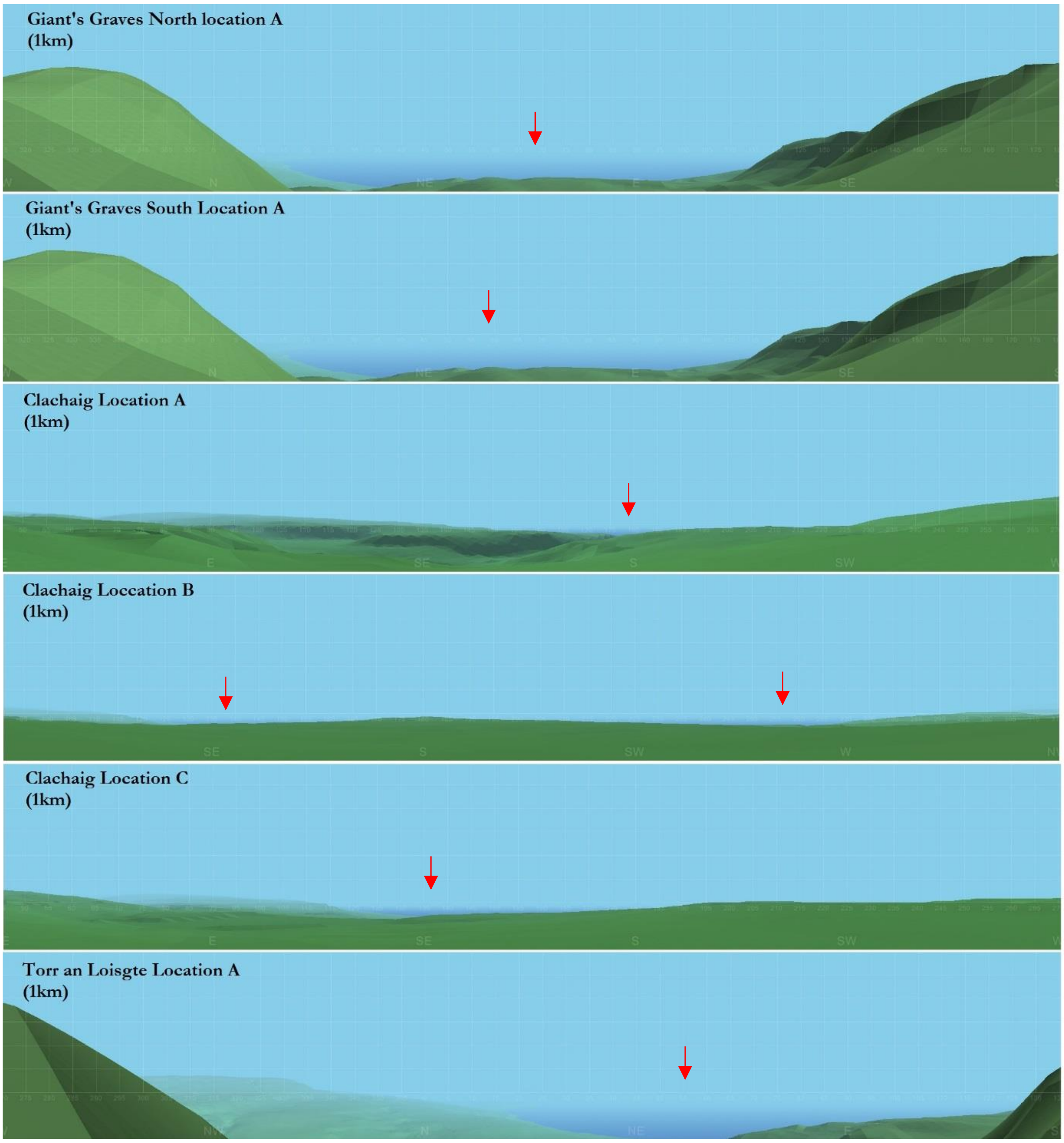


Figure 9.25: Horizon panoramas for the preview locations for Giant's Graves North, Giant's Graves South, Clachaig and Torr an Loisgte, displaying the effects of atmospheric conditions.
See Figure 9.16, for Horizon panoramas for cairn sites showing atmospheric conditions.

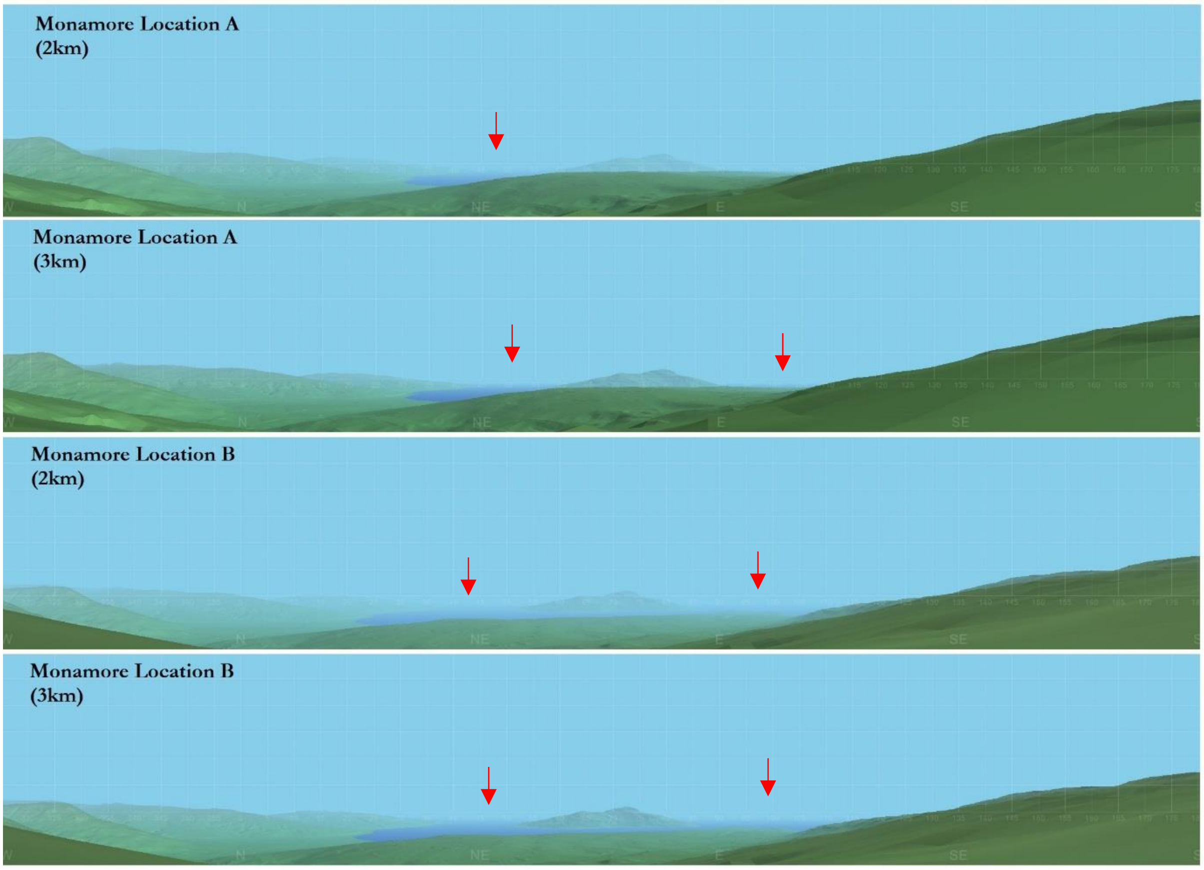


Figure 9.26: Horizon panoramas of the preview locations for Monamore, displaying the effects of atmospheric conditions.
See Figure 9.16, for Horizon panoramas of the cairn site showing atmospheric conditions.

9.4 Alignments of Long Cairns' Axes, Sea Views and Pathways

Orientation of Cairns Relative to Sea Views

To determine whether the long cairns of the Isle of Arran reference the sea, the orientation of the monuments' long axes were compared with the ranges of the available sea views in each instance. In making these comparisons, caution was taken not to overestimate the accuracy of the findings; as the sites of Arran could not be visited in person, the orientations of the monuments' long axes needed to be determined through other means. In the case of this region, Henshall's work, including her site plans (1972), was sometimes used exclusively to gain relevant information about a site, but as described in Chapter 4, Section 2, the orientations of some of Henshall plans from the southwest region of Scotland appear to be inaccurate. This is an issue as the Isle of Arran is found in that region of Scotland. In those instances, long axis orientations deviated from

Henshall's plans by around 10º, which is attributable to the variance in Magnetic North from True North at the time she took her measurements, and it is likely that Henshall did not correct for that variance. As the accuracy of Henshall's plans could not be investigated further, and since they could be incorrect by as much as 10º, the measurements used here were considered as holding a higher margin of error. Hence, only the general cardinal, ordinal and secondary intercardinal directions (ie. N, NW, and NNW, etc.) were used to determine cairn orientations and alignments in this region, as opposed to the precise azimuthal directions (measured in degrees) that were used to determine orientations in the other regions.

It was not possible to acquire site plans or the required information for Tormore I. This is unfortunate as, although that site does not offer substantial or even noticeable sea views (see Figures 9.3 and 9.4), there is a direct alignment between the seaward pathway and the very narrow area where the sea may, in principle, be visible. Hence, the sea's location, if not also any such sea view, may be referenced by a cairn structure oriented in that direction, but whether that is the case was unable to be determined. There was some difficulty in acquiring site plans for Torr an Loisgte, however, some information was given for that monument on the CANMORE database, which describes its long axis as lying in a N–S direction. One site, Moinechoill, is built in a topographic location that achieves 0% sea affordance and does not have sea views with which the monument might otherwise be aligned. Therefore, the alignments of a total of ten sites in this region were investigated.

Each of the ten long cairns analysed showed at least one form of alignment with sea views (see Table 9.7). Eight cairns exhibit axis-alignments with sea views, and because of the expansive sea views available from two of those sites, Clachaig and Giant's Grave South, it could be confirmed that those cairns hold direct axis alignments (despite the higher margin of error for the site plans, as described above). Six of these eight cairns also exhibit side-alignments with sea views, in addition to axis-alignments, and these were able to be confirmed to be direct side-alignments in the cases of Torr an Loigste and Giant's Grave North. The two remaining sites, East Bennan and Carn Ban, hold side-alignments with sea views, and the alignment is direct at East Bennan.

Site name	Direction of seaward pathways	Direction of sea views	Orientation of monument long axis	Part of monument approached by pathway(s)
Clachaig	Path 1 (SW) Path 2 (SSW) Path 3 (SSE)	ESE–WSW (108–251º)	SSE–NNW (153–333º)	proximal end
East Bennan	Path 1 (S/SSE)	SSE–SSW (159–211º)	E–W (98–278º)	proximal end
Tormore I	Path 1 (S)	S (182–182.5º)	N/A	N/A
Carn Ban	Path 1 (SSW)	SSE (150–156º) SSE–SSW (167–197º)	NE–SW (49–229º)	proximal end
Moinechoill	Path 1 (SW)	N/A	E–W (86–266º)	side
Monamore	Path 1 (ESE) Path 2 (NNE)	NE–ENE (34–60º) E–ESE (87–111º)	NNE–SSW (33–213º)	proximal end
Baile Meadhonach	Path 1(SSE)	SE–S (136.5–185.5º)	NNE–SSW (23–203º)	proximal/distal end (uncertain)
Torr an Loisgte	Path 1 (E)	N–NNE (0.5–12º) NNE–ESE (15–115º) SE (135.5–140º)	N–S	uncertain
Giant's Graves North	Path 1 (E)	N (359–7.5º) NNE–SSE (13.5–154º)	S–N (178–358º)	distal end
Giant's Graves South	Path 1 (E)	NNE–SSE (20–150º)	ESE–WNW (102–282º)	proximal end
Dunan Beag	Path 1 (SE) Path 2 (SSE)	SE–S (135–174º)	NNE–SSW (14–194º)	proximal end
Glenrickard	Path 1 (NE)	N–NE (10.5–45º)	S–N (178–358º)	proximal end

Table 9.712: Long cairn, pathway and sea view orientations.

Orientation of Pathways Relative to Sea Views and Monuments

Including the path to Tormore I, 15 seaward paths were identified as potential means of accessing from a seaward direction the 11 cairns sites in this region that offer sea views. All paths offer a direct line of site with the sea except path 2 to Monamore, which forms a general but not a direct alignment with the sea.

There was a certain degree of uniformity in the way that some sites were or could be approached by the pathways. At Clachaig, all three pathways approach the proximal end from angles of between 45–90º to the monument's long axis (see Figure 9.27). Similarly, Path 1 to Glenrickard and Path 2 to Dunan Beag approach the respective monument's proximal ends from their sides at angle of approximately 45º to the sites' long axes. Path 1 to Dunan Beag and Path 1 to Monamore approach towards the proximal ends of the monuments' sides, at angle of approximately 90º to the cairns' long axes (see Figures 9.28 and 9.29). Path 2 to Monamore, however, approaches the monument's proximal end more directly, and in alignment with the long axis of the monument. Comparing the angle of approach with the orientation of the long axes of monuments also revealed that only one site, Giant's Graves North, had a pathway that approaches the monument towards its distal end. The site of Moinechoill appears to have been approached towards its side (see Figure 9.30), while the site of Baile Meadhonach was approached either towards its proximal or distal end, with remains being insufficiently preserved to establish which.

Investigation of the direction of pathways relative to monument orientation revealed that sightlines were found at seven of the ten sites with sea views and available details with which to measure cairn orientations. Four sites had paths that approach the monument towards its proximal end to form a proximal–distal sightline, these pathways were: Path 3 to Clachaig, Path 1 to Carn Ban, Path 2 to Monamore, and Path 1 to Giant's Graves South.[51] No distal–proximal sightlines were found in this region. Six instances of sideway sightlines were found, these were on: Path 1 to Clachaig, Path 1 to East Bennan, Path 1 to Monamore, Path 1 to Torr an Loisgte, Path 1 to Giant's Graves North, and Path 1 to Dunan Beag.

[51] As seen in Figure 9.27, Path 3 to Clachaig approaches on a southerly direction at 100m from the site, momentarily forming a proximal–distal sightline before the angle of approach changes closer to the site.

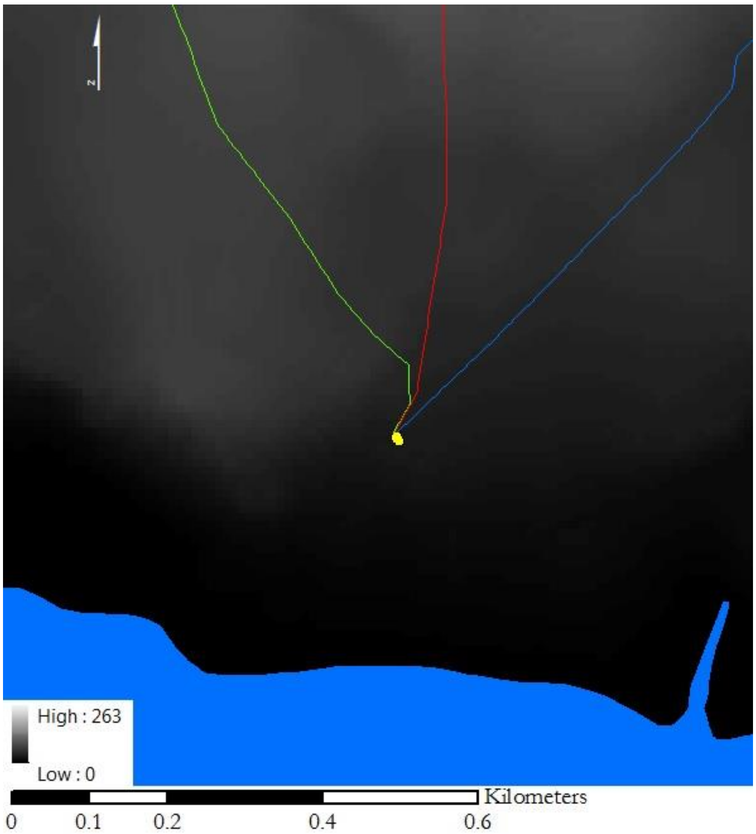


Figure 9.27: Paths 1, 2 and 3 of Clachaig. Paths 1, 2 and 3 approach at angles that range from approximately 45–90º to the monument's long axis.

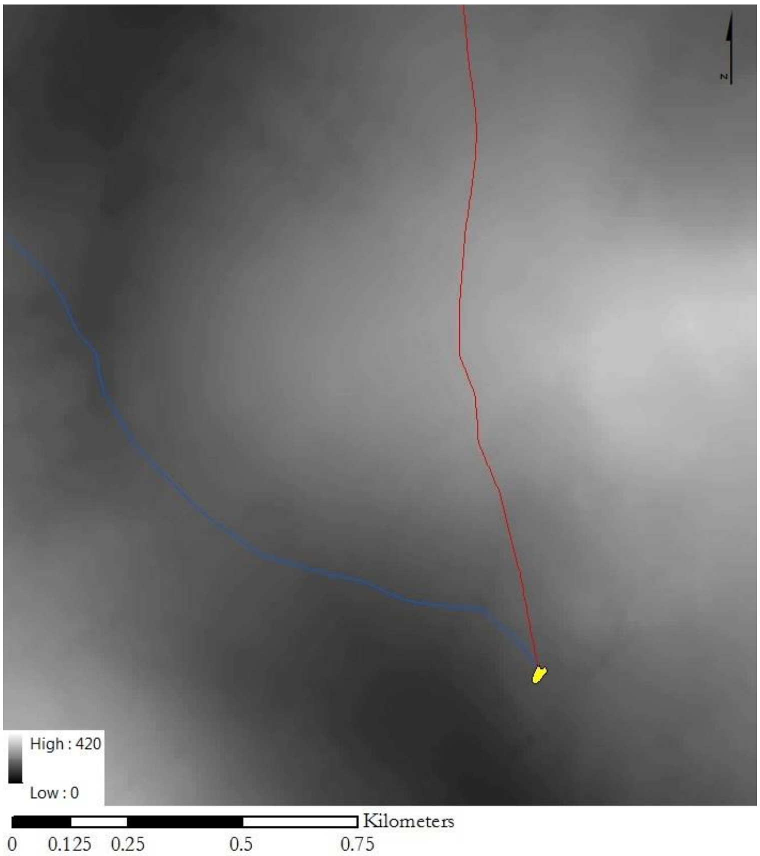


Figure 9.28: Path 1 and 2 of Dunan Beag. Path 1(blue) approaches at an angle of approximately 90º, while Path 2 (red) approaches at approximately 45º angle to the monument's long axis.

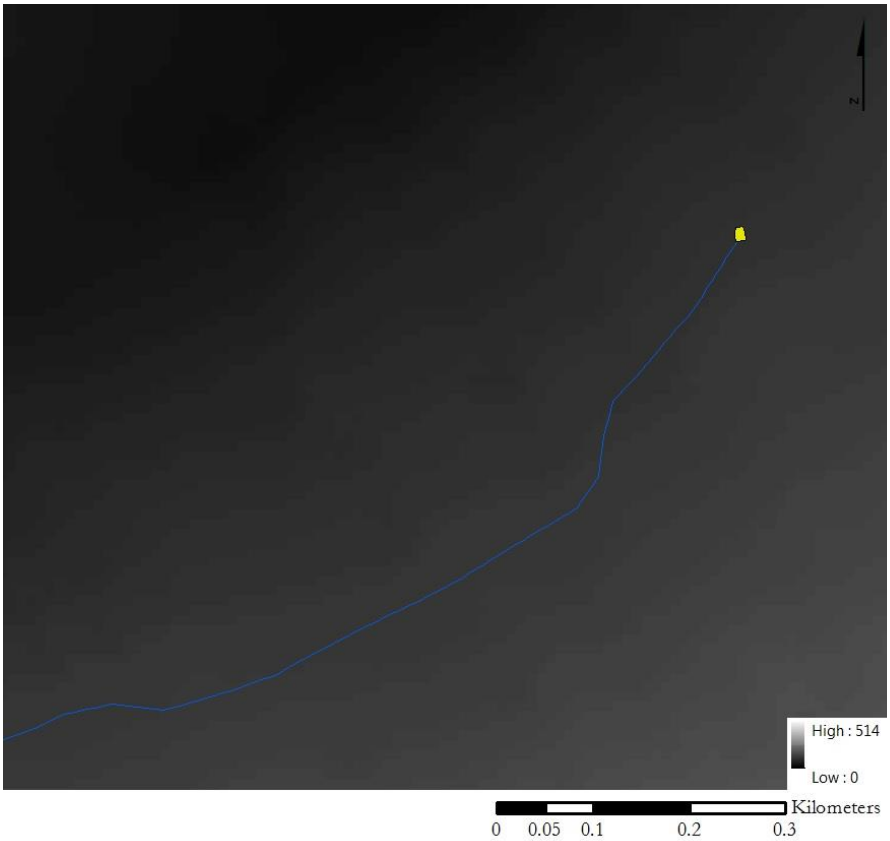


Figure 9.29: Path 1 of Glenrickard. Path 1 (blue) approaches at an angle of approximately 45º angle to the monument's long axis.

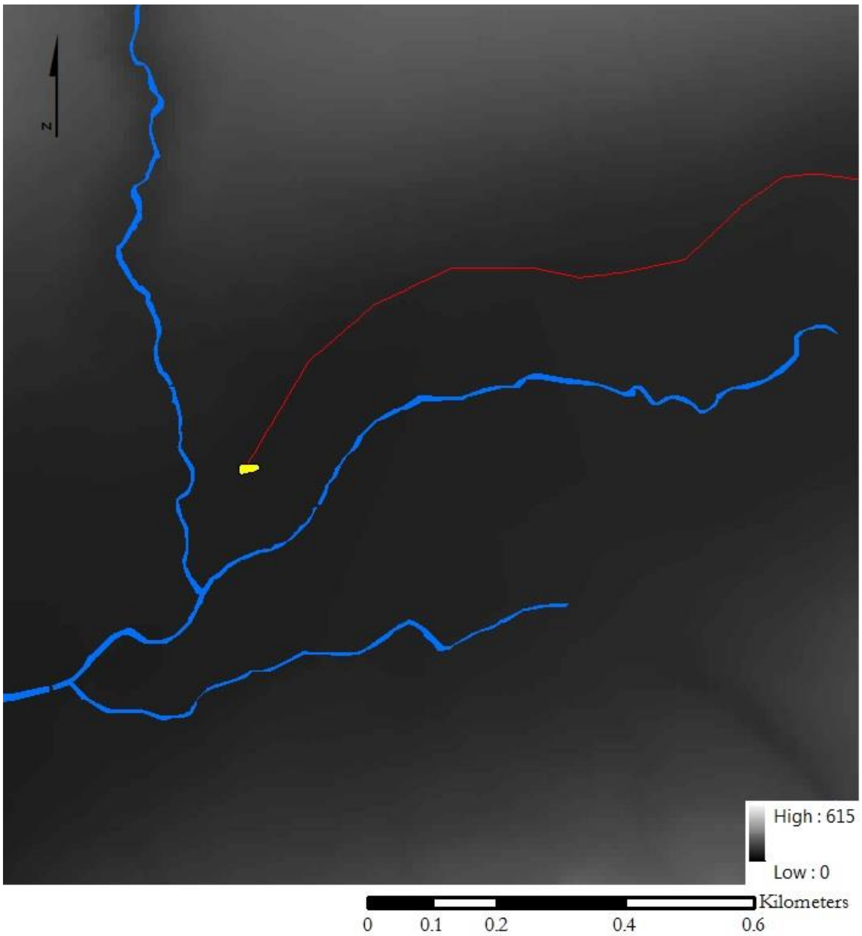


Figure 9.30: Path 1 to Moinechoill. Path 1 (red) approaches towards the side of the monument.

9.5 Summary

As described in 9.2, of the 12 long cairn sites in the Isle of Arran, 9 offer noticeable sea views. Statistical considerations of these sites, described in 9.2, revealed that they are not located in areas that are unique for their surroundings, in terms of sea views. Such an outcome may lead to the conclusion that the prehistoric peoples of Arran did not have a single-minded desire to achieve sea views the places they chose to build their monuments, that there were other motivations for placing monuments where they did. However, that outcome does not discount the possibility that sea views were important to those peoples, and more relevantly, that their monuments do not somehow reference the sea in their construction. Thus, further investigation, in terms of qualitative analysis, was carried out to examine the ways in which these cairns were placed within the landscape as well as what kinds of location choices were available for the prehistoric peoples that lived there. In a small number of locations, cairns seem to be placed to maximize the sea views available on the paths that approach them. However, it was also frequently found that in areas where great sea views are abundant, sites were not placed to maximize those views. Rather, in such cases, it seems that sites are placed more or less consistently so as to afford a sufficient degree of sea views. Nevertheless, confirmation for the tested hypothesis was found in the high numbers of alignments between cairn structures and sea views, with all such sites having some form of alignment with the sea. Further confirmation was also found in the seven of ten sites with sea views demonstrating at least one form of sightline.

Chapter 10: Discussion of Results

This chapter presents and contrasts the findings of the investigations carried out for the five regions of Dumfries and Galloway, Argyll and Bute, the Highlands, Aberdeenshire, and the Isle of Arran. Common trends are identified and differences in outcomes for the regions are considered alongside the regions' particular characteristics. Section 1 compares the results of the statistical analysis of sea affordance surfaces and the preliminary assessments of the sea views offered at cairn sites and their surrounding landscapes. Section 2 compares the results of the qualitative assessment of the landscapes surrounding the cairn sites, which involved the investigation of the possibility that there may be alternative sites for cairn placement that offered greater sea views than are available from cairn sites. Section 3 compares the results of the investigation of whether cairn sites offer revelatory views of the sea. Section 4 compares the alignments evinced by long cairn axes and the sea and the pathways that approach them. Section 5 provides an overview of the investigation and discusses the implications of the findings for interpreting the long cairns of Scotland.

10.1 Consideration of Sea Affordance Values and the Sea Views at Cairn Sites

To test the hypothesis that the long cairns of Scotland were placed so as to reference the sea, the first step in the analysis of each region involved generating sea affordance surfaces and verifying those surfaces with Horizon panoramas. This allowed recordings to be made of the kinds of sea views available at each site and how those views may compare with the views available from the surrounding areas. This step resulted in a negative outcome for the tested hypothesis: significant numbers of cairn sites did not afford sea views, and it was also found that for four of the five regions under investigation, long cairns were not placed in locations that offer higher affordance values than could be expected from a random distribution of sites.

The region of Aberdeenshire was an exception. A high proportion of the sample of sites under consideration for that region offered sea views and were placed in locations that had higher affordance values than could be expected by chance. However, in terms of the scale of the present study, Aberdeenshire holds only nine sites that are within a sufficiently short distance to the sea to be considered coastal. The result observed for that small number of sites cannot, then, be interpreted as representative or as having a significant bearing on the trends observed throughout the other regions of Scotland. Hence, the findings of this step of the analysis for all five regions taken together may seem to stand firmly against the hypothesis under consideration, and suggest that long cairns are not placed so as to reference the sea. Thus, this result may call into question models of landscape that maintain that the sea played a role as a central motif for cairn builders and one that influenced the construction of cairns and other such monuments (see Cummings and Fowler 2004, p. 82, Richards 1996a, p. 203, 1996b, p. 317; Rudhardt 1987, pp. 350-58). However, there are several reasons as to why the negative result from this step should not be taken as a definitive indication regarding the hypothesis's veracity.

First, the aforementioned outcomes were found via two separate forms of statistical analysis: a chi-square significance test, which analysed all sites collectively in each region; and a 'surrounding area test', which involved an examination of the area surrounding each site on an individual basis, within radii of 500m and 1500m. The results of the surrounding area tests shed some light on the relevance of the particular findings made from the chi-square significance tests. The sea affordance surfaces indicated that a substantial number of sites in each region were placed in areas that offer little to no sea views, and this suggests that those sites are placed within landscapes that may have had significantly less association with the sea as compared with sites that are located in areas where sea views are prevalent or at least obtainable. Therefore, the inclusion in the chi-squared significance tests of sites not associated with the sea may have led to a dilution of otherwise observable trends in site placement. As sea views in many areas in Scotland are often unavailable outside a distance of 2km from the coast, the negative outcome for the hypothesis may therefore be, at least in part, explained by the generous distance of 10km from the coast that determined which sites would be included in the analysis.

The stretch of land of 10km from the coast was used to define the study areas for two main reasons. As explained in Chapter 4, Section 3, the 10km distance was considered as appropriately demarcating the limit to what could generally be considered a coastal region. This decision was based on the assumption that coastal-dwelling peoples may have had an interest in the sea (Cummings and Fowler 2004, p. 82, Richards 1996a, p. 203, 1996b, p. 317; Rudhardt 1987, pp. 350-58). Thus, if they had an interest in referencing the sea with their constructions, it might also be plausible that they would place their monuments in locations that afforded views of the sea. If such assumptions hold true, it might be expected that there would be a tendency for sites within a certain distance of the coast to be placed closer to the sea and in locations where sea views are available.

A second main reason that the 10km stretch of land from the coast was chosen to define the study areas is that, after a preliminary assessment of the generated sea affordance surfaces, it was found that sea views could, at least in some regions such as in Aberdeenshire, often be found within such a distance inland, even if that was not always the case. Hence, it was deemed important to include in the analyses sites with such sea views. Applying the rule uniformly across all regions, by including sites within a 10km stretch of land from the coast, was considered an appropriate way through which that could be accomplished. A further and associated factor also taken into account was that water bodies such as rivers, sea lochs and small firths could, in places, extend for some distance inland. Hence, a means of incorporating such areas in the analysis was to include the expansive area from the coast that is defined by the 10km buffer.

However, as noted above, a drawback of using the inclusive 10km stretch of land, as opposed to a more modest distance from the coast to define the study areas is that it led to the inclusion in the chi-square significance tests many sites that are positioned in areas that are utterly devoid of sea views. Inside the inclusive 10km study areas there are, for example, locations where the sea may not have been easily accessible. This occurs in much of Caithness, where cliff faces make the coastline less accessible and, consequently, visibility of the sea is lost within a short distance of the coast. In other locations, there are arable stretches of land at a distance from the coast that occur together with available water sources. In such areas, prehistoric people may have had a decisively limited association with the sea. The long cairns of Aberdeenshire may, however, present the exception that proves the rule: in Aberdeenshire, the topography affords long-distance views of the sea with reasonable consistency, so that the inhabitants of the landscape may have had an association with the sea—whether symbolic or practical—even at the greater distances from the coast that fall within the study area. Therefore, in the instance of that region, the chi-square significance test was capable of detecting a trend in site placement in terms of sea affordance values. Yet, in areas where such views are rare, the inclusion in the data set of sites that are found that far inland may have led to a dilution of trends that might otherwise have been detected.

A reduction in the 10km distance from the coast that defines the study areas might, then, be one way to improve the ability to detect trends through a statistical analysis, such as a chi-square significance test. However, an outcome of that strategy would also be to reduce the sample sizes of sites tested. As the current sample size is already modest according to other statistical studies (cf. Hoskin 2001), that was not deemed to be a suitable option. A further method of increasing the ability to detect trends in site placement may simply be to set a threshold for what constitutes an area of land that holds sufficient association with the sea, in terms of sea views. This may be identifiable through sea affordance values: areas that have sea affordance values below a set threshold might be excluded from the significance tests on the grounds that they do not present environments that are likely to offer the same kinds of opportunities for prehistoric people both to gain sufficient association with the sea and to reference the sea through their monumental constructions, such as long cairns. Nevertheless, despite the availability of such an avenue for further analysis, there are further reasons which will be outlined below as to why trends in site placement may be undiscoverable through a statistical analysis of differential sea affordance values alone. These reasons came to light after consideration of the results of the aforementioned surrounding area tests, which investigated site placement in terms of sea affordance values on a site-by-site basis as opposed to by collectives of sites considered region-by-region.

It was found that, when investigated on a site-by-site basis, long cairns do not appear to be consistently placed in locations of unique or better than average sea affordance, even in areas where sea views are present. Again, such a finding may seem to stand against the hypothesis that the long cairns of Scotland's coastal regions were, at least often, placed so as to reference the sea, as has been suggested by Cummings and Fowler (2004). However, such a conclusion may be premature in light of other factors that may determine site placement. Take, for instance, one of the many occasions where a cairn site is situated in a landscape that is heterogeneous in terms of sea affordance, and where it is placed in neither high nor low affordance for its area. An example of this situation is the site of Boreland, in Dumfries and Galloway, discussed in Chapter 5, Section 1. The surrounding areas contain locations that are both high and low in sea affordance values (and, hence, it is a heterogeneous sea affordance area), and yet the cairn site holds comparably average sea affordance values—that is, neither high nor low sea affordance values. In such cases, there will be predictably higher levels of sea affordance, and correspondingly better sea views, on hill-tops and ridges. Yet, it is precisely those elevated areas that may also be unsuitable for site placement due to reasons of accessibility and as viable locations to which building material may be transported.

Associated with these points is Henshall's (1972) observation that sites may often be placed on the sides of hills and not on prominent locations due to a need to find shelter from Scotland's harsh weather conditions. For instance, safety from strong winds that could also be laden with sleet may have proved to be more valuable than the views afforded from hill-tops or other open spaces. Yet, there are many counterexamples that demonstrate otherwise. One such case may be Beacharr in Argyll, analysed in Chapter 6, which is placed on an auspicious location that offers no shelter from winds and yet affords spectacular 174º panoramic sea views (see Figure 10.1). Hence, shelter from winds may not have been a factor of significance for monument location choice in that case. However, it may also be plausible that the location of Beacharr was simply too attractive despite possible weather conditions, an inference that is supported by the case of Gordon in Aberdeenshire (Figure 10.2), another example of a cairn being placed on location that is exposed to winds and yet offers spectacular sea views.

Figure 10.60 Beacharr in Argyll offers spectacular views and is not placed in a location that affords shelter from winds.

Figure 10.2 Gourdon in Aberdeenshire offers spectacular views and is not placed in a location that affords shelter from winds.

An associated observation weighs against the utility of the statistical consideration of affordance surfaces. Monuments often sit within natural bowls or valleys in the landscape, or along contours in ways that aesthetically position them so as to accentuate or frame their features and dimensions, arguably contrasting them with their surrounding environments and the cosmos beyond (cf. Higginbottom 2020, Richards 1996a). If such monument positions were chosen preferentially, this would also explain why hill-tops or the higher parts of hill-sides were often disregarded for site placement, and thus why sites often do not have high or particularly high sea affordance values for their areas even if, *ex hypothesi*, builders maintained an interest in referencing the sea with their constructions. Examples that support this explanation include Cairnholy I, in Dumfries and Galloway, and Caen Burn, in the Highlands (see Figures 10.3 and 10.4).

As the analysis in Chapter 5, Section 2 indicates, greater sea views than those offered at Cairnholy I are available from nearby locations. Yet, the cairn site may have been chosen over such alternative locations in virtue of the way that the surrounding landscape frames or nestles the monument (see Figure 10.3), which is surrounded by gentle hillslopes on all sides except the side on which the sea is located. This positioning may have been intended to achieve a certain aesthetic effect that suggests relations between the cairn site to the wider cosmos, relations that are auspicious in light of the fact the its long axis is aligned within three degrees of both vernal and autumnal equinoxes' rising and setting suns. The available sea views may, thus, have been an important component of the cairn's landscape, but only one such component among the variety of features it exhibits.

Caen Burn in the highlands is situated on an elevated plateau that lies below the surrounding hills. When viewed from the site location, the hills seem to frame the cairn, accentuating its features. Moreover, viewed from below, the cairn looks more imposing and impressive in virtue of the height it gains from the elevated platform on which it rests. Caen Burn is also positioned in one of the only locations at the same elevation in its area that offers views of the narrow stretch of sea in the distance (see Figure 10.4). Hence, the site's positioning is consistent with the notion that prehistoric people primarily favoured a position for placement in an area that held the appropriate aesthetic features. After such a primary criterion was satisfied, a more specific location in the vicinity could be chosen so as also to reference the sea with the monument itself. If these or similar criteria determined builders' location choices, it is to be expected that sites would not have unusually high sea affordance values in comparison to their immediate landscape contexts; locations with high sea affordance values, such as hilltops and ridges, may have been disregarded for site placement due to those locations not being able to frame a monument in the desired way.

Aside from aesthetic considerations, hilltops and ridges may also have been avoided for purposes of practicality, in terms of building a stable cairn structure and in terms of supplying building material to the site. Thus, it should be expected that cairns are not placed on pieces of land that are on steep slopes, notwithstanding the sea views such locations offer. Similarly, for a location to be viable for cairn placement, prehistoric peoples must have been able to access the location while carrying the necessary building materials to assemble the cairn, which often involved megaliths in addition to vast amounts of smaller stones. Thus, the lie of the land would be expected to reduce considerably the areas in which cairns could be constructed in a way that was practical, affecting the degree to which cairn sites are placed in areas of high sea affordance.

Figure 10.3: Cairnholy I in Dumfries and Galloway is situated in the landscape in a way that aesthetically frames the monument. Gentle slopes and hills surround the monument on all sides except for the side facing the sea.

(Top Left: The front of the cairn façade or forecourt with hills in the background. Top Right: The sea view is present when looking to the left [south] of the cairn from the forecourt. Bottom: The view from the cairn's distal end toward the proximal end showing hills in the background. While the forcourt is visible, the cairn material is covered in grass.)

Figure 10.4: Caern Burn in The Highlands is situated on an elevated plateau that lies below surrounding hills while also offering sea views.

There is a potential alternative that holds the self-same implication to the aforementioned explanation. Namely, that monuments may be placed along pathways through the landscape so that the sites acted as waypoints, landmarks (Wheatley et al. 2012), or as centres for social interaction between contiguous or distant peoples (Johansen et al. 2004). Thus, statistically insignificant sea affordance values at many cairn sites might be attributable to their being placed along the pathways that prehistoric people used for traversing the landscape. While these pathways may often be elevated above other areas of the landscape, they will also necessarily avoid the highest peaks and hilltops that would otherwise require peoples to travel up and down in elevation. Such pathways will often avoid the highest areas of topography in terms of elevation, which are also usually the areas with the highest levels of sea affordance. As discussed in Chapter 4, Section 5, these pathways also avoid the low-lying areas prone to flooding. Hence, this explanation would also account for the particular placement of Caen Burn, described above (Figure 10.4). Location choices may, therefore, have been primarily determined by how pathways cut across the landscapes concerned, and in a majority of cases this may have excluded the use of locations that offered the highest sea affordance values in the respective landscapes. However, this is not to say that the ability to reference the sea with a cairn site was not at least a secondary criterion that determined site placement. Hence, it is altogether plausible that the low and statistically insignificant sea affordance values observed at cairn sites is consistent with the hypothesis considered in this thesis holding true at many of the cairn sites considered, and that such sites were indeed intended to reference the sea.

The differential survival of cairn sites may also go some way towards accounting for the results obtained from the statistical analysis of long cairn distributions. As described in Chapter 3, Section 4, it is widely accepted and understood that cairn material has been used and reused in the construction of post-prehistoric monuments and buildings and that such activity has led to the disappearance of long cairns in certain areas where they may once have been prominent (Henshall 1972, Phillips 2002). This has led to the disproportionate survival of cairn sites, so that they are more frequently found in the less populated areas of the Scottish landscape. Unfortunately, since human settlement patterns follow lochs and rivers, many long cairns that were once positioned with such bodies of water in view may have long since been destroyed. Among other locations, the areas encompassed by Inverness, Glasgow and Edinburgh, for example, may all have contained many long cairns that once overlooked Loch Ness, the River Clyde, or the Firth of Forth, but which are now undetectable or, perhaps, might only be detectable through geophysical survey.

For the reasons outlined here, it remains plausible that prehistoric people intended to reference the sea through monument construction, despite the results for the first step of this investigation indicating that long cairns are, generally, not placed in locations of uniquely high sea affordance for their respective areas. Statistical analysis of the sea affordance surfaces may, therefore, have limited utility, and this is particularly the case for the investigation of regions that are especially hilly; where relative shelter from the elements is possible; where aesthetic considerations may override those regarding sea views; and where specific pathways through the landscape are of particular importance.

In these respects, Aberdeenshire may once again present the exception that proves the rule. In addition to sea views in that region extending for a greater distance inland than in other regions, its landscape is not quite as hilly as many of the other regions in Scotland. Cairns in Aberdeenshire are, accordingly, found on wide, open and flat plateaus with views that extend far out to sea. The topography of that region may have afforded less-restricted routeways and given prehistoric peoples a chance to select from a wider variety of locations for site placement that also afforded sea views. Moreover, in such areas, it may not always have been practical, possible, or desirable to situate cairns so as to nestle them in the contours of the landscape to achieve an aesthetic effect. The findings of the first step of the investigation are not, then, definitive in establishing that the long cairns of Scotland were not placed so as to reference the sea, or that prehistoric people had no preferences to do so. Further investigation into that possibility would need to be carried out on a qualitative level in terms of the examination of the particular landscape contexts in which the sites are situated, on a largely one-by-one basis, as opposed to the widescale examination of site locations in each region, as considered above.

In considering as a collective the long cairn sites in Scotland's coastal regions, there did not seem to be any particularly obvious pattern or trend in the sea views they offer, where present. Sea views were sometimes in a SE direction, in the direction of the rising sun, but this was not a consistent finding. Moreover, as mentioned above, there were also many site locations that did not offer sea views. The findings offer some support for Cummings and Whittle's (2004, p. 82) suggestion that prehistoric builders may have had a preference for narrow over broader and expansive sea views. Their contention is that this may mark the extent to which the sea played a role in the lives of monument builders, such that the narrowness of these views 'signif[ies] the diminishing role of coastal resources' (Cummings and Whittle 2004, p. 82). However, in certain regions it was also found that, if an observer is placed at a sufficient distance inland, surrounding hills would obscure much of the sea, leaving only narrow views. Hilly landscapes would often, therefore, necessarily lead to sea views being narrow, which significantly reduces the likelihood that narrow views in those landscapes were intentionally achieved at cairn sites: if sea views were valued at all in such landscapes, the fact that those views were narrow as opposed to expansive is, therefore, likely to have been an unintended consequence of their hilly surrounds. Open landscapes characterised by flat plateaus, alternatively, offer wide and expansive sea views, and these would appear as mere slivers on the horizon the further inland the cairn and observer is situated. Such open landscapes could be found with greater frequency in Aberdeenshire and in much of the Highlands. Hilly landscapes were more often found in Scotland's South West, in the regions of Argyll and Bute, Dumfries and Galloway, and the Isle of Arran.

10.2 Study of Alternative Locations

As described above, the vast majority of the long cairns considered were found to be placed in locations that did not have above-average levels of sea affordance respective of their surrounding areas. Nevertheless, for the reasons outlined above, these findings are insufficient to refute the hypothesis (Cummings and Fowler 2004, p. 82, Richards 1996a, p. 203, 1996b, p. 317; Rudhardt 1987, pp. 350-58) that the long cairns of Scotland's coastal areas were constructed so as to reference the sea, that is, when it was possible and practical for their builders to do so. Further investigation into this notion was carried out through a qualitative consideration of the landscapes surrounding long cairn sites and the sea views available in those areas, as described in Chapter 4, Section 4. The aim of this step was to assess the availability of sea views in the landscapes surrounding cairn sites. This would reveal whether cairns were placed either in locations that afforded the greatest sea views in their given areas, or in locations that offered sufficient sea views so as to enable the respective monuments to reference the sea.

While the quantitative consideration of sea affordance surfaces, for regions as collectives, only offered confirmation of the tested hypothesis for the region of Aberdeenshire, a different result was obtained from the qualitative investigation of sites in the five regions. A distinct pattern was found in the data that, for a majority of the sites examined, long cairns appear to be placed preferentially to afford sea views. This pattern was revealed after certain conservative assumptions were made. It must first be assumed that prehistoric people were insufficiently motivated to travel too far across the landscape, to find locations for cairn-placement that afford greater sea views that what were available at closer locations. It must also be assumed that such people would avoid areas of higher elevation beyond a certain limit, purely to build monuments on locations that afford greater sea views than otherwise. Under these conditions, the general finding was that there were few alternative locations that offered decisively greater sea views than those offered at corresponding cairn sites. If these assumptions are sufficiently robust, and they may be, this finding would lend significant support for the notion that the sea, or water more generally, played a role in a prehistoric belief system or way of life that was incorporated into the construction of these and other such prehistoric monuments.

There is some range in the ways in which the sea may have played such a role. Water may have been referenced in monument building, perhaps serving symbolic purposes in ritualistic activities or in marking auspicious locations where gatherings ought to occur. The visibility of monuments from waterways that were likely to have been used as means of transportation may have served as territorial markers or even as waypoints for travellers on those waterways (Bradley 2016; Frieman 2008). Furthermore, points of arrival and departure for seagoing journeys may also have been ritualised and referenced through monument construction (e.g. Van de Noort 2003, p. 412). Whatever the role that sea visibility served, the findings here indicate that some such role was likely to have been played, given the prevalence of sea visibility in the landscapes surrounding the long cairns of Scotland, where sea visibility was a criterion that could be achieved without significant opportunity costs.

Of the 13 sites examined in Dumfries and Galloway, only one alternative location offered decisively greater sea views than were available at the cairn site it corresponded to, and that cairn site – Cairnholy I – may have, nevertheless, offered sufficient views with which to reference the sea. The alternative locations for only 1 of the 31 sites in Argyll and Bute – Blasthill – offered decisively greater sea views that were also substantial and obvious on the horizon, and as with Cairnholy I, the views available from Blasthill may also have been sufficient for prehistoric builders to use to reference the sea. Of the 47 cairn sites considered in the Highlands, alternative locations were identified for only 3 cairn sites – Sgarbach, Latheronwheel Long and Ardnamurchan – that offered decisively greater sea views that were also substantial and obvious on the horizon. Again, in each of these instances, the views from the cairn sites appear to offer ample opportunities to reference the sea through the monumental constructions. The same trend was observed for both Aberdeenshire and Arran, where alternative locations offering decidedly greater sea views than their corresponding cairn sites could be identified for only two of nine sites investigated in Aberdeenshire – Gourdon and Longman Hill – and three of ten sites considered in Arran, North Ayrshire – East, Bennan, Clachaig and Torr an Loisgte. In each of these five cases, the views from the cairn sites appear to provide sufficient opportunity for the monuments to reference the sea. Hence, in total, only ten cairn sites in all five regions taken together were found to offer sea views that were not comparable to or were not decisively greater than the sea views found in their surrounding areas, when elevation and distance were taken into consideration. Moreover, in all ten cases, sufficient views were available at site locations, such that the monuments may have, nevertheless, referenced the sea.

These findings provide significant substantiation for the notion that the long cairns of Scotland reference the sea (see Fowler and Cummings 2004, p. 82), when it was practical for their builders to incorporate such a reference. Certainly, many of the 110 cairn sites investigated did not offer sea views. As noted in the previous section, given that sea views were rare in some areas, that fact may be unsurprising. However, noticeable sea views were apparent at 61 of those 110 cairns, with a further 10 sites offering faint sea views that may have been obscured either by atmospheric deterioration or vegetation. These figures are significant as they establish that, at least 61 cairns, and possibly 71 cairns, were located in places that may have held an association with the sea. In light of this number of cairns, only a small minority of ten cairn monuments are located in places that do not offer the greatest sea views in their given areas. Yet, in light of the sufficient levels of sea views that they offer, even those sites may, nevertheless, arguably evince references of the sea.

For these reasons, this study provides significant confirmation for the hypothesis that the long cairns of Scotland's coastal regions were, in certain instances, placed so as to reference the sea and, moreover, that prehistoric builders had a preference of incorporating such references when doing so was practical.

10.3 Investigation of the Idea of a Revelatory View of the Sea

Assuming that references to the sea were, in fact, present and intended by the builders of prehistoric cairns, we now turn to examine how those references might have been achieved. A cairn site offers a revelatory view to the extent that it both offers sea views and that such views are obscured on approach of the site. Thus, to the extent that sea views, or 'sea previews', are present on approach, a 'revelatory effect' is proportionately reduced. Sea previews may be found to be either comparable to or significantly greater than the sea views offered at the cairn site. In such instances, questions are raised as to whether those previews detract from the final sea view at cairn sites and as to whether those preview locations might have offered more suitable locations for site placement (that is, if in fact sea views were highly regarded by prehistoric builders). In either case, however, whether or not sea previews detract from revelatory effects, the GIS models developed here provide at least some support for the notion that revelatory views were intentional. Relatedly, these models also provide further support for the hypothesis confirmed above, which is that sea views were intentionally achieved at cairn sites. The results of this stage in the analysis for the five regions studied are briefly described and contrasted below.

In Dumfries and Galloway, the only three of four sites that offer noticeable sea views might also be interpreted as offering revelatory views; although respectively greater sea previews are also observable on the seaward pathways to each of these sites, and the presence of such previews may have detracted from the effect of those revelatory views, casting doubt on whether the revelatory views as such were intended. Of the 20 sites with noticeable sea views in Argyll and Bute, 19 offered revelatory views. The sea views at preview locations were greater on the pathways to three of those sites, and pathways to eight sites offer sudden and dramatic reveals of the sea. Twenty-two sites in the Highlands had noticeable sea views and the pathways to 19 of those sites appear to present revelatory views. The pathways to 6 of those 19 sites had sea previews that were greater than the sea views at the corresponding cairn sites. Pathways to 2 more of those 19 sites had sea previews that were comparable to the sea views at the corresponding cairn sites. However, pathways to nine sites offer sudden and dramatic reveals of the sea. Of the six cairn sites analysed in Aberdeenshire with noticeable sea views, the pathways to five of those sites evinced revelatory views, with only one such pathway having a sea preview that was greater than the sea view offered at the corresponding cairn sites. Pathways to four sites offer sudden and dramatic reveals of the sea. On the Isle of Arran, revelatory views were found on the pathways to all eight cairn sites with noticeable sea views. One such pathway had a sea preview that was found to have a greater sea view than what was observable from the corresponding site, and three further pathways had sea previews that were comparable to the sea views at the corresponding sites. However, sudden and dramatic reveals of the sea are present on the pathways to six of these eight sites.

These are reasonably consistent findings in all regions, with significantly high numbers of revelatory views, as opposed to mere sea views at the cairn sites investigated. As for the sites from the regions taken together, of the 61 sites with noticeable sea views, models of pathways to a total of 55 sites indicate that the views at those sites may be revelatory in nature; although pathways to 14 of those 55 sites were found to have sea previews greater than the sea views offered at the sites themselves and pathways to a further 5 sites held sea previews that were comparable. Of the remaining 36 sites with pathways that have revelatory views, and for which neither comparable nor greater sea previews are observed, 27 offer sudden and dramatic and, therefore, persuasive cases of revelatory views. This is a significant proportion of all 61 sites with noticeable sea views.

The Significance of Previews

The presence of sea previews that are greater than the sea views offered at a cairn site are significant as they suggest that sea views as such were not the primary criterion for monument-location choice. However, the presence of such previews does not establish that the respective revelatory views were wholly ineffective at evoking a response of anticipation and awe, say, for those approaching a monument. Moreover, there is the further possibility that sea previews did not, in fact, detract significantly from any such effect. Where a sea preview occurs and is subsequently obscured before a final sea reveal upon arriving at a site, the temporary obscuring of the sea view may have been sufficient to evoke a response in many of the cases under consideration (cf. Fowler and Cummings 2003, p. 3; Scarre 2002, p. 86). Therefore, the final figure of 55 revelatory views out of 61 sites with noticeable sea views might be construed as significant support in confirmation of the notion that revelatory views were, in the majority, an intended feature at the long cairns sites in Scotland's coastal regions.

This result appears to add weight to the findings of the previous section, where it was demonstrated that long cairn sites in Scotland were frequently and even usually placed in the locations that have the greatest sea views in comparison to the other available locations in their surrounding areas that are within a suitable distance and level of elevation. Hence, in addition to cairn sites being placed preferentially to afford sea views, it appears that the sea's presence is consistently and intentionally referenced through cairn placement in locations that afford revelatory views of the sea.

However, one possibility in particular should be considered before the aforementioned conclusion is accepted. Namely, the occurrence of a revelatory view, in some if not many instances, is merely a fortuitous outcome and not the outcome of a specific intention of prehistoric builders to choreograph persons' movements and visual exposure. This may have happened on occasions when prehistoric people were motivated to select locations for site placement closest to a point of origin that was further inland. This follows from the fact that, on a seaward pathway that begins from an inland settlement, the location with the greatest sea views up until a given point on that pathway would offer what could be considered revelatory views. In this scenario, such a location might be chosen only by virtue of being the location closest to a prehistoric settlement that offers sea views, and not due to the revelatory nature of such sea views. Contrary, then, to what has been suggested (Fowler and Cummings 2003, p. 3; Scarre 2002, p. 86), instances of revelatory views may not be due to builders deliberately choreographing visual exposure in order to produce that particular effect. It is to be expected that locations with the greatest sea views up until a point on a seaward pathway would also, incidentally, afford revelatory views of the sea.

This account does not stand against the significance that sea views may have had, as are found at cairn sites in the coastal regions of Scotland. To the contrary, the fact that what are termed 'revelatory views' are found in such great numbers for the cairn sites under consideration provides further support for the notion that prehistoric builders were motivated specifically to achieve sea views, and to reference the sea, at the sites of their monumental constructions. What this explanation for the presence of revelatory views does in part is to mitigate against the hypothesis that prehistoric builders expressly and originally intended to achieve the specific visual effects that they did. Nevertheless, taking this explanation for granted, it is conceivable that even in cases where sea views at cairn sites were not originally intended to be revelatory as such, prehistoric people ultimately came to value the revelatory nature of those views. If true, then it is plausible that later reproductions of the cairn-building tradition in other locations may have involved the intentional incorporation of the same style of sea views as revelatory.

Yet, this explanation does not account for why there should be so many sea previews on the seaward paths that approach the cairn sites, previews that are not just comparable to the sea views offered at cairns sites but that are sometimes greater than those views, either in terms of being more expansive or more prominent, or both. The occurrence of such sea previews is at odds with the notion that prehistoric builders travelling seaward were simply looking for locations with sea views for site placement. The data show that neither a sufficient sea view nor a revelatory view was the only criterion for monument-location choice. There was, in other words, an additional factor that drew prehistoric builders further seaward, past the preview locations with greater or comparable sea views to those offered at the cairn sites.

There are at least two obvious possibilities that might account for why preview locations were overlooked for site placement, when such locations offer greater or comparable sea views to those offered at cairn sites. First, something about the nature of the sea views that builders wanted to achieve at cairn locations may have led them past preview locations and towards the sites they ultimately chose for monument placement. As Cummings and Whittle (2004, p. 33) observe, regarding sites in south-west Wales: 'Sites such as Carreg Coetan and Carreg Samsom are located only a few hundred metres from the sea, yet they are not positioned to have wide views of the coast.' These authors comment that, 'it seems that although it may have been desirable to build a monument [at a location] from which the sea was visible, this view should not be too expansive.' (2004, p. 33) Later in the same text, Cummings and Whittle (2004, p. 82) write: 'it is interesting that most sites seem to be concerned to have only a small area of sea visible. Could this refer in some way to the diminishing role of coastal resources in the diets of Neolithic people, as suggested by current stable isotope analysis (Schulting 1998)?' Along a similar rationale, it might be supposed that preview locations could have been overlooked for site placement on account of builders wanting to place a monument on a location with lesser sea views, either in terms of having a narrower or less prominent area of sea visible from the cairn location than could be observed from preview locations. However, a second possibility seems to be more plausible: a cairn's proximity to the sea may have been of greater importance than the kinds of sea views that it could offer. This would account for the occurrence of sites that held comparable sea views to those observed at preview locations, in addition to cairn locations that held lesser sea views than preview locations.

There are a number of reasons to suppose that a cairn's proximity to the sea would have at least comparable to, if not of greater importance than, the sea views available from its location, and these reasons are consistent with such a cairn also being placed to reference the sea. Ethnographic accounts (Cummings and Whittle 2004, p. 82; Richards 1996a, p. 203, 1996b, p. 317; Rudhardt 1987, pp. 350-58) record how the sea, and water more generally, symbolizes transformation and death. It is fitting, then, that cairn builders who intended to use sites for burial practices and rituals that reference the sea would choose locations for monument-placement in areas closer to the sea.

A separate possibility, discussed by Van de Noort (2003, p. 412), is that monuments were used as points for departure or arrival for seagoing journeys. Such journeys may have formed rites of passage for young members of elite groups in Britain who would one day be eligible to rule. Van de Noort supposes that these journeys could have been essential for the legitimacy and stability of future political power through their ability to contribute to the loyalty and prestige given to future leaders by their crews and the wider community. A cairn site's proximity to the sea would, then, be critical for facilitating such departures and arrivals, and it should be expected that, if this interpretation holds true, cairn sites are generally placed in locations that satisfy both criteria, of affording sea views as well as proximity to the sea itself.

A further and associated possibility, suggested by the 19 cases in which sea previews were comparable to or greater than the views at cairn sites themselves, is that cairns may be placed not simply as departure and arrival points for seagoing members of a local community, but also for members of distant communities travelling and arriving by sea. As one of the main forms of prehistoric travel may have been by boat, prehistoric people may have routinely travelled along the coast and into lochs and rivers and between the isles (Bradley 2016; Frieman 2008). For such people, revelatory views would surely not have been a consideration, as they presumably would have accessed the cairn sites from direction that headed inland. For these people, cairn sites may have served as a meeting place and a site of ritualistic activities for groups traveling from different directions (cf. Johansen et al. 2004). If this is assumed, a greater ease of access for persons arriving via water, in particular, may account for why sites are sometimes closer to the coast than is necessary in order to afford the greatest sea views. This consideration may, for instance, explain why some sites, such as Blasthill, were chosen over preview locations that offer greater sea views. This may also account for prehistoric builders' choice of the site of Slewcairn over a preview location on the path to that site that is 60m higher in elevation. Thus, if prehistoric people were travelling from both inland and from the sea, to the cairn as a meeting point, that elevated preview location on the path to Slewcairn is likely to have been unsuitable.

On the Noticeability of Sea Views and 'Revelatory' Views

A further detail that was revealed by the data from the five regions studied was the difference in the kinds of sea views offered at cairn sites, and the extent to which the pathways to sites might be seen as offering a revelatory view. Some pathways with revelatory views exhibited increases in sea affordance values that corresponded to sea views that appear suddenly and dramatically. However, other pathways with revelatory views exhibited more gradual increases that, on occasion, corresponded to subtle sea views that are barely if at all noticeable. It might be supposed that these differences indicate differences in intention as far as prehistoric builders' location choices for cairn placement are concerned. In areas where pathways with gradual revelatory views are prevalent, as opposed to sudden and dramatic revelatory views, builders might, on this view, have held the sea and the ability to reference it in their constructions with less importance.

Yet, given the nature of the data, and in particular the fact that the cairns sites studied have been demonstrated to achieve the greatest sea views in their areas—as discussed in the previous section—it is decisively more probable that another interpretation holds true. This interpretation is that differences in the dramatic or subtle nature of revelatory views are not attributable to their level of importance but, rather, to the availability of such views in the kinds of landscape in which respective cairns are located, and in particular their distance from the coast. This is because the further a given landscape is from the sea, the scarcer sea views become, so that even scant sea views may be valued for people inhabiting such landscapes. Under this interpretation of the 'relative value of sea views', the sea may have retained at least a significant level of importance for prehistoric people building cairns further inland, or in other coastal landscapes where the sea is obscured—where sea views would occupy a relatively small area in an observer's visual field, appearing only as slivers of sea on the horizon.

This notion may go some way toward explaining the prevalence of sea views at cairn sites where those views appear very faint to an observer, but yet are the greatest sea views available in their areas. As shown earlier, consideration of the sea affordance surfaces and the kinds of sea views available in the landscapes surrounding the long cairn monuments considered in this study reveals that, even in locations where sea views are slight and almost unnoticeable, cairn sites appear to be placed preferentially in locations that maximise those views. Therefore, if sea views retain their importance even when they become fainter, at locations that are at a distance from the coast, then it may be expected that sites are placed preferentially to afford even these slight sea views when such placements were practical for builders. The observations made here are consistent with and confirm the contention that those views held significant value to prehistoric builders.

Of course, one issue that must be addressed is that many such faint and slight views may have been obscured by atmospheric conditions occasionally or even frequently. Furthermore, vegetation, which was somewhat abundant in the form of woodlands across Scotland during the Neolithic, would also have had a particularly significant impact on sea visibility. However, one possibility suggests that this may not have always been the case. As described in Chapter 2, Section 1, Cummings and Whittle (2003, pp. 255-266) postulate that cairn monuments may have been used in the winter months for particular purposes. They draw on an analogy between leaves and flesh, which are respectively absent from deciduous trees in winter and human remains at the later stages of decomposition. Cummings and Whittle suggest that it is in the winter months that bones may have been deposited in the cairns, and that at such a time trees and their foliage would not have had the same restricting effects on visibility from sites. If this account is correct, then even slight slivers of sea on the horizon may have been visible in the winter months, and consequently been capable of holding significance for the prehistoric people building and using those monuments.

However, these notions do not explain the placement of cairn sites in locations that afford what might be described as liminal sea views, that is, sea views that are on the cusp of being entirely unobservable and unnoticeable because they are so slight. In these instances, cairns are placed in locations in which the direction of the sea may be marked by dips between hills and slopes on the horizon, even though the sea is not fully visible. Some cairns were discovered to be placed in such locations due to the way in which the sea affordance maps were generated. As described in Chapter 4, Section 3, the GIS analyses identified locations from which the sea could be visible in principle and not in practice: from those locations, areas of sea are in line with the eye of the observer so that they might be visible, but because of the distance of that area of sea to the observer – whom could be situated as far as 10km inland – or because of the size of the area, the sea might occupy an infinitesimal area in the observer's visual field and, therefore, be nearly or completely undetectable to the naked eye. Hence, when views from those locations were compared with both Horizon panoramas and photographs taken during onsite visits, it was sometimes discovered that positive sea affordance values at a cairn site did not translate to noticeable or, in extreme cases, even subtle sea views (see Figure 10.5). The sea affordance values in these instances do not, then, indicate that sea views as such are present, but rather that particular features of the landscape might be understood to signal the sea or its general direction.

There is also some likelihood that the direction of the sea, and not any sea views as such, held importance, as marked by dips in hills or other relevant landmarks in each case. Certainly, prehistoric people may be assumed to have had knowledge of the landscapes over their horizons, from which the sea is both visible and located. Similarly, they may also be assumed to have had an awareness of the direction of the sea. Therefore, there may be instances where a cairn monument is placed to reference the sea, even in locations where the sea is, in actuality, unobservable. The sea affordance analysis and analysis of possible revelatory views functioned to reveal examples where prehistoric people journeying seaward could place a monument in a location that could reference the direction of the sea, despite the sea not being effectively visually present, and this is a phenomenon that occurs with great frequency throughout the regions under consideration. The widespread presence of this phenomenon suggests that a different approach to studying the landscapes within which long cairns were built may also be fruitful: namely, an approach that perhaps primarily considers non-visual elements of the landscape (see Chapter 2, Section 2, cf. Cummings 2002b; Frieman and Gillings 2007; Saunders 2001; Scarre and Lawson 2006; Watson and Keating 1999; Waller 2006; 2012). Such a study might, in this respect, take into account builders' awareness of the sea's location, or the location of other bodies of water or auspicious landmarks, alongside the characteristics of monument construction with which such features may have been referenced.

Thus far, the data produced in this study appear to provide consistent support for the hypothesis that the long cairn monuments of Scotland's coastal regions are placed preferentially to reference the sea when doing so was possible and practical. A final step in the investigation that would reveal the extent to which such references may have been achieved concerns the way that monuments are oriented in their landscapes.

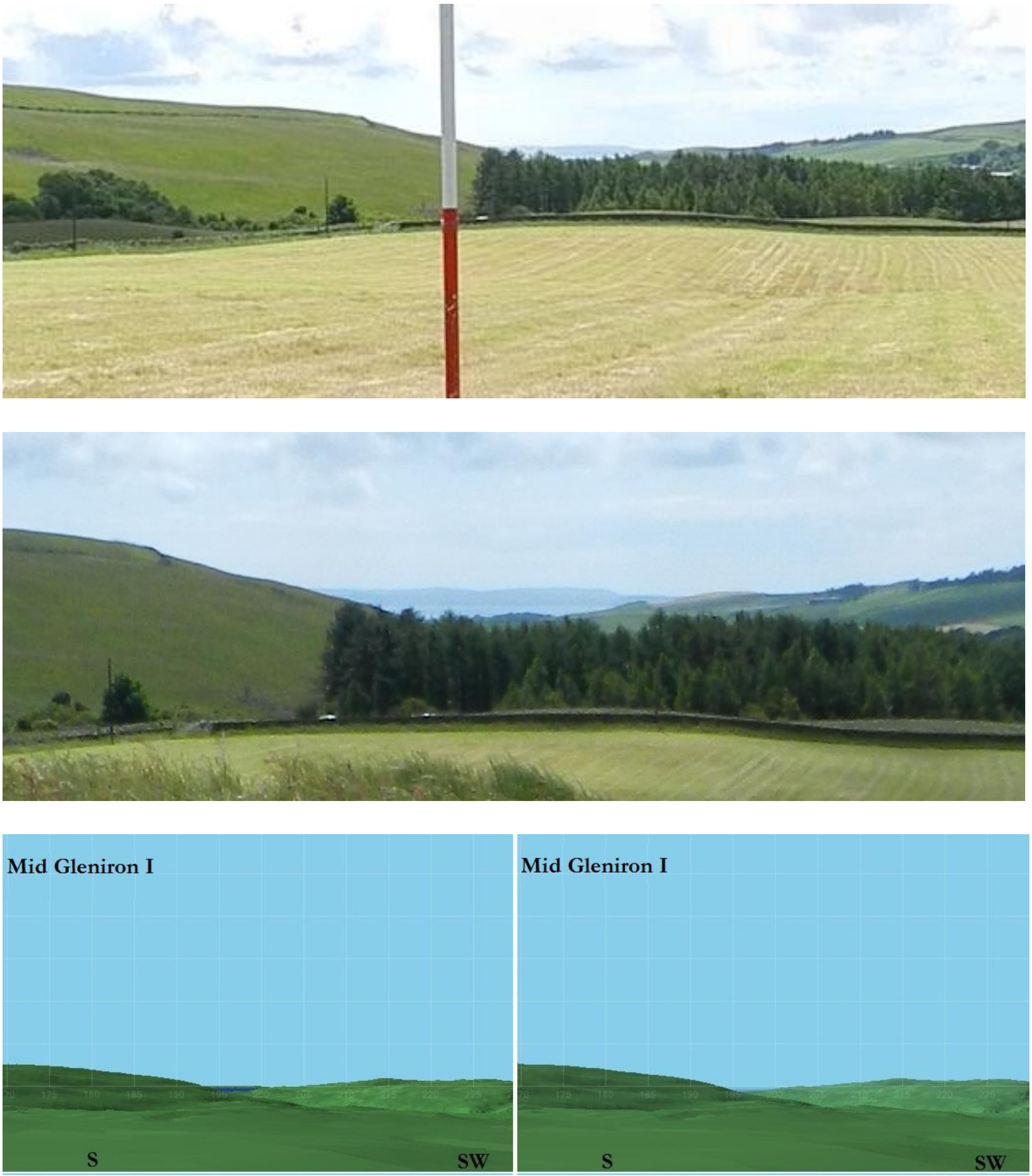


Figure 10.5: Above, photograph of direction of the sea from Mid Gleniron I, in Dumfries and Galloway. Below, Horizon panorama of view in the direction of the sea from that site.

Sea views are available in principle from Mid Gleniron I, in Dumfries and Galloway. In practice, or in person, the sea seems to be visible only in terms of the faint glow on the horizon, as reflected by the midday sun – as seen in the photograph above (taken at 1pm).

10.4 Investigation of Long Cairn Orientations and Potential Alignments with the Sea

Due to having a defined long axis, long cairns can have particularly distinct and dramatic orientations. The directions of these orientations are of interest as they present a means by which monuments may have been used to reference the sea. Moreover, when considered alongside sea views from cairn sites and the orientation of the pathways used to approach the monuments from a seaward direction, these orientations present a rich source of information from which inferences may be drawn regarding the intentionality of long cairn construction. Various kinds of alignments were found between monument and pathway orientations and the directions of sea views. Such alignments were found to be more obvious and clear in some cases more than in others, and it appears that other considerations, such as the lie of surrounding landscapes, may also have influenced the way that some cairns were orientated. Nevertheless, this final stage in the investigation revealed some interesting trends in cairn construction and in the way that they arguably reference the sea.

Alignments Toward Sea Views

The results show that the vast majority of cairn sites with sea views demonstrate alignments between monuments and sea views and the revelatory pathways that approach them. While this may be a significant finding, as it is indicative of a prehistoric intention to reference the sea through monumental construction, care must be taken not to overestimate its significance; these alignments must be considered alongside any likelihoods that they are merely fortuitous and, thus, alongside the possibility that they were not intended by prehistoric builders to reference the sea.

As foreshadowed in Chapter 4, Section 6, there is some difficulty in determining the intentionality of alignments, between cairn axes and sea views, in cases where cairn sites offer particularly expansive views. These are instances where sea views extend over 90° on the horizontal plane, say, from left to right. If a long cairn is considered to be aligned with sea views whenever its long axis is oriented within the range of those views, there will be a greater likelihood than otherwise that an alignment of that kind will be achieved. Moreover, if it is also accepted that the side of a cairn may be aligned in a second way, with the direction of the sea, so that the cairn's long axis is parallel to the sea, then there will also be a greater likelihood than otherwise that this second kind of alignment will be achieved. Combining the probabilities of these two different forms of alignment gives the outcome that, where expansive sea views (over 90°) are present, it will be impossible for a long cairn not to be aligned with those sea views, in one way or another. It is, therefore, to be expected that high numbers of alignments were found. Furthermore, it may also be unsurprising that, in cases that sea views spanned well beyond 90°, cairns were found to demonstrate both types of alignment with the available sea views, so that cairns' long axes both point in the direction of the sea while also being parallel to the sea; examples of these sites include Beachhar in Argyll and Bute, with sea views spanning 174°, and Ballynaughton also in Argyll and Bute, with sea views spanning 155.5°.

Hence, findings of alignments at cairn sites that offer particularly expansive sea views (of 90° or above) must, accordingly, be considered alongside the possibility that they are merely fortuitous. This is not to say that such alignments are not of interest. Certainly, the fact alone that those sites offer such expansive sea views may indicate an intention of builders to reference the sea, and alignments towards those views may accordingly hold significance. However, in order to distil the most persuasive evidence for the intentionality of cairn builders to reference the sea, sites offering narrower sea views will be examined particularly closely, as it is in the connections between those sites and the sea that the nature of prehistoric builders' intentions will be more evident.

A second caveat to this study of cairn alignments is that, as described in Chapter 4, Section 6, cairns may be more or less aligned with the sea. A cairn's long axis might be oriented inside the range of sea views, in which case the alignment is 'direct', or it might be oriented only generally or roughly toward the direction of those views and, thus, have an alignment that is slightly askew. The same holds for cases of side-alignments, where a cairn long axis is parallel to the sea in the sense of being either perpendicular to the heading of a point of sea inside the range of sea views (a direct side-alignment) or slightly askew of being perpendicular to a point inside the range of those views. The significance of an alignment being either direct or general depends largely on the extent to which the respective sea view is narrow or expansive. Thus, a direct alignment with an expansive sea view may be more likely to have occurred simply by chance or accident than a general alignment with a narrow sea view, even though both instances bear possible significance. In the following, it is noted where alignments are both direct and coincide with narrower sea views.

When considering both forms of alignment together, of axis- and side-alignments, high numbers of alignments were found to occur between long cairn axes and narrower sea views—where 'narrower sea views' are those that span less than 90° and are not described as 'narrow' as they may still be expansive by other standards. As these kinds of alignments are far less likely to have occurred by chance, they provide reasonably robust evidential support for the notion that these monuments were intended to reference the sea.

In Dumfries and Galloway, five of six long cairns with sea views, including two sites with barely if at all noticeable sea views, were found to be aligned with the sea—two of these alignments were direct. All five sites offered only narrower sea views. The landscape of Argyll and Bute offered both expansive and narrower sea views at the cairn sites in the region. Nineteen of the 20 long cairn sites that offer sea views were also found to demonstrate alignments between monuments and the sea. Eleven of these were alignments with narrower sea views, and six of these eleven sites had direct alignments with those views. Of the 28 sites with sea views in the Highlands (where site plans are available), including 26 sites with revelatory views, 27 long cairns held an alignment with sea views. Fifteen of these were alignments with narrower views, while 7 of those 15 were also direct alignments. In Aberdeenshire, alignments were found for all five sites where both sea views were present along with plans or extant remains with which to measure cairn orientations. Only one of these sites offered narrower sea views, and the alignment in that instance was direct (with the side of the cairn). On the Isle of Arran, alignments were found for eight of the ten sites with sea views and available plans with which to measure orientations. Four of those were alignments with narrower sea views, and only one of those four were direct alignments.

In summary, out of the 69 cairn sites that offer sea views (including faint sea views) and extant remains or plans with which to measure orientations, the vast majority of sites, a total of 64, held alignments in the direction of sea views. Setting aside sites that hold expansive views, to better appreciate the significance of this result: out of 39 sites placed where narrower sea views were available, all but two sites aligned with those views, and 17 of those were direct alignments.[52]

This result may offer strong support for the notion that the long cairns of Scotland's coastal regions were oriented to reference the sea. Yet, these figures must also be considered in light of the variety of alignments that they include, as axis- as well as side-alignments. This is a critical point for one main reason: due to the lie of the land in many instances, it may have been greatly advantageous for prehistoric people to construct some cairns in ways that are parallel to bodies of water, only because doing so would have enhanced the stability of the cairn mound and any chambers within. This may have occurred, most primarily, where cairns were built along slopes and hillsides, and hence, it is possible that the presence of some side-alignments may often not be due to any express intention to reference the sea or other bodies of water, but may simply be an incidental outcome. This is not to discount altogether side-alignments along hillsides, as the adjacent bodies of water may, of course, also have been a factor in determining the location choice

[52] Furthermore, an outlier here, Caen Burn in the Highlands, the one of the only two sites without at least a general alignment with a narrower sea views, is askew of a direct alignment by only 32º (see Figure 10.4, above). This is only slightly outside the criterion for a general alignment specified in Chapter 4, Section 6 of being askew by no more than one secondary intercardinal direction (which span 22.5º). This takes on further significance given that the sea views available from Caen Burn are not just 'narrower', but decisively narrow, spanning only 13.5º, hence that site might also reasonably be construed to be oriented toward the sea, albeit roughly.

for those monuments. However, this observation does provide grounds to consider the prevalence of axis-alignments separate to side-alignments, in the context of sites that offer narrower sea views, as above.

Axis Alignments Towards 'Narrower' Sea Views

In Dumfries and Galloway, there were six long cairn sites where narrower sea views were available. Four of those cairns held axis-alignments with those views, and two of those were direct. Of eleven narrower sea views at cairn sites in Argyll and Bute, axis-alignments were found in seven instances, with two being direct. Sixteen narrower sea views were found in the Highlands while eleven axis-alignments were formed with those views and six of those were direct. Only one sea view in Aberdeenshire was narrower in the specified sense; the long cairn at that site forms a side-alignment and not an axis-alignment with that view. There were five narrower sea views in the cairn sites studied in Arran, three long cairns form axis-alignments and none where direct. Thus, from a total of 39 long cairns placed where narrower sea views were available (and for which site plans were also available) in all areas considered in Scotland, 25 long cairns formed axis-alignments with those views, and 10 of those were direct alignments.

This outcome is of interest as it is unlikely that it can be explained by chance alone. The narrower sea views considered here not only spanned for less than 90º across the horizon, most were also much narrower. Correspondingly, there is a significantly lower probability than otherwise of most long cairns in this sample of cairns forming an axis-alignment with the sea views by chance, yet nearly two thirds form axis-alignments. Hence, this outcome provides significant support for the contention that a non-random factor, such as a prehistoric intention to reference the sea, influenced the construction of these monuments such that they were, more often than not, oriented towards the sea.

The Prevalence of Sightlines

As described in Chapter 4, Section 6, three varieties of sightlines were recorded, as comprising the alignment of seaward pathways to sites alongside the direction of sea views and monument orientations: where travellers to a site are presented with a cairn's long axis in alignment with both the pathway on which they travelled and the sea, either with the cairn in a proximal–distal or distal–proximal orientation, or with the side of the cairn body perpendicular to both the sea and the pathway. These specific arrangements for these elements of a cairn site were considered for investigation because they seem to be the most intuitive and salient way that a long cairn structure might be accentuated along with the sea, which may likely have been a crucial feature that defined its landscape context, capable of importing sociological and cosmological significance to the site and the activities that took place there.

The case for considering the long cairns of Scotland as referencing the sea sees further support through the investigation of such long cairn sightlines. This is because seaward pathways present a largely independent variable from which to assess the intentionality of cairn alignments.[53] While it is possible that cairn long axes may, on many occasion, be aligned with sea views by chance and not design, the alignment of pathways with cairn structures and the sea views behind those structures presents a more complicated arrangement that is less likely to have occurred by chance. Thus, even though the presence of particularly expansive views at some cairn sites might mean that an alignment between the cairn structure and the sea is highly probable, and indeed guaranteed if side-alignments are taken into account, this changes when seaward pathways are factored into the analysis, which present a further means of determining whether and how a cairn might have been oriented to meet seaward travellers.

Sightlines are found on paths to the following cairn sites with sea views and plans with which to measure orientations: at five sites of six potential sites (with sea views and plans) in Dumfries and Galloway; 17 of 20 in Argyll and Bute; 16 of 28 in the Highlands; four of five in Aberdeenshire; and, seven of ten in Arran. Thus, of a total of 69 sites, at least one form of sightline was found at each of 49 cairn sites in the regions studied.

This figure included pathways that offered merely general and not direct alignments between pathways, cairn structures and sea views behind them—where a general alignment could be askew of a direct alignment by no more than one adjacent, secondary intercardinal direction (i.e., the angular distance between N and NNE). This was considered to be an appropriate criterion for identifying alignments due to, among other potential factors, the influence of the shape of the landscape on cairn orientation and possible alterations to cairn structures carried out over successive generations. This criterion has, thus, been helpful in considering the totality of the coastal long cairn sites investigated and understanding the final number of sites that hold potential associations with and references to the sea.

However, it should also be helpful to consider sightlines in which pathways form a direct line of sight with the cairn structure and the sea behind it: 'direct sightlines'. If in fact this group of monuments do consistently evince references to the sea, it should also be expected that more

[53] As discussed later, in certain landscape types, contours may affect the extent to which these variables—of cairn orientation, the direction of sea views, and the direction of seaward pathways—are independent.

direct alignments such as these are at least occasionally observable. For this reason, 'direct sightlines' were also recorded. It was found that all sightlines except one, in Argyll and Bute, were also direct sightlines. A traveller to a cairn site offering this more precise alignment would be oriented toward their final destination for a longer length of their passage on the pathway, which would subsequently enhance both their experience of their journey as well as the manner in which their final sight of the cairn structure, including the sea view with which it is accompanied, is revealed. Note that all paths already approach the cairn sites directly, what is different about a path that holds a direct line of sight is that it is in line with the sea view as well as the cairn. Thus, in a direct sightline, the cairn structure itself may be generally and not directly aligned with the sea, and yet for a person approaching the cairn site, the sea will be especially emphasised, perhaps as though it were the final point referenced by the orientation of the site in its entirety—as including the path along with the cairn.

Taking a more stringent approach to the identification of sightlines reveals a different trend. While the category of 'direct sightlines' includes sites in which cairn axes are generally aligned with the sea and not also directly aligned with the sea, those sites are excluded in the following, which examines the occurrence of 'precise sightlines'. This category requires that all three elements of a site (the pathway, cairn and sea) hold a direct and, therefore, a more precise alignment. An examination of precise sightlines is especially important since the factors that may have influenced cairns' final orientations that may have on occasion caused them to be askew are unlikely to have held in each and every case. If in fact long cairns were intended to reference the sea, it should be expected that precise sightlines are also observed.

Precise sightlines were found at: 3 of 6 sites with sea views in Dumfries and Galloway; 4 of 20 sites with sea views in Argyll and Bute; 12 of 27 sites with sea views in the Highlands; 5 of 5 sites in Aberdeenshire; and, 2 of 10 sites on the Isle of Arran.[54] This gives a total number of 26 precise sightlines out of 69 sites with sea views.

Note that there is a higher proportion of sites holding precise sightlines on the flatter landscapes of Scotland's north and east, in the Highlands and Aberdeenshire, where expansive sea views are also more frequent, than the hilly landscapes of the west, of Dumfries and Galloway, Argyll and Bute, and the Isle of Arran, which hold a greater frequency of narrow sea views. The combined figures give a total of 17 of 33 sites with sea views holding precise sightlines in the north

[54] These figures refer only to sites where there are available site plans or extant remains with which to measure cairn orientations.

and east, in comparison to 9 of 36 sites in the west. These figures demonstrate far greater uniformity in cairn alignments in the Highlands and in Aberdeenshire than in the western regions.

Several explanations may account for this finding. The hilly slopes of the west may not have afforded the same opportunities with which to orient cairns in what may have been preferred ways for prehistoric builders, as did the flat plateaus that are more commonly found in the Highlands and Aberdeenshire. Moreover, as described earlier, there may have been a variety of factors that determined a monument's ultimate orientation—examples include aesthetic reasons, and the liability of structures to be flooded or to become unstable if positioned against a slope in the wrong way. However, this finding may also be related to the fact that the cairns of the Highlands and Aberdeenshire share some particular structural similarities that are not seen in Scotland's west to the same degree. As described in Chapter 3, Section 2, the majority of cairns in the Highlands belong to what Henshall (1972) calls the Orkney-Cromarty group, which comprise passage-grave tombs that have formal entrances or passageways that can extend through much of structure and, where chambers are present, provide access to chambers within the cairn. These passageways give this group of cairns a regular or more uniform appearance, making their structures more streamlined. This feature would also aid in orienting the monument in a given direction. The long cairns of Aberdeenshire, which belong to the Balnagown group, also share this feature; but the cairns in Dumfries and Galloway, Argyll and Bute, and the Isle of Arran are different. Henshall characterises them as Clyde-type cairns. They are more irregular and are sometimes trapezoidal in shape, and lack the symmetry seen in the Orkney-Cromarty and Balnagowan cairns. These differences make the long axes of the cairns of Scotland's north and east much more distinct and defined. It, therefore, stands to reason that it would have been much easier for prehistoric builders to orient towards the sea an Orkney-Cromarty or Balnagown type cairn than a Clyde-type cairn.

The above finding concerning the proportions of sites holding precise sightlines in the different regions of Scotland holds particular significance in light of one possibility: landscape contours may have affected both the directions of the seaward paths that approach sites as well as the orientations of the cairn monuments themselves in such a way that, in many cases, makes them almost systematically aligned. As mentioned earlier, cairns positioned against a slope in the wrong way may have been liable to have entrances flooded, or their structures compromised, and thus, the contours of the landscape may have had a significant effect on how long cairns were ultimately oriented. These contours were also used to identify the pathways used to access cairn sites, through cost-corridor analysis. Moreover, as many such contours were created by ice streams and glacial melt-water (Clark et al. 2018), those contours are often the self-same determinants of the pathways of rivers, which flow to the sea. Therefore, there exists this one factor that may potentially account for many of the alignments and sightlines found here, such that no one variable is strictly independent, and this stands to challenge the ability of the results found here to confirm the hypothesis that the long cairns studied here were intended to reference the sea. Nevertheless, it remains unlikely that the figures reported here can be explained by the influence of landscape contours alone. While many cairns were built along slopes or in locations that were restricted by surrounding inclines, many are also built on flat areas that would have given builders the opportunity to orient cairns in whatever way they preferred. It is of great significance, then, that in the flatter regions of the Highlands and Aberdeenshire, where cairn builders may have had much more freedom to orient their structures independently to the landscape, cairns are found to have a closer and more direct orientation toward the sea, and sightlines are aligned more precisely.

To be sure, those flatter landscapes are also the same landscapes in which expansive sea views are more frequent. Hence, there would also be less difficulty in aligning monuments with such sea views. However, as the sightlines considered here also involve alignments between seaward pathways, and the sea views behind them. The probability of accidental sightlines, even with expansive sea views, is significantly reduced, thereby giving greater cause to consider these monuments as intentionally referencing the sea.

Axial Sightlines in Isolation

Considering only 'axial sightlines', that is, proximal–distal and distal–proximal sightlines together, and in isolation from sideway sightlines, reveals the following figures. Axial sightlines are observed at: 4 of 6 sites with sea views in Dumfries and Galloway; 10 of 20 sites with sea views in Argyll and Bute; 9 of 27 sites with sea views in the Highlands; 4 of 5 sites in Aberdeenshire; and, 4 of 10 sites on the Isle of Arran.[55] This gives a total number of 31 axial sightlines out of 69 sites with sea views.

Due to the greater frequency of sites without axial sightlines than otherwise, this result might be interpreted as standing against the notion that a cairn long axis might be used to reference the sea. However, that is not the only plausible interpretation of these results. One interpretation draws on the significant evidence that has been uncovered thus far, in the earlier stages of this investigation regarding alternative locations (described in Section 2) and revelatory views (described in Section 3). That evidence supports the contention that these monuments reference

[55] These figures refer only to sites where there are available site plans or extant remains with which to measure cairn orientations.

the sea and, in light of that as a probability, the lesser frequency of axial sightlines may simply indicate that other pathways were also used to access these sites in addition to the seaward pathways investigated here.

A further possibility takes into account observations made regarding side-alignments, and specifically the occurrence of side-alignments at sites with narrow and 'narrower' sea views, such as Hillhead Plantation in Aberdeenshire, or Cairnholy I in Dumfries and Galloway. Such cairn sites seem to reference the sea with the side of their structures, where chambers may be found. Hence, an alternative and plausible interpretation of this result is that it indicates the importance of the side-alignments and sideway sightlines in addition to axis-alignments, and the specific arrangement of the axial sightline.

Arrival Locations of Seaward Pathways

The following further possibility was considered in this study: seaward paths may have been used predominantly to access sites, that is, if those cairn sites were indeed used to reference the sea. If true, it may follow that there would be a prevalence of arrival points of seaward paths occurring either at proximal ends, which hold entrance chambers or, the sides of the cairn bodies, in which other chambers could be located. Specifically, the possibility envisaged here is that prehistoric travellers carrying human remains for deposition would have approached on a seaward direction, which is symbolic of death in virtue of the association with water (see Chapter 2, Section 1), to arrive at the cairn body and the chamber to be used for deposition. The construction of the cairn site would, *ex hypothesi*, reflect this if it were the intended purpose of the monument and, thus, if chambers were located at the arrival points of seaward paths, their presence would confirm this theory.

There was a high degree of inconsistency regarding the locations to which seaward paths arrive at cairn sites. Moreover, there was also much inconsistency in the ability to determine where a given path arrives at a cairn site, in relation to the cairn body. However, some viable data was gleaned from the investigation. To make sense of this data, cairn sites were reduced to two categories. First, a sample of sites was identified by which there were unambiguous or clear points of access for seaward paths. To this end, sites were disregarded when two or more pathways did not converge on a single access point. Second, two different kinds of access points were used, so that sites could be separated into two groups: a) sites whose seaward paths terminate at a potential chamber location, which could either be a proximal end, or the side of a cairn body; and b) sites whose seaward paths terminate at the distal end, at which chambers are much less likely to occur. Thus, if it were found that a greater proportion of sites with unambiguous arrival points were oriented so that seaward pathways met with chambers for deposition, say, then there would be grounds to suppose those sites were intended to reference the sea.

It should be noted, however, that long cairns in the highlands were sometimes horned on both the distal and proximal ends of the monument. In such instances, there may be reason to be suppose that chambers and ceremonies or other activities may have occurred at either end of the monument. Nevertheless, as even those sites have defined proximal ends, that are more grand and pronounced than their distal ends, testing for the occurrence of proximal ends at arrival sites may still hold some validity, as presumably the primary arrival locations would be located at proximal ends.

A further issue is that the Orkney-Cromarty cairns found in the Highlands, along with the Balnagowan cairns of Aberdeenshire, are often passage graves, in which chambers are accessed from a central passage (for these terms, see Chapter 3, Section 2). Hence, for those regions, only the proximal ends of the monuments were treated as locations in which chambers were likely to occur, and the sides of the monuments were treated as unlikely to have chambers accessible from outside the monument structure.

The number of unambiguous arrival locations of seaward paths at cairn sites that coincided with likely or confirmed chamber locations in the regions studied are as follows: three of six unambiguous arrival locations in Dumfries and Galloway coincided with chamber locations; all eight unambiguous arrival locations in Argyll and Bute coincided with chamber locations; twelve of 18 terminated at chamber locations in the Highlands; two of four occurred in Aberdeenshire; and, seven of eight occurred in the Isle of Arran. This gives a total of 33 of 44 unambiguous arrival locations for seaward paths coinciding with likely or confirmed chamber locations; a result that is firmly in support of the hypothesis that seaward paths were indeed used to access the cairn sites of the regions studied, and relatedly that these cairn structures were used to reference the sea.

10.5 Overview and Discussion of the Four Steps of the Investigation

Taken together, the four steps of the investigation into the long cairns of Scotland's coastal regions offer a reasonable level of support for the hypothesis that these monuments were, at least preferentially, placed to reference the sea. With the exception of the region of Aberdeenshire, the initial analysis into sea affordance surfaces did not indicate statistically unique distributions of cairn sites in their landscapes in terms of the sea views they offer. However, in the second step of the investigation, further consideration of the factors that may have led to location choice, as well as further consideration of locations near to cairn sites that offer comparative or better sea affordance values, revealed that the long cairns studied here are in fact generally placed in locations that have the greatest sea views within limits defined by distance and elevation. Moreover, where cairns did not afford the greatest sea views within those limits, it was found that they were placed in locations that, nevertheless, offer what are arguably sufficient views with which to reference the sea.

The third step in the investigation revealed that long cairns are also frequently placed in locations that afford revelatory views of the sea, a particularly effective way of referencing the sea. However, sea previews were found on the pathways to many such sites, 19 of 55, which suggests that sea views were among other factors relevant to location-choice for cairn builders. As discussed in Section 3, it is likely that proximity to the sea was one such consideration that builders took into account when choosing locations for placement.

The fourth and final step of the investigation examined the possibility that cairn sites are orientated towards the sea and incorporate alignments of interest. It was found that the long cairns considered in this study seemed to reference the sea in their orientations with a high but not absolute degree of consistency. It was also found that this trend is more prominent in Scotland's north and east, home to the passage-grave tradition of tomb building and the associated Orkney-Cromarty and Balnagown type cairns in which the orientation of monuments are more precise and are emphasised more consistently.

There is some evidence to support the notion that cairns may have been intentionally placed at locations with narrow sea views and that there may be some significance in a sea view being narrow rather than expansive—this occurs at several sites, described in Section 10.3. It has been suggested (Cummings and Whittle 2004, p. 82) that such a placement may mark a declining role of coastal resources in the Neolithic diet, that perhaps somehow a decreasing association with the sea might have been indicated by a monumental construction whereby the sea is less obvious from its location. However, another reason why such a location choice may have been preferred is that a narrow sea view may have enabled the sea to be referenced in a more obvious way by a cairn's orientation: having less area of sea being visible may make the sea's appearance at a site more auspicious, especially when combined with a monument's orientation marking the sea's direction. This explanation may account for the particular patterns observed across the regions examined, where areas in which sea views are especially prominent, cairns are placed in locations that offer comparatively restricted sea views. Examples include but are not limited to the sites of:

Gourdon in Aberdeenshire; Blasthill in Argyll and Bute; Cairnholy I in Dumfries and Galloway; and, Clachaig in Arran.

There is also evidence to suggest that the sea may have been referenced even in locations in which sea views were almost entirely absent. This is suggested by the investigation of the sea affordance maps whereby it was determined that a majority of sites are located in the highest areas of sea affordance in their proximities, in terms of both distance and elevation, even in cases where the sea itself was not reliably observable, whether that was due to atmospheric conditions or simply the faintness of the sea views available. Thus, the findings of this study support the notion that prehistoric builders may often have chosen these locations for the placement of their monuments while also orienting those monuments in the *direction* of the sea, effectively referencing the sea despite their position further inland.

However, before conclusions may be drawn in any decisive way, these interpretations regarding the placement of the long cairns investigated must first be compared against the likelihood of either complementary or alternative explanations that also explain the data. One such interpretation that should be examined holds that cairns served as territorial markers. According to this view, a group of people may demonstrate that they occupy a given territory with highly visible and imposing burial monuments that signify to other groups that their ancestors are buried there, and for that reason the land belongs to them. This notion has been widely studied in the British Isles in addition to continental Europe, and is used to account for the why these monuments (and the long barrow) were first constructed in the Neolithic (e.g. Malone 2001, p. 107).

If long cairns, and other cairn structures for that matter, were constructed to serve as territorial markers, then it is to be expected that they would be placed on prominent positions on the landscapes that maximise their visibility from their surrounding landscapes. Importantly, such a distribution of sites might also fit with the distribution of sites that has been found in this study, whereby sites seem to be selected to achieve either the greatest or sufficient views with which to reference the sea. This is because prominent positions in the landscape that are visible from their surrounding areas may also, more often than not, afford such views of the sea. This will be referred to as the 'land prominence' interpretation of cairn distribution. If the data is entirely explained by this competing interpretation, then there may be no compelling evidence to suggest that the cairn sites studied are also placed to reference the sea.

There are several reasons to suppose that the land prominence interpretation of cairn distribution does not account for the findings of this study. One major reason is that while sea views may be afforded by prominent locations in the landscape, the land prominence interpretation may not, in isolation, explain why cairn locations should appear to be placed preferentially to hold sea views as such, and not simply be placed preferentially to afford views of their surrounding landscapes. Yet, there is a further interpretation that is complementary to the land prominence interpretation: if a cairn site is to serve as a territorial marker that is visible to groups of people travelling to, or near, a given area, it follows that the cairn should also be visible from the sea. This is because people in prehistoric times were also known to have used waterways as a means of transportation (Bradley 2016; Frieman 2008). Having a cairn site observable from the sea would, then, in theory also have been of some importance in marking a people's territory (cf. Gillings 2009). This is of particular relevance to the findings of this study because sea affordance values model not simply what areas of sea are visible from a cairn site, but also from what areas of sea the cairn site is visible. Hence, the 'prominence from sea' interpretation of cairn distribution, together with the land prominence interpretation, may account for much although not all of the data observed in this study (see Chapter 4, Section 3). If cairn sites are demonstrated to maximize sea views, as they have been shown to do in this study, cairn sites are also, therefore, demonstrated to maximize visibility from the sea and, consequently, to maximize their ability to serve as territorial markers to seafaring travellers.

Nevertheless, there are several pieces of evidence discovered here that either support the notion that cairn sites reference the sea, or stand against the notion that their only or primary purpose was to serve as territorial markers. First, on the seaward paths to sites that offer revelatory views, 14 preview locations offer greater sea views than available at the cairn sites. This finding stands against the notion that territoriality was of primary importance; if it were, such preview locations would likely have been optimal choices for monument placement. Second, there seems to be no obvious reason why cairn structures should be oriented towards the sea with such consistency, beyond what is likely attributable to the influence of landscape contours, if these monuments were merely placed to serve as territorial markers. Hence, the finding that cairn sites are frequently oriented toward the sea, whether it is in view or not, is highly significant for confirming the hypothesis considered in this study. Of additional significance are the findings that sightlines are also prevalent and that, with much greater frequency than otherwise, seaward paths identifiably arrive at locations at cairn sites where chambers may be found. These findings substantiate the notion that not only were the long cairns considered here accessed through seaward pathways, but also that the cairn structures reference the sea in a way that is especially visible from those seaward pathways.

Implications of the Findings for Interpreting the Long Cairns of Scotland

The above discussion concerns two main themes: the alleged territoriality of cairn structures on the one hand, and the references to the sea these structures seem to hold, on the other. The findings made in this study give some merit to either interpretation of these structures. However, it should be noted that these interpretations are not mutually exclusive and that in light of both the consistency of the findings and their specific characteristics, these themes or interpretations may even be implied by each other. By this it is meant that both themes involve the prehistoric individual's connection or relationship to, first, the community of which they are a part and, second, the community's wider context. And moreover, as is detailed here, elements of both interpretations seem to be implied by the findings.

On the 'cairn monument as territorial' interpretation, a monument stands to mark the boundaries of a community's territory with boundaries of the areas that may be used or travelled to by members of surrounding communities. On the 'cairn monument as referencing the sea' interpretation, a monument stands to connect 'the landscape of the living' with the wider cosmos (Fowler and Cummings 2003). The monuments are meeting places, on either view. They are inter-community meeting places, whether for honouring members of a community who were departing on and arriving from journeys on the sea (Van de Noort 2003), or meeting members of other communities who were making contact with inhabitants for trade or larger social gatherings. Monuments are also seen as 'intra-community' meeting places, where the dead are commemorated, such as through the multi-phased rituals of excarnation and disarticulation of corpses, and their deposition (Henshal 1972, Smith and Brickley 2009). Additionally, cairns serve as intra-community meeting places through the act of constructing the monuments over time, which likely involved members of the community contributing stones to the cairn more often than not on a location of the cairn body closest to the sea—as seen in the predominance of axis alignments with the sea. Hence, also in this view, the individual, community, and monument may be thought to meet with the wider cosmos, symbolized by the sea and its transformative powers, as discussed in Chapter 2, Section 4.

Evidence for both interpretations is seen throughout the findings made here. First, the notion that cain monuments were inter-community meeting places is implied by the finding that they were placed preferentially to afford sea views under limits defined by distance and elevation. While alternative locations with greater sea views than those offered at cairn sites were available in their surrounding areas, they were rarely available at similar elevations, which as discussed above suggests that the monuments were placed on routeways through the landscape that facilitated meetings between travelling peoples. Analogues for such meetings are seen in the Indigenous Australian ' 'Welcome to Country' ceremonies, which require visitors to wait at the boundaries to a territory, and signal through fire, to be welcomed and to pay their respects to locals before entering their space. Such customs would be crucial for preserving the lifeways of the Neolithic, as incorporating a greater onus on a community's ownership of livestock, cereal stores as well as cultivated land (Malone 2001, p. 18). And the use of long cairns for similar ceremonies may be one among the possible explanations for why some cairn sites have two distinct sets of forecourts, as often occurs in the Highlands; it is plausible that one forecourt was used for meetings with visitors, the other for exclusive, local gatherings.

Note that the aforementioned interpretation invokes both themes simultaneously, of cairns referencing of the sea as well as their role as territorial markers. Both themes are also invoked by the findings regarding the potential revelatory views offered at cairn sites. Significant numbers of cairn sites, a vast majority, are placed so as to offer arguably revelatory views of the sea, yet many are placed closer to the sea than is necessary to achieve such a view. An explanation considered here is that this may have facilitated the use of a cairn site as an inter-community meeting place, that is, if it were closer to travellers' sites of arrival or departure via the sea. In addition, while such sites are further seaward than is necessary to achieve a revelatory view, others are placed further inland than would be ideal to maximise sea views, suggesting that builders favoured having a site not too close to the sea. The findings, thus, imply that a cairn must be placed at a suitable halfway point between those areas, neither too close to the coast nor too far inland, perhaps to demarcate the boundary between them. This notion, that cairns are placed at what might be called the 'meeting point' between landscapes, is further substantiated by the finding that cairn sites are occasionally placed on locations that might mark an awareness of the sea—where monuments might point in the direction of the sea, even when the sea is not in view.

Taken together, these themes and the way in which they are implied by the findings made here suggest that the long cairns of Scotland served to mark and define the Neolithic individuals' place in and awareness of their socio-cosmological context. From the act of constructing the cairns themselves to the way that they were used over subsequent generations, these monuments marked and arguably acted to anchor: first, the individual's presence in their local community; second, the community's presence in the wider landscape; and third, the presence of 'the living' in a Neolithic conception of the cosmos, which invoked the perceived transformative forces that were represented by the sea. The efforts with which these monuments were constructed signal the importance of fulfilling such roles in the human psyche. Moreover, the success of the long cairn's fulfilment of these roles is evidenced by its proliferation, monumental proportions, and continued use over many generations, until the subsequent age in prehistory which would see further transformation of social organization and, relatedly, other methods of referencing elements of a prehistoric cosmology.

Chapter 11: Conclusion

This thesis held three aims. First, at the most general level, it sought to develop and realize the benefits of a hybrid approach to landscape archaeology that incorporates both the rich sources of insight provided by phenomenological inquiries as well as the rigorous and comprehensive forms of analysis afforded by GIS-based methodologies. Second, by using such an approach, this thesis sought to address and interrogate the specific claim made in phenomenological studies of landscape archaeology that ancient monuments often reference the sea in such a way that is indicative of important aspects of their builders' belief systems. Nested within these more general aims was the third and most specific aim of this thesis, which was to determine if the long cairns of Scotland, as an example of a group of ancient monuments, do in fact reference the sea in any such way. The means and the extent to which this study met these aims is addressed here, as are the ways in which the research conducted here can be continued and developed further, in future studies.

11.1 The Long Cairns of Scotland as Referencing the Sea

A Case Study for a Hybrid Approach to Landscape Archaeology

The methodology developed here presents an example of a phenomenologically directed GIS-based analysis. The impetus for the research question was taken from phenomenological analyses of landscape that consider the notion that prehistoric builders may have intended to reference the sea in the construction of their monuments (Fowler and Cummings 2003; Scarre 2002). Resources and methods available from the current use of GIS technologies (Gillings 2009) were then adapted, developed and used in combination with on-site observations and recordings to test that notion.

'Sea affordance surfaces' were generated using a cumulative viewshed technique, to represent the extent to which sea views are available in a given landscape. These surfaces consist of maps of the landscape surrounding each site that depict the percentage of the nearby area of sea that is visible from each point in those landscapes. These affordance surfaces were first analysed from a quantitative, statistical standpoint to determine whether the cairn sites considered were placed in locations that had a higher degree of sea views than would be obtained through chance, and thus whether there was any indication that sites were placed intentionally to receive sea views.

As described in Chapter 10, Section 1, much consideration was needed before the data produced by this technique could be meaningfully interpreted. The initial results of the statistical analysis of the affordance surfaces appeared to reject the hypothesis that the long cairns of Scotland's coastal regions are at least often constructed in a way that references the sea. With the exception of the analysis of Aberdeenshire, which did indicate intentionality in this regard, definite trends only began to appear after further and a more in-depth, qualitative consideration of the landscapes and affordance surfaces.

At the broader level of methodological framework, the strategy implemented in this next step was largely deductive. Affordance surfaces were examined to determine the availability of locations that offered greater sea views than those available at the cairn sites, in terms of how far away those locations were in both distance and elevation, and thus whether it would have been practical for monuments to be placed at those 'alternative locations' instead of the sites on which the cairns are located. If it were determined that cairns were placed on locations that afforded the greatest sea views that were practically obtainable, this would provide grounds to support the notion that those monuments were placed to reference the sea. Ultimately, the conclusions drawn supported the notion that the long cairns of Scotland's coastal regions reference the sea. As described in Chapter 10, Section 2, the data showed that it was rare for sites to be placed in locations that did not offer what were the greatest, practically obtainable sea views in their areas, in terms of either the expanse or prominence of sea area visible. Moreover, the only 10 cairn sites of the sample of 110 not placed to maximize views in such a way exhibit what are reasonably construed to be sufficient areas of sea visible with which the monuments might have used to reference the sea.

An idea considered in phenomenological studies is that one possible way that monuments might have referenced the sea was to be placed in specific locations that offer 'revelatory views' of the sea, which involves a sea view being revealed in a more or less dramatic way upon a person's approach to a cairn site. To test this notion, cost corridor analyses were conducted to determine the pathways likely used to access sites from a seaward direction. These pathways were then used in combination with the affordance surfaces to generate 'sea affordance profiles': graphic representations that depict the extent to which sea views are present on a given pathway.

Consideration of these sea affordance profiles led to the discovery of large numbers of sites that could be construed as offering revelatory views. This result offers significant substantiation to the notion that not only was the sea referenced by the placement of the monuments studied, but also that the sea was often referenced in a particularly dramatic and potentially meaningful way.

As described in Chapter 10, Section 3, some doubts may remain regarding the extent to which revelatory views were, at least originally, intended to be revelatory as such in any given case. This is because the presence of distinctly revelatory views might also be explained by a site being intentionally placed at the closest location that offered sea views, relative to a location further inland from where prehistoric peoples may have travelled. In any case, however, the large numbers of sites with such sea views, whether or not they were intended as 'revelatory views' by cairn builders, stands as significant evidence that these ancient monuments often reference the sea in a way that may be indicative of meaningful aspects of builders' belief systems.

Pathways to roughly one third of sites (19 of 55) that offer revelatory views were also found to have points that offer sea views either greater than or comparable to the sea views observed at the corresponding cairn locations. The presence of previews may have limited the extent to which the final sea view available at a cairn is 'revelatory' as such, and hence the presence of these sea previews may be indicative of a further criterion for location-choice sought after by prehistoric builders. Moreover, as sea previews were often comparable to the final sea views (at cairn sites), it is unlikely that this criterion related to the kind of sea views available, rather the data may simply be explained by builders seeking a location for monument placement that was in closer proximity to the sea. Importantly, as discussed in Chapter 10, Section 3, this is consistent with prehistoric peoples using cairn monuments for rituals and purposes that also involve a reference to the sea.

A further observation can be made due to the presence of the 14 sea previews that are greater than the final sea views available at their corresponding cairn sites. This observation regards the notion that cairns are placed to mark a people's territory to others, a widely held interpretation of location-choice that may account for much but not all of the data observed in this study. If cairns are placed so as to maximize views of their surrounding seascapes, which are areas on which other peoples travelled, then this entails that cairns are also placed in such a way that maximizes their visibility from those areas of sea. Hence, the data discussed above may largely be interpreted to confirm this interpretation of cairn placement, which is consistent with builders wanting to claim their territory through monument placement, to other groups of people, and whom use waterways as a means of travel. However, from the presence of sea previews greater than sea views at cairn sites, it can be inferred that it is unlikely that cairns were placed only or even primarily to mark a people's territory to others: these sea preview locations would have offered decisively more prominent locations than the sites on which cairns were placed, and therefore these locations would have been better for monument placement for the purpose of marking territory to neighbouring peoples whom were travelling via sea. Therefore, as these sea preview locations were not chosen, and because prehistoric peoples were likely aware of these preview locations' presence due to their placement on the seaward pathways that access the cairn sites, it is arguable that territoriality was not the main reason for monument-location choice.

The final step to the study concerned the orientation of cairn structures in their landscape contexts, as could relate to available sea views and seaward paths that access the sites. It was supposed that if cairn structures were intended to reference the sea then their orientations would reflect this, and hence a study of their orientations could help to confirm or reject that notion. It was found that almost all the long cairns considered, 64 of 69, were either aligned toward or parallel with the sea. As that figure included rather vague orientations with particularly expansive sea views, the data was considered in finer detail to determine if any distinctive patterns would emerge that could not be attributed so easily to chance. The sample was reduced to examine, first, the 39 sites that are placed where narrower sea views were available and, second, sites that held 'axis-alignments', which point in the direction of such sea views. All but 2 of the 39 cairns were placed in either axis- or side-alignment with narrower sea views, and that figure reduced to 25, or 64%, when side-alignments were removed.

Two conclusions were drawn from these figures. First, cairn long-axis alignments seem to occur with far greater frequency than what might be expected to be the result of chance alone. Second, no one form of alignment was preferred by builders universally, so that large proportions of long axes seem to be oriented either toward (in axis-alignment) or parallel with (in side-alignment) sea views.

The inclusion of seaward paths in the examination of cairn orientations in their landscape contexts led to the discovery of a similarly high frequency of 'sightlines', which occur when a seaward pathway aligns with both a cairn structure and the sea view behind it. Forty-nine sites of 69 were found to offer at least one form of sightline, a figure that reduced to 31 of 69, when sideway sightlines were removed and only axial sightlines (holding axis-alignments) were considered.[56]

Not only does the arrangement of factors in a sightline present a potentially auspicious view of the cairn and the sea that it may reference, but, in virtue of the inclusion of the seaward pathway, it is also less likely to have occurred by chance than mere alignments between cairn and sea view. This is a factor that gains greater importance when considered alongside the high proportion of sites whose seaward pathways arrive at a location on a cairn body in which a chamber was held. This implies that those seaward pathways were likely to have been used by prehistoric travellers to access the monuments, and were not simply one among other means of accessing these sites.

It was noted, in Chapter 10, Section 4, that the consistency of these findings should be considered in light of the possibility that landscape contours may have had a substantial effect in leading cairn structures and, similarly, seaward pathways to align with each other and with the direction of sea views. Yet, it was also found that, in flatter plateaus more common in the Highlands and Aberdeenshire, a higher proportion of sightlines were held with precision. In those landscapes in particular, prehistoric builders had greater freedom to orient cairns according to their preferences, as may have been defined by their belief systems. Hence, where landscape contours had less impact in determining the alignment of cairns with pathways and sea views, where those contours are less dramatic, a higher degree of alignment is observed. This outcome, then, is indicative of builders' intentions to reference the sea with their monuments.

This study provides a high degree of confirmation that the long cairns of Scotland's coastal areas reference the sea, through the analysis of different elements, comprising: the way in which sites are placed to either maximize sea views, or afford sufficient views of the sea; the high numbers of revelatory views; and, the way in which cairn sites and the pathways that approach them were arranged around views of the sea, forming alignments and sightlines. The results found here, thus, indicate that the sea, and perhaps water more generally, held a place of particular importance in Neolithic belief systems.

The inferences drawn in the study are made with a relatively high level of confidence, in comparison to the claims made in standard phenomenological studies of landscape (cf. Cummings

[56] Note that there are more 'axial sightlines' here than axis-alignments with narrower sea views, because the total number of axial sightlines (which involve axis-alignments) considered include sites with expansive sea views as well as narrower sea views.

and Whittle 2004; Fowler and Cummings 2003; Scarre 2002; Tilley 1994). This higher level of confidence presents the source of this study's significance in the wider research context, as offering a way forward for both improving established methodologies, and making a decisive step in increasing the known information and understanding regarding the long cairns of Scotland and their prehistoric builders. However, it must also be acknowledged that, by the same token, the validity of the inferences made in this study largely relies on the extent to which all relevant data could be apprehended and included in the models and affordance surfaces produced, and in how they were interpreted. Thus, while the consideration of these comprehensive data sets differentiates the method employed from those of previous studies, avenues for improving upon and developing the way in which landscape was considered in this study are presented by: first, the inclusion of further factors that may inform our understanding of the past, and the generation of new data for analysis; and second, the potential for a more refined analysis of any such new data, as well as the data generated in this study.

11.2 Wider Implications of this Study

The findings made here have several wider implications for archaeological research. As described in Chapter 2, two key approaches to landscape archaeology have until recent years largely been used separately from each other. These are approaches that solely invoke either phenomenological methodologies on the one hand or GIS-based techniques on the other. Researchers have begun to incorporate elements, concepts and techniques from both of these subfields of landscape archaeology, in combination, and this thesis has aimed to contribute to the resources that might be used in such a hybrid approach.

The results of this study demonstrate that such an approach can indeed be fruitful. Phenomenological theories and concepts, and GIS-based techniques and methods can be used in complementary ways, to enhance each other and to attain more informed research outcomes. Several examples of interplay between these complementary approaches are found here. First, at the most basic level, there are phenomenologically directed GIS techniques: phenomenological concepts direct the application of GIS techniques, which are employed either to model the way that landscapes can be phenomenologically engaged with, as through Horizon panoramas, or to model and extract data that represents such engagement, as through the use of sea affordance profiles to depict revelatory views. Furthermore, in using ideas gathered from phenomenological narratives, such GIS-based techniques also establish a factual basis from which to test the veracity of those ideas..

The creative interaction between these approaches also makes possible the following, second tier of interplay, the further exploration of which was unfortunately outside the scope of the present study. Through the engagement with the phenomenological notion of revelatory views, GIS techniques were used to identify certain pathways through the Scottish landscape that stand to offer particularly novel experiences, as encompassing cairn alignments and revelatory views. Now that these pathways have been identified, the possibility presents itself to use the phenomenological method (Tilley 1994) of walking those pathways and engaging with the landscape while stepping in what were likely the actual footsteps of prehistoric builders and their more immediate descendants.

In this way, each approach informs the other in a way that realizes the dual potential for this hybrid approach: first, GIS-techniques model how the claim made in phenomenology might hold true; second, with additional insight into the nature of the landscape and how it may have been engaged with, as verified through GIS techniques, phenomenological investigators may take the opportunity to engage more deeply with the landscape and, thus, inhabit more informed perspectives of the past.

11.3 The Inclusion of Further Factors Relevant to Location Choice: Further Avenues for Research

Other factors may have been determinates in prehistoric peoples' landscape choices in Scotland that were not included here and that may better explain why monuments are constructed the way that they are. One such factor, for instance, may be the use of cairn sites as meeting places, as well as ritualistic practices, for different communities or groups, some of whom may have had to travel over water to reach the sites. It would stand to reason, on that count, that cairn sites would be placed in locations that could be visible from the sea from particular directions, or that they are placed in locations specifically between the sea and an inland settlement. To be sure, that explanation does not negate the conclusion supported by this study, which is that the long cairns of Scotland's coastal regions are generally found to reference the sea, for there may be many such reasons why they do. However, the inclusion of further information in that way may render a more accurate depiction of prehistoric builders' intentions and belief systems. Therefore, a fruitful avenue for improving and developing both the methodology employed here and the study of the long cairns of Scotland in particular, is the inclusion of further data sets and the consideration of additional possibilities.

Among the potential lines of inquiry is the inclusion of data that depict the availability of building material and the locations of settlement sites so that there is a more accurate account of where prehistoric people were travelling from and how they likely approached a given monument. This may be aided by further GIS modelling, such as cost corridor analysis, that depicts not simply how prehistoric people traversed the landscape to access cairn sites, as was implemented here, but also of how wider landscape may have been traversed independent to such sites, and where settlement sites are likely to be found when such locations are not already known.

It may also be considered a possibility that cairn sites are oriented towards specific locations out to sea, marking the locations of settlement sites in distant islands or lands beyond the sea. Long cairns may also be oriented towards other specific features on the seascape, such as mountain peaks on a distant island that may have held some form of symbolic significance. Similarly, it would be of interest to examine the possibility that long cairn sites hold astronomical alignments, and were involved in ceremonies associated with celestial bodies or events, such as solstices, equinoxes, or lunar standstills. Such alignments are observed at several major sites in Britain and Ireland, such as Maeshowe, Stonehenge, and Newgrange, as well as the long cairn site Cairnholy I, which holds a precise E–W alignment to the vernal and autumnal equinoxes (see Chapter 5, Table 5.7). Hence, such orientations may also be incorporated by cairn structures, including their sometimes elaborate facades. This line of inquiry, moreover, is readily pursued using Horizon panoramas, as the original purpose of that program is to depict the movements of the sun, moon and stars, at a given latitude, time period in history and over a given landscape with its unique horizon profile.

The affordance viewshed technique used in this study can also be used in different ways to shed light on further relationships between cairns, their builders, the landscapes in which they are situated, and the pathways used to approach them. A further elaboration on the methodology used here could aid in representing the effects of vegetation when modelling visibility. Moreover, visibility of a monument from the pathway that approaches it can be modelled, so that it might be determined whether or not and how often sites are hidden from persons until their arrival, which may create senses of anticipation and, upon arrival, of seclusion and sacred space. A different effect that may be created through monument placement is seen in the extent to which a cairn is positioned so that it is observable from its surrounding landscape. Where cairns or other monuments are used as territorial markers, they will likely be placed in such prominent locations, and as described in Chapter 10, Section 5, this can be modelled and tested for using a 'land prominence' affordance viewshed (Gillings 2009). All such techniques stand to shed further light on the ways in which cairn sites were used by their builders and their more immediate descendants.

The limited scope of the present study, as a broad-scale analysis on the possibility that the long cairns of Scotland reference the sea in particular, did not permit investigation into these further areas. However, the inclusion of several above factors in the analysis of a given group of cairns stands to garner a more comprehensive understanding. In this way, the method might be developed further not only through the inclusion of additional factors for analysis, but also by focusing on a smaller and confined group of monuments as opposed to the kind of large-scale analysis done herein. Nevertheless, whether by broad-scale analysis or by a focused study, the method developed here and its hybrid approach to landscape archaeology is largely applicable to other monument types within and beyond Scotland, to other places in world archaeology.

References

Agugiaroa, G., Remondinoa, F., Girardib, G., von Schwerinc, J., Richards-Rissettod, H. and De Amicisb R. 2011, A Web-Based Interactive Tool for Multi-Resolution 3D Models of a Maya Archaeological Site. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* [ISPRS Trento 2011 Workshop, 2-4 March 2011], 38/5, pp. 23-30.

Ashmore, W. and Knapp, A. B., eds., 1999. *Archaeologies of Landscape: Contemporary Perspectives.* Malden: Blackwell Publishing.

Aveni, A.F. 1999. *Stairways to the Stars: Sky Watching in Three Great Ancient Cultures.* New York: John Wiley and Sons.

Aveni, A.F. 2010. Cosmology and Cultural Landscape: The Late Post-Classic Classic Maya of North Yucatan. In: Gabrielle Vail and Christine Hernández, eds., 2010. *Astronomers, Scribes, and Priests: Intellectual Interchange Between the Northern Maya Lowlands and Highland Mexico in the Late Postclassic Period.* Washington, Dumbarton Oaks Research Library and Collection. pp. 115-127.

Barrett, J. 2004. Comment on Tilley. *Cambridge Archaeological Journal*, 14, p. 199.

Barrett, J. and Ko, I. 2009. A Phenomenology of Landscape: A Crisis in British Landscape Archaeology? *Journal of Social Archaeology*, 9(3), pp. 275-94.

Barrett, J., Bradley R and Green, M. T. 2009. *Landscape, Monuments and Society: The Prehistory of Cranborne Chase.* Cambridge: Cambridge University Press.

Bar-Yosef, O. 2014. Upper Palaeolithic Hunter-Gatherers in Western Asia. In: Cummings, V. Jordan, P. and Zvelebil *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*. Oxford: Oxford University Press. [online] Available at: Oxford Handbooks Online. DOI: 10.1093/oxfordhb/9780199551224.013.062

Baxter, M. J. 2009. Archaeological Data Analysis and Fuzzy Clustering. *Archaeometry*, 51/6, pp. 1035-1054.

Bell, J. A. 1994. *Reconstructing Prehistory: Scientific Method in Archaeology.* Philadelphia: Temple University Press.

Bender, B. 1993. *Landscape: Politics and Perspectives*. Providence: Berg.

Bender, B., Miller, D. and Gilroy, P. 1998. *Stonehenge: Making Space*. Oxford: Berg.

Benwell, G. L., McLennan, B. R., Grasberger, T. and Fryer, J. 2002. Spatial Data Analysis of Aboriginal Rock Extraction Sites at Brewarrina, NSW, Australia. *The 14th Annual Colloquium of the Spatial Information Research Centre Victoria University of Wellington* [SIRC Wellington, 3-5 December 2002].

Bergh, S. 2002. Knocknarea: The Ultimate Monument: Megaliths and Monuments in Neolithic Cuil Irra, North-west Ireland. In: Scarre, C., ed., 2002. *Monuments and Landscape in Atlantic Europe: Perception and Society during the Neolithic and Early Bronze Age*. London: Routledge. pp. 139-151.

Bevana, A. and Conolly, J. 2009. Modelling Spatial Heterogeneity and Nonstationarity in Artifact-Rich Landscapes. *Journal of Archaeological Science*, 36(4), pp. 956-964.

Bishop, R. R. 2015. Did Late Neolithic Farming Fail or Flourish? A Scottish perspective on the Evidence for Late Neolithic Arable Cultivation in the British Isles. *World Archaeology*, 47(5), pp. 834-855.

Boado, F. C. and V´azquez, V. V. 2000: Monumentalising Landscape. From Present Perception to the Past Meaning of Galician Megalithism (North-West Iberian peninsula). *European Journal of Archaeology* 3, pp. 188-216.

Brace S., Diekmann, Y., Booth, T. J., Faltyskova, Z., Rohland, N., Mallick, S., …Barnes, I. 2018. Population Replacement in Early Neolithic Britain. B*ioRxiv*, [online] DOI: http://dx.doi.org/10.1101/267443

Bradley, R. 1998. *The Significance of Monuments: on the Shaping of Human Experience in Neolithic and Bronze Age Europe*. London: Routledge.

Bradley, R. 2016. Maritime Havens in Earlier Prehistoric Britain. *Proceedings of the Prehistoric Society,* 82, pp. 125-159.

Bradley, R. 2011. *Stages and Screens: an Investigation of Four Henge Monuments in Northern and North Eastern Scotland.* Ediburgh: Society of Antiquaries of Scotland.

Bradley, R. and Lamdin-Whymark, H., The Excavation of a Small Henge Monument at Pullyhour, Halkirk, Caithness. In: *Interim Report*, 2008. [online] Available at: https://www.reading.ac.uk/web/FILES/archaeology/arch-Pullyhour_interim_Small.pdf

Brophy, K. 2013. Houses, Halls, and Occupation in Britain and Ireland. In: Fowler, C, Harding and J. Hofmann, D., eds., 2014. *The Oxford Handbook of Neolithic Europe*. Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780199545841.013.077

Bruck, J. 1998. In the Footsteps of the Ancestors: A Review of Tilley's 'A Phenomenology of Landscape: Places, Paths and Monuments'. *Archaeological Review from Cambridge*, 15(1), pp. 23-36.

Bruck, J. 2005. Experiencing the Past? The Development of a Phenomenological Archaeology in British Prehistory. *Archaeological Dialogues*, 12(1), pp. 45-72.

Chadwick, A. 2004: 'Geographies of Sentience' – An Introduction to Space, Place and Time. In: A. Chadwick (ed.), *Stories from the Landscape: Archaeologies of Inhabitation*. Oxford: British Archaeological Reports, International Series 1238. pp. 1-31.

Ch'ng, E. (2009) Experiential Archaeology: Is Virtual Time Travel Possible? *Journal of Cultural Heritage*, 20, pp. 458-470.

Ch'ng, E, Stone, R. J. and Arvanitis T. N. 2005. Evaluating Artificial Life-Based Vegetation Dynamics in the Context of a Virtual Reality Representation of Ancient Landscapes. *Virtual Systems and Multimedia* [VSMM 2005. Ghent, Belgium Oct 3-6 2005], pp. 112-118.

Ch'ng E. and Stone R. J. 2006. Enhancing Virtual Reality with Artificial Life: Reconstructing a Flooded European Mesolithic landscape. *Presence: Teleoperators and Virtual Environments,* 15(3), pp. 341-352.

Ch'ng, E., Chapman, H., Gaffney, V. and Murgatroyd, P. 2011. From Sites to Landscapes: How Computing Technology is Shaping Archaeological Practice, *Computer*, 44(7), pp. 40-46.

Clarke, K.C. 2013. What is the World's Oldest Map? *Cartographic Journal*, 50, pp. 136-143.

Clarke, C. D. , Ely, J. C., Greenwood, S. L., Hughes, A. L. C., Meehan, R., et al. 2018. BRITICE GlacialMap,version2: a map and GIS database of glacial landforms of the last British–Irish Ice Sheet. *Boreas* 47, pp.11-27. https://doi.org/10.1111/bor.12273.ISSN0300-9483.

Collard, M., Edinborough, K., Shennan, S. and Thomas, M. 2010. Radiocarbon Evidence Indicates that Migrants Introduced Farming to Britain. *Journal of Archaeological Science*, 37, pp. 866-70.

Cosgrove, D. E. 1984. *Social Formation and Symbolic Landscape*. London: Croom Helm.

Cosgrove, D.E. and Daniels, S., eds., 1988. *The Iconography of Landscape: Essays on the Symbolic Representation, Design, and Use of Past Environment*s. Cambridge: Cambridge University Press.

Crary, J. 1995. *Techniques of the Observer*. Cambridge: MIT Press.

Corbin, A. 1998. *Village Bells*. New York, Columbia University Press.

Cummings, V. 2002a: Between Mountains and Sea: A Reconsideration of the Neolithic Monuments of South-West Scotland, *Proceedings of the Prehistoric Society*, 68, pp. 125-46.

Cummings, V. 2002b. Experiencing Texture and Transformation in the British Neolithic. *Oxford Journal of Archaeology,* 21(3), pp. 249-261.

Cummings, V. 2003. Building from Memory: Remembering the Past at Neolithic Monuments in Western Britain. In: Williams, H., ed., 1998. *Archaeologies of Remembrance: Death and Memory in Past Societies*. London: Routledge. pp .25-43.

Cummings, V. 2004. Connecting the Mountains and Sea: The Monuments of the Eastern Irish Sea Zone. In: Cummings, V. and Fowler, C., eds., *The Neolithic of the Irish Sea: Materiality and Traditions of Practice*. Oxford: Oxbow Books. pp. 29-36.

Cummings, V. and Harris, O J. T. 2014. The Continuity of Hunting and Gathering in the Neolithic and Beyond in Britain and Ireland. In: Cummings, V. Jordan, P. and Zvelebil, M. 2014. *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*. Oxford: Oxford University Press. [online] Available at: Oxford Handbooks Online. DOI: 10.1093/oxfordhb/9780199551224.013.049

Cummings, V. Jordan, P. and Zvelebil, M. 2014. *The Oxford Handbook of the Archaeology and Anthropology of Hunter-Gatherers*. Oxford: Oxford University Press.

Cummings, V., Midgley, M. S. and Scarre, C. 2014. Chambered Tombs and Passage Graves of Western and Northern Europe. In: Fowler, C, Harding and J. Hofmann, D., eds., 2014. *The Oxford Handbook of Neolithic Europe*. Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780199545841.013.043

Cummings, V. and Whittle, C. 2003. Tombs with a View: Landscapes, Monuments and Trees. *Antiquity,* 77, pp. 255-266.

Cummings, V. and Whittle, C. 2004. *Places of Special Virtue: Megaliths in the Neolithic Landscapes of Wales*. Oxford: Oxbow Books.

Curry, M. 1998. *Digital Places: Living with Geographic Information Technologies.* London: Routledge.

Davidson, J. L. and Henshall, A. 1989. *The Chambered Cairns of Orkney: An Inventory of the Structures and Their Contents*. Edinburgh: Edinburgh University Press.

Davidson, J. L. and Henshall, A. 1991. *The Chambered Cairns of Caithness: An Inventory of the Structures and Their Contents*. Edinburgh: Edinburgh University Press.

Dawson, P., Levy, R., Gardner, D. and Walls, M. 2007. Simulating the Behaviour of Light inside Arctic Dwellings: Implications for Assessing the Role of Vision in Task Performance. *World Archaeology*, 39(1), pp. 17-35.

Däniken, v. E. 1968. *Chariots of the Gods*. New York: Putnam.

Dodge, M., Kitchin, R. and Perkins, C. 2011. *The Map Reader: Theories of Mapping Practice and Cartographic Representation.* Oxford: Wiley-Blackwell.

Duncan, J. 1993. Sites of Representation: Place, Time, and the Discourse of the Other. In: Duncan J. and Ley D., eds., *Place / Culture / Representation.* New York: Routledge. pp. 39-56.

Edmonds, M. 1999. *Ancestral Geographies of the Neolithic: Landscape, Monuments and Memory*. London: Routledge.

Edmonds, M. 2004. *The Langdales: Landscape and Prehistory in the Lakeland Valley*. Michigan: Tempus.

Eliade, M., ed., 1987. *The Encyclopaedia of Religion*. London: MacMillan.

English Heritage, 2003. *Ripping up History: Archaeology under the Plough*, [online] Available at: http://www.english-heritage.org.uk/publications/ripping-up-history-archaeology-under-the-plough/030725rippinguphistory.pdf/

Eve, S. 2012. Augmenting Phenomenology: Using Augmented Reality to Aid Archaeological Phenomenology. *The Landscape Journal of Archaeological Method and Theory,* 19(4), pp. 582-600.

Eve, S. 2012. Embodied GIS How To: Part 1 – Loading Archaeological Landscapes into Unity3D (via Blender). *Dead Men's Eyes: Augmented Reality and Heritage*, [Online] Available at: http://www.dead-mens-eyes.org/embodied-gis-howto-part-1-loading-archaeological-landscapes-into-unity3d-via-blender/

Eve, S. 2014. Augmented Reality, a New Horizon in Archaeology. ASOR Blog [Online]. DOI: http://asorblog.org/?p=4707

Fewster, K. 2013. The Relationship between Ethnoarchaeology and Archaeologies of the Contemporary Past: a Historical Investigation. In: Graves-Brown, P., Harrison, R. and Piccini, A. 2013. *The Oxford Handbook of the Archaeology of the Contemporary World.* Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780199602001.013.046

Finlayson, B. 2013. Introduction to the Levant During the Neolithic Period. In: Killebrew, A. E., and Steine, M. 2013. *The Oxford Handbook of the Archaeology of the Levant: c. 8000-332 BCE.* Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780199212972.013.009

Fitzjohn, M. 2007. Viewing Places: GIS Applications for Examining the Perception of Space in the Mountains of Sicily. *World Archaeology*, 39(1), pp. 36-50.

Fleming, A. 1999. Phenomenology and the Megaliths of Wales: A Dreaming Too Far? *Oxford Journal of Archaeology*, 18, pp. 119-25.

Fleming A. 2005. Megaliths and Post-Modernism: The Case of Wales. *Antiquity,* 79, pp. 921-32.

Fleming A. 2006. Post-Processual Landscape Archaeology: A Critique. *Cambridge Archaeological Journal*, 16(3), pp. 267-80.

Fowler, C. and Cummings, V. 2003. Places of Transformation: Building Monuments from Water and Stone in the Neolithic of the Irish Sea. *The Journal of the Royal Anthropological Institute*, 9(1), pp. 1-20.

Foley, C., Gibbons, M. and Stout, G. 1991. Forestry and Archaeology [Report produced by the Subcommittee on Forestry and Archaeology, April 1991], *Irish Association of Professional Archaeologists*.

Frieman, C. 2008. Islandscapes and Islandness: The Prehistoric Isle of Man in the Irish Seascape. *The Oxford Journal of Archaeology,* 27(2), pp. 135-151.

Frieman, C. and Gillings, M. 2007. Seeing is Perceiving? *World Archaeology*, 39(1), pp. 4-16.

Fowler, C, Harding J. and Hofmann, D. 2014. The Oxford Handbook of Neolithic Europe: An Introduction. In: Fowler, C., Harding J. and Hofmann, D., eds., 2014. *The Oxford Handbook of Neolithic Europe*. Oxford Handbooks Online.
DOI: 10.1093/oxfordhb/9780199545841.013.061

Fowler, C, Harding and J. Hofmann, D., eds., 2014. *The Oxford Handbook of Neolithic Europe*. Oxford: Oxford University Press.

Finlayson, B. 2013. Introduction to the Levant During the Neolithic Period. In: Killebrew, A. E., and Steine, M. 2013. *The Oxford Handbook of the Archaeology of the Levant: c. 8000-332 BCE*. Oxford: Oxford University Press. [online] Available at: Oxford Handbooks Online. DOI: 10.1093/oxfordhb/9780199212972.013.009

Gaffney, V. and Leusen, V. 1995. Postscript—GIS, Environmental Determinism and Archaeology: A Parallel Text. In: Lock G. R. and Stancic Z., eds., *Archaeology and Geographic Information Systems: A European Perspective*. New York: Taylor and Francis. pp. 367-382.

Gao, C., Wang, X., Jiang, T. and Jin, G. 2009. Spatial Distribution of Archaeological Sites in Lakeshore of Chaohu Lake in China Based on GIS. *Chinese Geographical Science*, 19(4), pp. 333-340.

Gell, A. 1995. The Language of the Forest: Landscape and Phonological Iconism in Umeda. In: Hirsch E. and O'Hanlon M., eds., *The Anthropology of Landscape: Perspectives on Place and Space.* Oxford: Clarendon. pp. 232–254.

Gillings, M., Mattingly, D. and van Dalen, J. 1999. *Geographical Information Systems and Landscape Archaeology*. Oxford: Oxbow.

Gillings, M. 2007. Approaching the Early Neolithic landscape of the Kiri-tó Meander: Developing GIS Approaches to the Archaeology of Place. In: Whittle, A., ed., *The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva*. Co. Békés: Archaeological Institute of the Hungarian Academy of Sciences. pp. 31-46.

Gillings, M. 2009. Visual Affordance, Landscape and the Megaliths of Alderney. *Oxford Journal of Archaeology*, 28(4), pp. 335-356.

Gillings, M. 2011. Chorography, Phenomenology and the Antiquarian Tradition. *Cambridge Archaeological Journal*, 21(1), pp. 53-64.

Gillings, M. 2012. Landscape Phenomenology, GIS and the Role of Affordance. *Journal of Archaeological Method Theory*, 19, pp. 601-611.

Godlewska, A. 1995. Map, Text, and Image. *Transactions of the British Institute of Geographers, NS,* 20, pp. 5-28.

Gosden, C. 1996. Can We Take the Aryan out of Heideggerian? *Archaeological Dialogues*, 3(1), pp. 22-25.

Graves, D. 2012. Qualitative Landscape Theories and Archaeological Predictive Modelling—A Journey Through No Man's Land? *Journal of Archaeological Method and Theory*, 19(4), pp. 526-547.

Graves, D. and Millican, K. 2012. Search of the Middle Ground: Quantitative Spatial Techniques and Experiential Theory in Archaeology. *Journal of Archaeological Method Theory,* 19(4), pp. 491-494.

Graves-Brown, P., Harrison, R. and Piccini, A. 2013. The Oxford Handbook of the Archaeology of the Contemporary World. Oxford: Oxford University Press.

Griffiths, R. 2020. The Case for an Orientation Signature Study of the 'Henges' of Scotland and Associated Methodological Difficulties. In: Dundar, L., Parkes, R., and Gant-Thompson, C., eds., *Yachay Wasi: The House of Knowledge of Ian Farrington*. Oxford: British Archaeological Reports. pp. 128-137.

Grün, A., Sauerbier, M. and Lambers, K. 2003. Visualisation and GIS-Based Analysis of the Nasca Geoglyphs. In: Doerr, M., Sarris, A., eds., *The Digital Heritage of Archaeology* [CAA, April 2002]. Athens: Hellenic Ministry of Culture, Archive of Monuments and Publications. pp. 161-167.

Hacıguzeller, P. 2012. GIS, Critique, Representation and Beyond. *Journal of Social Archaeology*, 12, pp. 245-263.

Hamilton, S. and Whitehouse, R. D. 2006. *Archaeology and Women: Ancient and Modern Issues.* California: Left Coast Press.

Harding, J. 2003. *Henge Monuments of the British Isles*. Stroud: Tempus.

Harding, J. 2012. Conformity, Routeways and Religious Experience – the Henges of Central Yorkshire. In: Gibson, A., ed., *Enclosing the Neolithic: Recent Studies in Britain and Europe*. Oxford: Archaeopress. pp. 67-78.

Harding, J., Johnson, B. and Goodrick, G. 2006. Neolithic Cosmology and the Monument Complex of Thornborough, North Yorkshire. *Archaeoastronomy*, 20, pp. 28-53.

Haraway, D. J. 1991. *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York: Routledge.

Heidegger, M. 1927. *Being and Time*. New York: Harper Perennial Modern Classics.

Henshall, A. 1963. *The Chambered Tombs of Scotland.* (vol. I) Edinburgh: Edinburgh University Press.

Henshall, A. 1972. *The Chambered Tombs of Scotland.* (vol. II) Edinburgh: Edinburgh University Press.

Henshall, A. and Richie J., N. G. 1995. *The Chambered Cairns of Sutherland: An Inventory of the Structures and Their Contents*. Edinburgh: Edinburgh University Press.

Henshall, A. and Richie J., N. G. 2001. *The Chambered Cairns of the Central Highlands: An Inventory of the Structures and Their Contents*. Edinburgh: Edinburgh University Press.

Higginbottom, G. 2020. The World Ends Here, the World Begins Here: Bronze Age Megalithic Monuments in Western Scotland. *Journal of World Prehistory*, 33, pp. 25-134.

Hoskin, M. 2001. *Tombs, Temples, and Their Orientations: A New Perspective on Mediterranean Prehistory.* Sussex: Ocarina Books.

Hudak, G. J., Hobbs, E., Brooks, A., Sersland, C. A., and Phillips, C. eds., (2002). *Final Report: A Predictive Model of Precontact Archaeological Site Location for the State of Minnesota.* St. Paul, Minnesota: Department of Transportation.

Ingold, T. 2000. *The Perception of the Environment: Essays in Livelihood, Dwelling and Skill.* London: Routledge.

Jay, M. 1988. Scopic Regimes of Modernity. In: Foster, H., ed., 1988. *Vision and Visuality*. Seattle: Bay Press. pp. 3-23.

Jerpåsen, G. 2009. Application of Visual Archaeological Landscape Analysis: Some Results. *Norwegian Archaeological Review,* 42(2), pp. 123-145.

Johnson, G. 1998. *Archaeology and Forestry in Ireland.* Kilkenny: The Heritage Council.

Johnson, M. 2000. Self-Made Man and the Staging of Agency. In: Dobres, M. A. and Robb, J. eds., 2000. *Agency in Archaeology*. London: Routledge. pp. 213-231.

Johnson, M. 2002. *Behind the Castle Gate*. London: Routledge.

Johnson, M. 2006. *Ideas of Landscapes*. Oxford: Blackwell.

Johnson, M. 2012. Phenomenological Approaches in Landscape Archaeology. *Annual Review of Anthropology,* 41, pp. 269-284.

Johansen, K. L., Laursen, S. T. and Holst, M. K. 2004. Spatial Patterns of Social Organization in the Early Bronze Age of South Scandinavia. *Journal of Anthropological Archaeology*, 23(1), pp. 33-55.

Johnson, I. and North, M. 1997. *Archaeological applications of GIS*. Sydney: University of Sydney.

Jung, C. G. 2014. *The Archetypes and the Collective Unconscious*. Second Edition. East Sussex: Routledge.

Killebrew, A. E., and Steine, M. 2013. *The Oxford Handbook of the Archaeology of the Levant: c. 8000-332 BCE*. Oxford: Oxford University Press.

Knapp, A. B. and Ashmore, W. 1999. Archaeological Landscapes: Constructed, Conceptualized, Ideational. In: Ashmore, W. and Knapp, A. B., eds., 1999. *Archaeologies of Landscape: Contemporary Perspectives*. Malden: Blackwell Publishers. pp. 1-30.

Lake, M., Woodman, P. and Mithen, S. 1998. Tailoring GIS Software for Archaeological Applications: An Example Concerning Viewshed Analysis. *Journal of Archaeological Science*, 25, pp. 27-38.

Lake, M. and Woodman, P. E. 2003. Visibility Studies in Archaeology: A Review and Case Study. *Environment and Planning B: Planning and Design*, 30, pp. 689-707.

Liddiard, R. and Williamson, T. M. 2008. There by Design? Some Reflections on Medieval Elite Landscapes. *Archaeological Journal*, 165, pp. 520-35.

Llobera, M. 2001. Building Past Landscape Perception with GIS: Understanding Topographic Prominence. *Journal of Archaeological Science*, 28, pp. 1005-1014.

Llobera, M. 2005. The Nature of Everyday Experience: Examples from the Study of Visual Space. In: Fisher, P., ed., 2005. *Re-Presenting GIS*. Chichester: John Wiley & Sons. pp. 171-194.

Llobera, M. 2007. Reconstructing Visual Landscapes. *World Archaeology*, 39(1), pp. 51-69.

Llobera, M. 2012. Life on a Pixel: Challenges in the Development of Digital Methods within an "Interpretive" Landscape Archaeology Framework. *Journal of Archaeological Method and Theory,* 19(4), pp. 495-509.

Llobera, M., Fábrega-Álvarez, P. and Parcero-Oubiña, C. 2011. Order in Movement: a GIS Approach to Accessibility. *Journal of Archaeological Science*, 38(4), pp. 843-851.

Mackie, E. 1997. Maeshowe and the Winter Solstice: Ceremonial Aspects of the Orkney Grooved Ware Culture. *Antiquity,* 71(272), pp. 338-359.

Malone, C. 2002. *Neolithic Britain and Ireland.* Gloucestershire: Tempus.

McLuhan, M. 1962. *The Gutenberg Galaxy: The Making of Typographic Man*. Toronto: University of Toronto Press.

Meece, S. 2006. "A Bird's Eye View – Of A Leopard's Spots: The Çatalhöyük 'Map' and the Development of Cartographic Representation in Prehistory*", Anatolian Studies*, 56, pp. 1-16.

Mehrer, M. W. and Wescott K. L., eds., 2005. *GIS and Archaeological Site Location Modeling.* Florida: CRC Press.

Mellaart, J. 1964a. 'Excavations at Çatal Hüyük, Third Preliminary Report.' *Anatolian Studies*, 14, pp. 39-120.

Mellaart, J. 1967. *Çatal Hüyük: a Neolithic Town in Anatolia*. London: Thames and Hudson.

Merleau-Ponty, M. 1945. *Phenomenology of Perception*. New York: Psychology Press.

Midgley, M. S. 2010. Monuments and Monumentality: The Cosmological Model of the World of Megaliths. *Documenta Praehistorica*, 37, pp. 55-64.

Millican, K. 2012a. The Outside Inside: Combining Aerial Photographs, Cropmarks and Landscape Experience. *Journal of Archaeological Method and Theory,* 19(4), pp. 548-563.

Millican, K. 2012b. Timber Monuments, Landscape and the Environment in the Nith Valley, Dumfries and Galloway. *Oxford Journal of Archaeology*, 31(1), pp. 27-46.

Mithen, S. and Lake, M. 1999. The Distribution of Mesolithic Sites on Islay: Field Survey. Numerical Classification and Viewshed Analysis. [Mesolithic conference, Leicester, 1998.]

Mlekuz, D. 2004. Listening to Landscapes: Modelling Past Soundscapes in GIS. *Internet Archaeology*, 16. [online] Available at: http://intarch.ac.uk/journal/issue16/mlekuz_index.html.

Moran, D. 2000. *Introduction to Phenomenology*. Oxford: Routledge.

Phillips, T. 2002. *Landscapes of the Living Landscapes of the Dead*. Oxford: Archaeopress.

Pink, S. 2009. *Doing Sensory Wthnography*. London: SAGE Publications Ltd.

Pollard, J. 2012. Living with Sacred Spaces: The Henge Monuments of Wessex. In: Gibson, A., ed., *Enclosing the Neolithic: Recent Studies in Britain and Europe*. Oxford: Archaeopress. pp. 93-107.

Pugh, T. W. 2003. A Cluster and Spatial Analysis of Ceremonial Architecture at Late Postclassic Mayapan. *Journal of Archaeological Science*, 30(8), pp. 941-953.

Rennell, R. 2012. Landscape, Experience and GIS: Exploring the Potential for Methodological Dialogue. *Journal of Archaeological Method Theory*, 19, pp. 510-525.

Richards, C. 1996a. Monuments as Landscape: Creating the Centre of the World in Late Neolithic Orkney. *World Archaeology,* 28(2), pp. 190-208.

Richards, C. 1996b. Henges and Water: Towards an Elemental Understanding of Monumentality and Landscape in Late Neolithic Britain. *Journal of Material Culture*, 1(3), pp. 313-336.

Rose, G. 1992. 'Geography as a Science of Observation: The Landscape, the Gaze, and Masculinity', In: Driver, F. and Rose, G., eds., *Nature and Science: Essays in the History of Geographical Knowledge*. London: Historical Geography Research Group. pp. 8-18.

Roughley, C. F. and Shell, C. A. 2004. Views of Carnac: Applications of Visibility Analysis and Dynamic Visualisation for Understanding the Neolithic Monuments of Southern Brittany. *Internet Archaeology*, 16. DOI: https://doi.org/10.11141/ia.16.8

Rudhardt, J. 1987. Water. In: *The Encyclopedia of Religion*, ed., M. Eliade. New York: MacMillan, Volume 15, pp. 350–58.

Saunders, N. 2001. A Dark Light: Reflections on Obsidian in Mesoamerica. *World Archaeology*, 33(2), pp. 220-236.

Scarre, C. 2002. 'A Place of Special Meaning: Interpreting Pre-Historic Monuments in the Landscape', In: David, B. and Wilson, M., eds., *Inscribed Landscapes*. Honolulu: University of Hawaii Press. pp. 154-175.

Scarre, C. 2002. Introduction: Situating Monuments: The Dialogue between Built Form and Landform in Atlantic Europe. In: Scarre, C. (ed.), *Monuments and Landscape in Atlantic Europe*. London: Routledge. pp. 1-14.

Scarre, C. and Lawson, G., eds., 2006. *Archaeoacoustics*. Cambridge: MacDonald Institute for Archaeological Research.

Schmitt A. K., Danišík, M., Aydar, E., Şen, E., Ulusoy, İ., et al. 2014. Identifying the Volcanic Eruption Depicted in a Neolithic Painting at Çatalhöyük, Central Anatolia, Turkey. *PLoS ONE*, 9(1), pp. 1-10.

ScARF, 2012. Neolithic Scotland: Panel Report. In: Brophy, K., and Sheridan, A., eds., *Scottish Archaeological Research Framework: Society of Antiquaries of Scotland.* [online] Available at: http://www.scottishheritagehub.com/sites/default/files/u12/ScARF%20Neolithic%20June%202012%20v2%20.pdf

Sheridan, J. A. 2006 The National Museums Scotland Radiocarbon Dating Programmes: Results obtained during 2005/6. *Discovery and Excavation in Scotland,* 7, pp. 204-206.

Shennan, S. 2002. *Genes, Memes and Human History*. London: Thames & Hudson.

Siart, C., Eitel, B. and Panagiotopoulos, D. 2008. Investigation of Past Archaeological Landscapes Using Remote Sensing and GIS: A Multi-Method Case Study from Mount Ida, Crete. *Journal of Archaeological Science,* 35(11), pp. 2918-2926.

Sims, L. 2009. Entering, and Returning from, the Underworld: Reconstituting Silbury Hill by Combining a Quantified Landscape Phenomenology with Archaeoastronomy. *The Journal of the Royal Anthropological Institute*, 15(2), pp. 386-408.

Stevens, C. J., and Fuller, D. Q. 2012. Did Neolithic Farming Fail? The Case for a Bronze Age Agricultural Revolution in the British Isles. *Antiquity*, 86, pp. 707-722.

Stirn 2014

Sturt, F. 2006. Local Knowledge is Required: A Rhythmanalytical Approach to the Late Mesolithic and Early Neolithic of the East Anglian Fenland, UK. *Journal of Maritime Archaeology* 1, pp. 119-139.

Sui, D. Z. 1994. GIS and Urban Studies: Positivism, Post-Positivism and Beyond. *Urban Geography*, 15, pp. 258-278.

Synnott, Anthony. 1991. Puzzling over the Senses: From Plato to Marx. In: Howes D., ed., 1991. *The Varieties of Sensory Experience: A Sourcebook in the Anthropology of the Senses*. Toronto: University of Toronto Press, pp. 61-78.

Renfrew, C. and Bahn, P. 2005. *Archaeology: The Key Concepts*. London: Routledge.

Teichmann, M. 2009. Visualisation in Archaeology: An Assessment of Modelling Archaeological Landscapes using Scientific and Gaming Software. *International Journal of Humanities & Arts Computing,* 3(1), pp. 101-125.

Thomas, J. 1991. *Rethinking the Neolithic.* Cambridge: Cambridge University Press.

Thomas, J. 1993. The Politics of Vision and Archaeologies of Landscape. In: Bender, B., ed., *Landscape: Politics and Perspectives*. Oxford: Berg. pp. 19-48.

Thomas, J. 1996. *Time, Culture and Identity: An Interpretive Archaeology.* London: Routledge.

Thomas, J. 1999. *Understanding the Neolithic.* London: Routledge.

Thomas, J. 2001. Archaeologies of Place and Landscape. In: Hodder, I., ed., *Archaeological Theory Today*. Malden: Polity Press. pp. 165-86.

Thomas, J. 2004. *Archaeology and Modernity*. London: Routledge.

Thomas, J. 2014. Commentary: What Do We Mean by 'Neolithic Societies'? In: Fowler, C, Harding and J. Hofmann, D., eds., 2014. *The Oxford Handbook of Neolithic Europe*. Oxford Handbooks Online.

Thorpe, N. 2014. The Atlantic Mesolithic–Neolithic Transition. In: Fowler, C, Harding and J. Hofmann, D., eds., 2014. *The Oxford Handbook of Neolithic Europe*. Oxford Handbooks Online. DOI: 10.1093/oxfordhb/9780199545841.013.071

Tilley, C. 1994. *A Phenomenology of Landscape: Places, Paths, and Monuments*. Berg: Oxford.

Tilley, C. 2004a. Round Barrows and Dykes as Landscape Metaphors. *Cambridge Archaeological Journal*, 14, pp. 185-203.

Tilley, C. 2004b. *The Materiality of Stone: Explorations in Landscape Phenomenology 1*. Oxford: Berg.

Tilley, C. 2008. *Body and Image: Explorations in Landscape Phenomenology 2*. Walnut Creek, CA: Left Coast Press.

Tilley, C. 2012. *Explorations in Landscape Phenomenology*. Left Coast Press: California.

Tilley, C. and Bennett, W. 2001. An Archaeology of Supernatural Places: The Case of West Penwith. *Journal of the Royal Anthropological Institute*, 7(2), pp. 335-362.

Tipping, R. 1994. The Form and Fate of Scotland's Woodlands. *Proceedings of the Society of Antiquaries of Scotland*, 124, pp. 1-54.

Trick, S. 2004. Bringing It All back Home: the Practical Visual Environments of Southeast European Tells. *Internet Archaeology,* 16. [online] Available at: http://intarch.ac.uk/journal/issue16/trick_index.html

Van de Noort, R. 2003. An Ancient Landscape: The Social Context of Seafaring in the Early Bronze Age. *World Archaeology*, 35(3), pp. 404-415.

Verhagen, P. ed., 2007. *Case Studies in Archaeological Predictive Modelling.* Leiden: Leiden University Press.

Verhagen, P. 2010 On the Road to Nowhere? Least Cost Paths, Accessibility and the Predictive Modelling Perspective. In Contreras F., Farjas M. and Melero F. J., eds., *Proceedings of the 38th Annual Conference on Computer Applications and Quantitative Methods in Archaeology,* CAA2010, pp. 383-390.

Verhagen, P. and Whitley, T. G. 2012. Integrating Archaeological Theory and Predictive Modeling: A Live Report from the Scene. *Journal of Archaeological Method and Theory*, 19(1), pp. 49-100.

Waller, S. 2006. The Divine Echo Twin Depicted at Echoing Rock Art Sites: Acoustic Testing to Substantiate Interpretations. *American Indian Rock Art*, 32, pp. 63-74.

Waller, S. 2012. Sounds and Symbolism from the Netherworld: Acoustic Archaeology at the Animal Master's Portal. [coauthored with Alan Garfinkel] *Pacific Coast Archaeological Society Quarterly*, 46(4), pp. 37-60.

Watson, A. and Keating, D. 1999: Architecture and Sound. An Acoustic Analysis of Megalithic Monuments in Prehistoric Britain. *Antiquity,* 73, pp. 325-336.

Watson, A. 2006. (Un)Intentional Sound? Acoustics and Neolithic monuments. In: Scarre, C. and Lawson, G., eds., 2006. *Archaeoacoustics*. Cambridge: McDonald Institute Monographs.

Wescott, J. and Brandon, R. 2000. *Practical Applications of GIS for Archaeologists: A Predictive Modelling Kit.* London: Taylor & Francis.

Winterbottom, S. J. and Long, D. 2006. From Abstract Digital Models to Rich Virtual Environments: Landscape Contexts in Kilmartin Glen, Scotland. *Journal of Archaeological Science,* 33(10), pp. 1356-1367.

Wheatley, D. 2004. Making Space for an Archaeology of Place. *Internet Archaeology*, 15. DOI: https://doi.org/10.11141/ia.15.10

Wheatley, D. 2014 Connecting Landscapes with Built Environments: Visibility Analysis, Scale and the Senses. In: Paliou, E., Lieberwirth, U. and Polla, S., eds., *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Historic and Prehistoric Built Environments*. Berlin: De Gruyter, pp. 115-134.

Wheatley, D. and Gillings, M. 2000. Vision, Perception and GIS: Developing Enriched Approaches to the Study of Archaeological Visibility. In: Lock, G., ed., *Beyond the Map: Archaeology and Spatial Technologies*. Amsterdam: IOS Press. pp. 1-27.

Wheatly, D., Earle, G, and Poppy, S. 2002. *Contemporary Themes in Archaeological Computing*. Oxford: Oxbow.

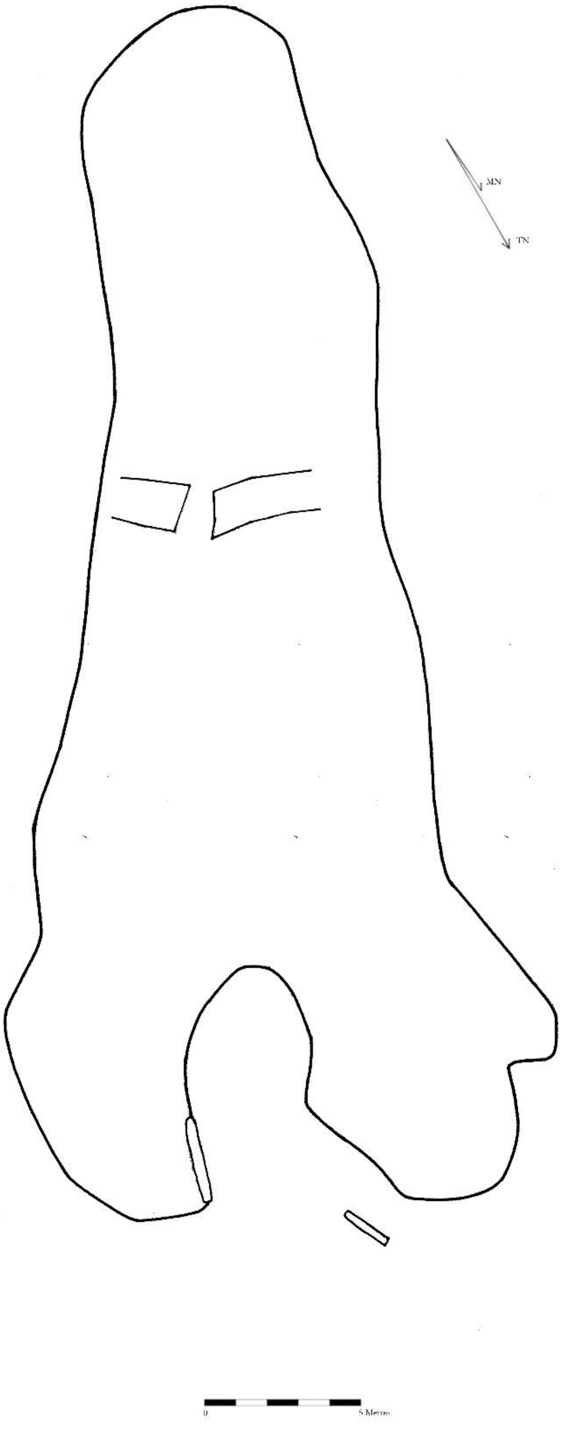
Wheatley, D. W., Sanjuán, L. G., Murrieta Flores, P. A. and Pérez, J. M. 2010. Approaching the Landscape Dimension of the Megalithic Phenomenon in Southern Spain. *Oxford Journal of Archaeology*, 29(4), pp. 387-405.

Whitley, T. G. and Hicks, L. M. 2003. A Geographic Information Systems Approach to Understanding Prehistoric and Historic Travel Corridors. *Southeastern Archaeology*, 22(1), pp. 77-91.

Woodham, A. 1955. Four Henge Monuments in Easter Ross. *Proceedings of the Society of Antiquaries of Scotland*, 87, pp. 72-79.

Appendix

Site Plans

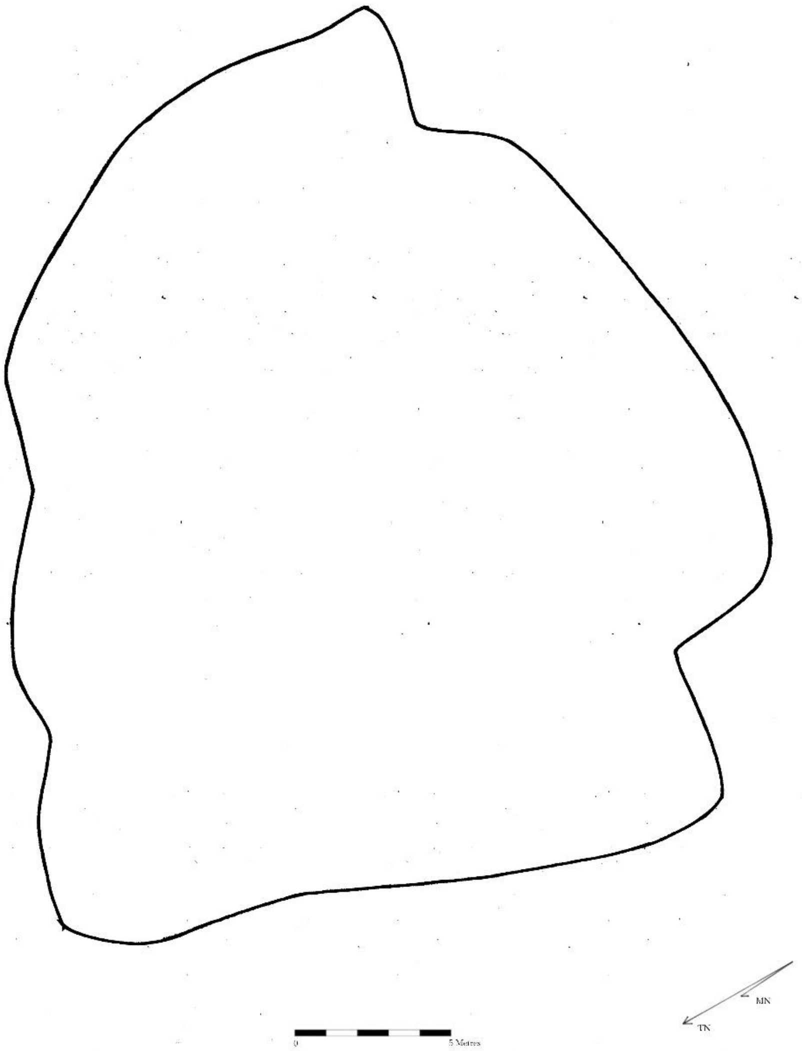


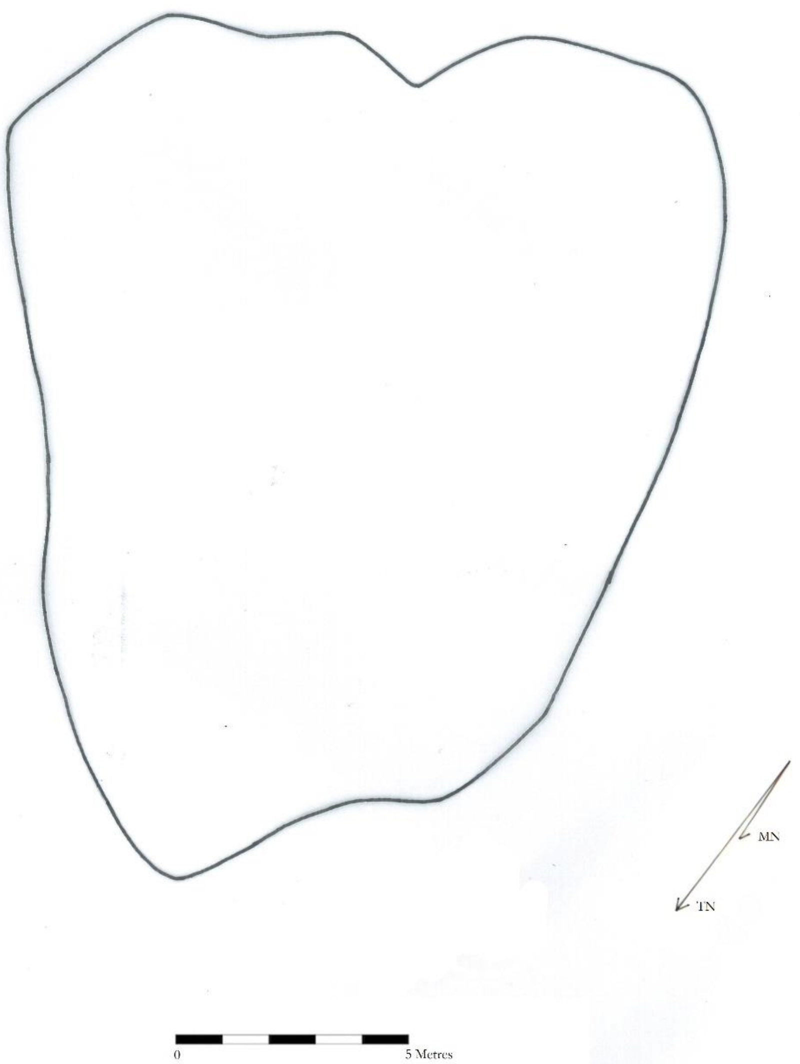
Site Name: Auchoise
Scale 1:100
Visible extent
Visible extent of chambers
Extant orthostats lying flat on the ground (Approx width)

Site surveyed by R.G. & P.G. on 20/07/2012
Site plan drawn by R.G. on 22/03/2013

Site Name: Aberscross
Scale 1:100
——— Visible extent

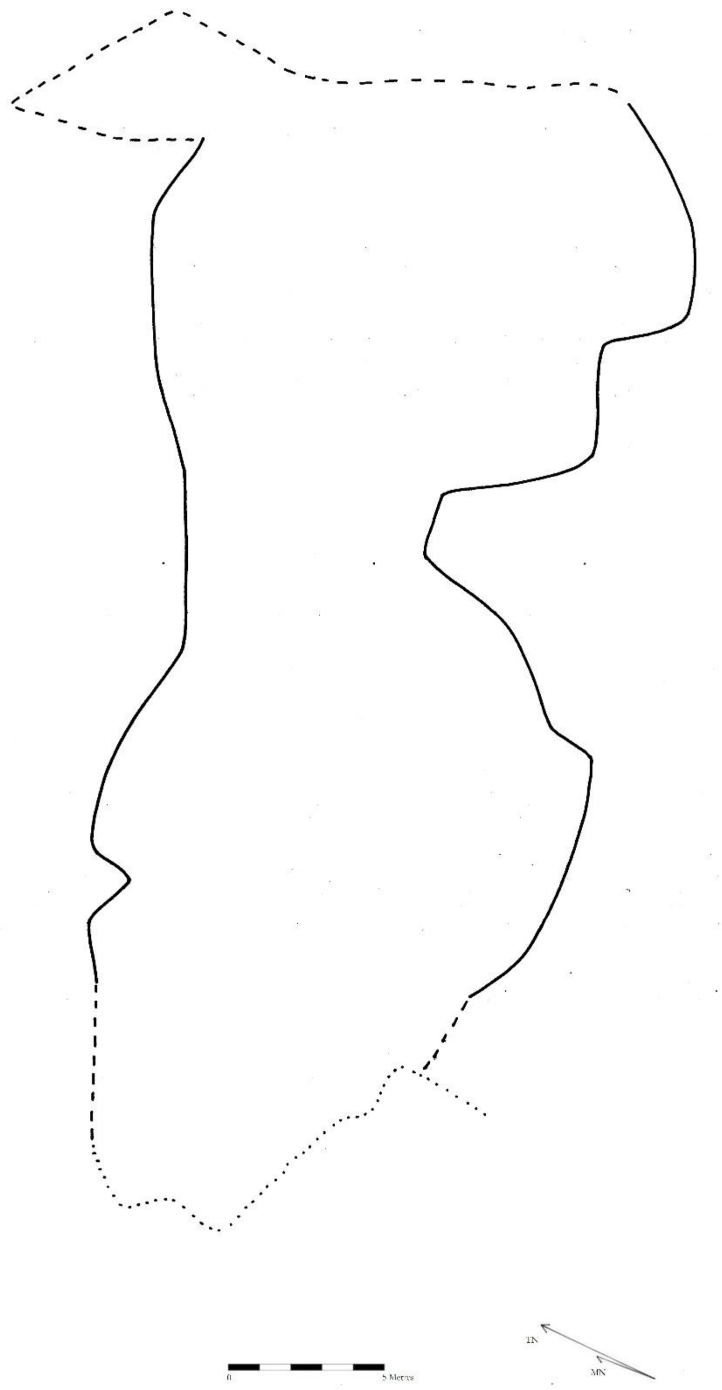
Site surveyed by R.G. & P.G on 09/08/2012
Site plan drawn by R.G on 20/30/2013





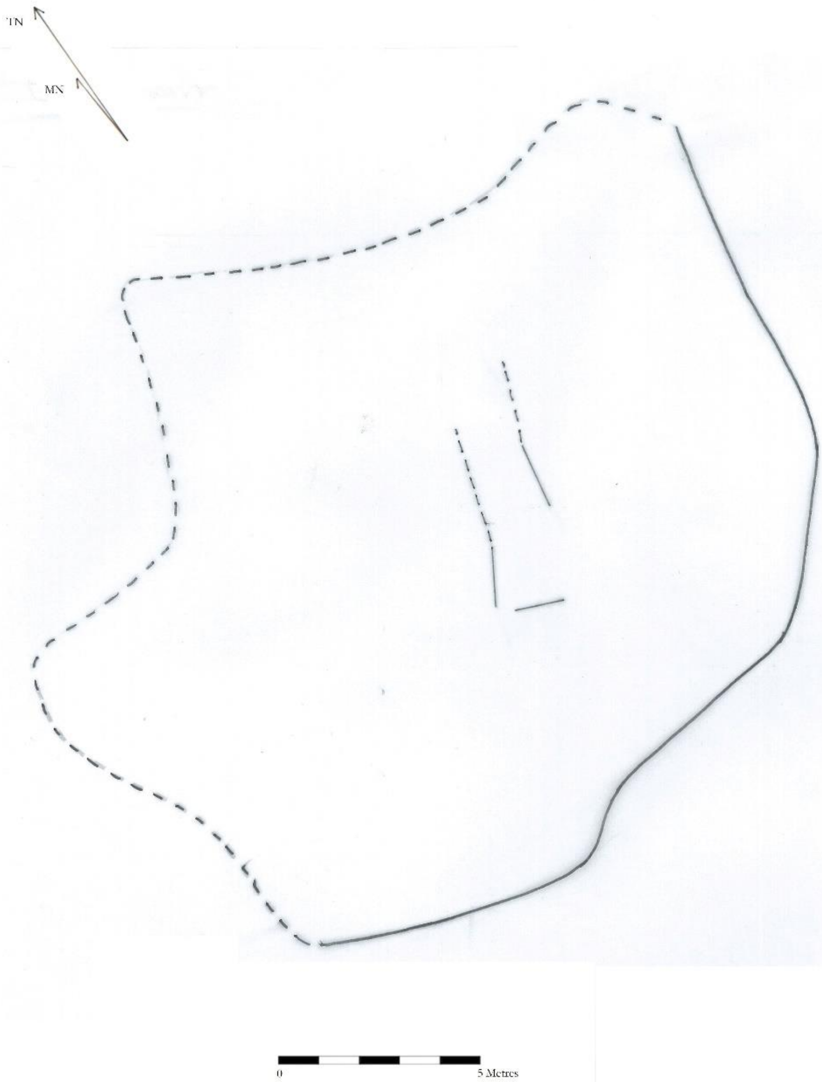
Site Name: Baille Hill
Scale 1:100
——— Visible extent

Site surveyed by R.G. & P.G. on 20/08/2012
Site plan drawn by R.G. on 24/01/2013



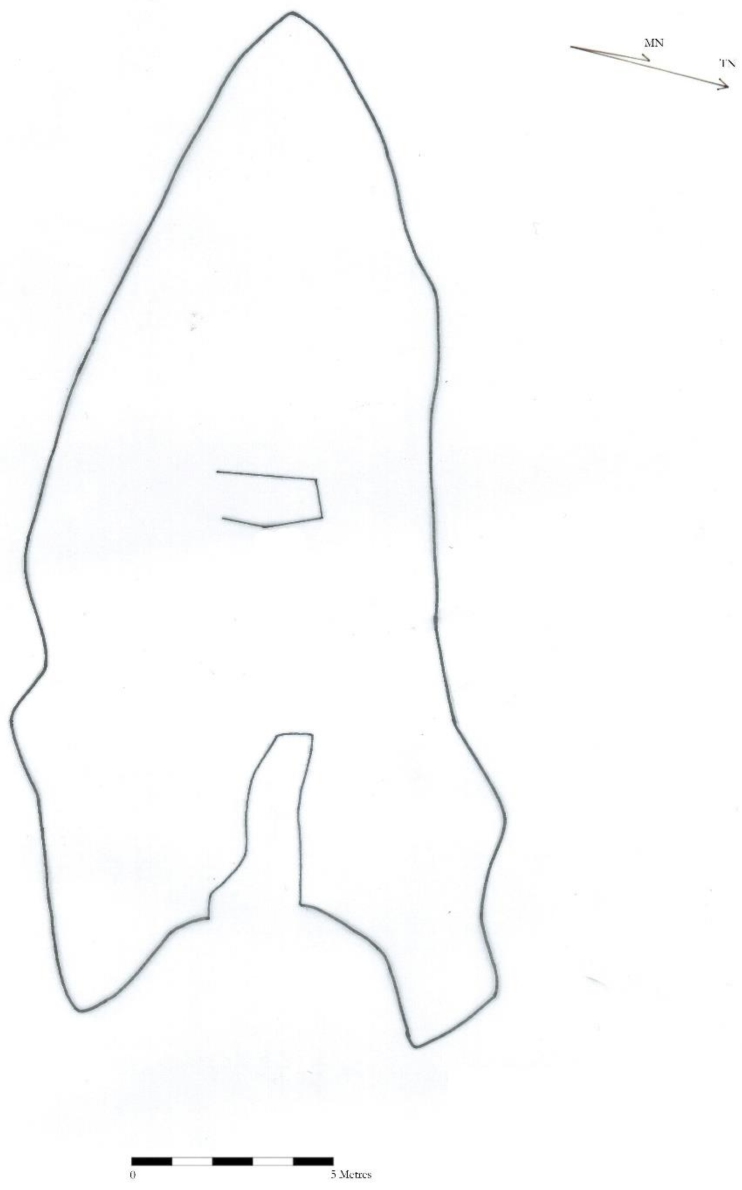
Site Name: Balnacraig
Scale 1:100
—— Visible extent
- - - - Uncertain extent
· · · · · · Stone wall structure

Site surveyed by R.G. & P.G. on 27/07/2012
Site plan drawn by R.G. on 31/03/2013



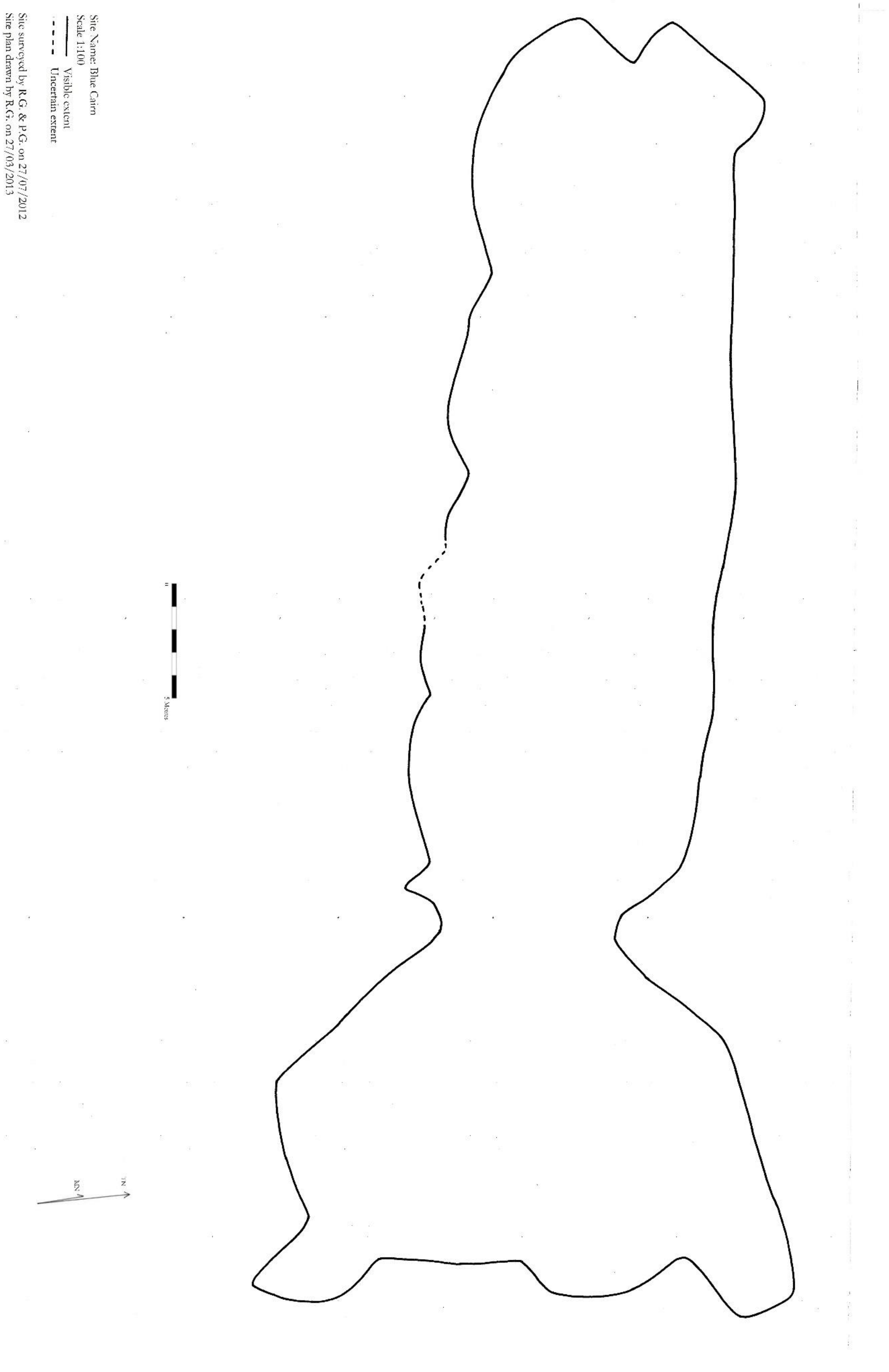
Site Name: Beacharr
Scale 1:100
Visible extent
Possible extent
Visible extent of chamber
Possible extent of chamber

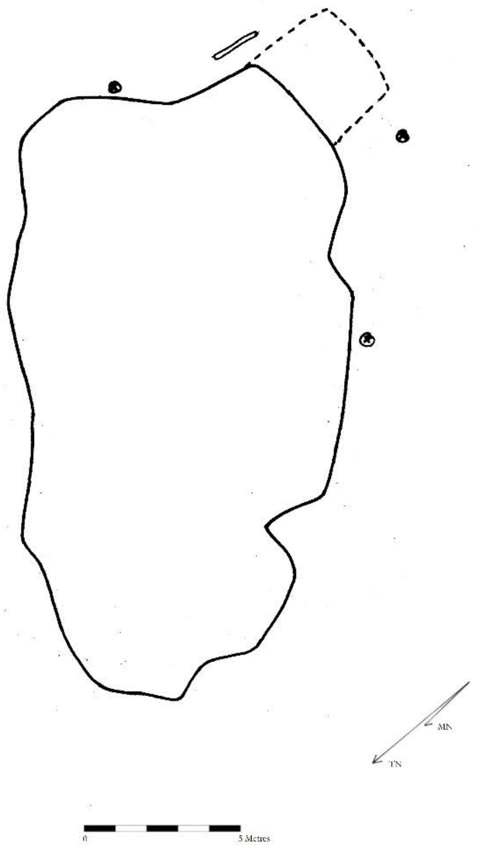
Site surveyed by R.G. & P.G on 22/07/2012
Site plan drawn by R.G. on 24/01/2013



Site Name: Blasthill
Scale 1:100
Visible extent
Visible extent of chamber/entrance chamber

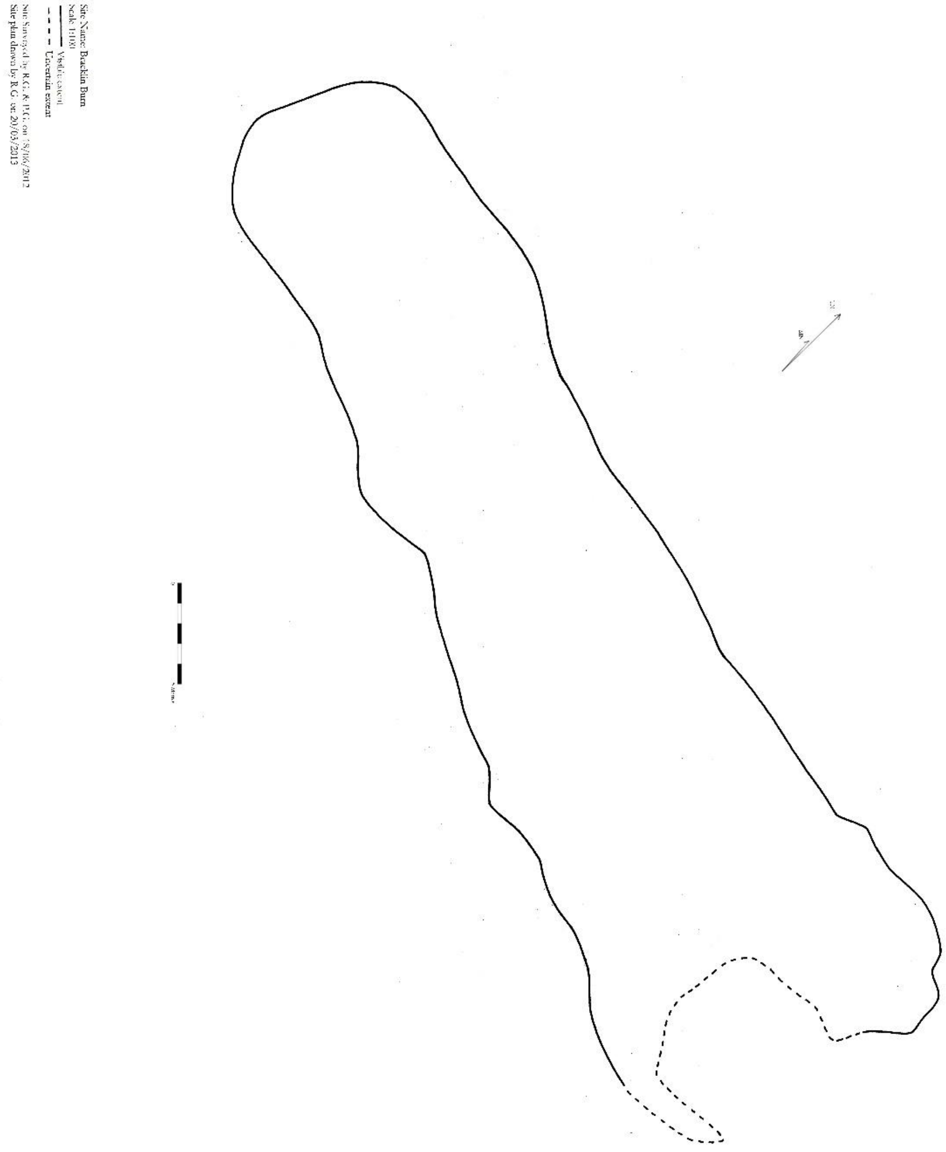
Site surveyed by R.G. & P.G. on 21/07/2012
Site plan drawn by R.G. on 23/01/2013


Site Name: Blue Cairn
Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G. on 27/07/2012
Site plan drawn by R.G. on 27/03/2013
0
5 Metres
TN
MN

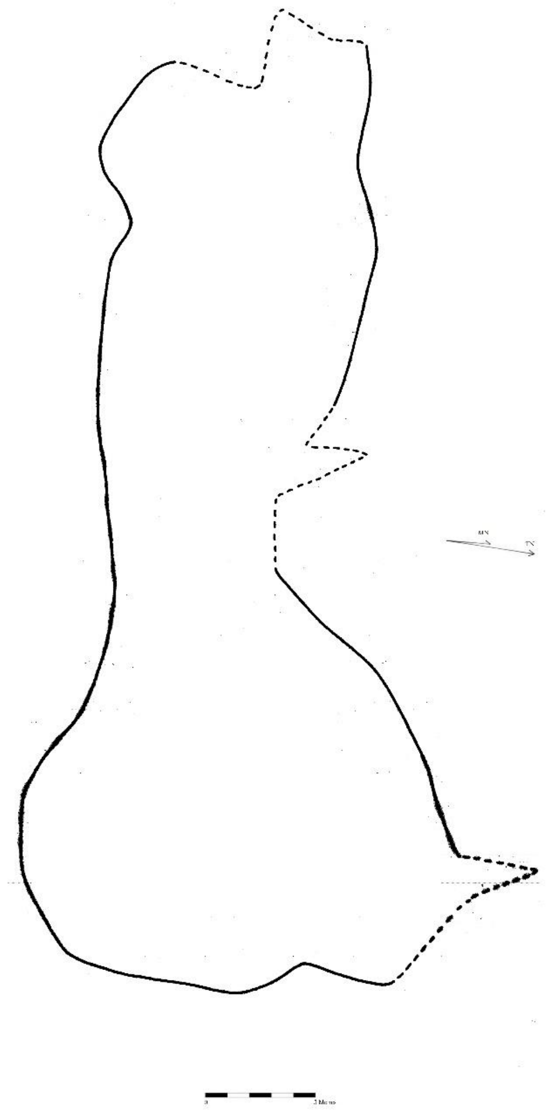


Site Name: Boreland
Scale 1:100
Visible extent
Possible extent
Extant orthostats (position of)
Extant orthostat (approx width)

Site surveyed by R.G. & P.G. on 25/06/2012
Site plan drawn by R.G. on 23/01/2013

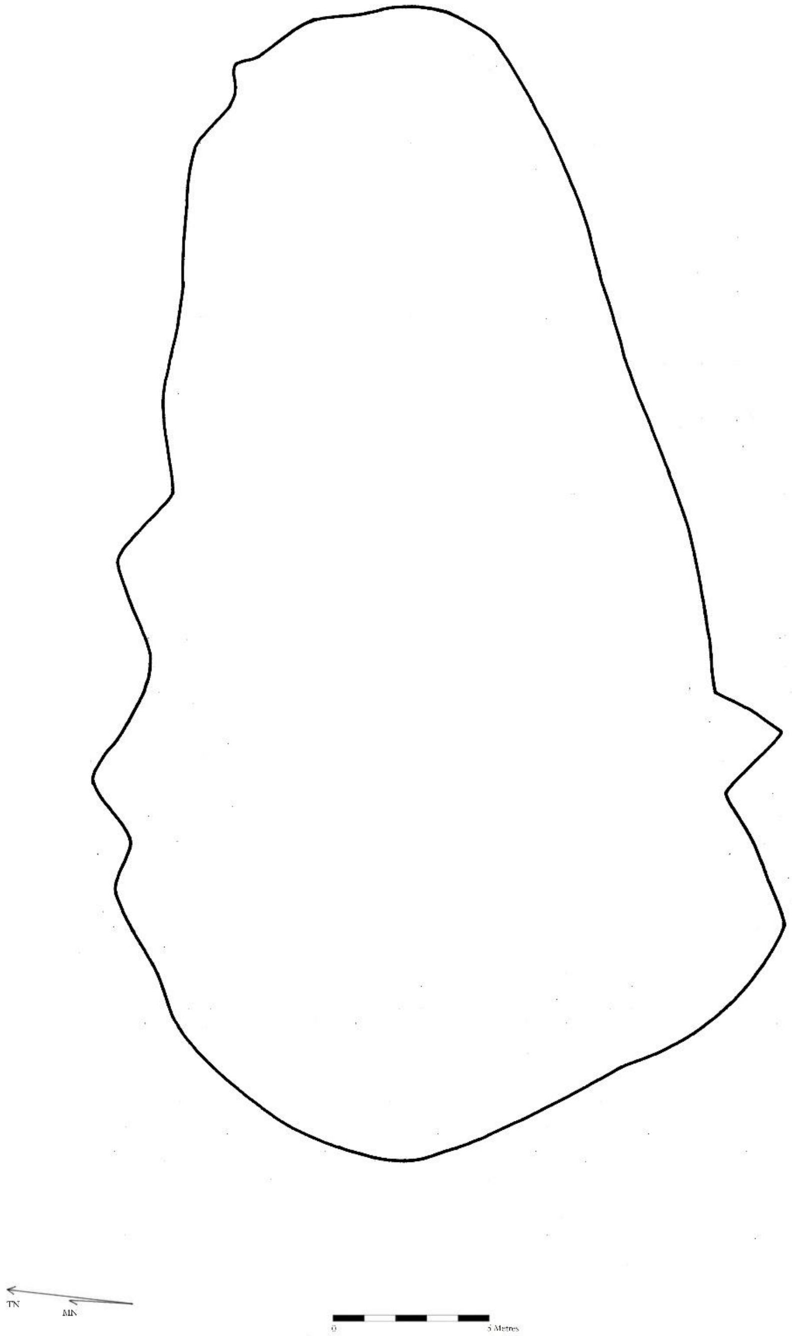


Site Name: Bracklin Burn
Scale 1:100
Visible extent
Uncertain extent
Site Surveyed by R.G. & P.G. on 18/06/2012
Site plan drawn by R.G. on 20/03/2013



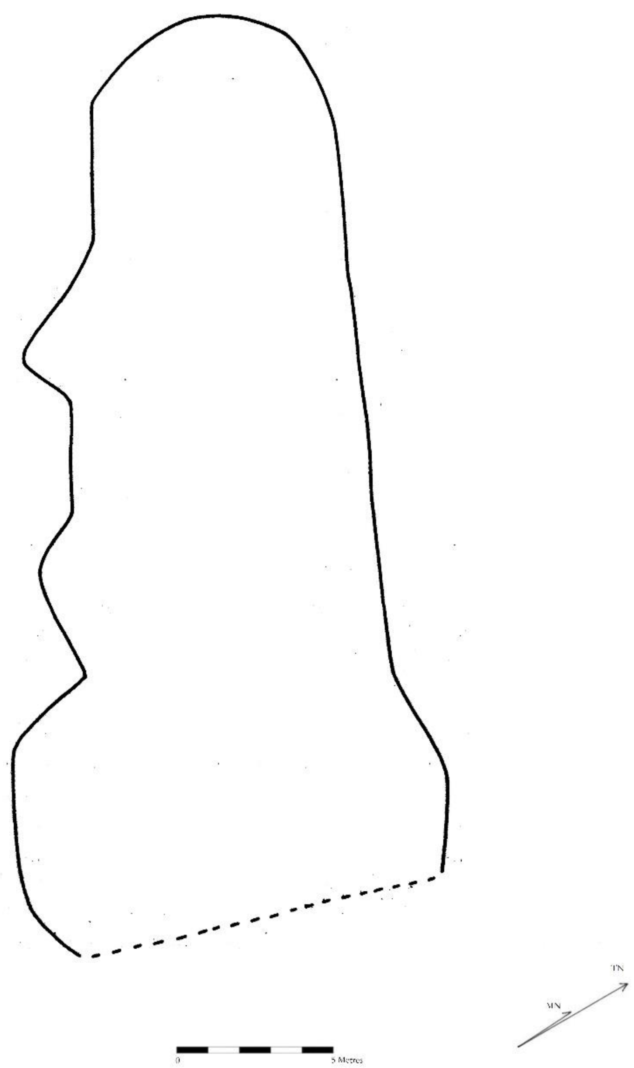
Site Name: Brounaban
Scale 1:100
Visible extent
Uncertain extent

Site surveyed by R.G. & P.G. on 11/08/2012
Site plan drawn by R.G. on 27/03/2013



Site Name: Bruxie Hill
Scale 1:100
Visible extent

Site surveyed by R.G. & P.G. on 27/07/2012
Site plan drawn by R.G. on 04/04/2013

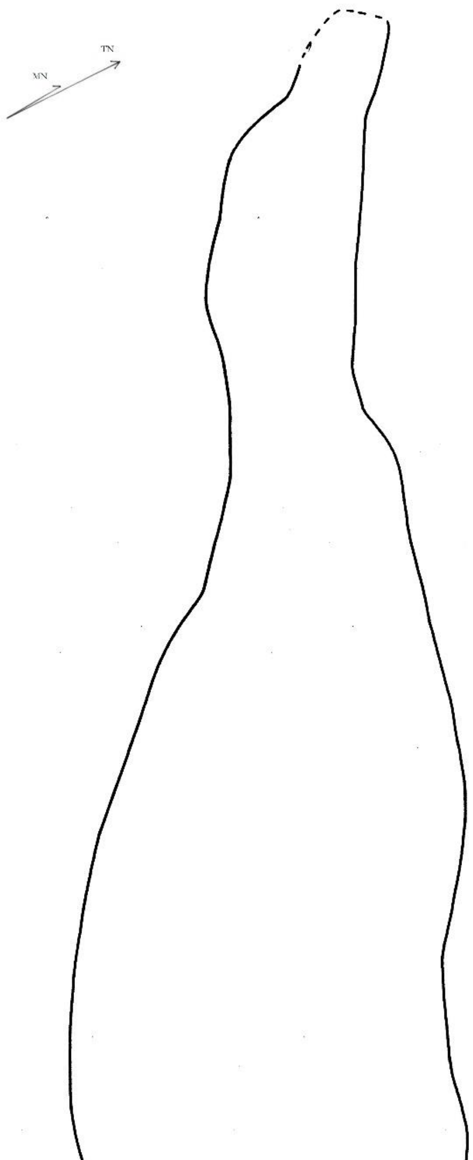


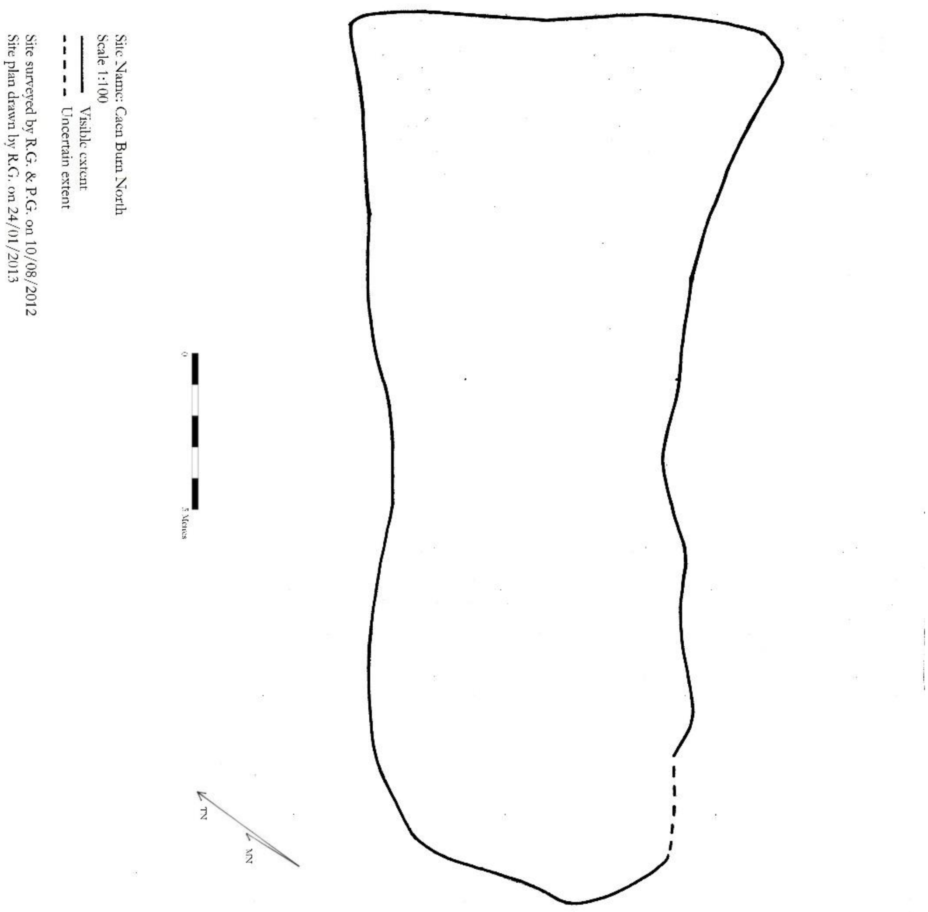
Site Name: Burngrange
Scale 1:100
——— Visible extent
- - - - - Uncertain extent

Site surveyed by R.G. & P.G on 12/07/2012
Site plan drawn by R.G. on 30/01/2013

Site Name: Caen Burn
Scale 1:100
——— Visible extent
- - - - Uncertain extent

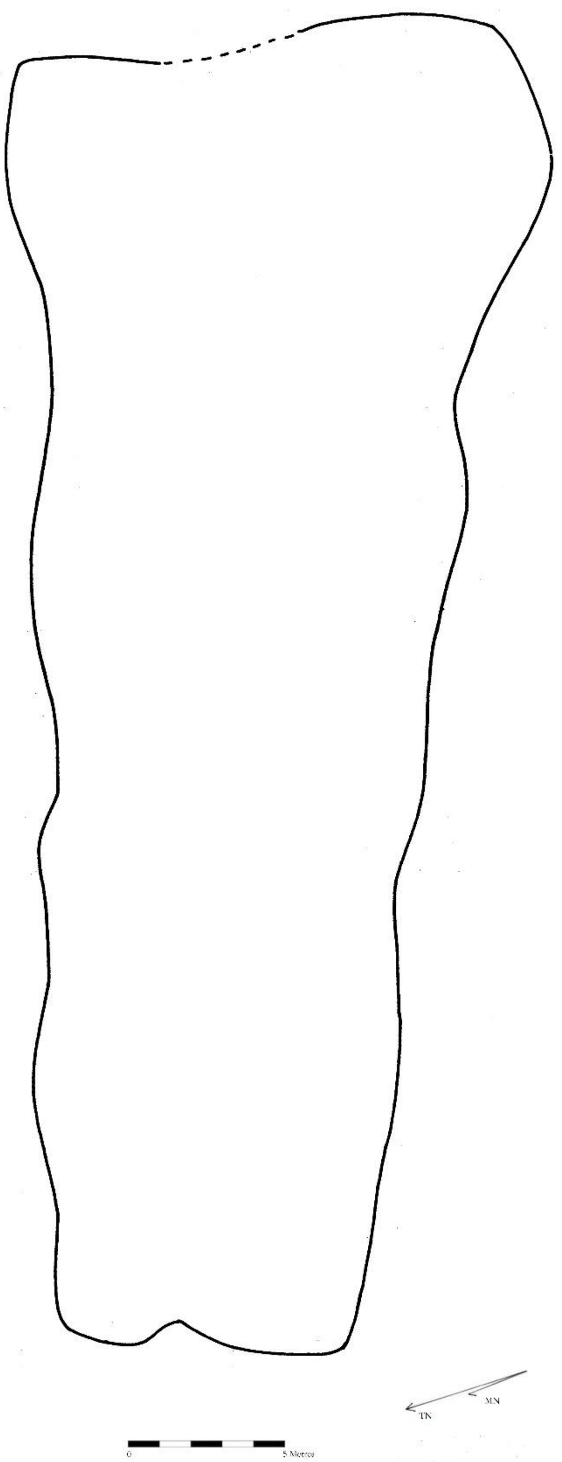
Site surveyed by R.G. & P.G. on 10/08/2012
Site plan drawn by R.G. on 31/03/2013

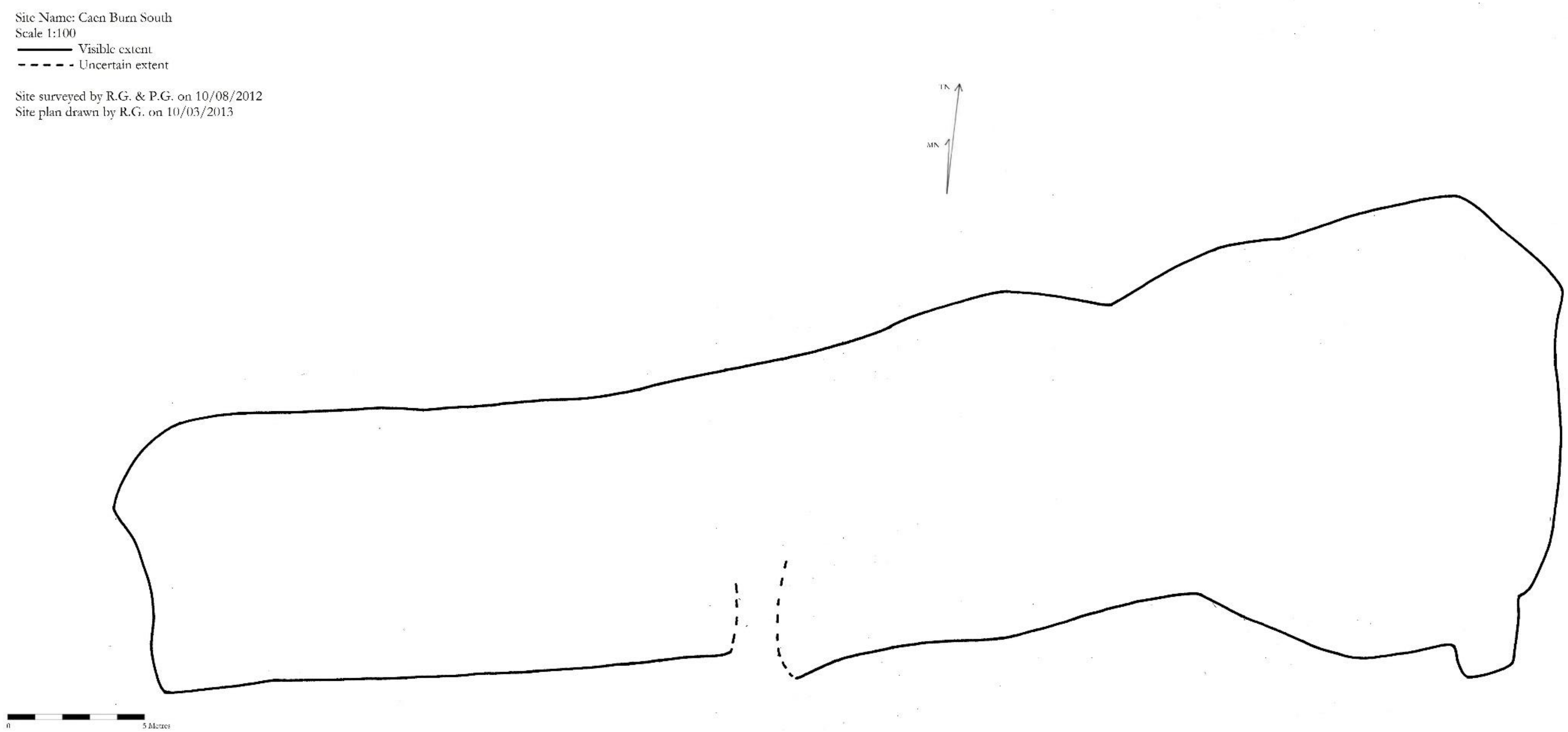



Site Name: Caen Burn North
Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G. on 10/08/2012
Site plan drawn by R.G. on 24/01/2013
0
5 Metres
TN
MN

Site Name: Caen Burn West
Scale 1:100
——— Visible extent
- - - - Uncertain extent

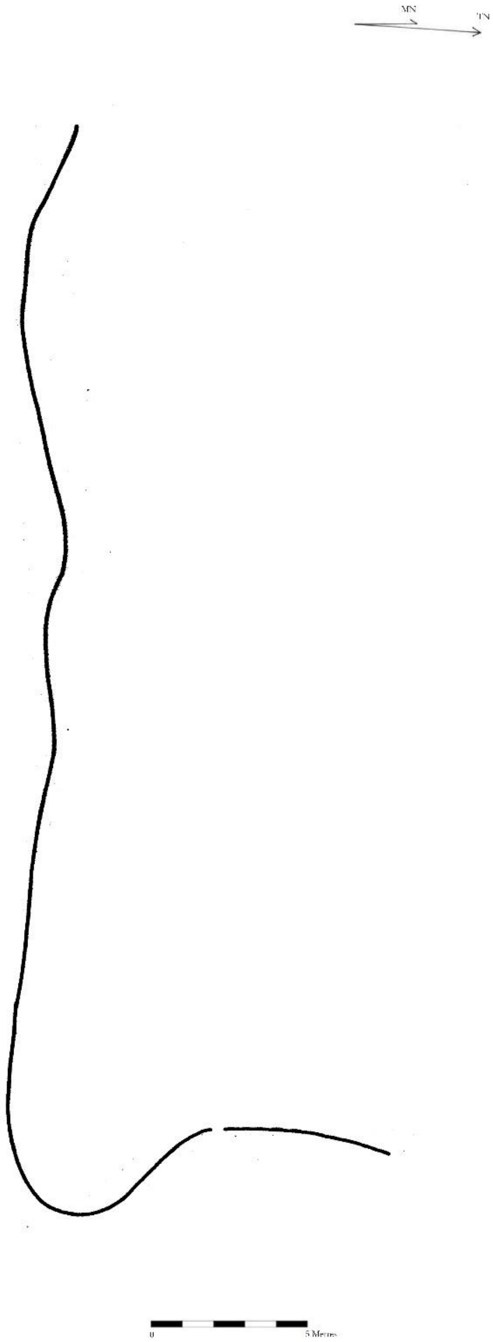
Site surveyed by R.G. & P.G. on 09/08/2012
Site plan drawn by R.G. on 20/03/2013

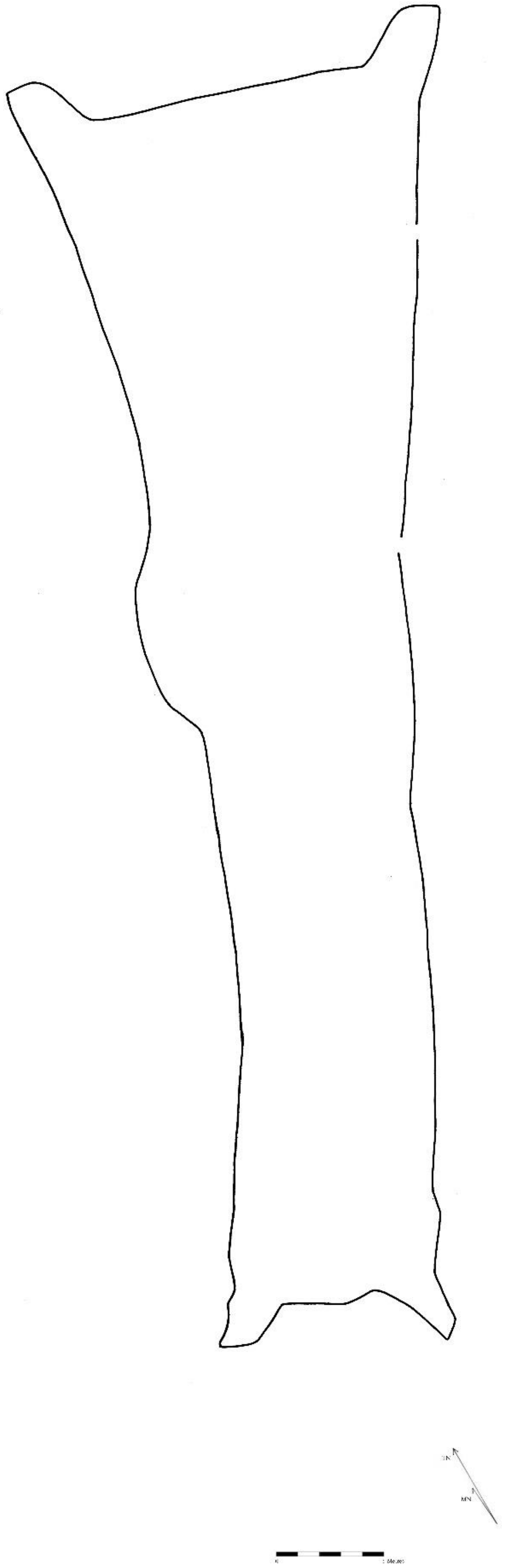



Site Name: Caen Burn South
Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G. on 10/08/2012
Site plan drawn by R.G. on 10/03/2013
TN
MN
0
5 Metres

Site Name: Carinholy I
Scale 1:100
Visible extent

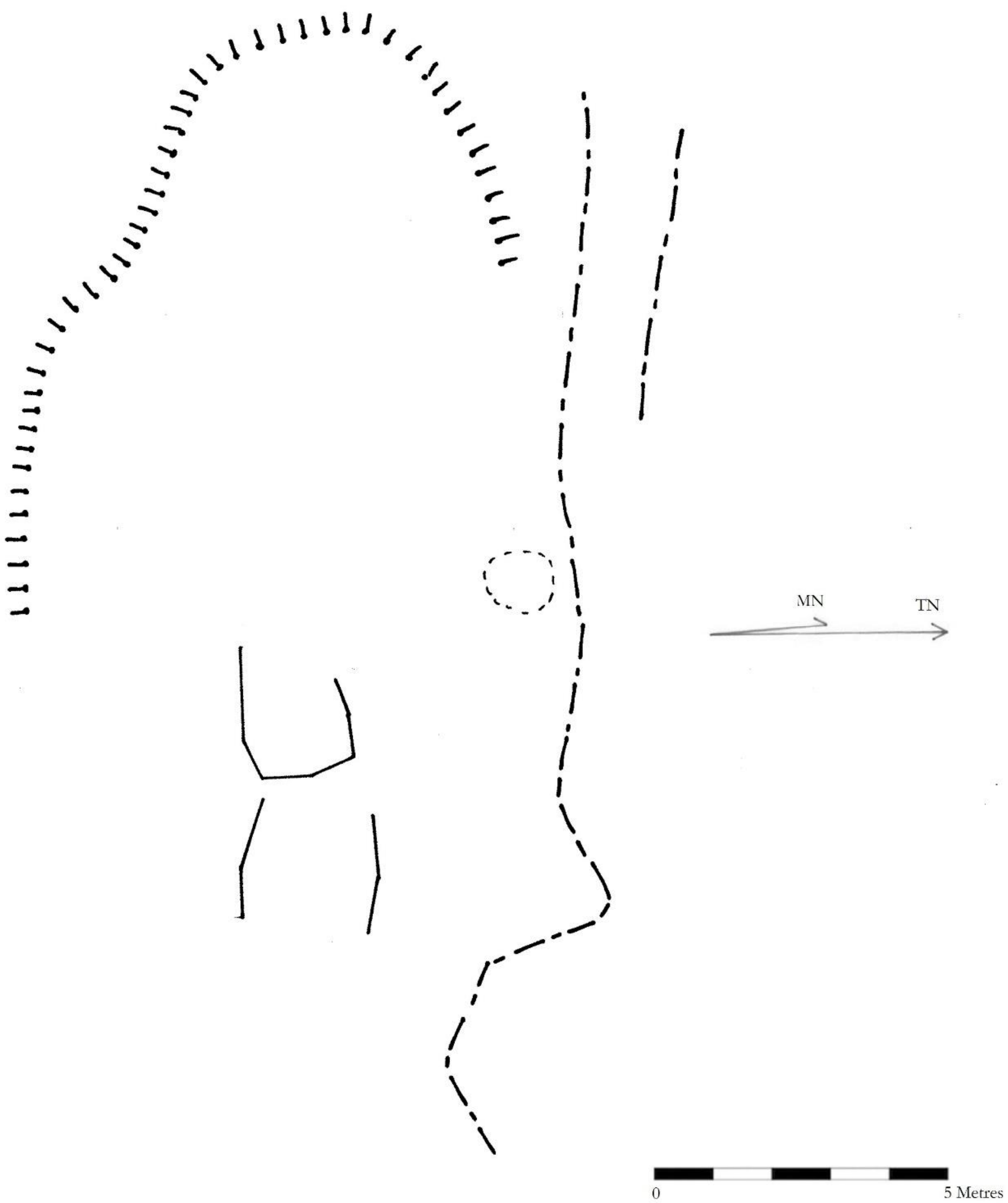
Site surveyed by R.G. & P.G. on 25/06/2012
Site plan drawn by R.G. on 24/01/2013





Site Name: Camster Long
Scal 1:100
Visible extent

Site surveyed by R.G. & P.G. on 11/08/2012
Site plan drawn by R.G. on 11/04/2013



Site Name: Carie

Scale 1:100

Inside/outside edge of wall-like structure

Edge of large tree

Slight slope

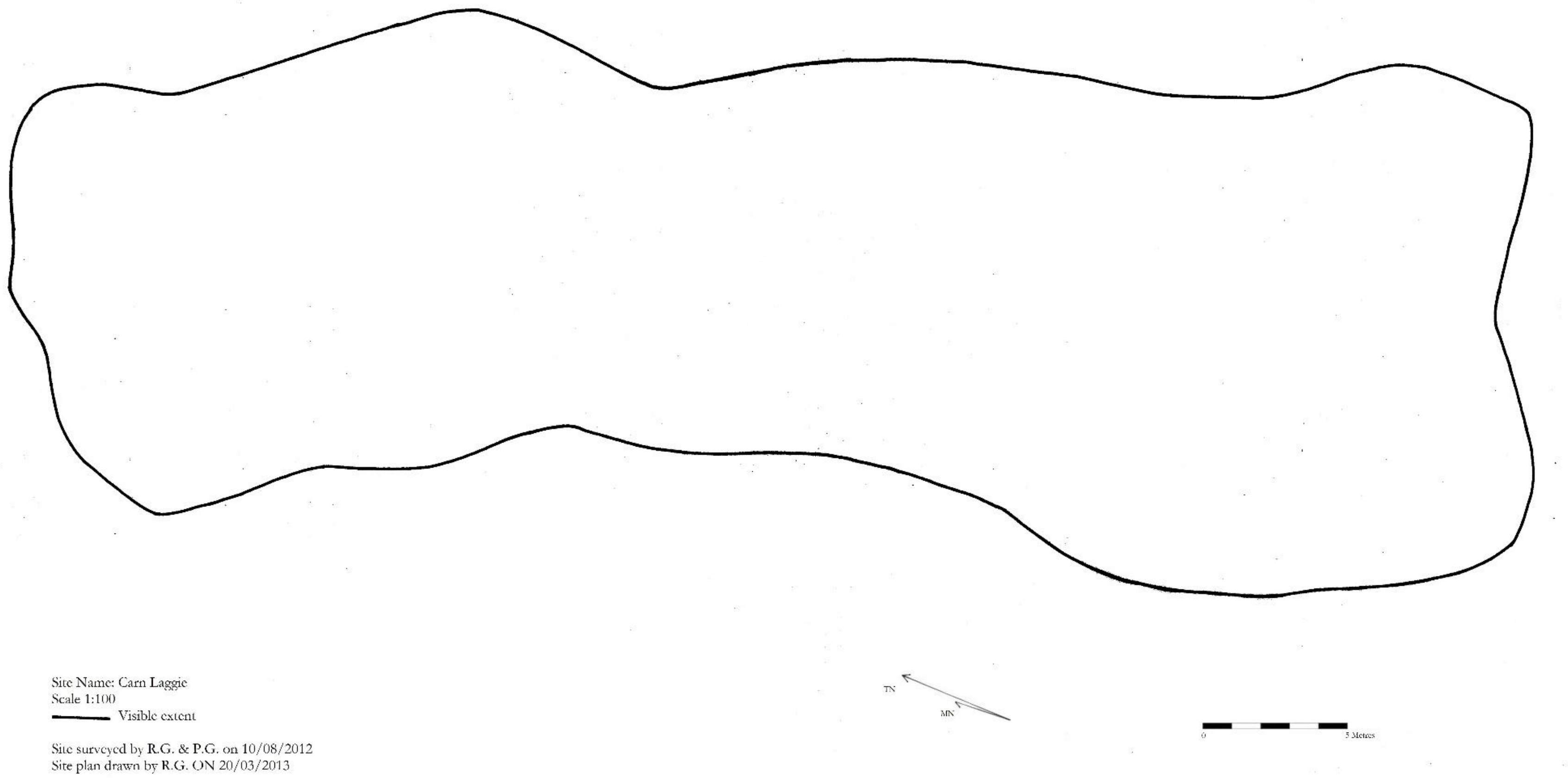
Visible extent of chamber

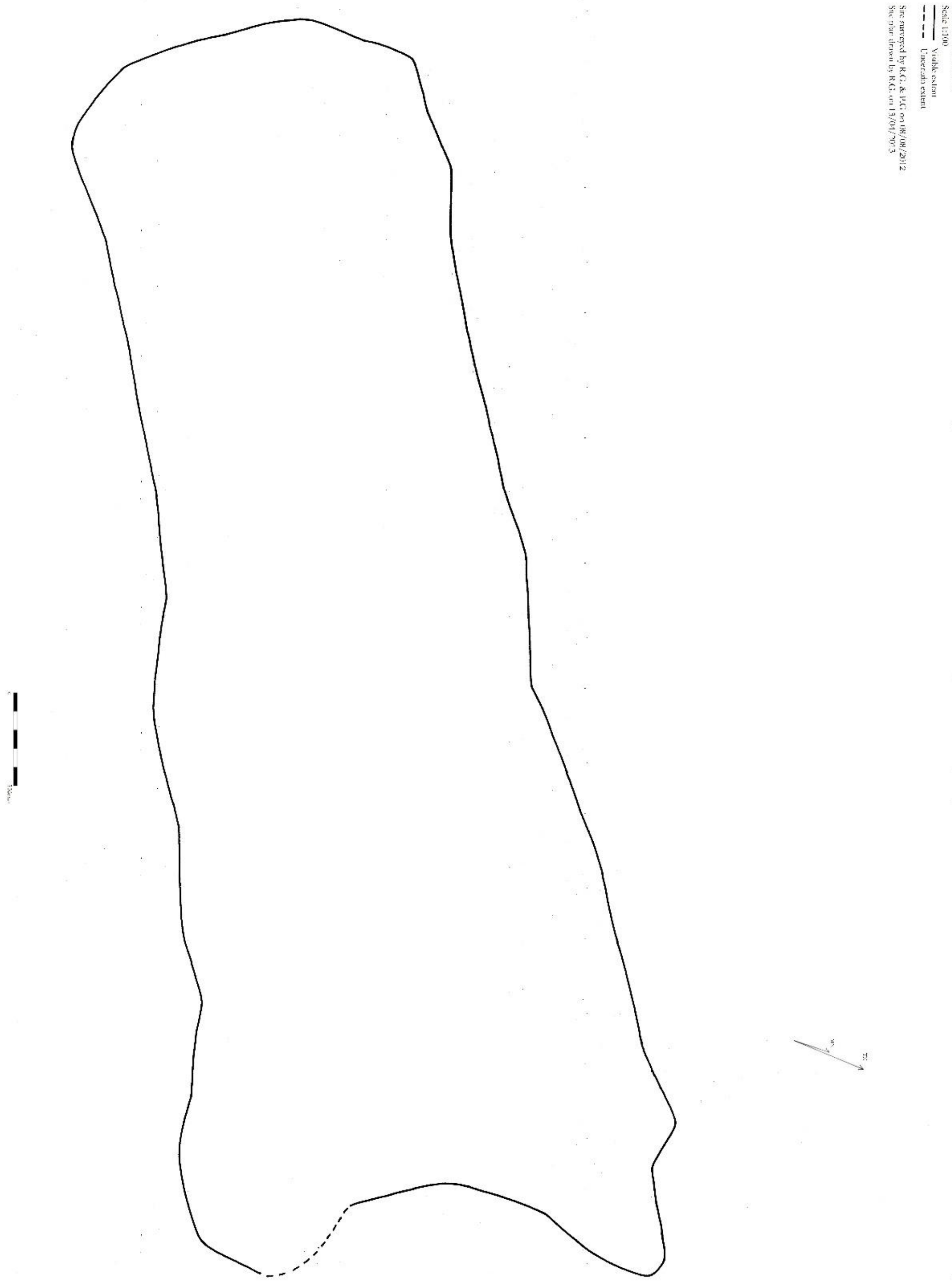
Site surveyed by R.G. & P.G. on 14/07/2012

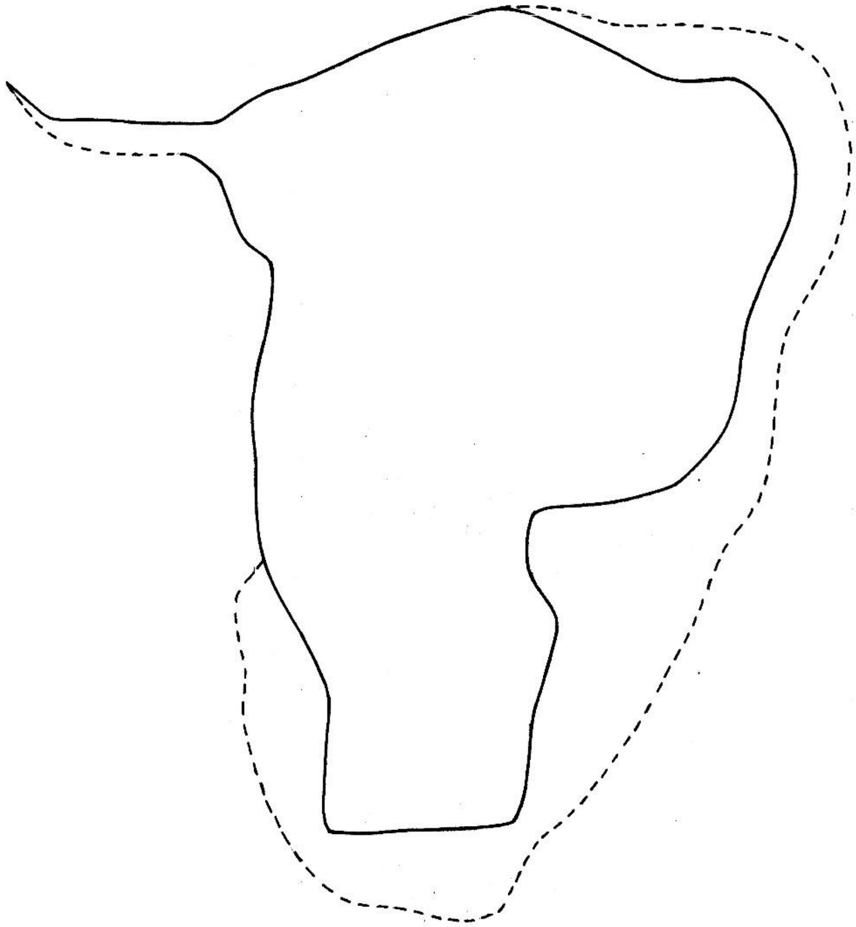
Site plan drawn by R.G. on 23/01/2013

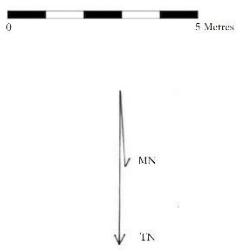
Site Name: Cairnholy II
Scale 1:100
Visible extent
Extant orthostats (approx width)
Visible extent of cairn material

Site surveyed by R.G. & P.G. on 25/06/2012
Site plan drawn by R.G. on 31/03/2013


Site Name: Carn Laggie
Scale 1:100
Visible extent
Site surveyed by R.G. & P.G. on 10/08/2012
Site plan drawn by R.G. ON 20/03/2013
TN
MN
0
5 Metres

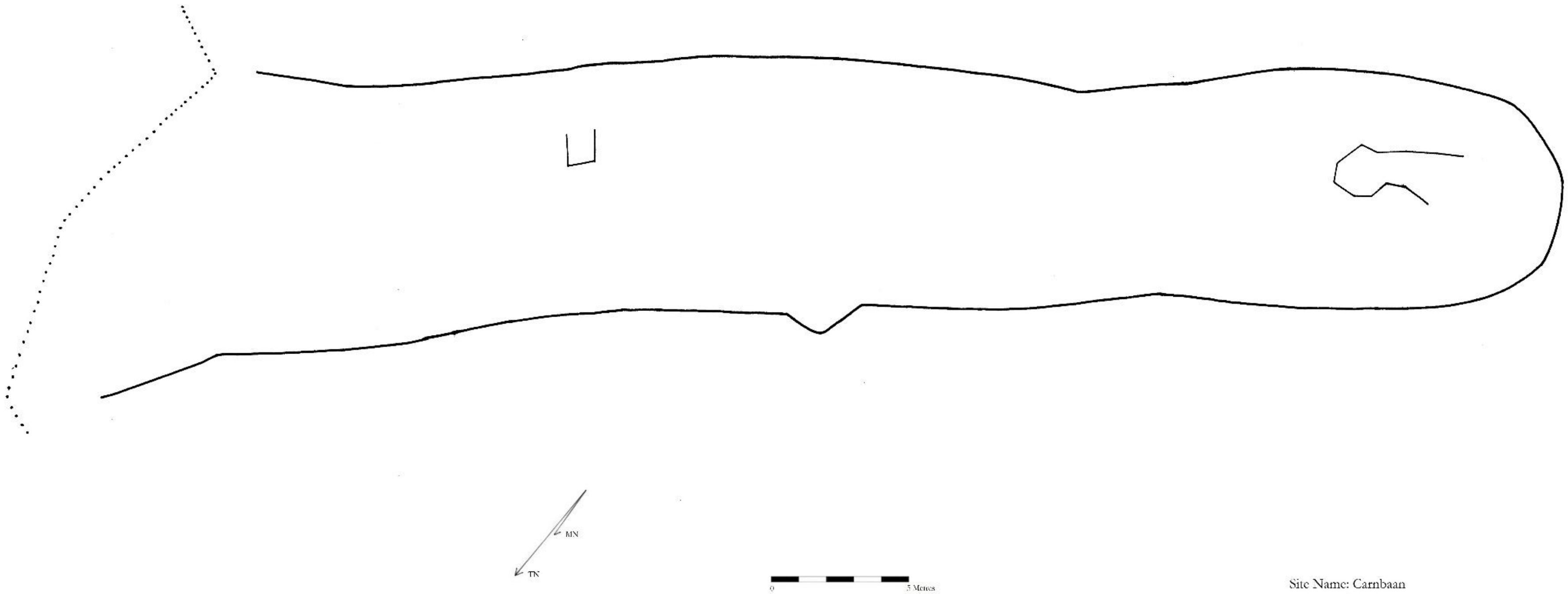

Site Name: Carn Liath
Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G on 08/08/2012
Site plan drawn by R.G. on 13/04/2013





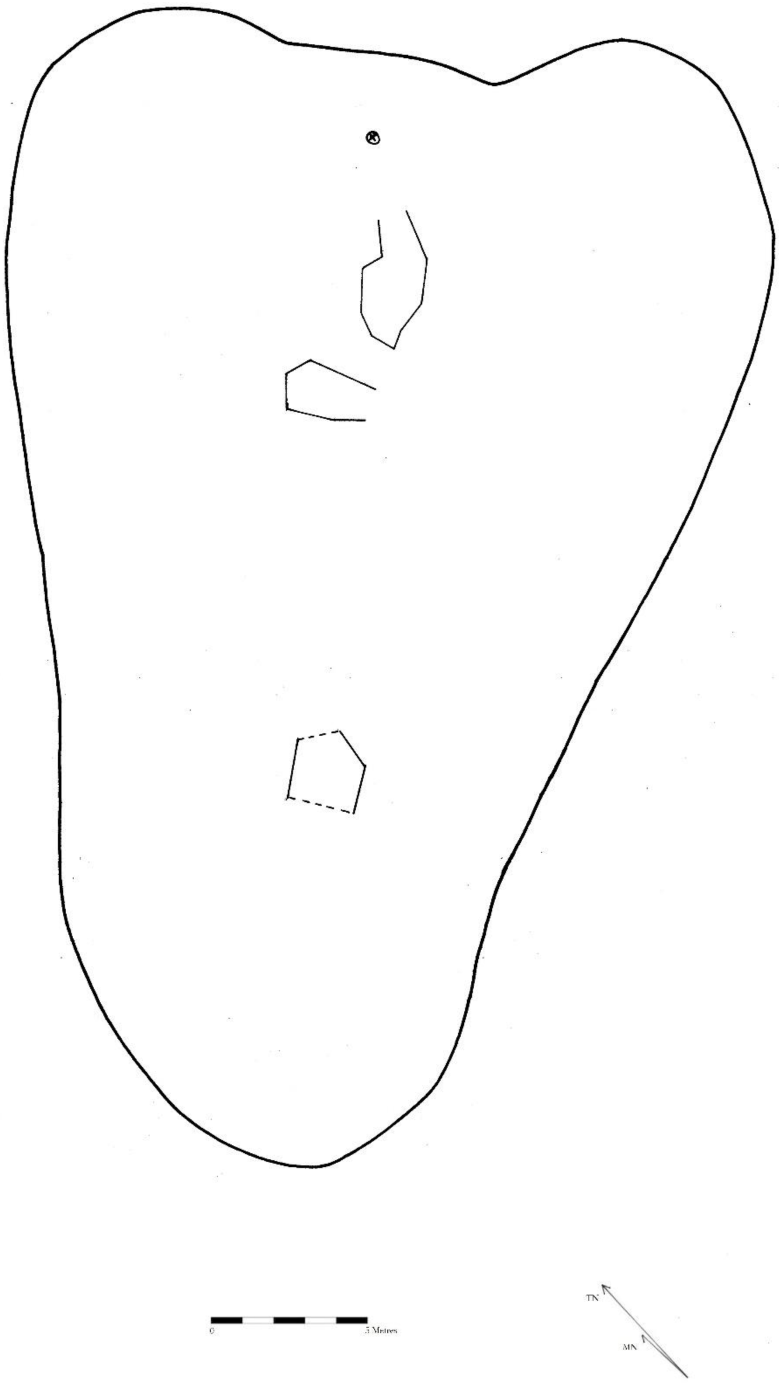
Site Name: Cairn-Na-Gath
Scale 1:100
——— Visible extent
- - - - - Possible extent

Site surveyed by R.G. & P.G. on 25/06/2012
Site plan drawn by R.G. on 26/01/2013



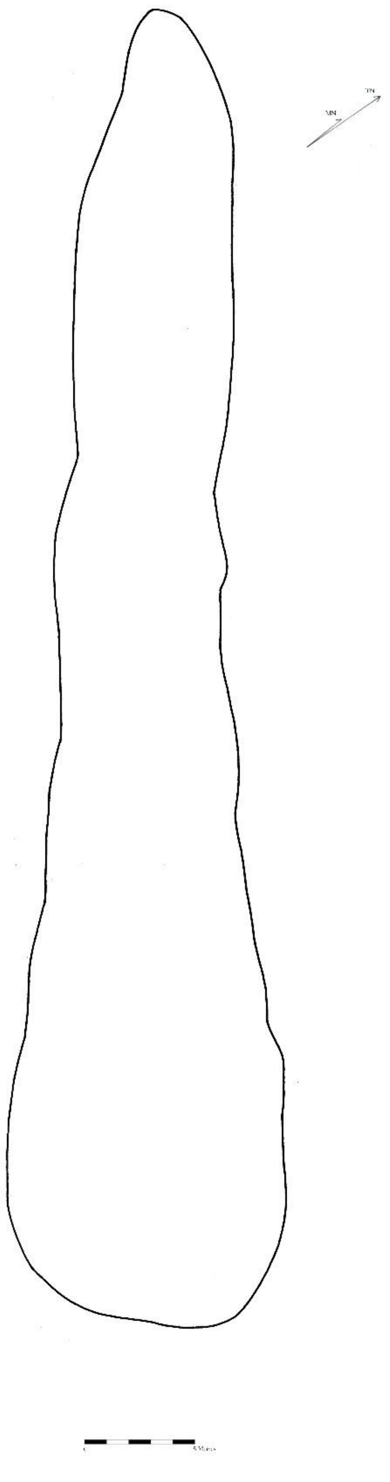
Site Name: Carnbaan
Scale 1:100
Visible extent
Visible extent of chambers
Wall-like structure

Site surveyed by R.G. & P.G. on 25/07/2012
Site plan drawn by R.G. on 04/04/2013



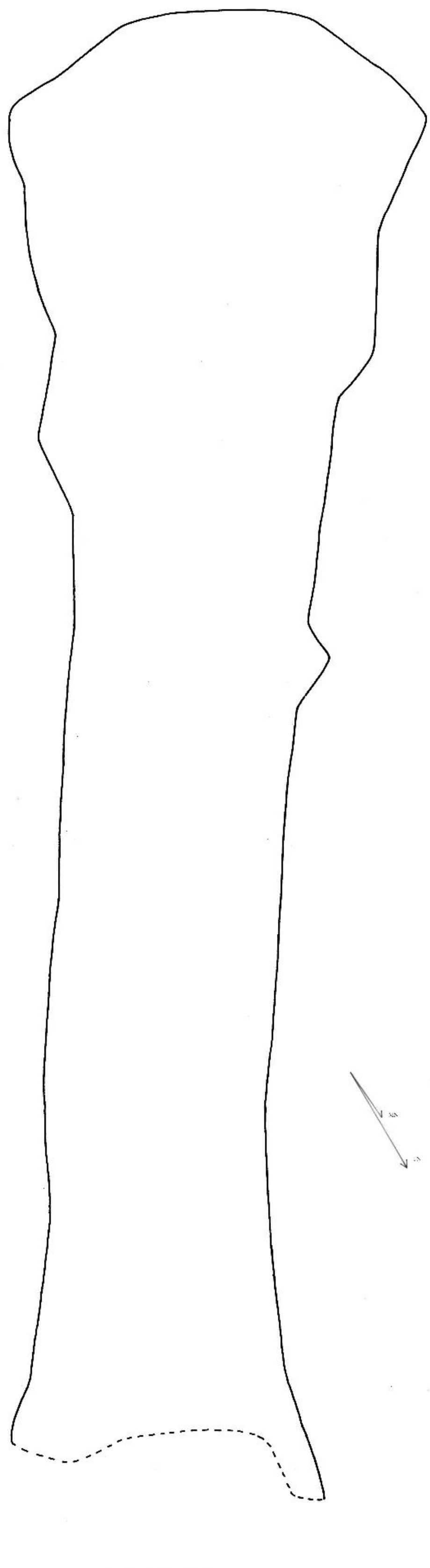
Site Name: Caves of Kilhern
Scale 1:100
Visible extent
Visible extent of chambers
Uncertain extent of chambers
Extant orthostats (position only)

Site surveyed by R.G. & P.G. on 24/06/2012
Site plan drawn by R.G. on 05/04/2012



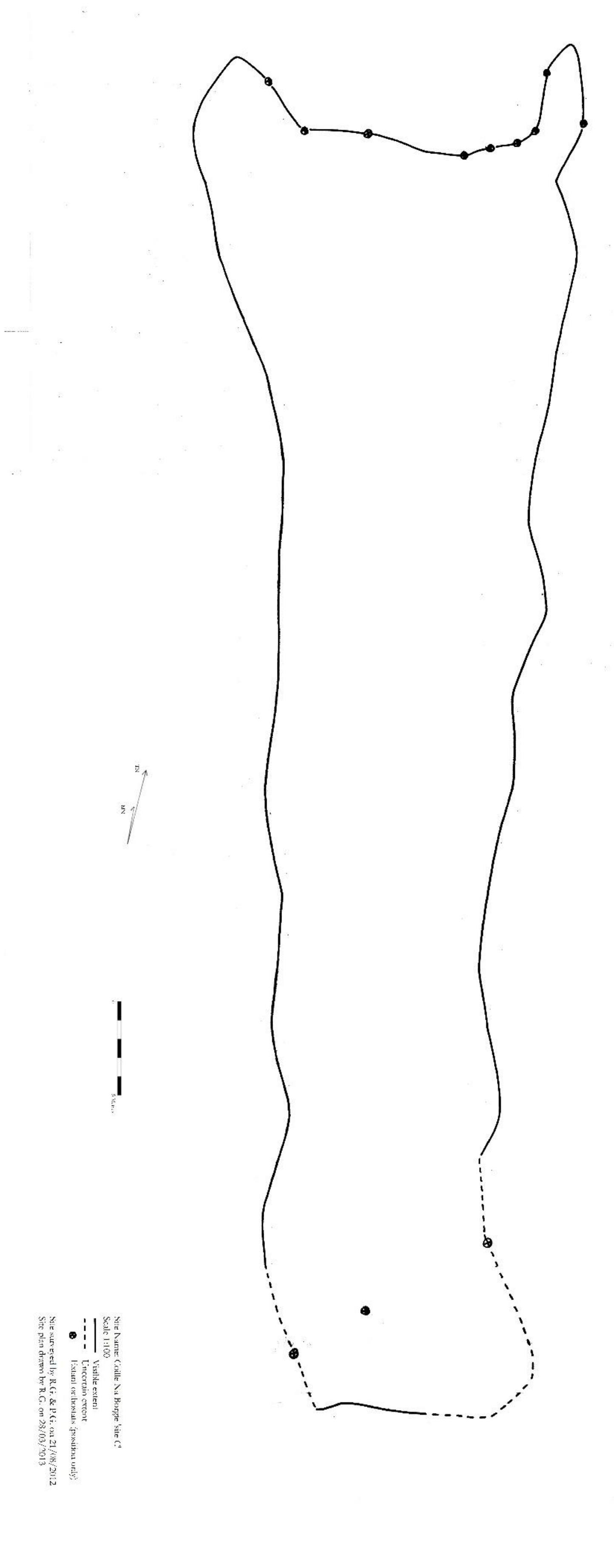
Site Nname: Clach Na Tiompan
Scale 1:100
Visible extent

Site surveyed by R.G. &P.G on 14/07/2012
Site plan drawn by R.G. on 22/03/2013

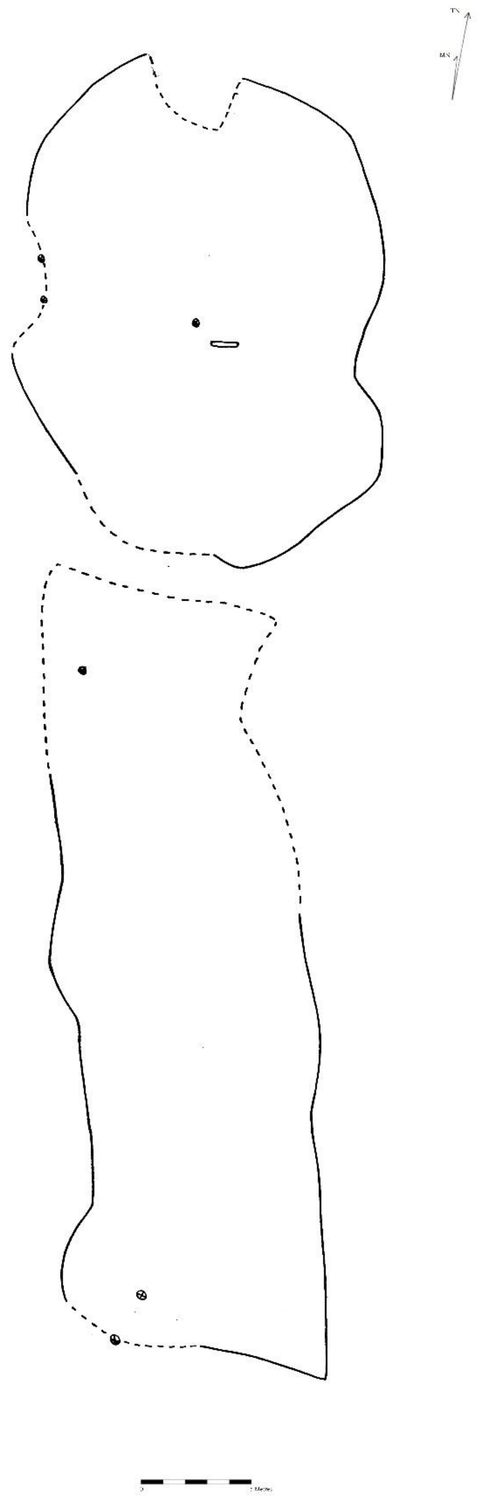


Site Name: Cnoc Freiceadain
Scale 1:100
Visible extent
Uncertain extent

Site surveyed by R.G. & P.G on 20/08/2012
Site plan drawn by R.G. on 11/04/2013

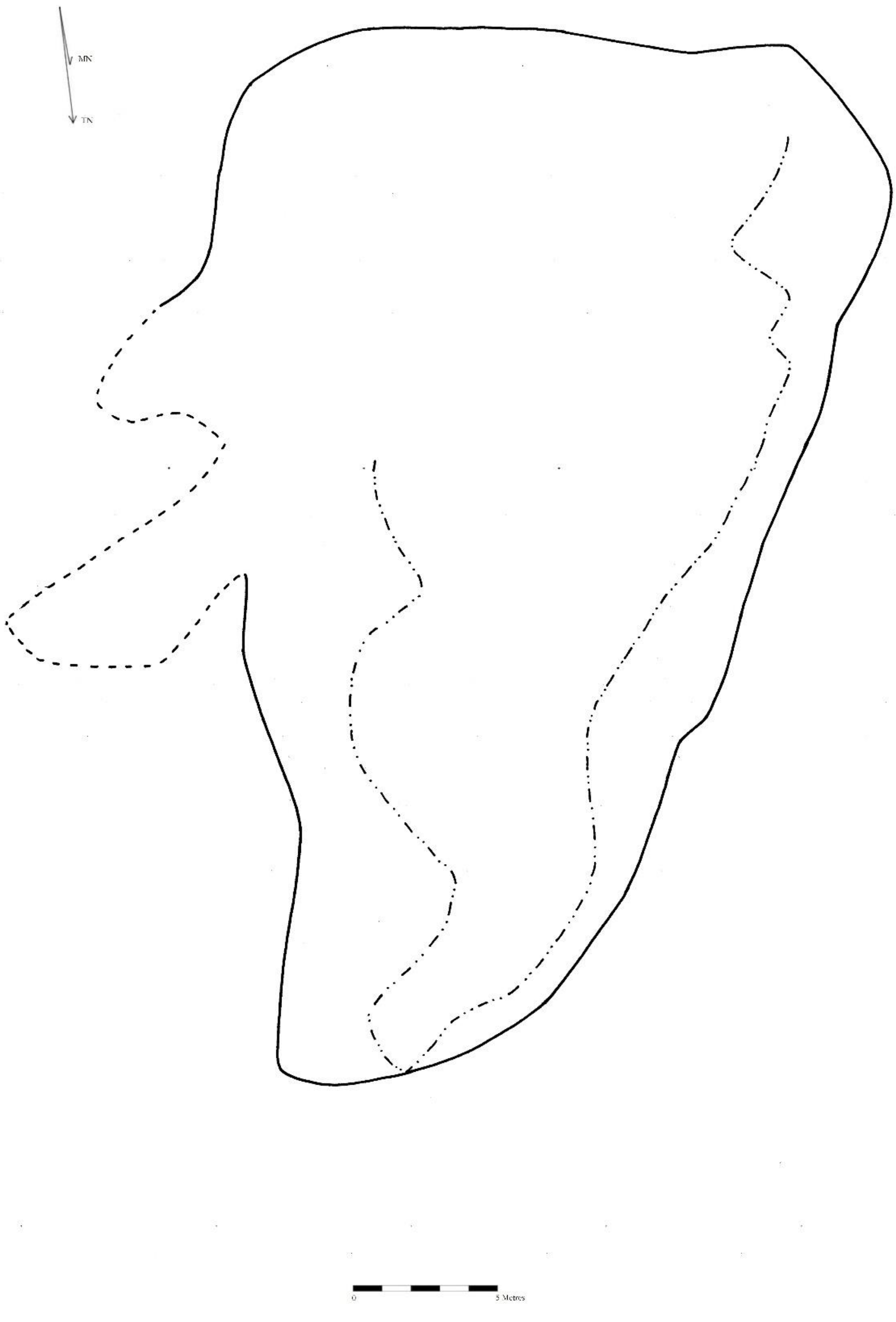


Site Name: Coille Na Borgie 'site C'
Scale 1:100
Visible extent
Uncertain extent
Extant orthostats (position only)
Site surveyed by R.G. & P.G. on 21/08/2012
Site plan drawn by R.G. on 28/03/2013



Site Name: Coille Na Borgie site 'A + B'
Scale 1:100
Visible extent
Uncertain extent
Extant orthostat (approx width)
Extant orthostats (position only)

Site surveyed by R.G. & P.G on 21/08/2012
Site plan drawn by R.G. on 28/03/2013

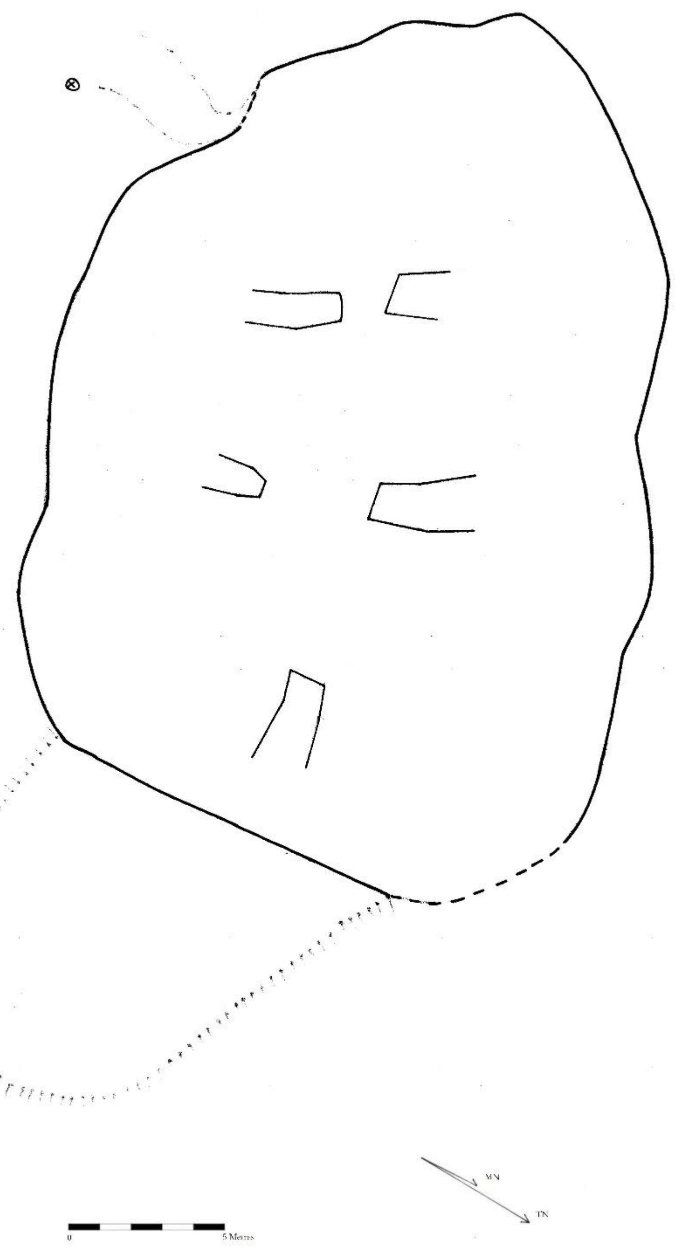


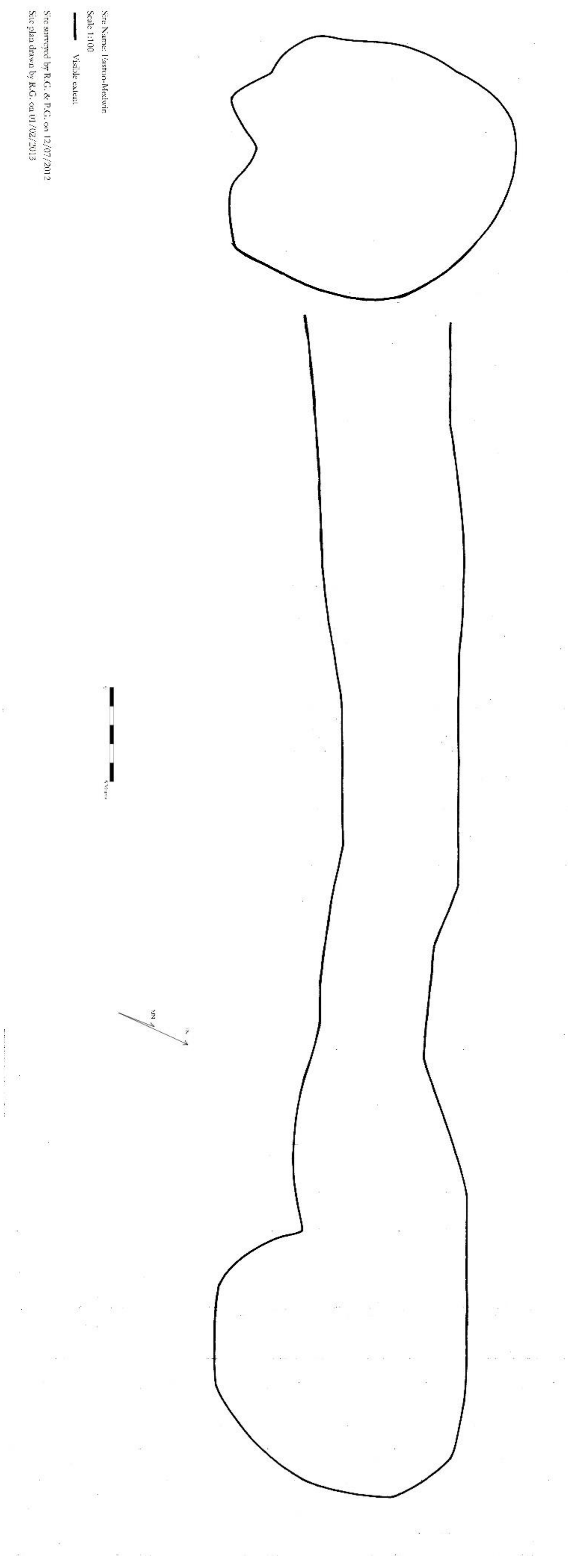
Site Name: Crossford Hill
Scale 1:100
——— Visible extent
- - - - Uncertain extent
-·-·- Visible extent of cairn rubble

Site surveyed by R.G. & P.G. on 26/06/2012
Site plan drawn by R.G. on 29/01/2013

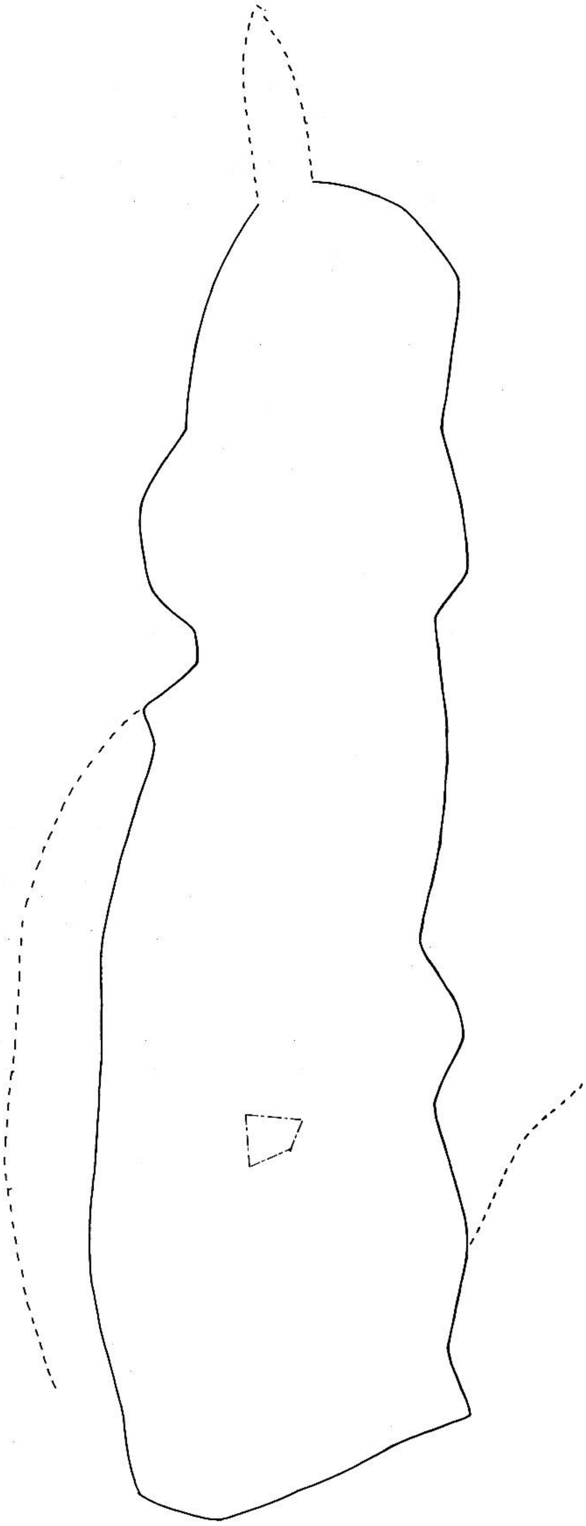
Site Name: Drannandow
Scale 1:100
Visible extent
Uncertain extent
Visible extent of chambers
Extant slab lying flat on the ground (Position only)

Site surveyed by R.G. & P.G. on 25/06/2012
Site plan drawn by R.G. on 25/01/2013





Site Name: Easton-Melwin
Scale 1:100
Visible extent
Site surveyed by R.G. & P.G. on 12/07/2012
Site plan drawn by R.G. on 01/02/2013



Site Name: Edinchip

Scale 1:100

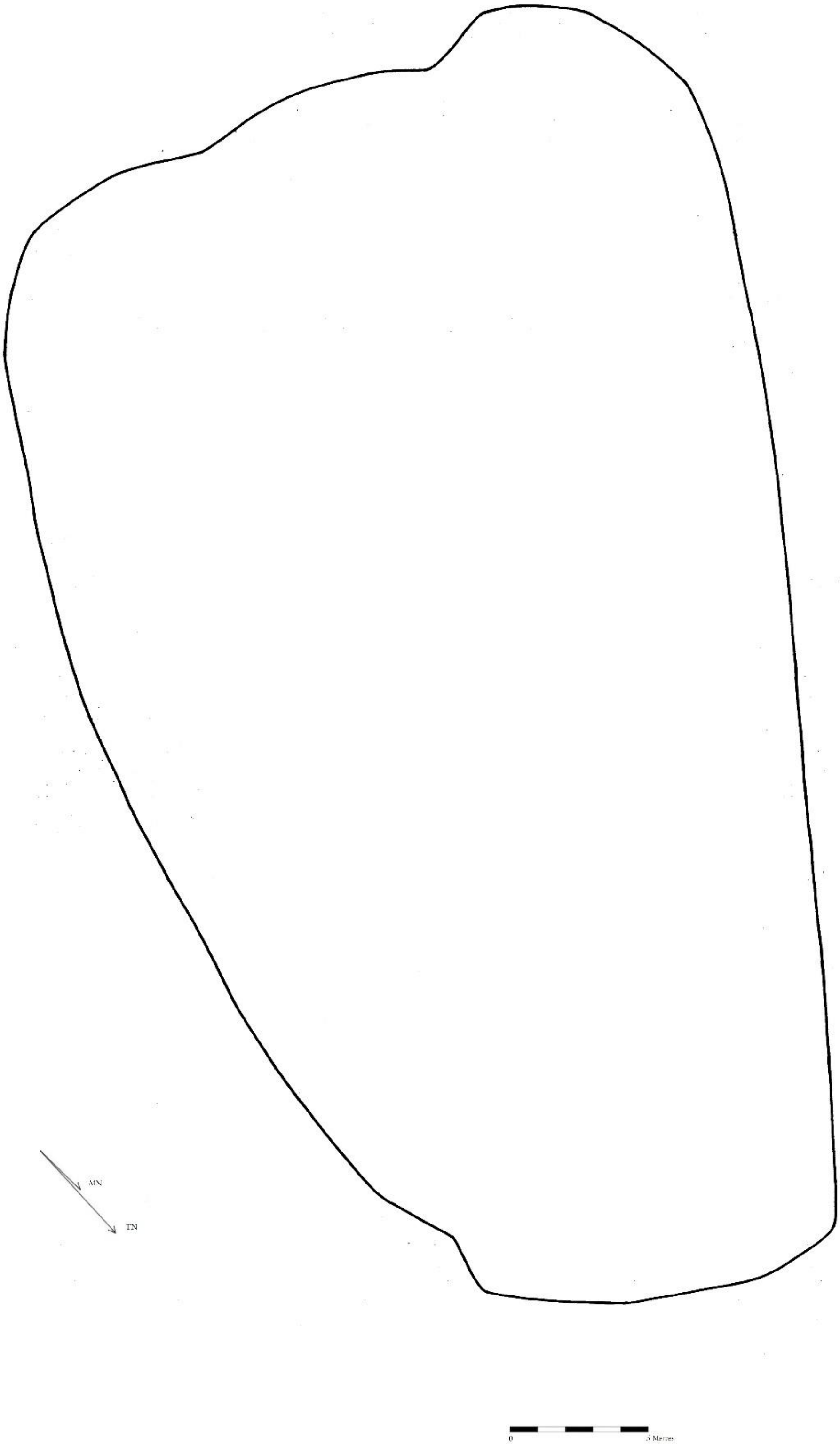
Visible extent

Possible/uncertain extent

Visible extent of capstone

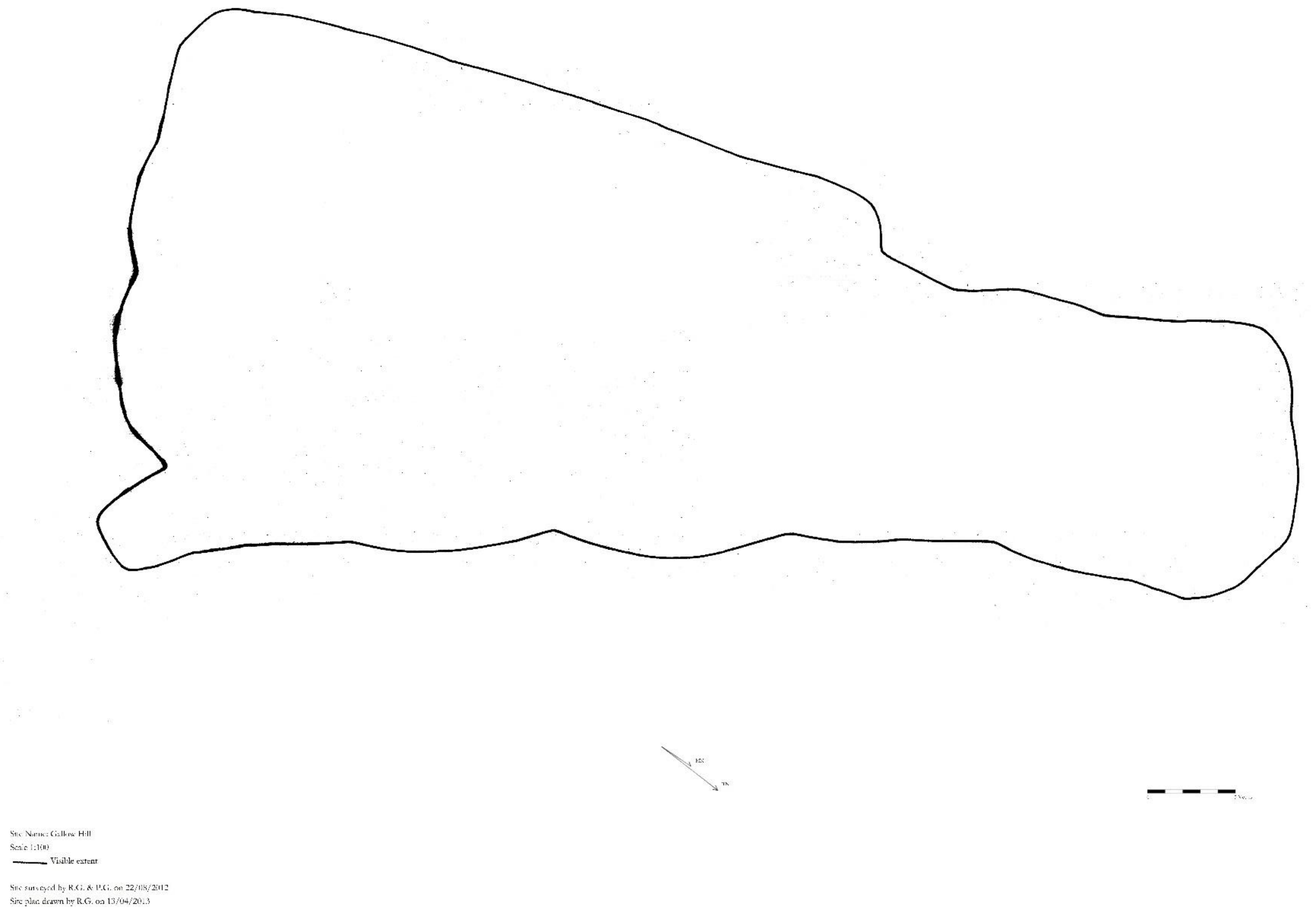
Site surveyed by R.G. & P.G. on 14/07/2012

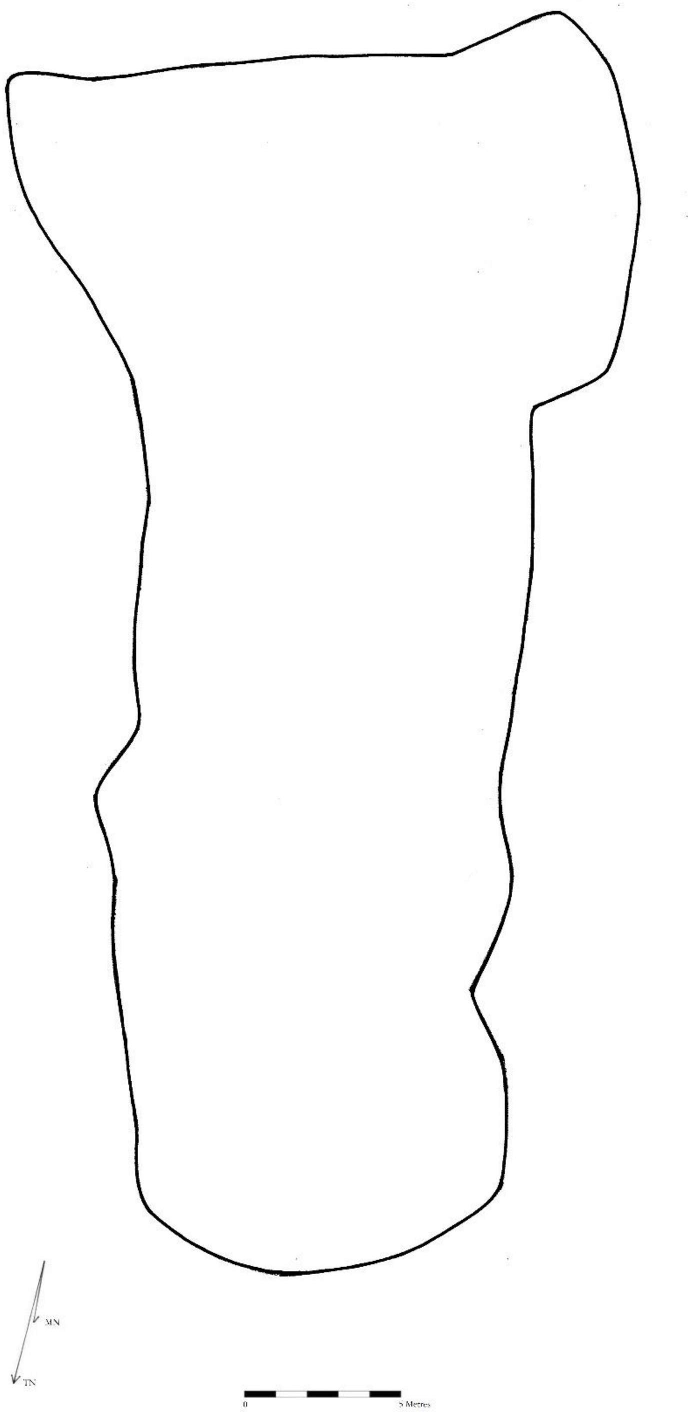
Site plan drawn by R.G. on 22/03/2013



Site Name: Fleuchlarg
Scale 1:100
Visible extent

Site surveyed by R.G. & P.G. on 26/06/2012
Site plan drawn by R.G. on 27/01/2013


Site Name: Gallow Hill
Scale 1:100
Visible extent
Site surveyed by R.G. & P.G. on 22/08/2012
Site plan drawn by R.G. on 13/04/2013



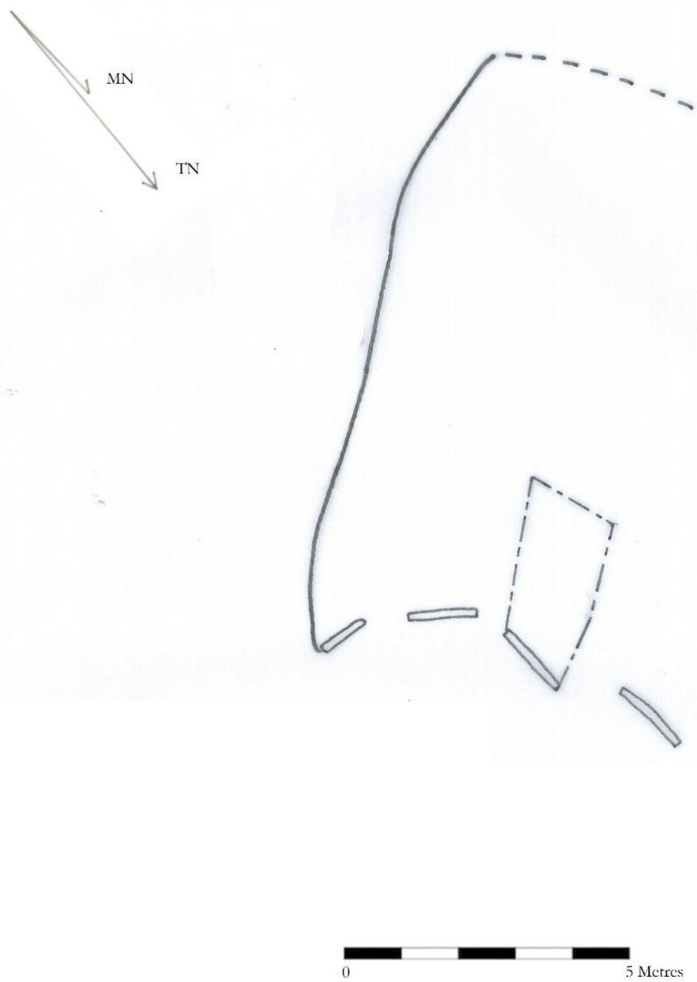
Site Name: Gallow Hill North

Scale 1:100

——— Visible extent

Site surveyed by R.G. & P.G. on 22/08/2012

Site plan drawn by R.G. on 02/02/2013



Site Name: Gartnagreanoch

Scale 1:100

Visible extent

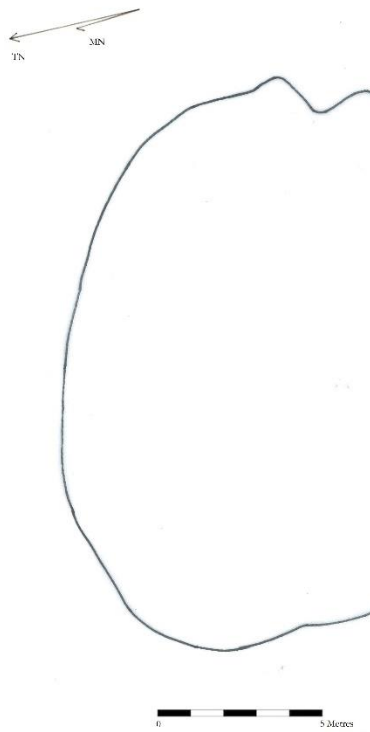
Possible extent

Extant orthostats (approx width)

Visible extent of capstone

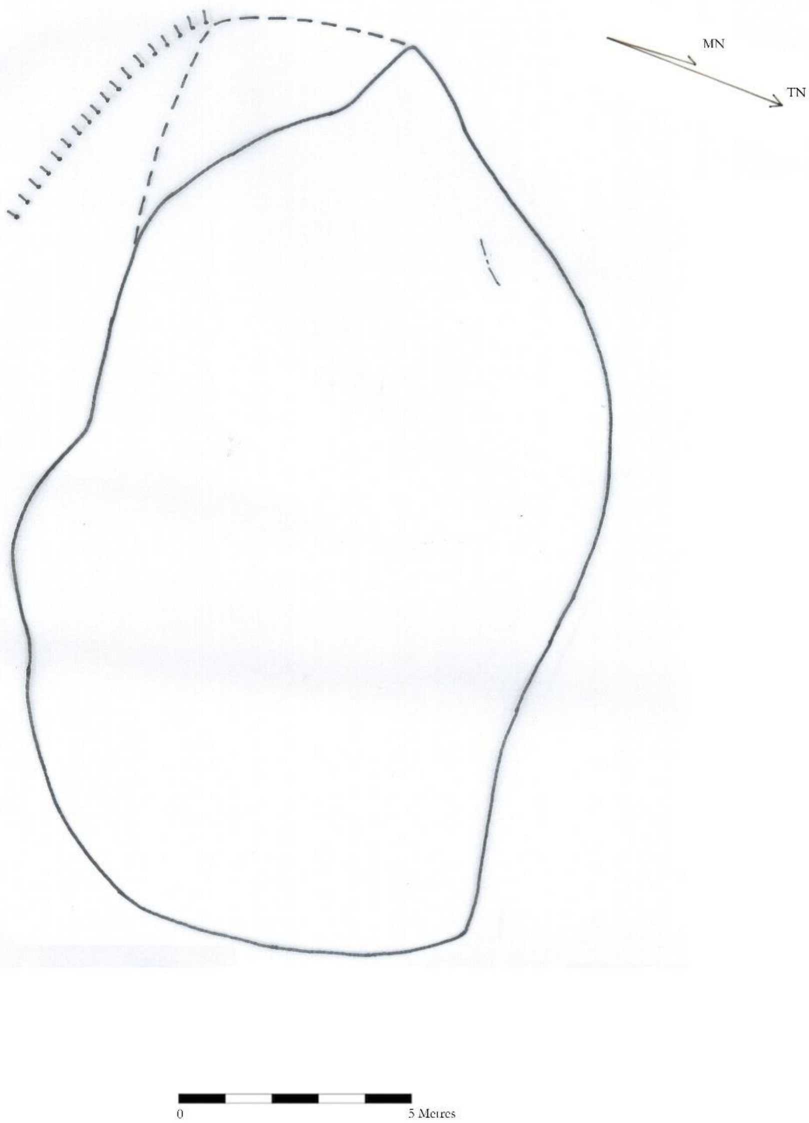
Site surveyed by R.G. & P.G. on 22/07/2012

Site plan drawn by R.G. on 23/01/2013



Site Name: Gask Burn
Scale 1:100
——— Visible extent

Site surveyed by R.G. & P.G. on 07/08/2012
Site plan drawn by R.G. on 24/01/2013



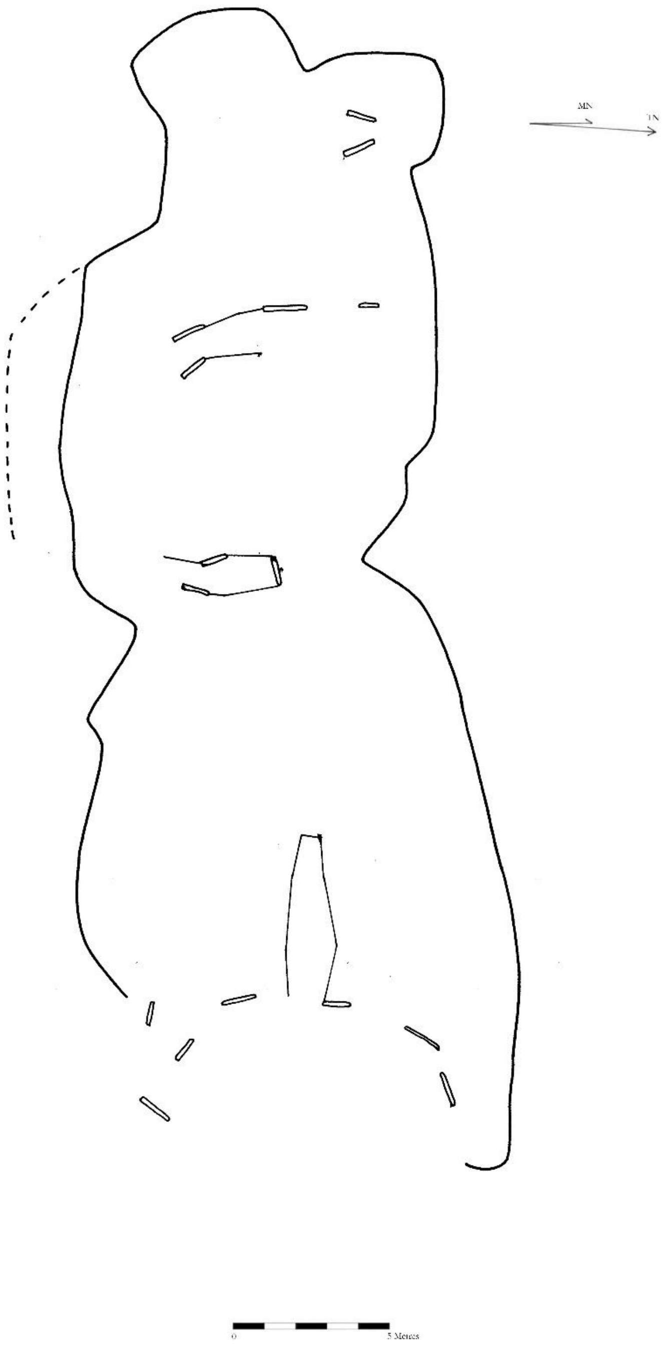
Site Name: Glecknabae

Scale 1:100

———	Visible extent
– – – –	Possible extent
— - —	Width of the visible capstone
↓↓↓↓↓	Natural slope (uncertain)

Site surveyed by R.G. & P.G. on 25/07/2012

Site plan drawn by R.G. on 24/01/2013



Site Name: Glen Lussa (Gort na h-Ulaidhe)

Scale 1:100

——— Visible extent

- - - - - Possible extent

——— Visible extent of chambers/entrance chamber

▭ Extant orthostats (approx width)

Site surveyed by R.G. & P.G. on 21/07/2012

Site plan drawn by R.G. on 27/03/2013

Site Name: Glenresdale Mains

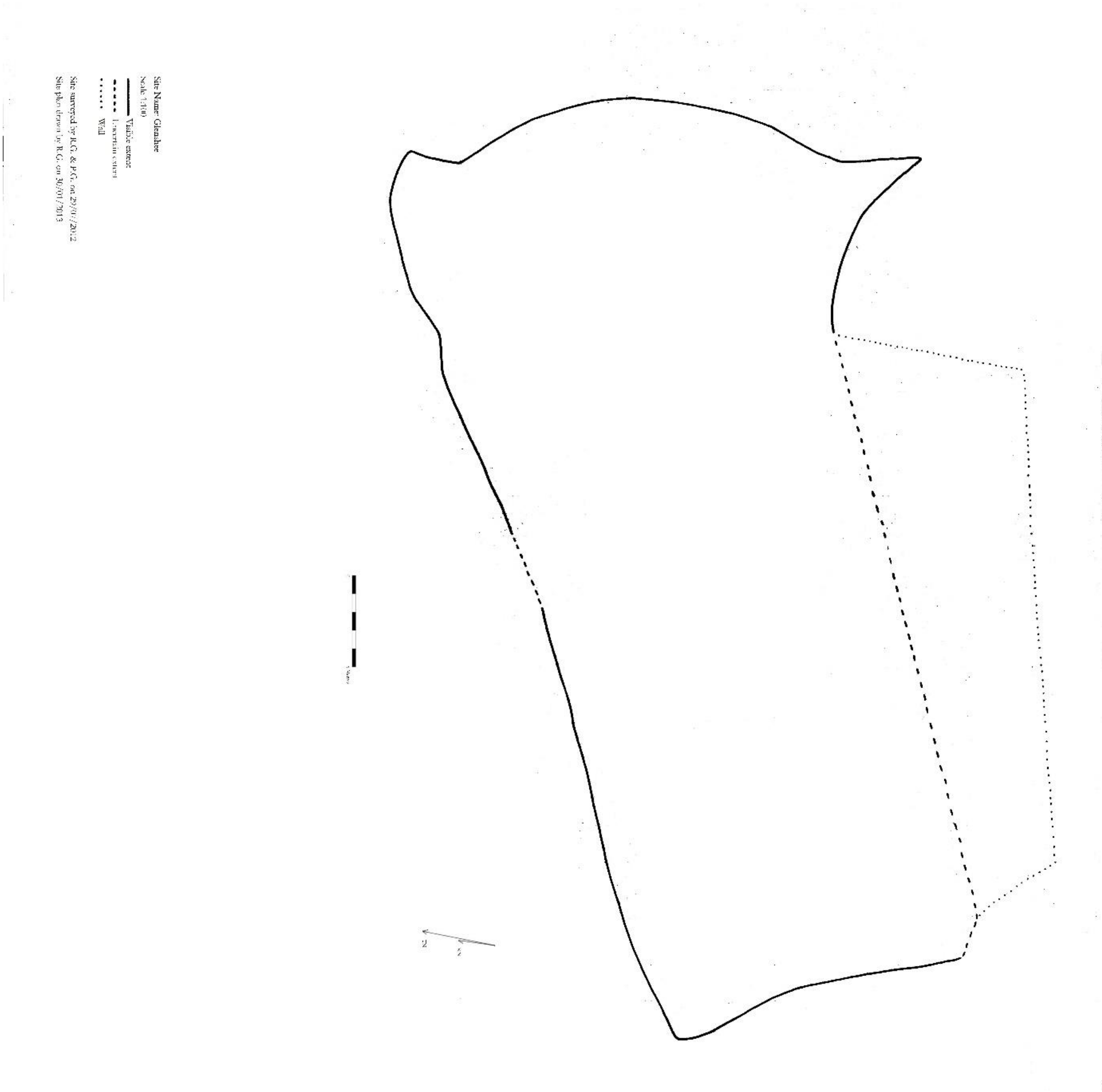
Scale 1:100

Visible extent

Visible extent of chambers

Site surveyed by R.G. & P.G. on 22/07/2012

Site plan drawn by R.G. on 23/01/2013


Site Name: Glenshee
Scale 1:100
Visible extent
Uncertain extent
Wall
Site surveyed by R.G. & P.G. on 29/01/2012
Site plan drawn by R.G. on 30/01/2013

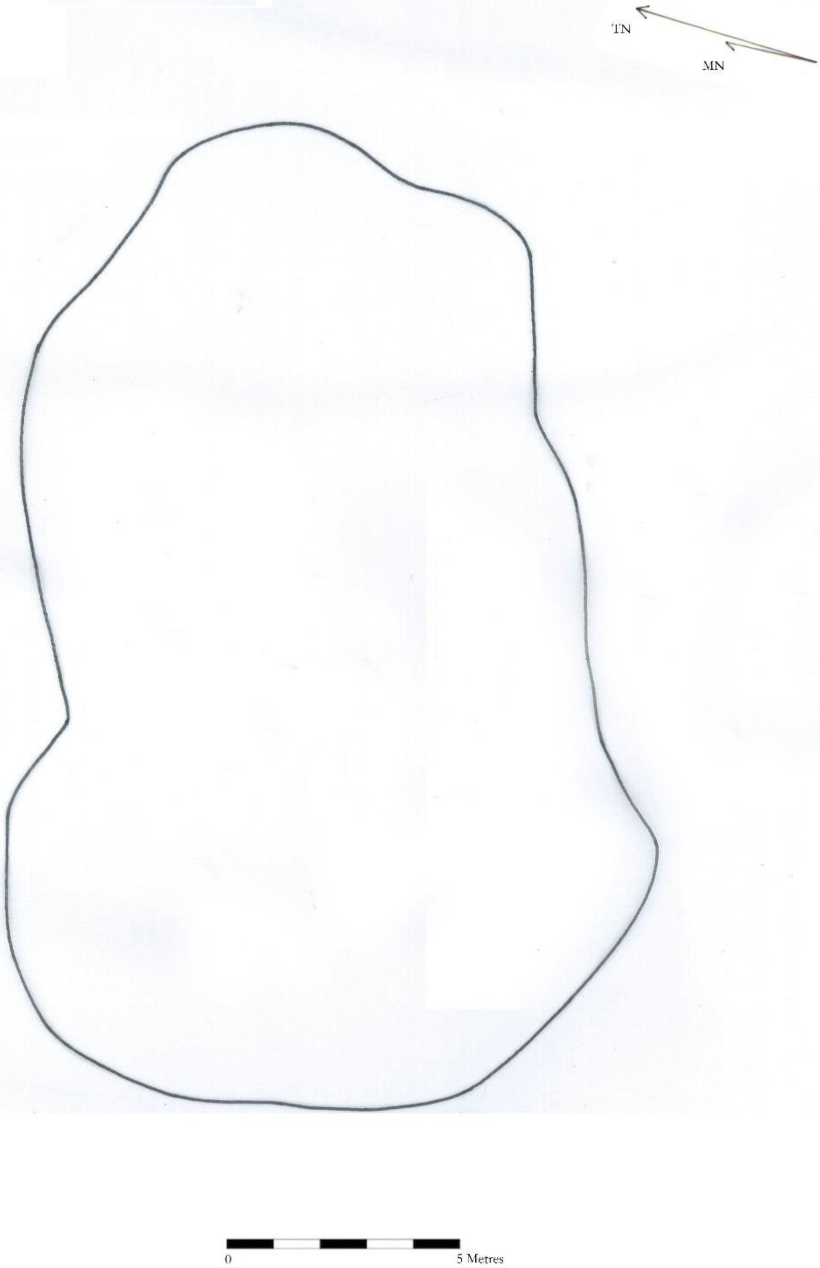
Site Name: Glenurquhart I

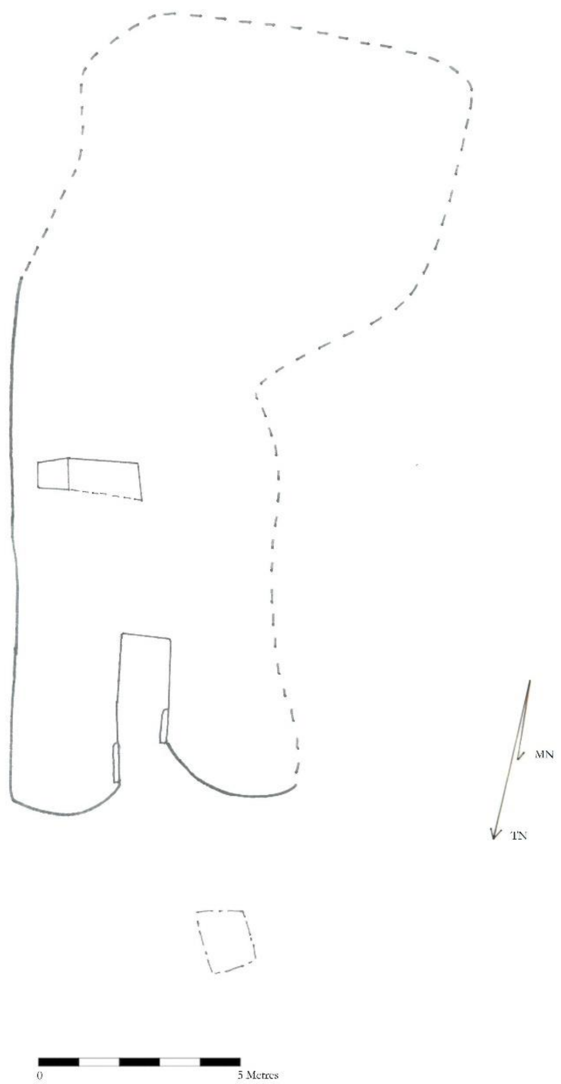
Scale 1:100

Visible extent

Site surveyed by R.G. & P.G. on 08/08/2012

Site plan drawn by R.G. on 24/01/2013





Site Name: Glenvoidean

Scale 1:100

Visible extent

Uncertain extent

Visible extent of chamber/axial chamber

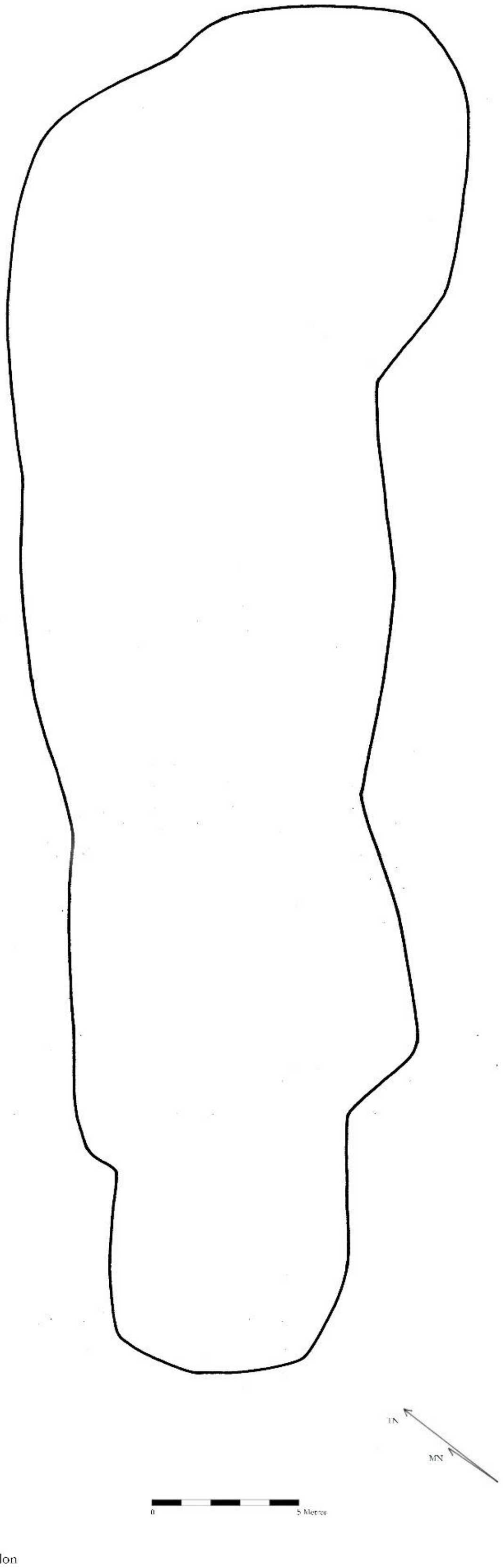
Uncertain extent of chamber

Extant orthostats (approx width)

Slab lying flat on the ground

Site surveyed by R.G. & P.G. on 25/07/2012

Site plan drawn by R.G. on 24/01/2013



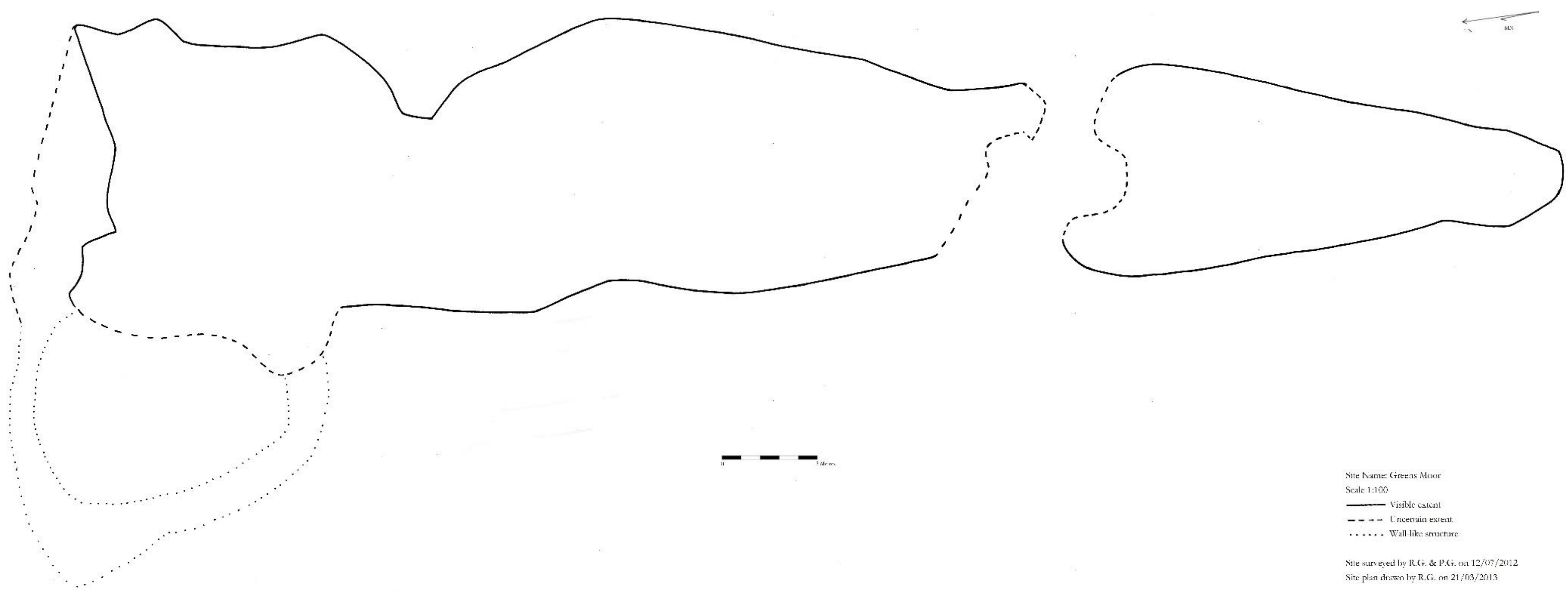
Site Name: Gourdon

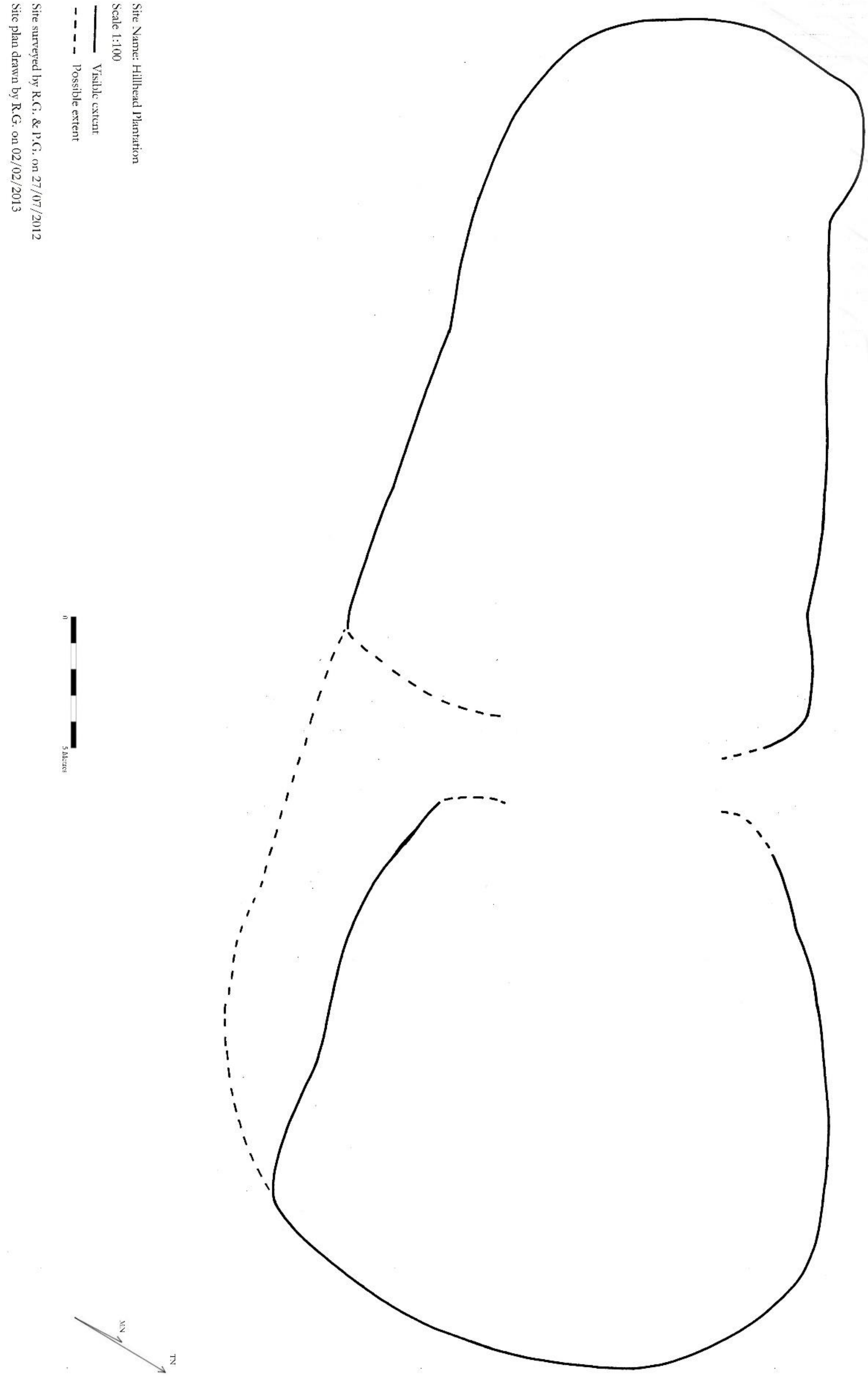
Scale 1:100

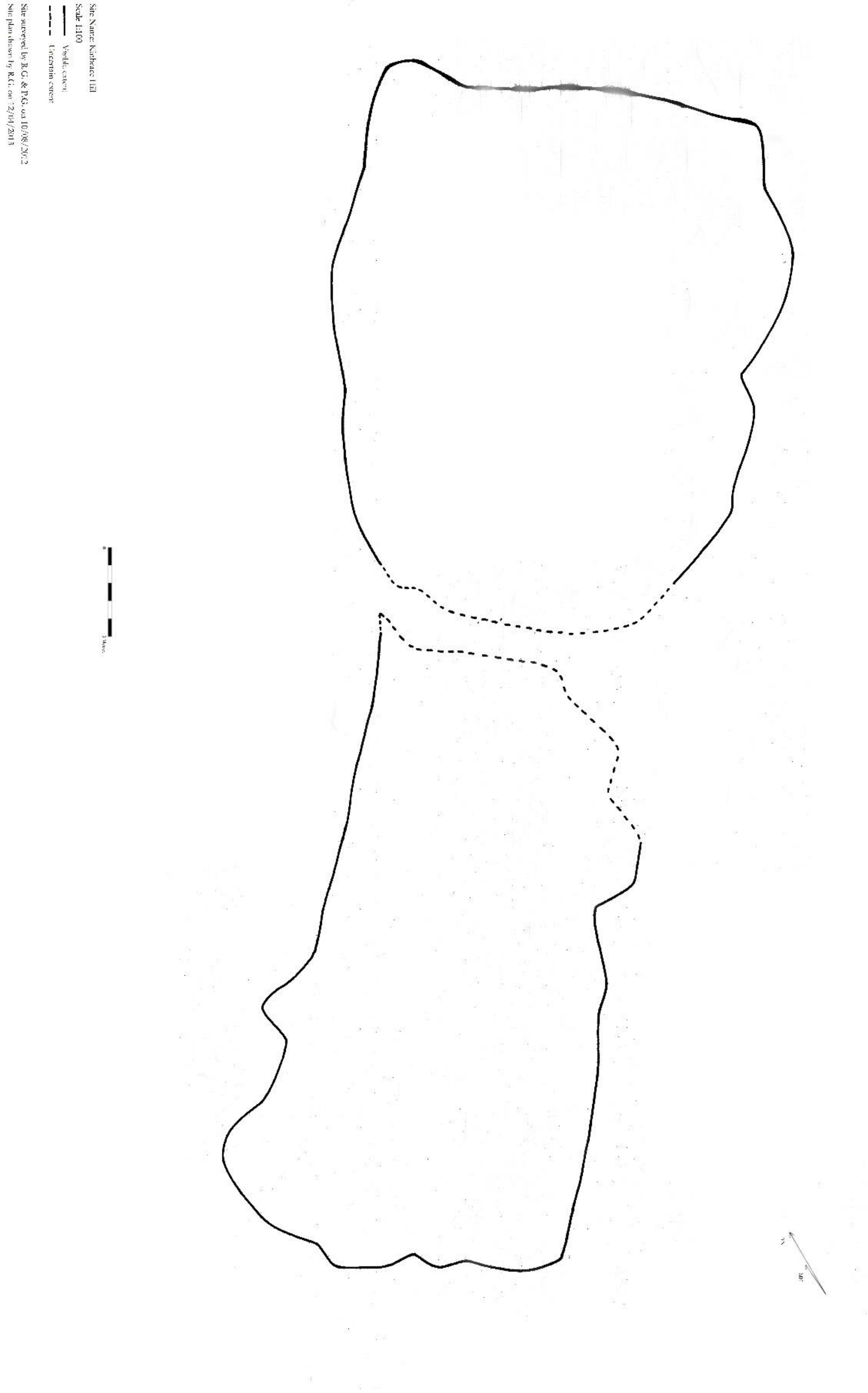
——— Visible extent

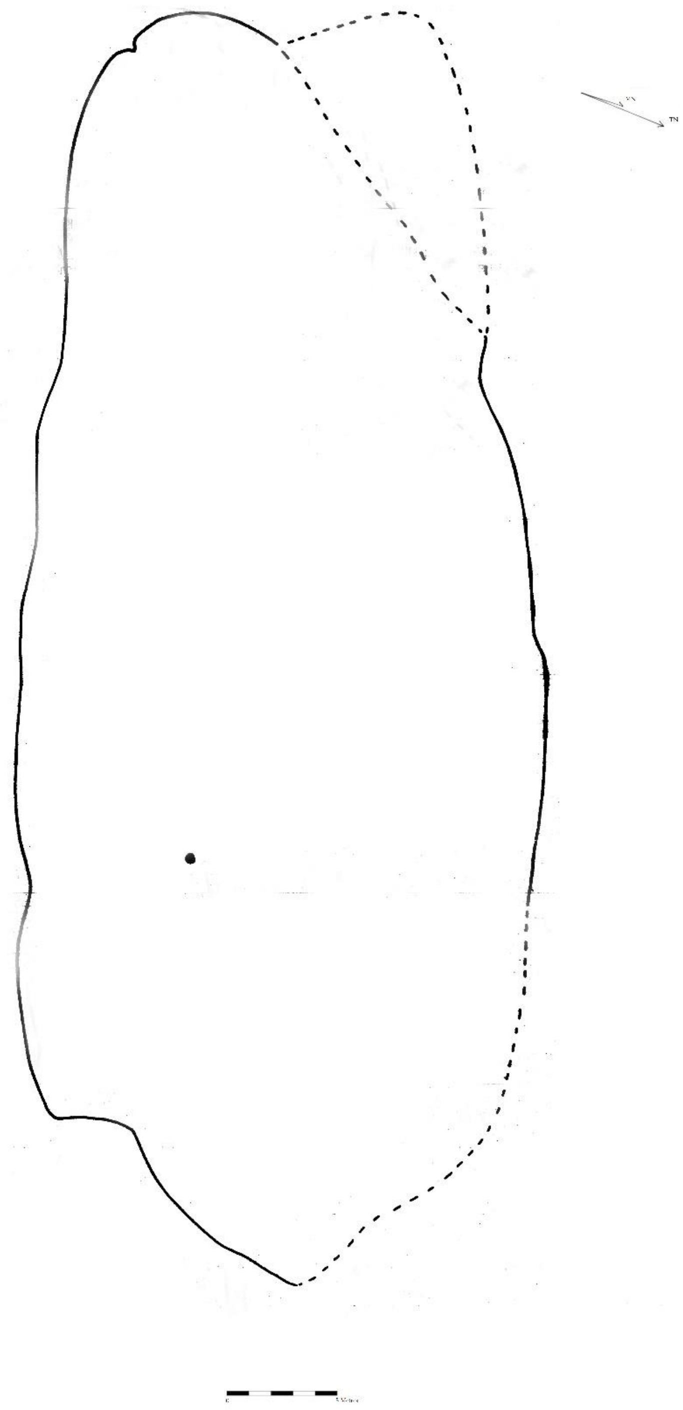
Site surveyed by R.G. & P.G. on 27/07/2012

Site plan drawn by R.G. on 04/04/2013


Site Name: Greens Moor
Scale 1:100
Visible extent
Uncertain extent
Wall-like structure
Site surveyed by R.G. & P.G. on 12/07/2012
Site plan drawn by R.G. on 21/03/2013


Site Name: Hillhead Plantation
Scale 1:100
Visible extent
Possible extent
Site surveyed by R.G. & P.G. on 27/07/2012
Site plan drawn by R.G. on 02/02/2013
0
5 Metres
MN
TN


Site Name: Kinbrace Hill
Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G. on 10/08/2012
Site plan drawn by R.G. on



Site Name: Kindrochet

Scale 1:100

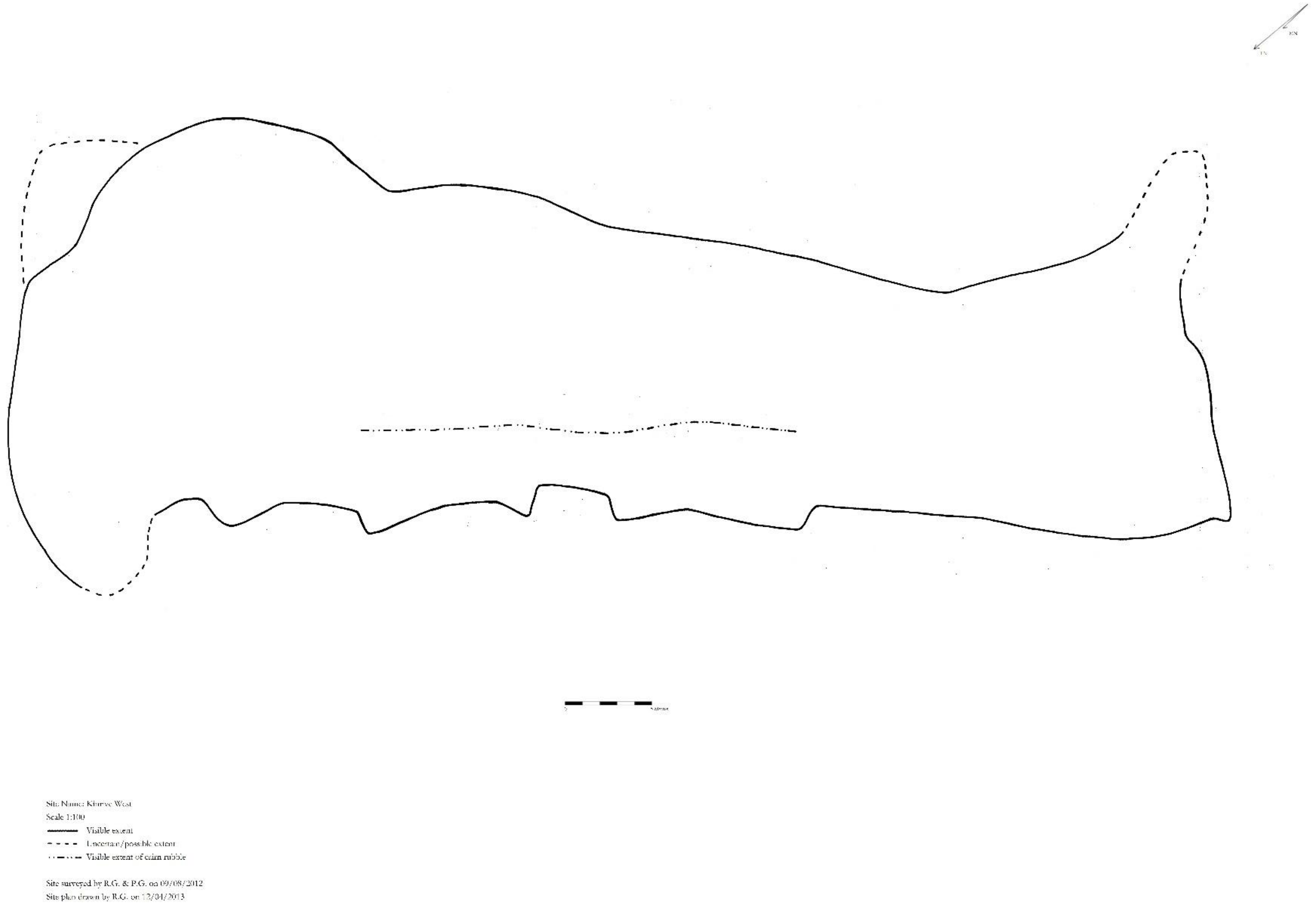
Visible extent

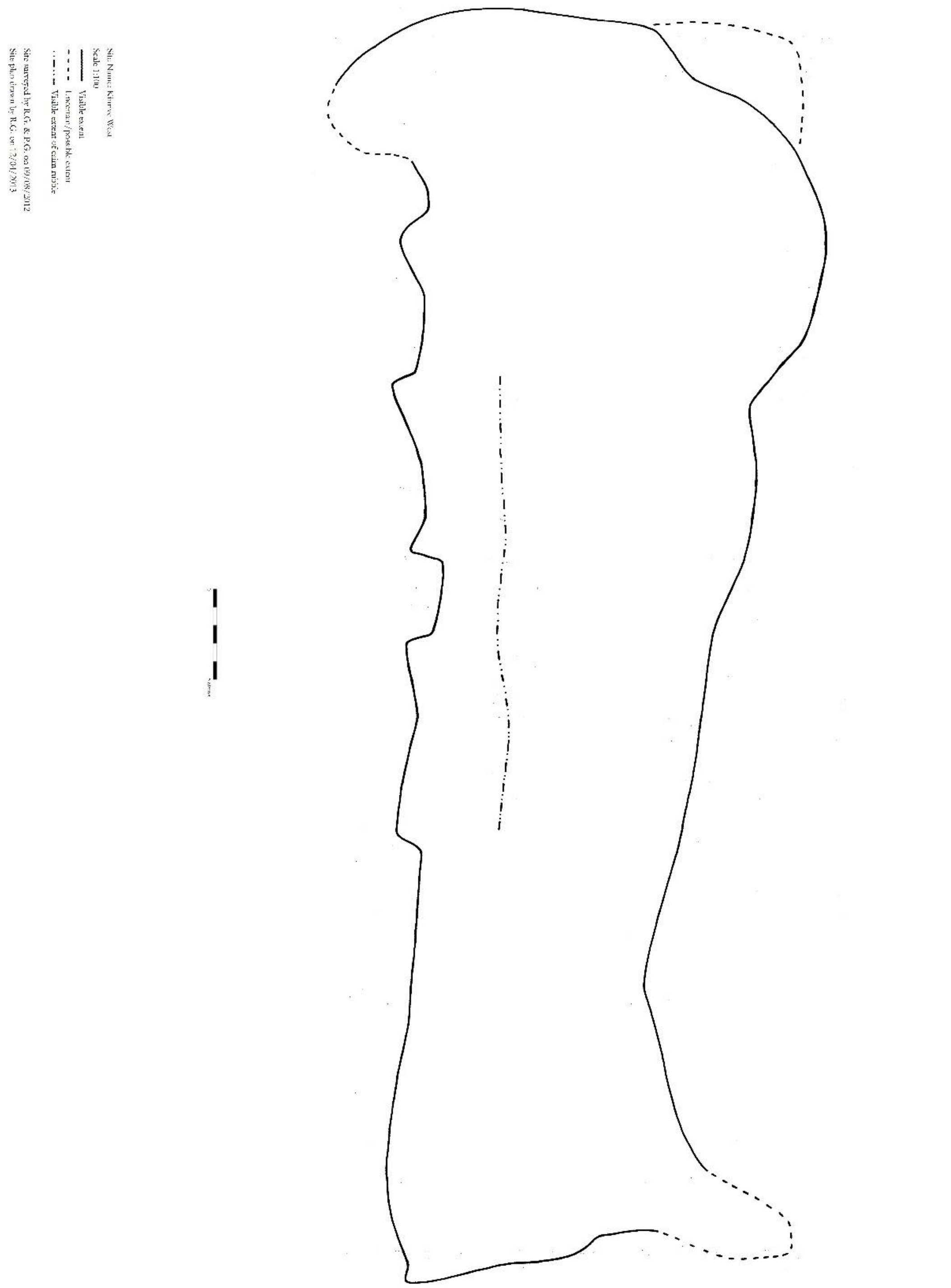
Uncertain extent

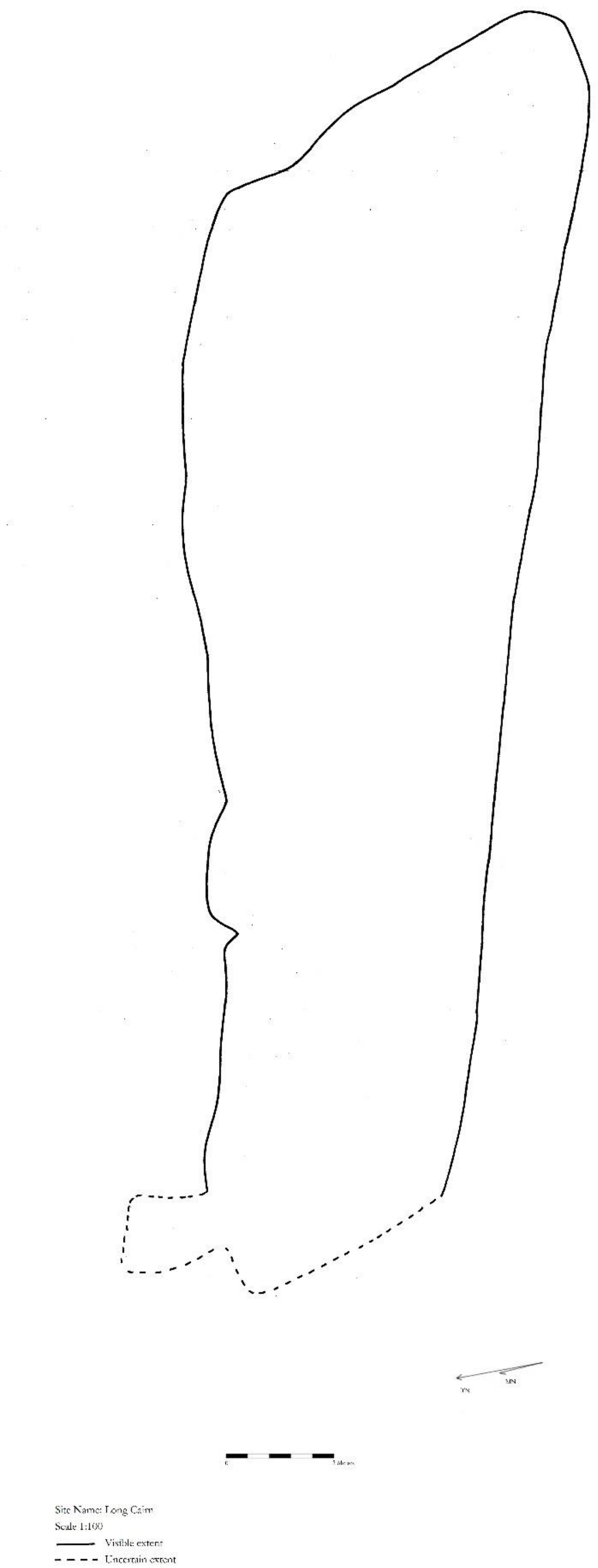
Extant orthostat (position only)

Site surveyed by R.G. & P.G. on 13/07/2012

Site plan drawn by R.G. on 30/01/2013


Site Name: Khurve West
Scale 1:100
Visible extent
Uncertain/possible extent
Visible extent of cairn rubble
Site surveyed by R.G. & P.G. on 09/08/2012
Site plan drawn by R.G. on 12/04/2013


Site Name:
Scale 1:100
Visible extent
Uncertain/possible extent
Visible extent of cairn rubble
Site surveyed by R.G. & P.G. on 09/08/2012
Site plan drawn by R.G. on 12/04/2013



Site Name: Long Cairn

Scale 1:100

Visible extent

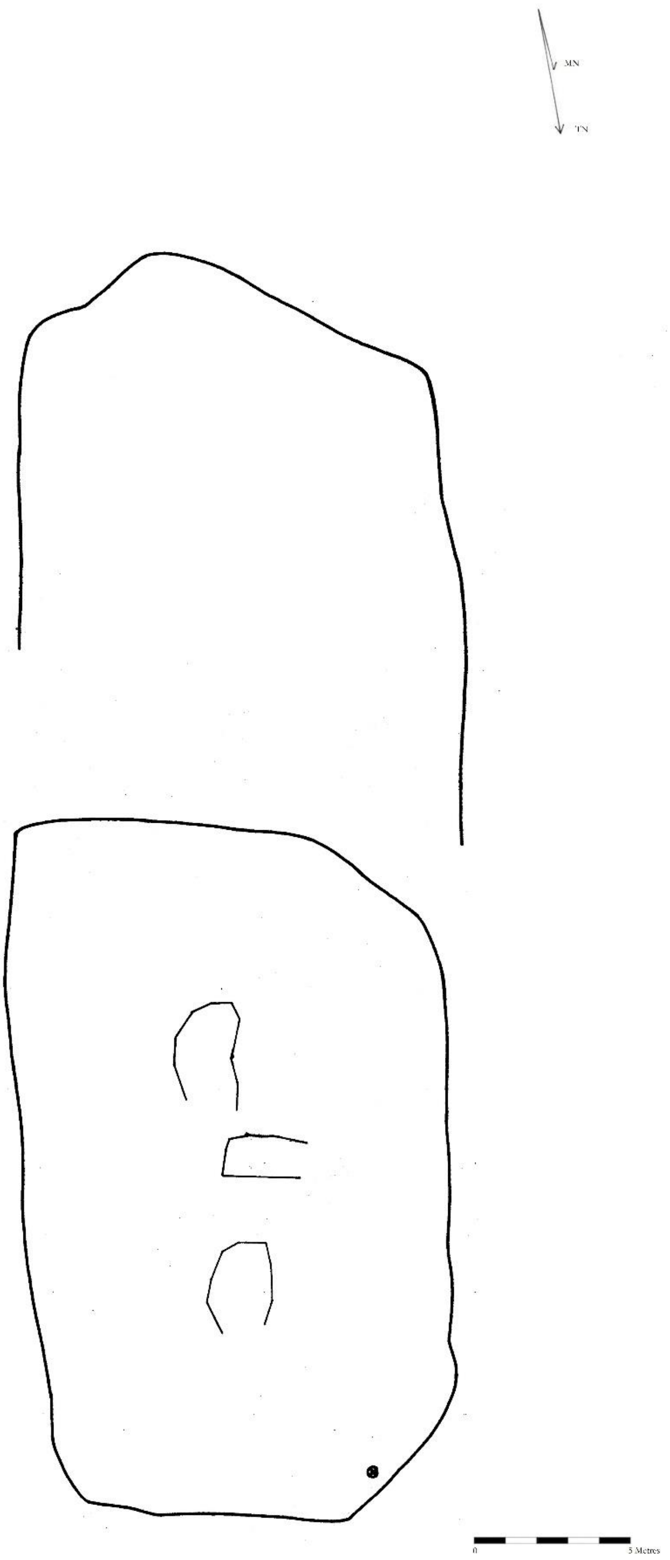
Uncertain extent

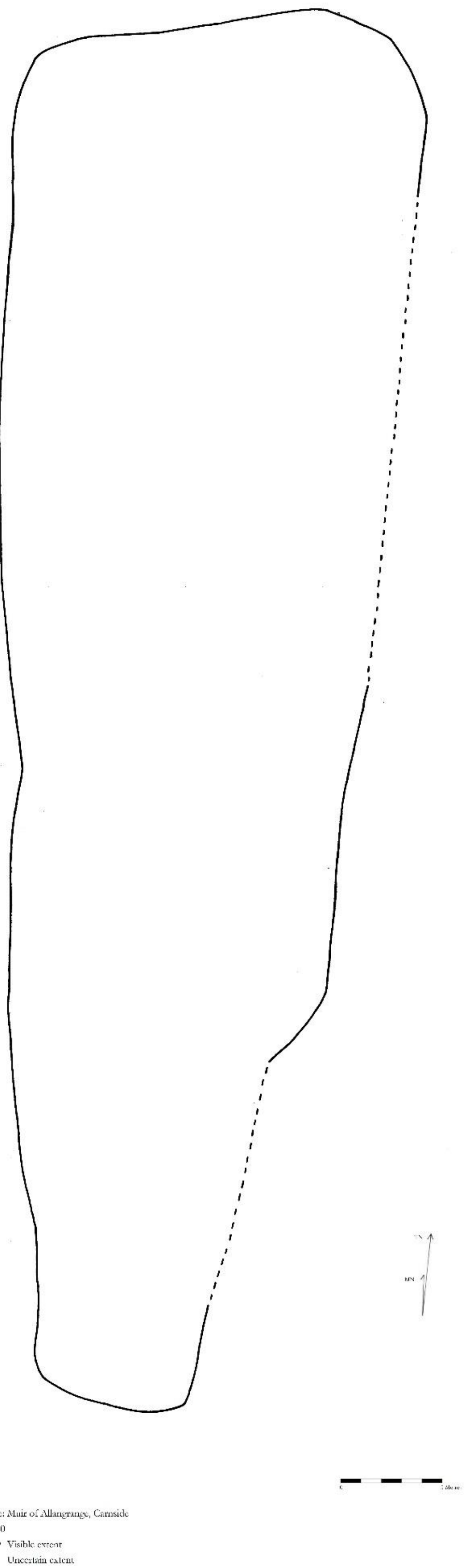
Site surveyed by R.G. & P.G. on 29/07/2012

Site plan drawn by R.G. on 01/02/2013

Site Name: Mid Gleniron
Scale 1:100
Visible extent
Uncertain extent of chambers
Extant orthostat (position only)

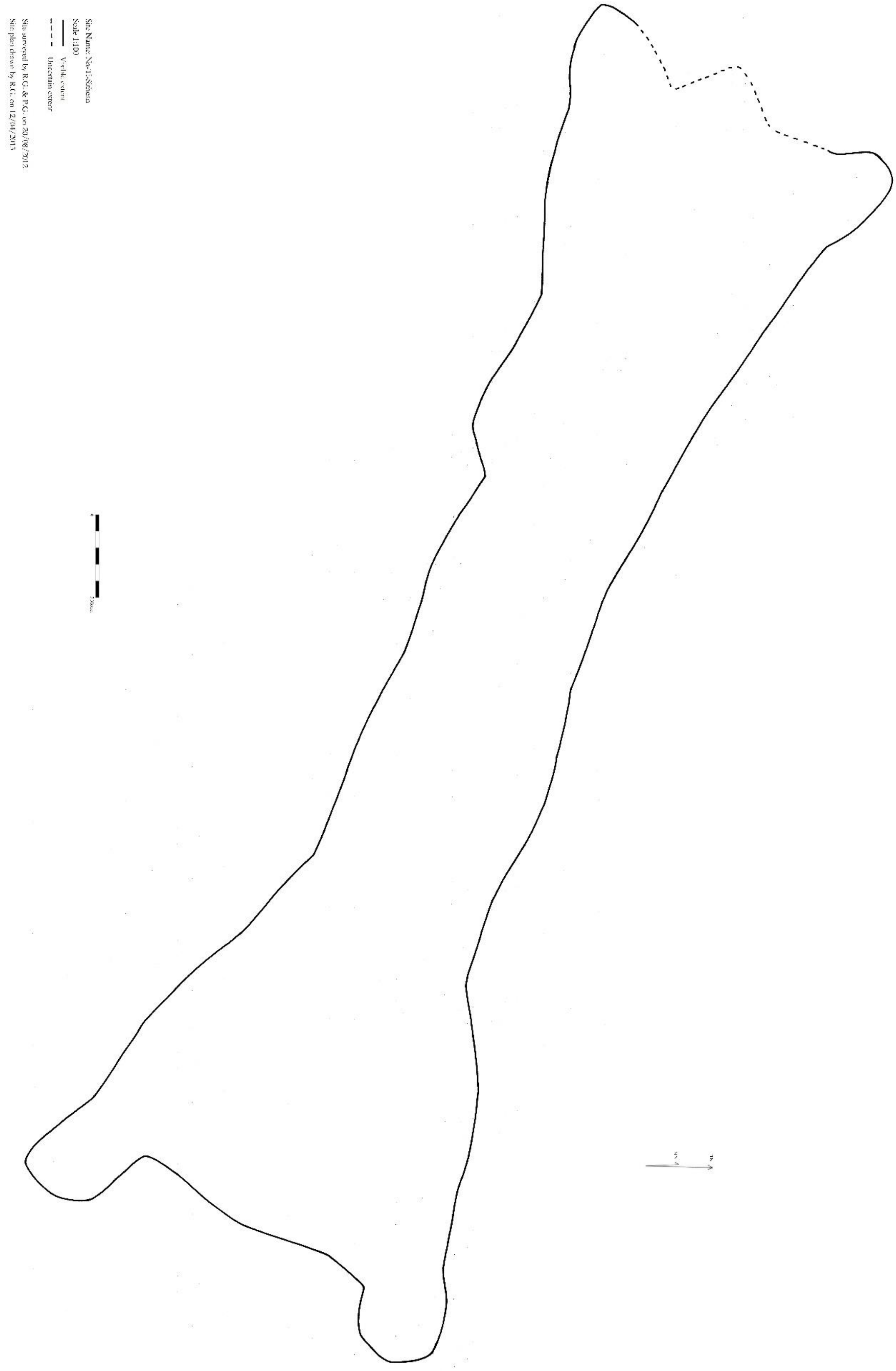
Site surveyed by R.G. & P.G. on 24/06/2012
Site plan drawn by R.G. on 05/04/2013

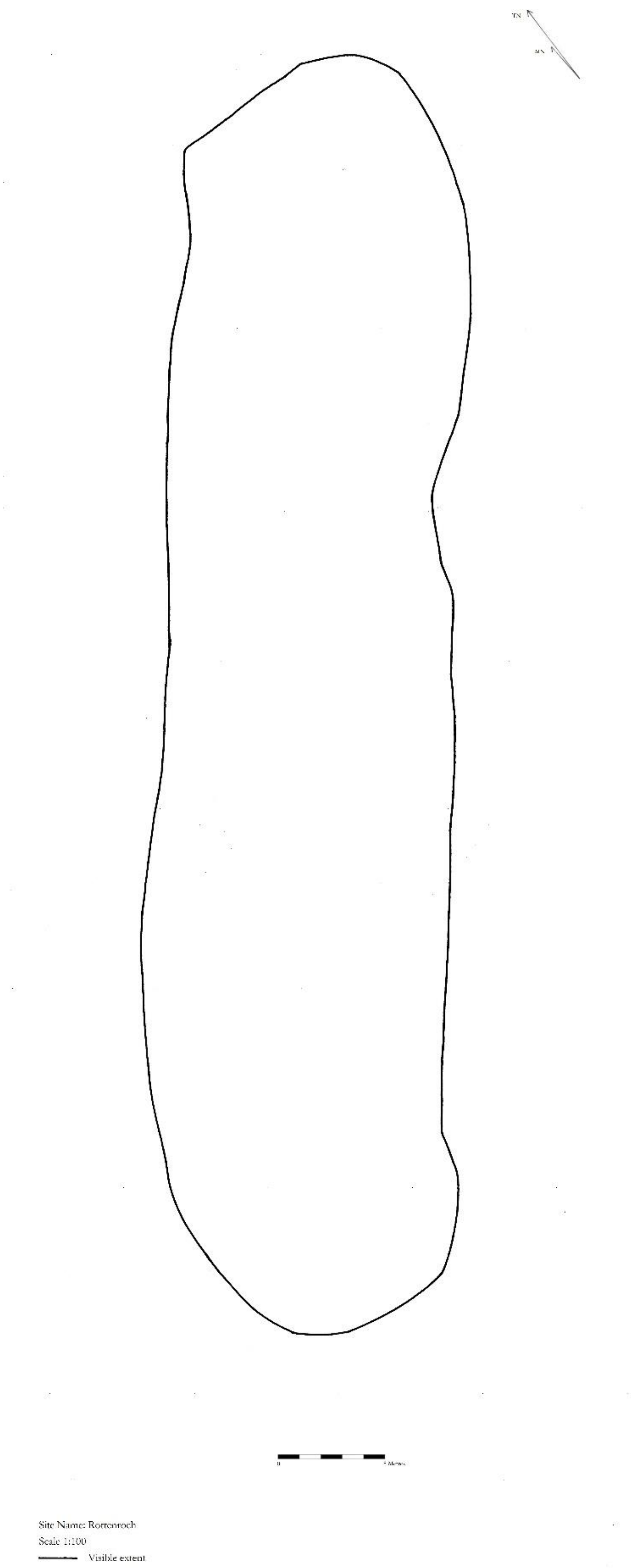




Site Name: Muir of Allangrange, Carnside
Scale 1:100
Visible extent
Uncertain extent

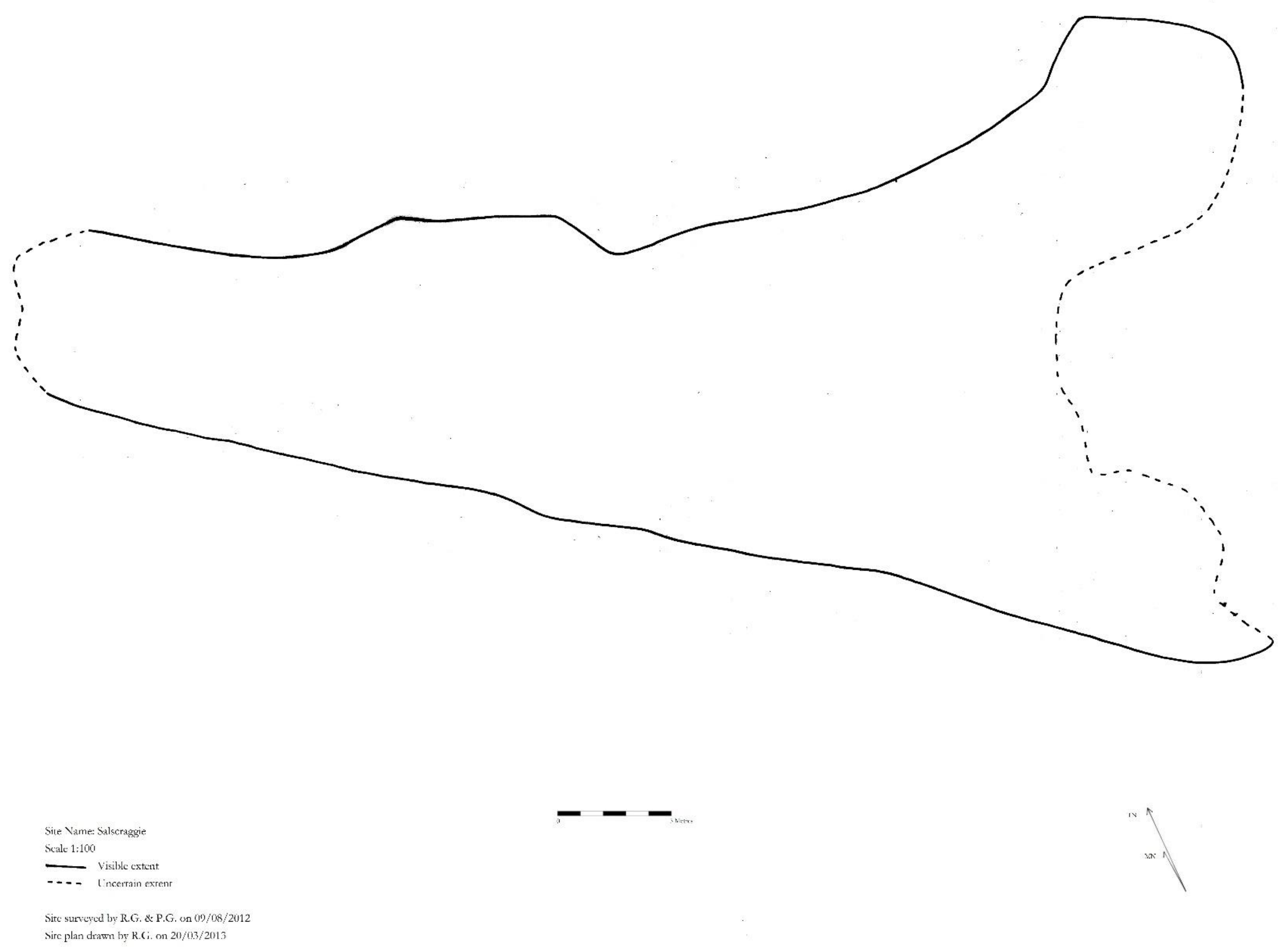
Site surveyed by R.G. & P.G. on 07/008/2012
Site plan drawn by R.G. on 05/04/2013

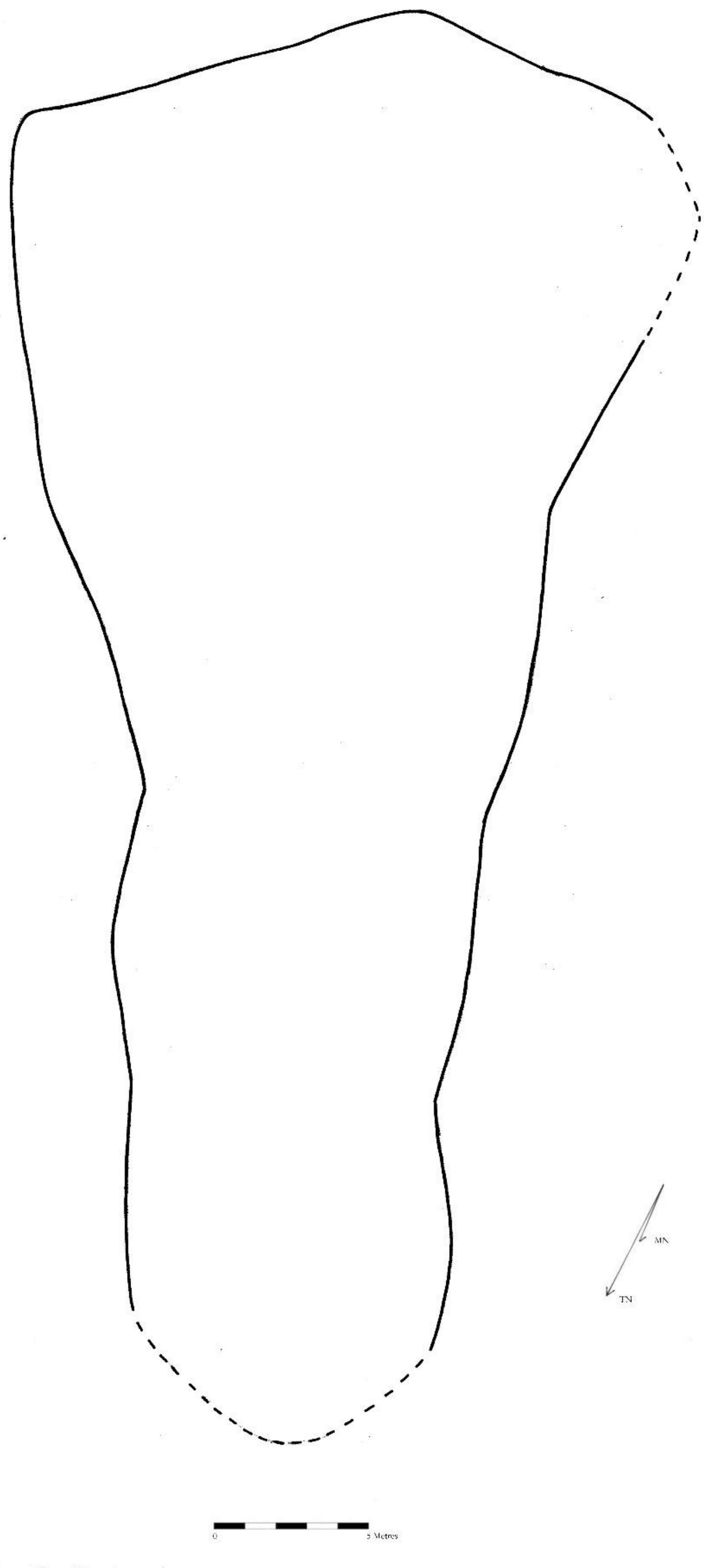

Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G. on 20/08/2012
Site plan drawn by R.G. on 12/04/2013



Site Name: Rottenroch
Scale 1:100
Visible extent

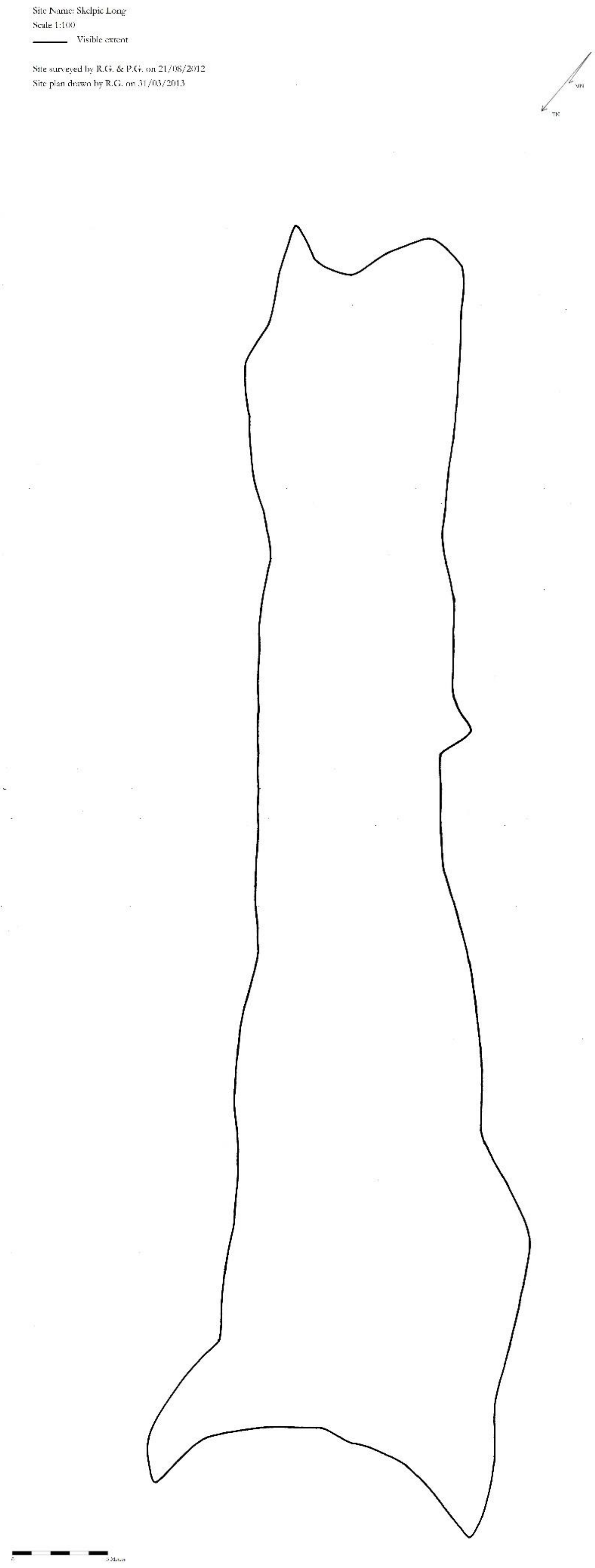
Site surveyed by R.G. & P.G. on 13/07/2012
Site plan drawn by R.G. on 22/03/2013


Site Name: Salscraggie
Scale 1:100
Visible extent
Uncertain extent
Site surveyed by R.G. & P.G. on 09/08/2012
Site plan drawn by R.G. on 20/03/2013
TN
MN

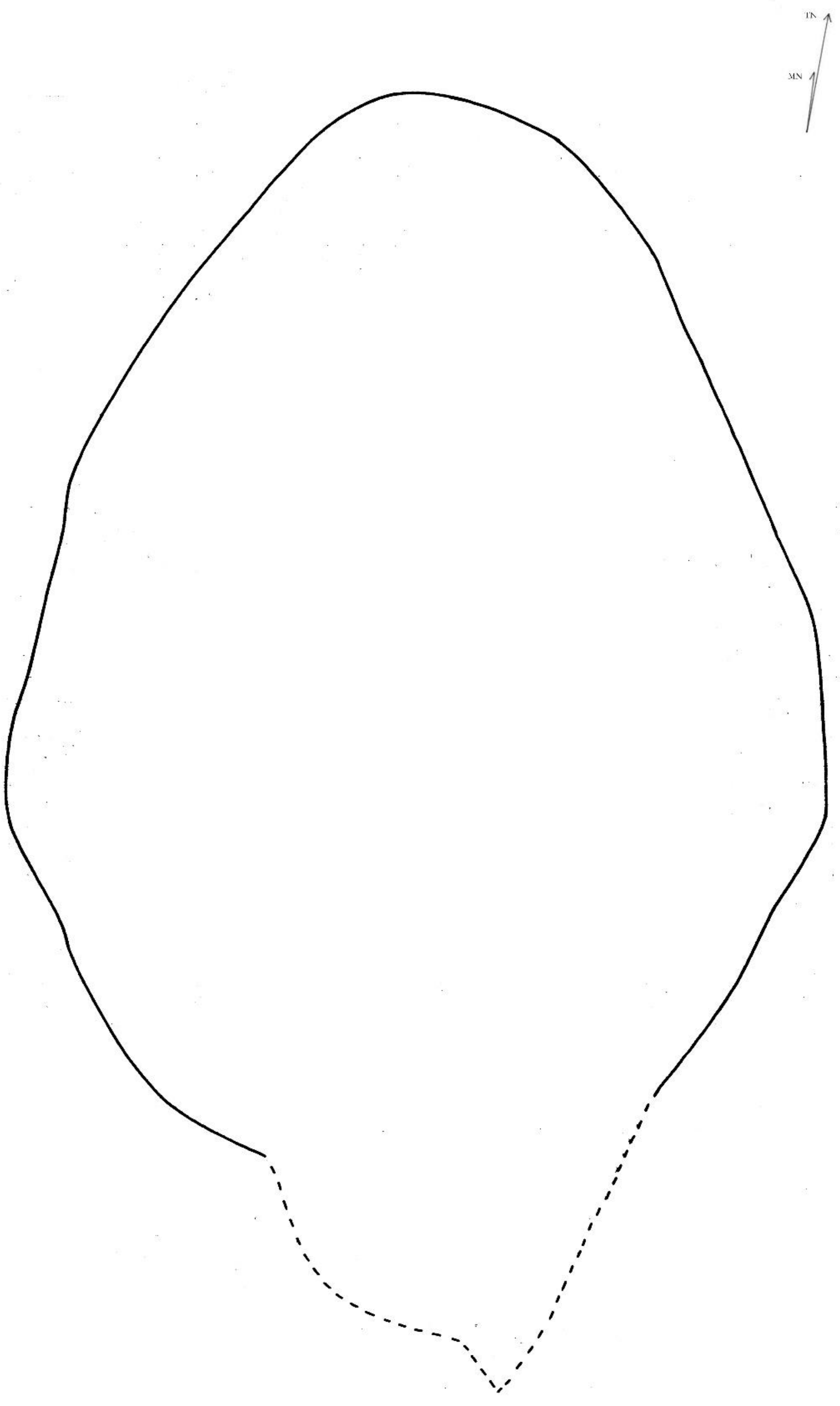


Site Name: Shean Stemster
Scale 1:100
—— Visible extent
- - - - Uncertain extent

Site surveyed by R.G. & P.G. on 22/08/2012
Site plan drawn by R.G. on 02/02/2013

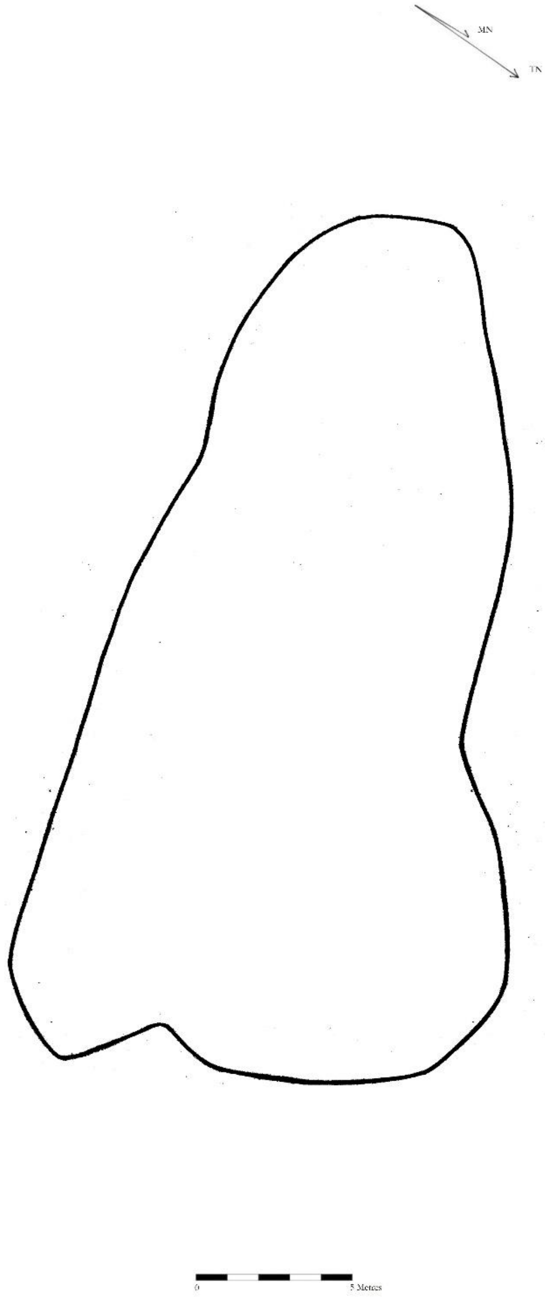


Site Name: Skelpic Long
Scale 1:100
Visible extent
Site surveyed by R.G. & P.G. on 21/08/2012
Site plan drawn by R.G. on 31/03/2013
MN
TN



Site Name: Stirling Cairn
Scale 1:100
Visible extent
Uncertain extent

Site surveyed by R.G. & P.G. on 29/07/2012
Site plan drawn by R.G. on 31/01/2013



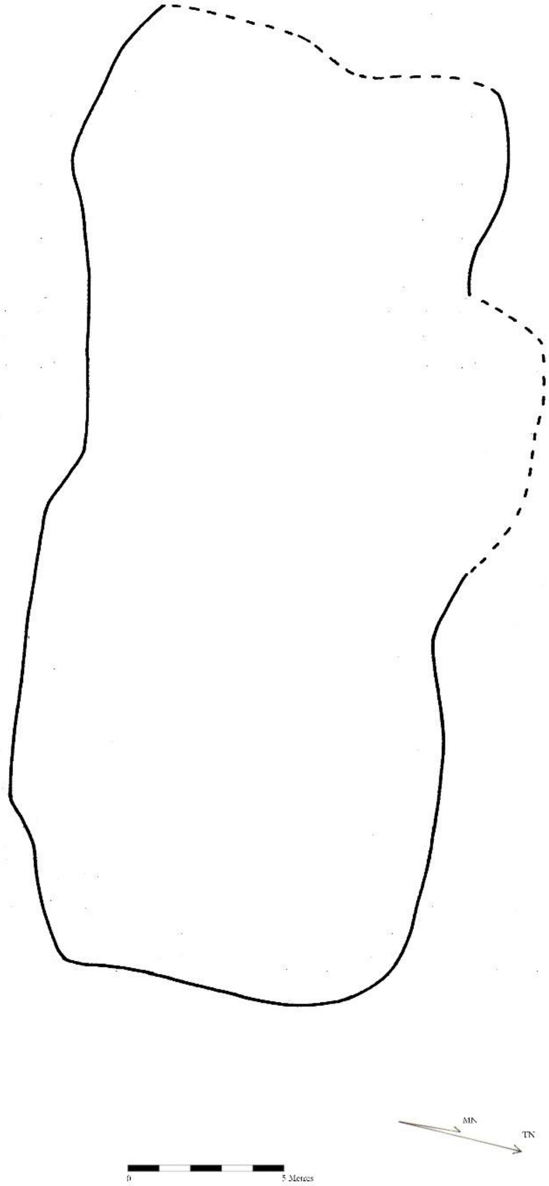
Site Name: Wester Brae

Scale 1:100

Visible extent

Site surveyed by R.G. & P.G. on 076/08/2012

Site plan drawn by R.G. on 06/04/2013



Site Name: Woodhead Long

Scale 1:100

——— Visible extent

- - - - Uncertain extent

Site surveyed by R.G. & P.G. on 08/08/2012

Site plan drawn by R.G. on 07/04/2013