

Háskóli Íslands  
Verkfræði- og raunvísindasvið  
Líf- og umhverfisvísindadeild



**Scenic natural landscapes in Iceland:  
An analysis of their visual characteristics and  
relationship to other Icelandic landscapes**

**Karen Pálsdóttir**

Júní 2009

60 eininga (ECTS) MS-ritgerð í umhverfis- og auðlindafræði

Leiðbeinendur: Þóra Ellen Þórhallsdóttir og Þorvarður Árnason

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Hér með lýsi ég því yfir að ritgerð þessi er byggð á mínum eigin athugunum, er samin af mér og að hún hefur hvorki að hluta né í heild verið lögð fram áður til hærri prófgráðu.

Karen Pálsdóttir, kt. 010581-5599

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## **Abstract**

In Iceland, many places have protected status or have been nominated for conservation because of their beautiful, diverse or extraordinary landscapes, or are otherwise renowned for scenic beauty. Neither landscape nor scenic beauty are, however, defined by law nor are they easy concepts to reach consensus about.

In this study, 48 acknowledged scenic landscapes in Iceland were visited and analyzed using methods developed in the Icelandic Landscape Project (ILP). The aim was to 1) ascertain whether the scenic landscapes had particular visual features in common, 2) establish whether they fit or are exclusive to the major landscape categories already defined by the ILP, and 3) explore how the newly developed methodology was suited to discern differences between “scenic” and “ordinary” landscapes (from a nationwide systematic sample). The sample was compiled from the following sources: 1) sites protected under the Nature Conservation Act because of landscape value, 2) sites in the Nature Conservation Registries and 3) Nature Conservation Strategy 2004-2008 where landscape was listed as a criterion for nomination, and 4) the preferences of a group of 8 landscape connoisseurs. Cluster Analysis was applied to classify the areas based on 21 visual physical characteristics and their defining and separating features were explored with Principal Component Analysis. This was done for the scenic areas on their own as well as with the scenic areas plus a sample of 112 systematically surveyed sites.

The results were that the assessed scenic areas were visually quite diverse. They had high scores for attributes which pertain to diversity in common; their high diversity scores underlined their variation. When classified within the sample of systematically surveyed sites, some of the scenic areas blended into different groups but others made up their own group. The results indicated that there were some visual physical characteristics which quite often set the scenic areas apart from other landscapes and that this method was sensitive to those qualities. These were especially characteristics which pertain to diversity, such as the diversity of forms, patterns, colors and texture, as well as scores for water cover, water current and water expression. On the other hand, vegetation diversity was not significantly different between the assessed scenic areas and other landscape sites in Iceland, and vegetation cover was lower, which may be counterintuitive when compared to scenic areas in other countries.

## Ágrip

Landslag er margvitt hugtak sem unnið er með á ýmsa vegu með mismunandi nálgunum. Það er óhætt að segja að fagurt, sérstætt eða stórbrotið landslag sé hátt metið um allan heim. Verndun slíks landslags hefur átt sér stað lengi – í sumum tilvikum í yfir öld. Í heimsminjaskrá Sameinuðu þjóðanna eru náttúrufegurð og sjónræn gæði nokkur af viðmiðunum við útnefningu bæði menningar- og náttúruminja, og hjá alþjóðlegu náttúruverndarsamtökunum IUCN hefur landslag sinn eigin verndarflokk. Einnig hafa mörg lönd viðmið fyrir náttúruvernd þar sem landslag og náttúrufegurð eru útlistuð. Í íslenskum lögum um náttúruvernd er landslag talið upp sem fyrsta röksemdin fyrir friðun bæði þjóðgarða og friðlanda. Fjölmörg svæði á Íslandi eru friðuð eða tilnefnd til friðlýsingar vegna landslags, eða rómuð vegna náttúrufegurðar. En landslag er ekki skilgreint í lögum á Íslandi né eru til samræmdar aðferðir til að meta sjónrænt gildi þess. Ekki er að sjá að svæði, sem hafa verið friðlýst á þessum forsendum, hafi verið metin með fyrir fram gefnum viðmiðum.

Í þessari rannsókn voru 48 íslenskar „náttúruperlur“ (eða „landslagsperlur“) greindar með aðferðum Íslenska landslagsverkefnisins (ÍLV). Markmiðið var að greina 1) hvort þessar náttúruperlur ættu eitthvað sameiginlegt innbyrðis, 2) hvort þær féllu inn í landslagsflokka Íslenska landslagsverkefnisins eða skæru sig frá, og 3) hvort að þessi nýja aðferðafræði greindi mun milli „fagurs“ landslags og „venjulegs“. Við val svæða var byggt á eftirfarandi: 1) friðlýst svæði þar sem landslag var talið ástæða friðlýsingar, 2) svæði á náttúruminjaskrá þar sem landslag var nefnt sem ástæða tilnefningar, 3) svæði í Náttúruverndaráætlun 2004-2008 þar sem landslag var nefnt sem ástæða tilnefningar, og 4) val sérfræðingahóps ÍLV. Svæðin voru heimsótt og 21 hlutbundinn sjónrænn þáttur skráður á gátlista. Kláðugreining (e. *cluster analysis*) var notuð til að flokka svæðin. Meginþátta-greining (e. *principal component analysis*) var notuð til að greina hvaða sjónrænu eiginleikar skýrðu mestan breytileika milli landslagsflokka. Náttúruperlurnar voru greindar einar og sér og einnig með úrtaki ÍLV, sem samanstóð af upplýsingum sem safnað var á kerfisbundinn hátt á 112 svæðum um allt Ísland.

Náttúruperlurnar áttu sameiginlegt háar einkunnir fyrir allar breytur sem við komu fjölbreytni. Þetta gerði það jafnframt að verkum að þær voru oft mjög ólíkar innbyrðis. Þeir þættir sem voru breytilegastir milli perlanna voru sjór, ferskvatn, form, línur, gróður, og fjölbreytni mynstra. Aðferðin greindi mun milli náttúruperla

og annars „venjulegs“ landslags (kerfispunktanna). Sumar náttúruperlur féllu inn í landslagsflokka ÍLV, en aðrar röðuðust saman og mynduðu sinn eigin flokk. Þegar einkunnagjöf fyrir kerfispunkta annars vegar og náttúruperla hins vegar var borin saman, kom í ljós að marktækur munur var á dreifingu 14 af þeim 21 þætti sem voru metnir. Náttúruperlur höfðu marktækt meiri vatnsþekju, meiri straumbunga vatnsfalla, fleiri birtingarmyndir vatns og voru oftár í námunda við jökul. Munur mældist á dreifingu einkunna fyrir hvassar línur, bugður og svigður, og fjölbreytni forma og lína þannig að meira var um þessi form, og þau fjölbreyttari, hjá náttúruperlum. Mynstur og áferð voru fjölbreyttari, blettastærð fingerðari og litbrigði meiri í tilfelli náttúruperla. Aðferð ÍLV greindi afgerandi mun á fjölbreytni náttúruperla og annars landslags, sem er í samræmi við erlend matskerfi þar sem fjölbreytni er oft nefnd sem eiginleiki sem gefur landslagi gildi. Aftur á móti sást ekki munur á gróðurfjölbreytni, og gróðurþekja var marktækt minni hjá náttúruperlum en kerfispunktum. Þetta rímar ekki við erlend matskerfi, þar sem sjónræn gæði eruð metin meiri og landslag talið náttúrulegra ef gróður er ríkulegur og fjölbreyttur.

## Formáli

Ég hef haft áhuga á umhverfismálum frá því að ég man eftir mér. Í barnaskóla í Bandaríkjunum var lögð mikil áhersla á umhverfismennt. Fræðslan var svo miklu meiri þar en hér, að þegar ég flutti heim varð ég fyrir töluverðu áfalli yfir því hvernig fólk hugsaði (ekki) um náttúruna. Stefnan hefur því alla tíð verið sett, bæði meðvitað og ómeðvitað, á umhverfisfræðinám.

Vorið 2004 var ég í hópi nemenda sem tók þátt í könnun fyrir meistaraverkefni Rutar Kristinsdóttur um mat á íslensku landslagi. Mér þótti efnið spennandi og hlustaði á meistaravörn hennar um haustið. Þarna frétti ég fyrst af umhverfisfræðináminu við Háskóla Íslands, sem nú heitir umhverfis- og auðlindafræði. Námið var framar vonum.

Ég vil færa leiðbeinendum mínum, Þóru Ellen Þórhallsdóttur og Þorvarði Árnasyni, bestu þakkir fyrir góða leiðsögn, aðstoð og yfirlestur á öllum stigum verkefnisins. Brynhildur Davíðsdóttir fær einnig þakkir fyrir að halda vel utan um námið og okkur sem námið stunda. Hlyni Bárðarsyni, Jónu Björk Jónsdóttur, Guðbjörgu Rannveigu Jóhannesdóttur og Hafdísi Hönnu Ægisdóttur vil ég þakka fyrir ánægjulegt samstarf í draumasumarvinnunni, sem fólst í að elta góða veðrið og greina landslag. Þeim tveimur fyrstnefndu vil ég einnig þakka sérstaklega fyrir ýmsa aðstoð og stuðning í stofu 285 í Öskju. Sigrún Helga Lund fær þakkir fyrir tölfræðiaðstoð og Andreas Zöhrer fyrir kortagerð. Sérfræðingahópur Íslenska landslagsverkefnisins fær þakkir fyrir aðstoð við val svæða. Síðast en ekki síst vil ég þakka fjölskyldu minni. Foreldrar og tengdaforeldrar fá miklar þakkir fyrir ómælda barnapössun á síðustu metrunum, og Magnús, sonur minn, fyrir að vera uppspretta endalausrar gleði. Sérstakar þakkir fær Atli Ísleifsson fyrir stuðning, þolinmæði og ást.

Verkefnið var styrkt af Rannsóknarnámssjóði Rannís. Sá hluti þess sem féll undir Íslenska landslagsverkefnið var greiddur af Orkusjóði.

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# 1. Introduction

## 1.1. *Prelude*

Scenic landscapes are admired and appreciated in all parts of the world. The conservation of such landscapes has been an ongoing concern of both policy-makers and members of the general public for decades or, in some cases, over a century (Brown, Mitchell, & Beresford, 2005; Fowler, 2004; The National Trust, 2009). While there is general agreement that some landscapes possess greater scenic values than others and are worthy of protection on this basis alone, methods for the assessment and evaluation of the aesthetic properties of landscapes differ considerably between countries. The precise demonstration of scenic value as a valid and important criterion of nature conservation can be difficult (e.g. Badman et al., 2008). Scenic value is often analyzed and described, to some extent, by studying and listing the visual, physical features in the landscape and their juxtapositions. Thus, connections are made between what is seen in the landscape and its scenic quality. It has been demonstrated that the presence of some physical landscape features contribute to an area's scenic value, i.e. that the contents of a scene matter. A common example of this is the presence of water, which is usually considered a positive attribute in the landscape (Herzog, 1985). Insights like these have led to the development of criteria to assess landscapes.

The concern with beautiful landscapes is rooted in the well-being that humans often feel when viewing them (e.g. Buergi, 2002). In common usage, the terms “landscape” and the “scenic” are very often found together. People are moved by landscapes that they find appealing, they are interested in such landscapes, awed, even mystified; they remember them, paint or photograph them, and often go to great lengths to experience and explore them. Some humans have even had spiritual or meditative experiences in breath-taking landscapes, where they encounter God and/or nourish their soul (Groom, Meffe, & Carroll, 2006; Ólafsdóttir, 2008).

The recognition of landscapes which are considered exceptionally scenic is seen as an important means to conserve and sustain the cultural and natural environment. Scenic value is in practice a criterion for landscape protection and has as such been a basis for landscape and nature protection for over a century. For example, the National Trust for the Preservation of Places of Historic Interest and Natural Beauty was founded in Britain in 1895 and is an active landscape and

building protection charity, caring for “over 248,000 hectares (612,000 acres) of *beautiful* countryside in England, Wales and Northern Ireland” (The National Trust, 2009, emphasis mine). It is now generally acknowledged that the role of national parks is to protect natural landscapes (Brabyn, 2005). International guidelines for protected areas, such as the International Union for the Conservation of Nature and Natural Resources’ (IUCN’s) Protected Areas Management Categories or the United Nations Educational, Scientific and Cultural Organization’s (UNESCO’s) World Heritage Convention, recognize the importance of aesthetic values and of scenic landscapes (Dudley, 2008; UNESCO, 2008). Many national frameworks do so as well (e.g. Landscape Aesthetics, 1995; Swanwick, 2002; Tyldesly, 2007). The European Landscape Convention was the first international legal instrument which dealt specifically with all landscapes, both “outstanding” and “ordinary” ones, and with their development, sustainable management and protection (Buerge, 2002; Council of Europe, 2000). In the European Landscape Convention, landscape is acknowledged as an important part of people’s quality of life, and the convention is said to be, among other things, a response to people’s wishes of enjoying high quality landscapes (Council of Europe, 2000).

The situation in Iceland is, in effect, no different from other Western countries with regard to scenic value being a criterion for landscape protection. Landscape is the first factor listed as a criterion for the protection of areas as national parks and nature reserves in the Icelandic Nature Conservation Act (Lög um náttúruvernd nr. 44, 1999), and a criterion for sites nominated for protection in the Nature Conservation Strategy (Umhverfisstofnun, 2003) and former Nature Conservation Registries (Geirsson, 1996 and former editions). Many locations in Iceland have received protected status or have been nominated for such status because of their scenic landscapes, or are otherwise renowned for visual quality or unusual landscapes. Landscape is also mentioned in the acts on Environmental Impact Assessment (Lög um mat á umhverfisáhrifum nr. 106, 2000), Strategic Environmental Impact Assessment (Lög um umhverfismat áætlana nr. 105, 2006) and the National Heritage Act (Þjóðminjalög nr. 107, 2001), as something that needs to be assessed before development, strategic planning, or as cultural heritage, respectively.

The nomination or protection of these numerous scenic landscapes in Iceland has, however, not been based on well-defined criteria. In the past, phrases such as

“outstanding landscape” and “visual quality” have been used as justifications for the protection of some sites, or nomination for their protection, but the actual meaning of such aesthetic designations is vague. In some cases it would appear that historical, political or even coincidental factors have led to the protection of some scenic landscapes but not others. Neither landscape nor visual quality is defined by law in Iceland. Of all classes of the natural environment, landscape probably has the least extensive and weakest protection (Umhverfisstofnun, 2003). There are no confirmed guidelines or frameworks for assessing landscapes in Iceland or evaluating their scenic qualities.

The aim of the current study was to 1) analyze the main visual physical characteristics of several acknowledged scenic landscapes in Iceland to determine if they had common features; 2) to see if they fit into the major landscape categories defined by the Icelandic Landscape Project (see section 1.2.), or if they stood apart; and 3) to test whether the newly developed methodology was suited to discern differences between landscapes which are recognized as being scenic and others. By comparing the visual, physical characteristics of areas, which for some reason or another are considered scenic, to ones which are more every-day, an understanding of what visual features contribute to landscape being perceived as scenic might be found.

In the following sections of this Introduction, the background of the project is presented, and different definitions and understandings of landscapes discussed. Then, the scenic properties of landscape as a basis for landscape protection are specifically discussed, as are studies which have shown that these particular properties are almost universally preferred. Finally, the main approaches and methods for landscape assessment are briefly compared, leading to the study itself on the visual, physical characteristics of scenic landscapes in Iceland.

## ***1.2. The landscapes of Iceland***

### **1.2.1. Icelandic and European landscapes compared**

Human impact on the natural environment and the earth's landscapes has increased progressively from the time of prehistoric hunter-gatherers through the agricultural revolution to modern industrial societies (Miller, 2004). Humans influence landscapes on a small and large scale, and have often completely transformed the original landscapes with modifications of the natural environment. This is happening more rapidly in current times than ever before (Vos & Meekes, 1999). Human activities can have strong and even irreversible impact on the landscape resource. Because of this, landscape research is now considered an essential part of land use planning and management, such as in environmental impact assessments (Buergi, 2002; Council of Europe, 2000). In Iceland, however, landscapes have not received as much attention as other aspects of the natural environment. Very little research had been done on landscapes until about ten years ago and it had received little academic attention. At the same time, there are indications that landscape is considered to be the primary national symbol of the country (T. Árnason, 2005), thus important to national identity and heritage, and that foreign tourists visit Iceland to a large extent because of its landscapes and natural beauty (Guðmundsson, 2003).

Icelandic landscapes are different from those European visitors experience in their densely populated and highly developed homelands. European landscapes are characterized by their land-use patterns, while geological features are not often visible because vegetation commonly covers much of the bedrock. The landscape in continental Europe is almost completely historic or cultural; it is shaped by man (Wascher, 2005). It is generally acknowledged that very few places in Europe (excluding Russia and some places in the Nordic countries) are untouched by humans (Fowler, 2004; Umhverfisstofnun, 2003). Practically all of the land in Europe is in use, planned, developed and/or managed (Umhverfisstofnun, 2003).

### **1.2.2. Icelandic landscapes**

Iceland is a large (103,000 km<sup>2</sup>) but sparsely populated (about 319,000 inhabitants) oceanic island in the North Atlantic Ocean just south of the Arctic Circle (Statistics Iceland, 2009a). Iceland has been settled for about 1100 years and human impact has been very different from that in continental Europe.

Most of the country appears quite pristine to look at. Many areas are free of human structures and may be perceived as natural - a type of “aesthetic naturalness” (e.g. Brabyn 2005) - even if this is not always true. The island is volcanically active, with an eruption on average every five years. Some volcanic features that are common in Iceland are globally rare, for example table mountains, lava shields, lava rings and crater rows (Guðmundsson, 2006; Umhverfissráðuneytið, 2002). Hyaloclastite ridges (Figure 1) have not been described elsewhere on Earth and may perhaps be unique to Iceland (Guðmundsson, 2006). Nowhere else is it possible to see the Mid-Atlantic rift on dry land. The central highlands are regarded as one of the largest remaining wildernesses in Europe, surpassed only by Svalbard and Russia (Thórhallsdóttir, 2007a), and they may constitute the only large remaining region south of the Arctic Circle in Europe that has never been inhabited by man (Thórhallsdóttir, 2007b).

Iceland is a country of rich and diverse landscapes. It often has strong contrasts in its landscapes, for example inviting and vegetated valleys under harsh, bare mountains; vast black sands close to magnificent glaciers; or glaciers on top of geothermal heat or volcanoes. Vast moss-covered lava fields are seen in many places in Iceland but are globally extremely rare (Thórhallsdóttir, 2009). Geothermal areas, which are also globally rare but common in Iceland, offer exceptional colors, sounds and smells. The diverse geological features and vast uninhabited highlands make Icelandic landscapes unique in comparison with continental Europe. Such large areas with no apparent human impact are scarce in Europe – and what is scarce can be looked at as valuable.



**Figure 1: Hyaloclastite ridges, perhaps unique to Iceland, are seen in the background of this photograph from Möðrudalsfjallgarður in the northeast of Iceland (site number 21 on the map in Figure 5). In the foreground are rolling hills and hillocks, which contribute to a high score for rolling lines and forms. Vegetation is scarce. Photograph: The Icelandic Landscape Project.**

Although Iceland often seems quite pristine, and a visitor may believe Iceland to be quite untouched and its landscapes natural, the land has certainly been impacted by humans to a significant extent. Many places in Iceland are not biophysically natural. Land has been overgrazed and almost all of the original natural forests have been lost. In a country with a harsh northern climate and volcanic activity, this vegetation loss has led to large-scale soil erosion. In the twentieth century, wetlands were drained, farms abandoned, and some plant species have been introduced, e.g. in plantations or as means to stop erosion, and some of these are invasive (Thórhallsdóttir, 2001). All of this is reflected in human-induced changes to the landscape.

In recent years it has become increasingly clear that much more work needs to be done on both the theoretical and applied aspects of landscape conservation in Iceland. Current practice calls for systematic and objective criteria to justify nature conservation (Umhverfisstofnun, 2003). Attempts have been made to do this with regard e.g. to biodiversity, which has been researched more extensively than landscapes. The formulation of stringent criteria for landscapes is, however, more difficult, both because of the lack of research and also because landscapes possess both objective and subjective qualities. In a white paper by the Ministry for the Environment on sustainable development in Iceland (Umhverfisstofnun, 2002, p. 39) it was thus stated that “nature conservation should be assessed in a systematic manner, and not only based on obvious aesthetic opinions, as has often been done before, although natural beauty is, of course, an acceptable reason for

conservation”<sup>1</sup>. Where does this leave landscapes? This is an important question, e.g. as recent disputes regarding large hydro- and geothermal electrical power plants have to a large extent been due to environmental sacrifices to landscape (e.g. Benediktsson, 2007; Sólnes, 2003).

### **1.2.3. The Icelandic Landscape Project**

In an attempt to reach compromise between further industrial development and environmental protection, a Framework Plan for the use of hydroelectric power and geothermal energy was launched (Thórhallsdóttir, 2007a, 2007b; Verkefnisstjórn um gerð rammaáætlunar um nýtingu vatnsafls og jarðvarma, 2003). As a part of this Framework Plan, the Icelandic Landscape Project (ILP) was initiated. The objective was to develop methods for landscape classification and evaluation, as little to no systematic, scientific work had been carried out on Icelandic landscapes before.

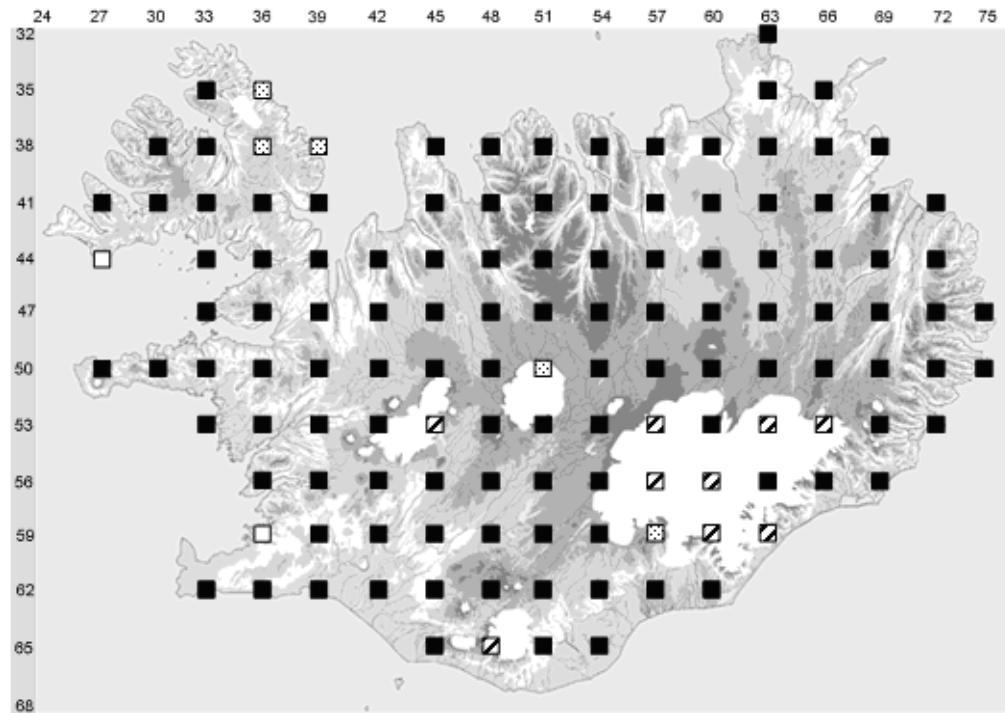
A landscape classification is fundamental to landscape research and land-use planning, so that one knows which types of landscapes are present in a given region or nation and how common or rare these landscapes might be. This makes it possible to compare landscapes objectively, assess and work with them, and even evaluate some of their qualities, such as their degree of diversity or their uniqueness on a regional or national level. A landscape classification, and its underlying data, can also be used as a basis for the evaluation of human induced changes, for example in environmental impact assessment or in strategic impact assessment. But, unlike classification systems in for example chemistry or biology, there is no universal classification and/or assessment system for working with landscapes. Many different systems exist which attempt to meet different needs in different places (e.g. Brabyn, 1996; Wascher, 2005). In Europe, for example, the many different classification schemes are usually based on factors such as parent material, topography, vegetation, soils, land cover, land use and climate (Wascher, 2005). The European classification methods were not found to answer the needs of an Icelandic classification, because of the differences in land use patterns, vegetation cover and visible human impact in the landscapes. For the classification phase of the ILP, a methodology suitable for Icelandic landscapes was developed, based on assessing

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<sup>1</sup> “Æskilegt er að slík verndun fari fram á kerfisbundinn hátt en ekki eingöngu á grundvelli augljósra fagurfræðilegra sjónarmiða, eins og oft hefur verið, þótt fegurð náttúrufyrirbæra sé að sjálfsögðu góð og gild ástæða verndunar.”



some of the visual, physical characteristics of the landscape both visually and by using maps (Figure 2, see also section 2). The methodology was then tested by doing a nationwide systematic survey (NSS) of Icelandic landscapes for natural and semi-natural landscapes (Bárðarson, 2009; Thórhallsdóttir, 2009). The results of this classification could then be used for assessing the diversity and rarity of Icelandic landscapes.



**Figure 2: The Nationwide Systematic Survey (NSS) sampled for the Icelandic Landscape Project (ILP). The grid system comes from the Icelandic Institute of Natural History (Kristinsson & Jóhannsson, 1970), with a known GPS point at each point of intersection in the 10\*10 km<sup>2</sup> grid. An attempt was made to sample every third point within the grid. Black points: sampled sites (112). White: sites excluded from study. Lined: Glacier sites which were not sampled. Dotted: Other sites not sampled. NSS sites were numbered according to this grid system. For example, the northernmost point on this map is read as 6332. See Thórhallsdóttir (2009).**

By using cluster analysis and principal component analysis, ten landscape groups (and three outlier groups, see Figure 26, Table 8) were defined and described. Simultaneously, an extensive database was built up, that could be utilized for other projects, as well as for the evaluation phase of the ILP. But while the nationwide systematic survey gave thorough information on “ordinary” Icelandic landscapes, it became apparent that some of the most renowned scenic landscapes were not included in the sample – among these many of the outstanding landscapes which Iceland is known for internationally. These included popular tourist destinations, such as national parks, many protected nature reserves or national monuments, or

sites that are acknowledged for their beautiful landscapes. Comparing these “outstanding” sites to the more “ordinary” was thus proposed as a next step, to see what their visual characteristics were, how or if they corresponded to the ILP’s landscape categories and whether the methodology was sensitive to any differences.

### **1.3. The landscape concept**

Landscapes can have many important values, such as economic value (e.g. tourism, housing prices, land use), ecological value (e.g. habitats, ecosystem services), aesthetic value (e.g. leading to artistic inspiration, leisure activities, better health, recreation), and cultural value (e.g. folklore, historical, spiritual, archeological value). These values are known to enhance the quality of life and need to be taken into account in decision-making. But landscape is a complex and multi-faceted term which can often prove complicated to work with in a concrete manner. Landscapes are being studied in many disciplines, such as philosophy (e.g. Berleant, 1997), human and cultural geography (e.g. Wylie, 2007) and the natural sciences (e.g. Farina, 2007). There are many different definitions and understandings of landscape, which vary between disciplines and even within, making work and ideas difficult to compare directly. This easily leads to misconception. It follows that the consistency, repeatability and validity of landscape assessments have sometimes been questioned (e.g. Palmer & Hoffman, 2001).

Garcia et al. (2005) concisely reviewed the confusion caused by the single term “landscape” being used simultaneously for three different concepts: the territorial landscape, the perceptual landscape, and the visual landscape. The territorial landscape refers to a homogeneous, restricted piece of land: a district, or region. The Nordic and Germanic usage of the word (i.e. *landskab/Landschaft*) historically referred to a province in which the inhabitants had certain rights and duties (Olwig, 1996). Some signs of this understanding can be discerned in the Icelandic language up until the twentieth century (Kristinsdóttir, 2004). The perceptual landscape has been a popular concept in the social sciences and philosophy, and in these fields the personal, cultural, emotional and experimental factors are studied (Dakin, 2003; García-Quintana et al., 2005). Finally, there is the visual landscape, which is probably the oldest concept, and etymologically the most correct one (as reviewed in

García-Quintana et al., 2005). British and American ideas of landscape were originally mainly scenic and visual, and indeed still are.

An example of an English dictionary definition of landscape is:

- 1) a section or expanse of rural scenery, usually extensive, that can be seen from a single viewpoint
- 2) a picture representing natural inland or coastal scenery
- 3) *Fine Arts*. the category of aesthetic subject matter in which natural scenery is represented (Dictionary.com, 2009)

In this definition, the visual senses are given priority – landscapes are viewed from a given perspective and the similarity to a “framed in” picture is imaginable. The verb “to landscape” is defined as “*to improve the appearance of (an area of land, a highway, etc.), as by planting trees, shrubs, or grass, or altering the contours of the ground*” (Dictionary.com, 2009, emphasis mine). To “improve the appearance” of something means to make it nicer – more appealing or beautiful. Again, the visual emphasis is clear, and aesthetic evaluation is implied.

The visual emphasis on the landscape (“*landslag*”) in the Icelandic language is just as notable as with landscape in English. It has been speculated that the suffix –*lag* refers to the legal issues and territories of the past (“*lög*”), drawing from the Germanic origin of the word, but in modern-day society, this connection is probably seldom made (Benediktsson, 2007) and this is probably not the true origin. It is more likely that the suffix originates from “–*lög*un” or “–*leg(a)*”, i.e. shape, form or the lay of the land. This seems to be how the term has been understood and used for centuries (Edda R. H. Waage and Karl Benediktsson, personal communication, May 14<sup>th</sup> 2009). An Icelandic dictionary defines landscape as “*the total appearance of an area, the form of nature at each particular place*”<sup>2</sup> (Árnason, 2003). This definition is entirely visual and physical, and human presence is not necessarily presupposed. The Icelandic public is probably most used to thinking about landscape as a natural entity, rather than as a human construct (Óladóttir, 2005).

Another example of a definition of landscape which is unattached to human presence comes from the field of landscape ecology: “*landscape as a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout*” (Forman & Godron 1986, from Farina, 2007, p. 5). In landscape

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<sup>2</sup> “*Heildarútlit landsvæðis, form náttúru á hverjum stað.*”

ecology, landscape is a spatial dimension in which ecological processes occur. Another starting point for landscapes is geology. Garcia et al. (2004) went so far as to say that landscape studies should always begin with the identification of geological features, because they affect and limit soils, vegetation and human possibilities. Geodiversity may be an important term for landscape research as well. Gray (2004, p. 8) defined it as “*the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (land form, processes) and soil features. It includes their assemblages, relationships, properties, interpretations and systems*”.

But not all landscape definitions are focused only on the physical or functional factors of an area and some understandings of the term are much more personal. Some see or work with landscape as a “*symbol, icon or myth, mirroring the cultural and social structures of human societies*” (Tress & Tress, 2001, p. 146).

Then there are understandings of landscape which bridge the gap between the physical and experiential definitions of it. Definitions of cultural landscape, for example, acknowledge the connection. Cultural landscape can be defined as:

cultural properties and represent the "combined works of nature and of man" [...]. They are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. (UNESCO, 2008, p. 14)

In Europe, the word “landscape” is commonly understood and used to introduce the human scope into the natural scene (Wascher, 2007). The well-known definition from the European Landscape Convention takes a wide approach and states landscape to be “*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*” (Council of Europe, 2000). This definition of landscape emphasizes the interaction of *people*, through *perception*, with their surroundings, whether natural or man-made or some mixture of the two. The European Landscape Convention’s definition of landscape includes all perception of landscape, not only the visual, and the interactions between the natural and human worlds.

We experience landscapes, not only with our sense of sight but with the active participation of all senses, incorporating the mind, and taking our social and cultural

upbringing, knowledge, and beliefs with us into our interpretation (Berleant, 1997). Research does, however, indicate that we receive the largest part of our information through our eyesight alone (Landscape Aesthetics, 1995) and in an Icelandic survey, the sense of sight was found to be what the participants believed to be the most important for perceiving landscapes (Kristinsdóttir, 2004). The visual aspects of the landscape are thus very important parts of our interpretation.

#### **1.4. Scenic landscapes: definitions and conservation**

As discussed above, the aesthetic properties of the visual landscape are among the most important justifications for landscape protection worldwide. But can these be the basis for the sort of systematic study that the Ministry for the Environment (Umhverfisstofnun, 2002) asks for, when it says that nature conservation should not merely be based on aesthetics, as often appears to have been the case in previous times? Perhaps the experience from other countries could here be put to use. How scenic landscapes are evaluated or chosen for protection (and/or management), by what kind of criteria, is the focus of this section<sup>3</sup>.

##### **1.4.1. Examples of international frameworks**

The objective of UNESCO's World Heritage Convention is the protection of global cultural and natural heritage – of “priceless and irreplaceable assets” considered of “outstanding value” to all humanity, on a global scale (UNESCO, 2008, p. 2). Aesthetic value is one of the ten criteria used for the assessment of things of “outstanding value”, i.e. number seven: that the nominated property has “*superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance*” (UNESCO, 2008, p. 20). It is noted that “superlative natural phenomena” is a quantifiable idea and can be measured objectively, for example the largest lake or deepest cave. On the other hand, “exceptional natural beauty and aesthetic importance” is difficult to measure and is usually assessed by many experts, somewhat subjectively although indicators of scenic value are used. As of 2008, a total of 120 sites had been inscribed on the World Heritage List under criterion seven, most using other criteria as well (Badman et al., 2008).

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<sup>3</sup> Terms such as (natural) beauty, scenic properties and visual quality seem to be used synonymously in the literature.

Landscapes can be inscribed on the World Heritage List as cultural and/or natural heritage. Aesthetic value is one of the terms used both when natural heritage (in Article 2) and cultural heritage (Article 1) are defined (UNESCO, 2008, p. 13). This means that landscapes with outstanding aesthetic value are worthy of inscription and they can be considered as cultural heritage, natural heritage, or a mixture of the two, depending on the circumstances. Natural beauty and aesthetic value are often mentioned in the Operational Guidelines for the Implementation of the World Heritage Convention, but not defined further as such, nor the criterion used to assess them, although terms like completeness, intactness, integrity and distinctiveness are used. For example, it is stated that natural beauty can be in danger or deteriorating, and its integrity can be at risk unless protected areas are large enough to include areas important to maintaining that beauty (UNESCO, 2008, pp. 49, 23). As of now, standards for the ten criteria for “outstanding value” are being developed (Badman et al., 2008).

Biodiversity is a well-known criterion for conservation and protection, and probably the one most commonly used. But it is now becoming more and more widespread that biodiversity and landscape are mentioned side-by-side. This is, for example, done in the introduction to the IUCN’s *Guidelines for Applying Protected Area Management* (Dudley, 2008, p. x). The protection of *landscape diversity* is a one of the main objectives for all of the IUCN’s Protected Areas categories, alongside biodiversity conservation, which is listed first. When appropriate, protected areas should also conserve significant *landscape features* and *scenic areas*, according to the IUCN guidelines. Geodiversity is also included under the term “nature conservation” in the guidelines. In the IUCN Guidelines for Applying Protected Area Management Categories (2008), *scenic value* and *quality* are often mentioned but not defined as such. Regardless of this, they are used as a basis for nature protection.

IUCN’s protected area categories Ib (wilderness areas), II (national parks), III (natural monuments or features) and V (protected landscape/seascape) can all be concerned, to some extent - and to a greater an extent than the remaining categories - with landscapes and their visual and scenic properties. The first three of these, i.e. Ib, II and III, emphasize the natural environment: relatively untouched land and intact ecosystems. Category V differs from the others in emphasizing the cultural

aspects of the landscape as well as the natural, and presupposes interactions between human beings and nature. Lived-in landscapes fit into this category and human care is promoted, given that it leads to the conservation of both nature and culture. The future of cultural landscapes relies on people sustaining them (Brown et al., 2005).

#### **1.4.2. An example from the United States of America**

The idea of modern protected areas originated in the United States of America, with the designation of Yellowstone National Park in the late nineteenth century. The initial notion was of conserving a vast, untouched wilderness, where man was seen as a guest, not a visitor (Brown et al., 2005). Now, protected areas worldwide are of many types: not only national parks, and not only untouched wildernesses.

Aesthetic values have been consciously taken into consideration in North American resource management since the 1960s (Dakin, 2003). In a U.S. Scenery Management Handbook (Landscape Aesthetics, 1995) a systematic approach is presented for determining the value and importance of scenery, so that future generations can enjoy it. In it, the *aesthetic value* of a landscape refers to the *visual appeal* provided by the physical environment. In this approach, the ecology, land use, landform, water characteristics, vegetation and cultural features are described; these make up the landscape character. This landscape character description is then used to determine the scenic attractiveness.

In the handbook, it is stated that generally, people value scenic and natural appearing landscapes most highly. Scenic landscapes are those containing both diversity and harmony. *“People value all landscapes, but they regard those having the most positive combinations of variety, vividness, mystery, intactness, coherence, harmony, uniqueness, pattern and balance as having the greatest potential for high scenic attractiveness.”* (Landscape Aesthetics, 1995, p. 1.14) Photographs are used to illustrate these terms, but otherwise, clear definitions, explanations of “most positive combinations”, or parameters are not provided as a tools to measure them. There are also guidelines for evaluating integrity, that is, how complete a scene is, based on levels of human alteration.

### 1.4.3. Examples from England, Scotland and Wales

Starting in the late 1960s, attempts have been made in Scotland to assess and evaluate scenic quality. In Scotland, 40 “National Scenic Areas” have now been designated. An approach has been developed to assess the special qualities of such areas. This is done by seeking the answer to the question of “*What are the characteristics that individually or when combined together make the area special in terms of its landscape or scenery?*” (Tyldesly, 2007, p. 31).

In the guidelines for identifying the National Scenic Areas, the features which are most frequently regarded as beautiful are said to be diverse landscapes which have some combinations of: prominent landforms, coastline, sea, freshwater, rivers, woodlands, moorlands, and some mixture of cultivated lands. Dramatic topography, sharp contrast, complexity of landscape features, sense of community, and very many other terms are also mentioned. The scenic qualities of landscape are the product of the way in which these features combine and interact. A method for identifying the special qualities of areas is described. It includes a desk study, field work and surveys, and three types of analyses: an objective analysis, a visual analysis and a subjective analysis. In the end, the special scenic qualities of the areas are described. In this framework, subjective judgments are essential and accepted, but an underlying tool is a systematic assessment of landscape character to discern what features are present. Professional judgment and public opinions are sought for as well (Fenton, 2008; Tyldesly, 2007).

In England, Wales and Northern Ireland, the Countryside Agency and the Countryside Council for Wales designate and describe Areas of Outstanding Natural Beauty (AONBs) and advise on policies for their protection. AONBs are defined as “precious landscapes whose distinctive character and natural beauty are so outstanding that it is in the nation’s interest to safeguard them” (Areas of Outstanding Natural Beauty, 2003). AONBs are considered important natural resources and differ from National Parks in their smaller size and their more limited opportunities for extensive outdoor recreation (Areas of Outstanding Natural Beauty, 2003; Natural England, 2009). Specific guidance for identifying the special qualities of such areas is, however, not given. Examples can be drawn from the designated AONBs to see what their special qualities were. They are, for instance, harmony and/or contrast of landscape components, richness and diversity, unspoilt or



characteristic features, sometimes building styles, and the value of diversity of land cover (especially woodlands) and water (Tyldesly, 2007).

#### **1.4.4. Summary**

From the discussion above, one can see that natural beauty and aesthetic values are used in many different national and international frameworks to formally protect or recognize scenic landscapes. Despite a lack of universal methods to assess scenic quality, there is a great deal of practical experience to draw from concerning the evaluation of scenic landscape qualities. There also seems to be a general consensus in these various frameworks about what properties in a landscape make it of higher quality than others. The qualities most commonly referred to are diversity (biodiversity, geodiversity, scenic diversity, variety, complexity), a natural appearance (naturalness, wildness, very often mentioning water and vegetation, especially woodland), some measure of intactness (integrity, coherence, balance, harmony), and distinctive characteristics (uniqueness, exceptionality, vividness, dramatic, mystery, rarity). Some of these terms are physical, and can be measured, but others are more subjective and related to feelings or atmosphere. The terms are usually not defined further in these frameworks, so it seems to be assumed that these particular characteristics which are recognizable by all viewers in the landscape.

In the frameworks from the USA, England and Scotland, it is stressed that assessments of scenic landscapes' special qualities should be done in a consistent and transparent manner – so that, even though people are working with subjective phenomena, their assessments and evaluations can be justified and presented clearly to others (Landscape Aesthetics, 1995; Swanwick, 2002; Tyldesly, 2007).

How did these different frameworks come up with the same or similar ideas for scenic quality, such as diversity, naturalness, harmony, and so on? Maybe it is because ideas and feelings about scenic areas are not purely subjective and not only based on personal, non-comparable emotions, as often claimed. They may rather be based on a general consensus of features which seem to appeal to most, if not all, humans, and which can be debated and justified.

### **1.5. Human perceptions of landscapes**

Research on landscape preferences in different countries has revealed that certain features, both physical and non-physical, in landscapes are perceived as positive attributes in all or nearly all cases. This implies that there is a common basis for human landscape appreciation, and that scenic value is not an arbitrary quality. There are two main schools of thought when it comes to explaining the foundations of aesthetic landscape preferences: an evolutionary and a cultural school (as reviewed by Tveit, Ode, & Fry, 2006).

*Evolutionary theories* explain human aesthetic preferences by looking at our evolutionary history. According to these theories, humans should have adapted to being attracted to scenes which improve their chances for survival. Appleton (1975) is much-cited with regard to evolutionary theories. His Prospect-Refuge theory describes how fitness and survival would be enhanced among individuals who preferred environments which gave them prospect (i.e. a good opportunity to see) and refuge (a good opportunity to hide). Similarly, the information processing theory (Kaplan & Kaplan, 1989) states that the human need for information and the ability to process it is essential for survival. Familiarity is a contributor to preference, while overly complex environments can be discomforting because they are difficult to understand. The advantage of the evolutionary theories is that they are not contingent upon cultures but can be applied universally. Our evolutionary background is a strong argument for the explanation of why people everywhere respond similarly with regards to landscape preferences (Tveit et al., 2006).

*Cultural theories*, on the other hand, look more into the background of each individual who perceives the landscape. Culture, education, occupation, past experiences, leisure activities and so forth shape people's preferences. Preferences are thus not innate, but learned, felt and experienced. These theories do explain the difference in people's opinions and how they can change, but not the similarities in preferences found both between and within cultures. Tveit et al. (2006) conclude their discussion by mentioning that recently some have started looking at the cultural and evolutionary schools of thought not as two polar opposites, but as compliments to one another (see e.g. Han, 2007). Our preferences are a mixture of our human nature, our culture, and our personal experiences. This is a very rational explanation for the origins of human preference, and explains neatly how some things are of

(almost) universal appeal to us but also how our ideas change and can be changed over a lifetime. As society evolves, as well as one's personal self, so do one's ideas, understanding and perception of nature.

Even if aesthetic landscape preferences are likely to vary among people and be contingent upon circumstances, as are all human preferences, there is a general cross-cultural agreement in the perception of beauty and a broad consensus amongst scholars about which landscape features are perceived as more appealing than others (e.g. Ode, Fry, Tveit, Messenger, & Miller, 2009; Yang & Brown, 1992). The following features (and this list is non-exhaustive) are often cited as enhancing visual quality, both in preference studies and in national and international frameworks for landscape assessment/evaluation (see also section 1.4): the physically measurable features of water presence, topographic variation, scenic diversity, vegetation, and the openness of a scene (more open landscapes more preferred), and more subjectively perceived features such as coherence, mystery, vividness and naturalness (Dramstad, Tveit, Fjellstad, & Fry, 2006; Gobster, Nassauer, Daniel, & Fry, 2007; Han, 2007; Herzog, 1985; Hudson, 2000; Kristinsdóttir, 2004; Landscape Aesthetics, 1995; Real, Arce, & Sabucedo, 2000; Tveit et al., 2006; Yang & Brown, 1992). A thorough discussion about all of these features is beyond the scope of this study, but the examples of water, vegetation and perceived naturalness will be discussed below (see Tveit et al. (2006) for an extensive literature review).

The presence of water and/or vegetation is very often mentioned as a physical feature in the landscape which generally leads to more positive evaluations of them (Dramstad et al., 2006; Herzog, 1985; Hudson, 2000; Sundell-Turner & Rodewald, 2008; Tveit et al., 2006). This was, for example, the case in a cross-cultural study exploring the preferences of Western and Korean people to different landscape styles: both always preferred water and vegetation (Yang & Brown, 1992). In another study, the perceived beauty of the landscape was found to be positively related to the amount of water present, but negatively related to the amount of human construction (Real et al., 2000). In a preference study focusing on landscapes containing water in different forms ("waterscapes"), rushing water and mountain lakes were preferred over swamps (Herzog, 1985). The conclusions in Herzog's study were that the physical characteristics of a landscape matter, and in his case, that the clarity and freshness of running water were more preferred than still or

cloudy water. Also, “spaciousness” and “coherence” were significant predictors of preferences for landscapes, where water was present in one form or another (Herzog, 1985).

The *perceived* naturalness of a landscape has also been found to be a factor leading to an evaluation of high visual quality (e.g. Arriaza, Canas-Ortega, Canas-Medueno, & Ruiz-Aviles, 2004; Hagerhall, Purcell, & Taylor, 2004). “Naturalness” can be difficult to define (in many cases) and the term, like landscape itself, can be understood differently by different people. Whether the scenery is truly “natural” is not, however, the question here, but rather how it is perceived. Some landscapes that are, for example, rich with culture, or ecologically disturbed, can still be perceived as being natural by some of their onlookers. Naturally perceived landscapes have been found to have positive effects on the body and soul, and to enhance people’s lives in various ways, thus benefiting both individuals and society (e.g. Landscape Aesthetics, 1995; Ólafsdóttir, 2008; Real et al., 2000). In Ode et al. (2009), three indicators of landscape naturalness were used to probe preferences in a large cross-cultural study, and the results indicated that the more natural-looking landscapes were higher rated universally than the other.

Only one extensive survey thus far has been carried out on the landscape preferences of Icelanders. A group of experts, which all had great experience of Icelandic landscapes, were used as a pilot for the study, and in the main survey, 207 university students from different faculties were asked to evaluate landscape photos and justify their choices. The results were that landscapes which included water were evaluated higher than landscapes without water (Kristinsdóttir, 2004). Also, diverse landscapes were preferred over homogenous landscapes. Homogenous landscapes lacking water were, in consequence, the least preferred. Both students and experts could most often justify and explain their preference choices quite clearly, showing that aesthetic preferences can be stated in logical terms (Kristinsdóttir, 2004). There were some differences between the experts and the students, showing how preferences can be contingent upon knowledge and experience. The main difference was that the experts valued barren landscapes – in this case, desert landscapes from the interior highland plateau - more highly than the university students, who preferred vegetated landscapes.

In another study, the importance of colors in Icelandic landscapes was explored through in-depth interviews with 12 different landscape “connoisseurs”

(see 1.6.1) (Eymundardóttir, 2007). The connoisseurs had different backgrounds (e.g. from art, natural science and tourism) but had in common great experience with and in Icelandic nature. The main results were that colors were considered an important part of the experience and perception of landscapes in Iceland and the color range was felt to be very wide. Similar to the results from Kristindóttir (2004), the connoisseurs were fond of the more barren and “greytone” landscapes of the interior central highlands, but not as attracted to the brighter and more colorful rhyolitic areas.

Foreign preferences for Icelandic landscapes have also been studied, in an indirect manner. Sales of postcards portraying Icelandic landscapes were investigated to find out what kind of landscapes (mainly) tourists find most attractive. The results indicated that the most popular postcards (in terms of sale) portrayed geothermal areas, colorful rhyolitic areas, glacial environments, volcanism, rivers and canyons. Iceland is commonly publicized as a country of “fire and ice”, and the most popular postcards depicted such features. These are also some of the features which are the most different from for example the landscapes that European tourists know from home (Óladóttir, 2005).

## **1.6. Landscape classification and assessment methods**

To plan, manage or protect a landscape, and to figure out which ones are of value, a landscape assessment has to be made. Many methods exist with different approaches and different degrees of subjectivity and objectivity. The different objectives of different methods can be to classify, measure, analyze, evaluate, assess change or do some combination of these. In general, three different approaches can be identified.

### **1.6.1. Perception-based approaches**

Many assessments of landscape value are carried out by surveying the aesthetic landscape preferences of the public. When such studies are used to assess the quality of a landscape systematically, they have been called *public perception-based approaches* (Daniel, 2001). Their emphasis is on learning about public perception, emotions and experience towards landscapes, and deriving an estimate of landscape value from this. They also give vital information about people’s opinions, local and national identity, and simultaneously raise people’s awareness. These methods have not been developed especially for environmental impact assessment or landscape

management, but their results can bring valuable information about value which can be utilized in making indicators (Ó. Árnason, 2005). In the European Landscape Convention (Council of Europe, 2000), public participation is regarded as being essential in the decision-making process, making the convention a democratizing instrument.

A variation of this approach concerns the preferences of experts, rather than the general public. Arler (2000) discussed the idea of landscape “connoisseurs”. He defined a “connoisseur” as “*a person, who knows the qualities in a certain area well, who is capable of identifying them, and, at least to a certain extent, of weighing them against each other on a scale of importance.*”(Arler, 2000, p. 293). Arler discussed how one’s opinion and valuation change as one gains more experience, and gave the examples of a wine taster or music critic. By learning from the experience of landscape connoisseurs, Arler said we can open our eyes to qualities we had not been aware of before. He recommended a dialogue with many different connoisseurs, rather than surveys and calculations of the current preferences of the general public, which may change frequently (Arler, 2000). However, the choice of who is an expert and who is not, as well as which expert to talk to can prove difficult, connoisseurs can have biased opinions just as other people, and this approach is vulnerable to the criticism of being elitist. In practice, recommendations from experts are often sought for, for example in policy-making or nature conservation (e.g. Badman et al., 2008).

### **1.6.2. Expert/design approaches**

Another type of approach towards landscape assessment has been called the *expert/design approach* (Daniel, 2001). In this type of assessment, landscape professionals, i.e. experts (although not the “connoisseurs” Arler speaks about), assess the landscape and apply systematic methods to classify it and establish criteria for its evaluation. There is always some subjectivity, both in the expert’s assessment, involved in the development of the methods, and in the definition of underlying criteria. These methods, however, provide a consistent tool to compare different landscapes. This is the largest and most developed category of landscape assessment techniques, and has become very common in environmental impact assessment and natural resource management (Ó. Árnason, 2005).

An example of this type of method is the Landscape Character Assessment (LCA) method from the United Kingdom. In the United Kingdom, LCA is a well-established process, which involves both identifying, mapping, classifying and describing landscape character, and then making judgments about this to inform decision-makers. It can help to monitor change and to assess an area's sensitivity to change (Swanwick, 2002). The British LCA has been used as a model for the development and localization of other landscape assessment schemes, such as in Denmark (Miljöministeriet, 2007) and partly for the ILP in Iceland (Thórhallsdóttir, 2009).

The LCA defines landscape character as:

“a distinct and recognizable pattern of elements that occur consistently in a particular type of landscape. Particular combinations of geology, landform, soils, vegetation, land use, field patterns and human settlement create character. Character makes each part of the landscape distinct, and gives each its particular sense of place. Whether we value certain landscapes for their distinctiveness, or for other reasons, is a separate question.” (Swanwick, 2002, p. 9)

In the British LCA a very clear division is made between the processes of characterizing, i.e. describing what is *different* in the landscape, not better or worse, and of making judgments – the evaluation. The former process should be an objective process in the main, while the latter involves some subjectivity which can be clarified by using established and justifiable criteria (Swanwick, 2002). Such criteria are for example physical state, natural beauty, rarity, representativeness, scenic quality, and association with historical events or people.

### **1.6.3. Quantitative holistic techniques**

A third category of assessment methods is called *quantitative holistic techniques* (Ó. Árnason, 2005). Quantitative holistic techniques are methods which combine aspects of expert approaches and perception-based approaches. By using the results from preference surveys, one can find the parameters to measure the physical components in the landscape and find an overall value score. The holistic methods are considered the most accurate landscape assessment models (Ó. Árnason, 2005). However, criteria can change both between areas (e.g. as what is rare and valuable in one area may be commonplace or plain in another) and over time. Assessments of this sort

should ideally be reviewed and revised frequently, but as such studies are large, expensive and time consuming, in practice this is usually not possible. The methodology can be quite complicated because it needs to take so many factors into consideration, but offers a wealth of information. It seems to make sense to base landscape assessment both on public preferences and on what physical factors are visible, and to try to link these factors together to the extent possible.

An example of this method can be seen in Tveit et al. (2006) and Ode et al. (2008). They stated that in order to analyze visual landscape character, a transparent, consistent, theory-based framework should be applied based on nine visual concepts that they identified through an extensive review of literature on this issue, and then found or developed indicators for (Table 1). These concepts were limited to the landscape's *visual*, physical features, thus differing in this regard from the UK's Landscape Character Assessment, to which it is otherwise somewhat similar to. This is similar to the approach chosen for the ILP, i.e. using only the landscape's visual, physical features (Thórhallsdóttir, 2009). Many of the indicators mentioned in Table 1 are also related to terms used in some of the international and national frameworks for protecting landscape, such as the natural, harmony, diversity, and unique elements.

The plan is then to test these indicators. At least three of them have already been tested. As mentioned above, the level of succession, number of woodland patches and shape index of woodland edges, which are set up as indicators of naturalness in Table 1, were used to test the preferences of people in a large cross-cultural study, and the results were that more natural-looking areas were most preferred (Å. Ode et al., 2009).



**Table 1: An example of a framework for analyzing visual landscape character. The key visual concepts for analyzing visual character were found through an extensive literature review. Visual quality is the holistic experience of all nine concepts. Compiled from Ode et al. (2008) and Tveit et al (2006).**

Key visual concept	Synonyms, explanations	Example of indicators
Stewardship	Sense of care, upkeep	Level of abandonment, presence of weed, management type, condition of structures such as buildings
Coherence	Unity, holistic, intactness, harmony	Proportion of water cover, correspondence of vegetation with natural conditions, fragmentation indices
Disturbance	Alteration, impact	Presence and density of disturbing elements, area visually affected by disturbance
Historicity	Historical richness and continuity	Vegetation with continuity, traditional land use, field size and shape, cultural elements
Visual scale	Visibility, openness, enclosure	Proportion of open land, size of view shed, depth of view, obstruction of view
Imageability	Sense of place, place identity, uniqueness	Density of landmark, density of unique and iconic elements, presence of water, viewpoints
Complexity	Diversity, richness, spatial pattern	Number of landscape elements, diversity indices, shape indices, size distribution indices
Naturalness	Intactness, wilderness, natural	Proportion of natural vegetation, level of succession, water, fragmentation indices
Ephemera	Seasonal change, weather change	Season-bound activities, presence of animals, farming activities, seasonal vegetation variation, water variation

### ***1.7. Assessment of scenic landscapes in Iceland***

In my study, the visual physical characteristics of scenic landscapes were analyzed, and they were then classified within a larger landscape sample to see how they fit in, e.g. whether scenic landscapes had any features in common or were or were not, as a group, different from a general landscape sample. The study was carried out by utilizing an expert-based method of landscape assessment, i.e. the classification method developed in the Icelandic Landscape Project. Likewise, I studied how the ILP's newly designed, and still being developed, methodology was suited for this task or whether (and how) it could be improved.

The nationwide systematic survey of Icelandic landscapes should be expected to contain a representative cross-selection of all types of Icelandic landscapes, from the coast to the mountains and from the commonplace to the spectacular (Thórhallsdóttir, 2009). My working hypothesis was that the higher aesthetic values of scenic areas – the perception of which formed the basis for their designation as scenic – would be reflected in some way in the composition of their visual, physical characteristics.

As there is no formal definition of scenic landscapes as such in Iceland, an approach for choosing them had to be decided upon. This involved identifying areas in Iceland which had been officially nominated for protected status on the basis of their landscapes. These protected or nominated areas, however, were not considered an exhaustive sample, as nominations for protected status are subject to constraints, e.g. various socio-political or historical circumstances. The personal nominations of scenic landscapes from eight Icelandic connoisseurs were therefore used to help “fill up” possible gaps in the sample (see a more detailed discussion in the next chapter).

It must be stressed that in this study I am *analyzing* the visual, physical characteristics of areas that have been deemed scenic by others, but do not attempt to *define* beauty in any way or to make *judgments* about the scenic value of any landscapes. The approach was strictly visual, in accordance with the available data and methodology, and also with the common dictionary definition of landscape in Iceland: “the total appearance of land, the form of nature at each place”; as well as the English definition previously cited (section 1.3.). However, other important dimensions of landscape, and some of the contributing reasons for these areas being renowned aesthetically, such as historical, coincidental, or relating to accessibility, must not be forgotten, even if they can’t be dealt with in this study.

This study does not attempt an evaluation of scenic value as such. However, it should contribute to a greater understanding of the natural features which are somehow linked to the aesthetic appreciation of landscapes. If there can be found visual, physical characteristics common to areas deemed scenic in Iceland, but which are less evident in other landscapes, then this should – at the very least – provide an indication for the need of a closer examination of the characteristics in question. This and subsequent work can thus help in determining important parameters for visual diversity, rarity and maybe even conservation value, as is done in some national and international frameworks (discussed in 1.4.). It also helps in

improving the methodology and knowledge base on Icelandic landscapes, so that it is possible to see which are rare or exceptionally diverse. This is likely to have implications for further studies and work, such as finding indicators so that environmental impact assessments can objectively assess landscape change in response to nature conservation authorities. Last but not least, this study will benefit the Icelandic Landscape Project, both with regard to the methodology in the classification phase and its subsequent evaluation phase. The evaluation phase, which will study the preferences of the general public in Iceland, will add valuable information to the project, and make its approach a more holistic one.

The project analysis was divided into two components:

In **study 1**, the 48 scenic areas were analyzed, to see what their characteristics were and if they had features in common.

In **study 2**, the 48 scenic areas were compared to and classified with the 112 NSS sites, to see how or if they fit into the major landscape categories defined by the ILP and if their features differed.

## 2. Materials and Methods

### 2.1. Site selection

A list of potential scenic sites was compiled from four different sources. Three related to sites officially designated as landscapes of outstanding value, but the fourth was based on personal preferences of a selected group of landscape “connoisseurs” (Arler, 2000). The four sources were:

1. Sites protected under the Nature Conservation Act (Lög um náttúruvernd nr. 44, 1999 and earlier) where landscape was listed a criterion for conservation. This included sites designated as national parks (*þjóðgarðar*), nature reserves (*friðlönd*), natural monuments (*náttúruvætti*) and country parks (*fólkvangar*) in the Nature Conservation Registry (Geirsson, 1996). Twenty four sites were contributed here: the three National Parks protected under the Nature Conservation Act at the beginning of this study (Skaftafell, Jökulsárgljúfur and Snæfellsjökull)<sup>4</sup>, 13 nature reserves, 3 natural monuments, 2 country parks, and also 3 areas protected under other legislation (Table 2).
2. Sites of special interest (*náttúruminjar*) listed in the Nature Conservation Registry (Geirsson, 1996 and earlier editions) where landscape was noted as being of value. These sites do not have a protected status but their listing was a declaration of intent by conservation authorities and a first step in negotiations for their protection, as well as serving as a guideline for land use planning. This role of the Registry has now been superseded by the Nature Conservation Strategy (Umhverfisstofnun, 2003). Fifty-five sites, which were undoubtedly nominated because of landscape reasons as sites of special interest, were contributed to the list here. Some of the other sites on the list in Table 2 were also sites of special interest, but not for landscape reasons and were thus not included under this criterion.
3. Sites proposed by the Environment Agency of Iceland in the Draft Nature Conservation Strategy 2004-2008 where landscape was listed as a criterion for conservation (Umhverfisstofnun, 2003). The Strategy included 75 areas, 37 of which had landscape listed as an important attribute.

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<sup>4</sup> As of 2008, Skaftafell and Jökulsárgljúfur were combined as part of Vatnajökull National Park (Reglugerð um Vatnajökulsþjóðgarð nr. 608, 2008)

4. The personal preferences of a group of eight landscape “connoisseurs” from the Icelandic Landscape Project (ILP) group. They were selected from different walks of life but had in common extensive knowledge of Icelandic landscapes. The group included: a) a painter who specializes in landscape impressions, b) a performance artist who likewise obtains her inspiration from Icelandic landscapes, c) a human geographer who has researched the cultural aspects of landscape, d) a geologist with extensive field experience in mapping, e) a biologist, environmentalist and landscape photographer, f) an ornithologist with extensive experience of impact assessment studies, g) a soil scientist with extensive experience of soil and land use mapping, and h) a hydrologist and geologist with very extensive field experience and knowledge. Each was asked to nominate 10-15 outstanding landscapes which they felt were unique, diverse or magnificent and which were lacking from the ILP sample. Altogether, 50 sites were mentioned by these connoisseurs, some sites by only one and some by up to four.

The complete list of nominated sites is shown in Table 2. Scenic areas that were mentioned more than once on this provisional list (e.g. mentioned by two connoisseurs, or mentioned in the Nature Conservation Registry and by one connoisseur, and so on) were then selected as possible sample sites (Table 3). All national parks were automatically included as sample sites, as by definition, landscape is a major reason for their conservation (Lög um náttúruvernd nr. 44, 1999). Attempts were then made to visit as many of these outstanding landscape sites, or scenic areas, as possible, for field sampling. Time, manpower, funding, weather conditions and difficult accessibility were restrictions which led to our not being able to visit all sites on the list.

**Table 2: Areas recognized as being scenic landscapes in Iceland, compiled from four sources. The first three included sites which have been officially recognized as having landscape of outstanding value: 1) areas protected under the Nature Conservation Act (Protected status), 2) Sites of Special Interest in the Nature Conservation Registry (S.S.I.), 3) sites contributed by the Environment and Food Agency to the Nature Conservation Strategy 2004-2008 (N.C.S.) The fourth source were the choices of eight connoisseurs (Connoiss.), each given a number from one to eight. No: Number. N/S/E/W: North/South/East/West. WF: Western fjords. CH: Central Highlands. NP: National Park. NR: Nature reserve. NM: Natural monument. CP: Country Park. OL: Protected by other legislation. Adjacent sites were sometimes merged into one line, when possible, to save space, e.g. a protected area plus its nomination on the N.C.S. for enlargement.**

No.	Region	Name of area	Source of justification			
			Protected status	S.S.I.	N.C.S.	Connoiss.
1	SW	Reykjanes, Eldvörp, Hafnaberg, Reykjanesfólkv.	CP		X	5
2	SW	Katlahraun at Selatangi, Grindavík		X		
3	SW	Brennisteinsfjöll, Herdísarvík			X	
4	SW	Ögmundarhraun & Selatangar			X	
5	SW	Viðey		X		
6	W	Brynjudalur, Botnsdalur, Hvalvatn, Glymur		X		
7	W	Hvalfjarðarströnd		X		
8	W	Álftanes, Akurar, Löngufjörur			X	
9	W	Reykjadalsá, Árhver, Rauðsgil			X	
10	W	Húsafell, Húsafellsskógur	NR			7
11	W	Grábrókarhraun and Hreðavatn		X		
12	W	Lava fields, craters and caves in Hnappadalur		X		
13	W	Helgafell		X		
14	W	Breiðarfjörður	OL			6
15	W	Fróðárheiði & outer Snæf.nes (enlargement of NP)			X	
16	W	The coast between Stapi and Hellnar	NR		X	4
17	W	Snæfellsjökull National Park	NP			3, 4, 6, 7
18	W	Út-Mýrar				5
19	W	Hítardalur				6
20	WF	Vatnsfjörður	NR			3
21	WF	Borgarland, Reykhólahreppi, A-Barðastr.sýslu		X		
22	WF	Geirþjófsfjörður, Vesturbyggð, V-Barðastr.sýslu		X		
23	WF	Látrabjarg - Rauðisandur			X	2, 3, 4, 6
24	WF	The peninsula between Arnarfj. and Dýrafj.		X		8
25	WF	Lambadalsfjall, Botn, Hestfjörður		X		
26	WF	Ketildalir in Arnarfjörður		X		3
27	WF	Botn in Ségandafj, Seljalandsdalur & Tungudalur		X		
28	WF	Mjóifjörður		X		
29	WF	Vatnsfjarðarnes		X		
30	WF	Kaldalón, Drangajökull		X		2, 4
31	WF	Snæfjallahreppur hinn forni		X	X	
32	WF	Veidíleysa & Kaldbaksdalur		X		
33	WF	Umhverfi Kaldbaks				6
34	WF	Ingólfsfjörður - Reykjarfjörður			X	
35	WF	Hornstrandir	NR			2, 4
36	WF	Heathlands in Western Fjords, e.g. Hálfán				1
37	WF	Dynjandi				4

No.	Region	Name of area	Source of justification			
			Protected status	S.S.I.	N.C.S.	Connoiss.
38	WF	Gláma, Dynjandisheiði				4, 8
39	WF	Coast btwn. Munaðarnes & Krossness				4
40	WF	Trostansfjörður, Hornatær				5
41	NW	Hindisvík, Þverárhreppi, V-Húnavatnssýslu		X		
42	NW	Björg og Borgarvirki		X		
43	NW	Rífsnes in Skagi		X		
44	NW	Lakes and ponds in Skagi				8
45	NW	Héðinsfjörður			X	
46	NW	Vatnsdalshólar				4
47	NE	Mountains btwn. Eyjafjörður & Skagafjörður		X		
48	NE	NR in Svarfaðardalur, Skíðadalur	NR			6, 8
49	NE	Hraun in Öxnadal	CP			
50	NE	The peninsula btwn. Eyjafj. and Skjálfandi, Látraströnd - Náttfaravíkur		X	X	8
51	NE	Bleiksmýrardalur		X		
52	NE	Ljósavatn		X		
53	NE	Þeistareykir				2, 8
54	NE	Halldórsstaðir in Laxárdalur		X		
55	NE	Mývatn & Laxá, Skútastaðagígar pseudocraters	OL, NM			3, 5
56	NE	Jökulsárgljúfur National Park	NP		X	2, 4, 7
57	NE	Fljótshéiði				1
58	NE	Gjástykki				2
59	NE	Þorgeirsfjörður in Fjörðum				8
60	NE	Blikalón at Slétta				8
61	E	Fagradalsfjöll & Kollumúli		X		
62	E	Stóruð & Hrafnabjörg		X		4
63	E	Njarðvík - Loðmundarfjörður			X	3
64	E	Egilsstaðaskógur			X	
65	E	Fell in Fellahreppur		X		
66	E	Gerpissvæðið		X	X	
67	E	Álftafjörður, Hamarsfjörður, Geithellnadalur			X	6
68	E	Blábjörg at Berufjörður, & Gautavík		X		8
69	E	Hálsar & Hálsarætur at Djúpavogur		X		
70	E	Papey		X	X	
71	E	Lónsfjörður & Hvalnes		X		3
72	E	Lónsöræfi	NR			1, 6
73	E	Þórisdalur í Lóni		X		
74	E	Fjalllendið utan Skarðsdals		X		
75	E	Umhverfi Hoffellsjökuls		X	X	
76	E	Skálafellsjökull and mountain area in Suðursveit		X		
77	E	Heinabergsfjöll, and Vatnsdalur á Mýrum		X		3
78	E	Steinadalur & Staðarfjall		X	X	
79	E	Jökulsárlón, Breiðamerkursandur - Kvíarmýrarkambur			X	2, 3, 4
80	E	Skaftafell National Park, - and Skeiðarársandur (enlargement of NP)	NP		X	2, 6
81	E	Öræfi: Skeiðarársandur to Breiðamerkursandur				5, 7

No.	Region	Name of area	Source of justification			
			Protected status	S.S.I.	N.C.S.	Connoiss.
82	E	Fljótsdalsheiði				1
83	E	Dimmugljúfur				2
84	E	Kollumúli/ Stafafellsfjöll				3
85	E	Morsárdalur/Kjós				6
86	S	Núpsstaður, Núpsstaðarskógar & Grænalón		X		
87	S	Skálarheiði, Rauðhóll, Bunuhólar & Hálsagígir, Skaftárhreppur		X		
88	S	Skaftáreldahraun, Eldhraun			X	8
89	S	Dyrhólaey, Dyrhólaós & Reynisdrangar	NR			4
90	S	Helgafell, Eldfell, Hellisey, Vestmannaeyjar		X	X	4
91	S	Arnarholt & Arnarbæli, Grímsnes		X		
92	S	Þingvellir & Þingvallavatn; Þingvellir - Skjaldbreiður, Tindaskagi (enlargement of NP)	OL (NP)		X	5, 7
93	S	Stokkseyri, Eyrarbakki			X	
94	S	Hengill area, Grændalur - Reykjadalur		X	X	2
95	S	Eldborgir at Lambafell		X	X	
96	S	Austurbakki Hvítárgljúfurs		X		
97	S	Hekla			X	2, 6
98	S	Þórsmörk		X	X	3, 6
99	S	Gullfoss	NR			2
100	S	Ingólfshöfði				2
101	S	Neðanverðar Austur-Landeyjar at Álar				5
102	CH	Guðlaugstungur, Álfgeirstungur	NR		X	
103	CH	Orravatnsrústir			X	
104	CH	Tungnafellsjökull & Nýidalur, Vonarskarð		X		1, 2, 6, 8
105	CH	Askja in Dyngjufjöll	NM			2, 3, 7
106	CH	Herðubreiðarfriðland	NR			
107	CH	Kverkfjöll & Hvannalindir, Krepputunga, Laugarvalladalur	NR		X	6, 7, 8
108	CH	Eyjabakkar & Vesturöræfi		X	X	
109	CH	Grænifjallgarður		X		
110	CH	Eldgjá		X		
111	CH	Veiðivötn		X	X	1, 6
112	CH	Barrens, sands and lava fields west of Veiðivötn and north of Þórisvatn				1
113	CH	Friðland að fjallabaki, Emstrur, Torfajökull	NR		X	2, 6, 7
114	CH	Þjórsárver	NR		X	2, 7
115	CH	Kerlingarfjöll		X		6, 7
116	CH	Þjófadalur - Jökulkrókur		X		
117	CH	Jarlhettur				1, 2
118	CH	Brytalækir				1, 8
119	CH	Bláfjallakvísl				1
120	CH	Trölladyngja				1
121	CH	Langisjór				2, 3, 6, 7
122	CH	Þjórsá: Dynkur & canyon below the waterfalls				4
123	CH	Tindfjöll				6
124	CH	Kaldidalur				7
125	CH	Lakagígar	NM			7, 8



No.	Region	Name of area	Source of justification			
			Protected status	S.S.I.	N.C.S.	Connoiss.
126	CH	Uxatindar/Sveinstindur/Fögrufjöll				6, 8
127	CH	Skaftá/Syðri-Ófæra				8
128	CH	Möðrudalur, view to Herðubreið				5

## 2.2. Sampling procedure

Field sampling was carried out in July and August of 2007 and 2008 by two-man groups. Sampling was standardized with regard to time of year (vegetation in summer colors), weather conditions (clear weather, and visibility at least such that all peaks within 20 km were cloud free), and time of day (from mid morning to late afternoon, so that shadows were not too long and colors not hazy). The weather conditions were sometimes not as good as we anticipated but sites were only assessed when weather was “good enough” and mountains could be seen (almost) cloud free.

Scenic areas were visited and sampling carried out at a preselected point(s) within each area, and/or the point(s) and the areas’ boundaries were decided upon in the field to represent the landscape of the scenic area. Preselected points of sampling were selected or recommended to us either by the connoisseurs, supervisors of the project, or wardens at the scenic area. Sometimes, samples were taken at several points within each area, either because within the area there are many different landscapes (for example, within the large national parks), or because the first sampling site turned out not to have been the best vantage point to represent the landscape in question.

The sites were evaluated using the approaches developed in the ILP (Bárðarson, 2009; Thórhallsdóttir, 2009). GPS coordinates and heights above mean sea level were noted using a hand-held GPS device (Magellan eXplorist 500 LE). Digital photographs (taken with Nikon D70s and Nikon D80 cameras) and videos (JVC Everio GZ-MG255) were recorded at each site for reference. Two full 360° circles of photographs were taken: one with the center of the viewfinder level to the horizon and another where the viewfinder was positioned so that one third of the top of the photograph was sky, to show the foreground in more detail. The video at each site was recorded in a slow 360° circle at the point of evaluation.

A field checklist (Figure 3) was completed at each scenic point, on which 22 visual physical features (called attributes) in the landscape were given a quantitative score of 1 to 5 or 0 to 5 depending on the amplitude of the attribute in question. The score did not imply value or quality – 5 was not better than 1, only more. The physical attributes visible from the point of evaluation and up to no more than 20 km away (when such a distance was visible) were assessed as part of the landscape being assessed. Mountains within 20 km thus gave the elevation range of the landscape; the elevation range was then read off maps of the areas. The scale of “very prominent” or “average”, and so on (Figure 3), was based on the ILP’s experience and knowledge of Icelandic landscapes.

The attributes given scores were:

1. Basic landscape shape: Very concave, e.g. a deep valley or fjord (score 1) – concave, e.g. a shallow valley (2) – flat, e.g. a plain (3) – convex and very convex, e.g. from the top of a hill (4 and 5, although a score of 5 was never given).
2. Visual depth: As eights (45°) of the horizon, using maps to measure the distance of 0-3 km (score of 1: very narrow or enclosed landscape), 3-10 km (score of 2: narrow), 11-20 km (score of 3: medium), 21-40 km (score of 4: wide), and more than 40 km (score of 5: very wide or open landscape). Here, we were not restricted by a 20 km radius but rather assessed as far as the eye could see at each site. The total score was then calculated as the sum of scores from the eights of the horizon.
3. Elevation range within the landscape in question (within the maximum of 20 km radius): An elevation range of 0-100 m receiving a score of 1, 100-300 m receiving a score of 2, and so on (see scale in Figure 3).
4. Straight lines/forms in the landscape: Most obvious as horizontal layers of lava in mountains, but also e.g. in hills, cliffs or columnar basalt; all lines and forms (attributes number 4, 5, 6 and 7) receiving scores on a scale of from 0 (not present) to 5 (very prominent).
5. Rolling lines/forms: For example, rolling hills, craters, drumlins, moraines.
6. Angular lines/forms: Sharp angles such as mountain peaks and cliffs.
7. Sinuous lines/forms: Most often due to winding rivers, but sometimes also prominent in geological formations.

8. The diversity of lines/forms: This score related to how many different kinds of lines and forms (attributes number 4 to 7) were seen in the landscape, in addition to “irregular” forms which did not enter any of the other forms’ scores, such as irregular but very prominent cliffs and avalanches. These were given scores from 1 (of little diversity) to 5 (very diverse), where a score of 3 meant “of average diversity”.
9. Repeated forms: Defined as features which are repeated on a large scale, these were often geological features such as lines of craters or hyaloclastite mountain ridges (see Figure 1), but also repeated lakes, cliffs, avalanches and so on.
10. Vegetation cover: This was assessed only visually and estimated as less than 1% (score of 0), 1-5% (score of 1), 6-25% (score of 2), and so on (see scale in Figure 3).
11. Vegetation diversity: Landscapes received scores based on the number of vegetation communities present. Each discernable vegetation community at each site was counted: sparsely vegetated sands and gravel, grasslands, cultivated pastures, heaths, palsas, wetlands, shrubs, forests. If only one type of plant community was visible, the site got a score of 1, and 2 for two types, etc, up to a maximum of 5 if five or more vegetation communities were present.
12. Color range: Based on the diversity of colors in the landscape, from a score of 1 for very homogenous colors, such as uniform grey sands, to 5 for very colorful areas with e.g. colorful vegetation and/or geothermal colors,
13. Pattern size: The size of the patches in the mosaic of forms and colors in the landscape, ranging from 1 (very small, fine-grained) to 5 (very large, coarse-grained patches, such as one large, uniform grassland in all of the foreground).
14. Pattern diversity: The diversity of the patches/mosaic of patterns at the site.
15. Surface texture diversity: The diversity of the surface texture: if it was of only one type of texture (e.g. only smooth), the site received a score of 1 for very homogenous; had it a variety of textures, such as smooth sands, patchy vegetation, rough lava fields, and jagged cliffs, it scored 5 for very diverse.

16. Surface texture roughness: The texture of the surface – from 1 (smooth) to 5 (rough). The score of 3 could both mean that the surface was of “average” texture (i.e. neither smooth nor rough; “in the middle”), or that there were both rough and smooth textures (and so the average score was 3; such a site would get a high score for surface texture diversity).
17. Water cover: From 0 (no surface freshwater present), to 5 (very prominent water, either as lakes or rivers).
18. Water current of the most prominent water expression: A score of 1 represented still water, 2-3 represented calm to medium strong running water in rivers, 4 represented rapids and 5 represented waterfalls.
19. Water expression: The types of water seen, scores representing counts of the following: lake, river, stream, rapids, waterfall, steam, boiling water (hot springs).
20. Sea: An estimate of how much of the 360° horizon had sea cover. Only one site was an island, scoring 5 for sea (sea cover in all directions, 360°). Coasts got scores of 4 or 3 (180°), while fjords usually scored 2 or 3. If sea was visible in a small amount in the horizon, it was given a score of 1.
21. Snow: An estimate of how much snow was visible in the landscape. A score of 1 meant that a small amount of snow was present, and a score of 5 meant that the landscape was covered. Usually, only scores of 1 and 2 were given.
22. Glacier cover: Glaciers visible within the 20 km radius. A score of 5 was given when samples were taken from atop a glacier or by its roots, while a score of 1 was given if a glacier was visible in a small amount within the 20 km radius. A score of 0 meant that no glacier was visible.

The 23<sup>rd</sup> attribute, overall diversity, was calculated as the mean of seven of the attributes (elevation range, diversity of lines and forms, vegetation diversity, color range, pattern diversity, texture diversity, and water expression). Colors were also recorded on a separate checklist (not shown in Figure 3) and given a score of 0 or 1 (absent or present).

Area name:			GPS coordinates:				
Date:			Height a.s.l.:				
Attribute:			Score:				
		Not Present 0	Very low 1	2	Average 3	4	Very prominent 5
basic landscape shape			concave		straight		convex
visible landscape depth (score for parts of horizon)			≤ 3 km	3-10 km	11-20 km	21-40 km	>40 km
elevation range			0-100 m	101 -300 m	301- 600 m	601- 1000 m	1000 + m
Land- scape lines and forms	straight						
	rolling						
	angular						
	sinuous						
	diversity						
repeated forms							
vegetation	cover	≤ 1%	1-5%	6-25%	26-50%	50-75%	75-100%
	diversity						
color range							
patterns	pattern size						
	diversity						
surface texture	diversity						
	roughness						
water	cover						
	current						
	expression						
sea	cover						
snow							
glacier, ice							
overall diversity							

**Figure 3: Field checklist for the landscape evaluation of 23 visual physical landscape features (attributes) developed in the Icelandic Landscape Project. All attributes were given scores of 0-5 or 0-1 at each site visited, except overall diversity, which was calculated afterwards. For more details, see text and Thórhallsdóttir (2009).**

For a more detailed description of the checklist, its attributes, the NSS sites and their classification, and the development of the methodology, see Bárðarson (2009) and Thórhallsdóttir (2009).

### **2.3. Analysis**

At the end of the field season, scores from all sites were reviewed against the photographs by all of the researchers who had been in the field, and a supervisor, to improve consistency and discuss any uncertainties. Scores from the field checklist from all sites were entered into a matrix and, using multivariate methods, the scenic areas successfully sampled were classified and ordinated within the Icelandic Landscape Project's sample of nationwide systematically surveyed (NSS) sites and among themselves.

Two attributes from the field checklist were taken out of the analysis: repeated forms and snow. Repeated forms were excluded because their scores were inconsistent and this was felt to be due to an ambiguous definition of what counted as a repeated form or not in the beginning of the field sampling. Scores from the beginning and the end of the field sampling differed. Snow was excluded because it is not actually a landscape attribute, but rather depends on weather conditions and changes frequently, even during summertime. The separate color checklist was not used in this study, but the color range was assessed (Figure 3) and so colors were taken into consideration. The matrix used in the analysis thus included 21 of the 23 attributes in Figure 3.

Statistical tests were performed with the statistical computing software R (R Development Core Team, 2007). The cluster analysis method used was the average agglomerative method in conjunction with the uncentered distance measure, along with 10,000 bootstraps. Principal component analyses and Chi-squared tests were also carried out. For a more thorough explanation of the development of the multivariate methods (cluster analysis and principal component analysis) for the use in the ILP, see Bárðarson (2009).

### **3. Study 1: An analysis of 48 scenic areas in Iceland**

#### **3.1. Aims and research questions**

As previously discussed, many Icelandic landscapes have been designated to be of scenic quality without much further clarification of what that means. No consistent, transparent method or criteria have been used to assess them. In this section, the visual characteristics of a scenic area sample were analyzed by using the newly developed methodology of the Icelandic Landscape Project (ILP). Thus, we looked at the qualities of the scenic areas *after* their formal designation (in most cases; some areas were chosen by connoisseurs) – and only the visual, physical properties were assessed, not the more subjective aspects. What were the characteristics of the areas, and did they have attributes in common? Did they possess any of the qualities that are often used to assess scenic value abroad?

#### **3.2. Site selection**

##### **3.2.1. Designation of scenic sites**

From Table 2, it was apparent that 54 areas were possible sample sites, being mentioned more than once (Table 3), and 32 of these areas were visited, as well as 2 which were only mentioned once but were sampled nonetheless, because of confusion with their nominations<sup>5</sup>. Within some areas, up to four samples were taken, resulting in a total of 48 samples of scenic areas for this study. (See section 2 for sampling methods and analysis.)

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<sup>5</sup> The two were Herðubreiðarfriðland, a nature reserve, and Möðrudalsfjallgarður, nominated by a connoisseur. In both nominations, the mountain Herðubreið was mentioned and thus these sites were counted together by mistake. This confusion in counts was not apparent until after the study, and a supervisor to the project, who is a landscape expert, recommended not excluding them from the final analysis.

**Table 3: The 54 possible sample sites in the study, with simplified criteria. The first three columns indicate the criteria: Protected status, S.S.I. (Sites of special interest), and/or N.C.S. (nature conservation strategy), or Conn. (choice of connoisseur). The criteria is simplified in comparison to Table 1, i.e. the S.S.I. and sites in the N.C.S. are combined in one column when areas were protected. The first three rows indicate protected sites, which may or may not have also been a S.S.I. or in the N.C.S. (thus marked by “±”), and were recognized by 0, 1-2 or 3 or more connoisseurs. The next three rows indicate sites which were either S.S.I. and in the N.C.S., and recognized by 0, 1-2 or 3 or more connoisseurs, then three rows with areas that were either S.S.I. or in the N.C.S., and the final three rows represent sites mentioned by connoisseurs but not recognized by nature conservation authorities. The sites we successfully sampled are shown in the second column from the right, and the sites we left out in the far right column. See list of sites and their full criteria, with the S.S.I. and N.C.I. separated, in Table 1.**

Protected	S.S.I. and/or N.C.S.	Conn.	No. of areas with criteria	Sites successfully sampled	Sites not used in final analysis
x	-	0	3	Only mentioned once and should thus not be sampled. Only Herðubreiðarlindir was sampled from this group.	
x	±	1 or 2	15	Seltún (2 samples), Stapi-Hellnar, Vatnsfjörður, Svarfaðardalur, Mývatn, Skaftafell, Dyrhólaey, Þingvellir, Þjórsárver, Lakagígar	Húsafell, Breiðarfjörður, Hornstrandir, Lónsöræfi, Gullfoss
x	±	3 or 4	5	Snæfellsjökull NP (3 samples), Jökulsárgjúfur NP (4 samples), Askja, Kverkfjöll and Krepputunga, Torfajökull area (3 samples)	
	S.S.I. and N.C.S.	0	7		Eyjabakkar and Vesturöræfi, Eldborgir við Lambafell, Steinadalur og Staðarfjall, Umhverfi Hoffellsjökuls, Snæfjallahreppur hinn forni, Gerpissvæðið, Papey
	S.S.I. and N.C.S.	1 or 2	5	Veiðivötn (3 samples), Þórsmörk, Grændalur	Vestmannaeyjar, Látrastönd/Náttfaravíkur
	S.S.I. and N.C.S.	3 or 4	0		
	S.S.I. or N.C.S.	0	44	Only mentioned once and should thus not be sampled	
	S.S.I. or N.C.S.	1 or 2	12	The peninsula between Arnarfjörður and Dýrafjörður (2 samples), Kaldalón, Stóruð, Geithellnadalur, Hvalnes, Kerlingarfjöll (3 samples),	Ketildalur, Loðmundarfjörður, Blábjörg, Heinabergsfjöll, Eldhraun, Hekla
	S.S.I. or N.C.S.	3 or 4	3	Rauðisandur, Jökulsárlón, Vonarskarð	
		1	27	Only mentioned once and should thus not be sampled. Only Möðrudalsfjallgarður was sampled from this group	
		2	6	Þeistareykir, Jarlhettur, Brytalækir, Skeiðarársandur	Gláma, Sveinstindar/Fögrufjöll
		3	1	Langisjór	



The areas in the column on the right in Table 3 (yellow color in Figure 4) should have been sampled but were not included at this time, for various reasons. Remoteness and prohibitive cost prevented us from visiting Hornstrandir, Gláma, Náttfaravíkur and Lónsöræfi. All of these could potentially have been important additions. It would have been easier to access other areas in the right hand column but time did not permit it. Gullfoss waterfall was considered a single landscape element and these were not included in this study. Attempts were made to sample Ketildalir, Blábjörg, Heinabergsfjöll and Vestmannaeyjar but these were left out in the final analysis because either weather conditions or other factors were unsatisfactory, and we felt that these samples did not represent the landscape of the designated areas.

Emphasis was put on sampling the national parks and the sites most often nominated. Of the areas successfully sampled, eight were within national parks (Snæfellsjökull, Djúpalónssandur and Svörtuloft within Snæfellsjökull national park; Ásbyrgi, Hljóðaklettur, Hólmatungur and Hafragilsfoss within Jökulsárgljúfur national park; and Sjórnarsker within Skaftafell national park), two were within a country park (2 sites at Seltún, within the Reykjanes country park), two were national monuments (Askja and Lakagígar), and two were protected by other legislation (Mývatn and Þingvellir). Eleven nature reserves were sampled: the coast between Stapi and Hellnar, Vatnsfjörður, Skíða- and Svarfaðadalur, Dyrhólaey, Landmannalaugar, Kaldaklof, Ljósártungur, Krepputunga, Kverkfjöll, Herðubreiðarlindir, and Þjórsárver. Other sampled areas did not have a protected status. The areas in Table 2 which were mentioned most often (5 times) were: the Torfajökull area including the nature reserve Friðland að Fjallabaki; Kverkfjöll & Hvannalindir, Krepputunga; Tungnafellsjökull & Nýidalur, Vonarskarð; Látrabjarg – Rauðisandur; Jökulsárgljúfur National Park and Snæfellsjökull National Park. All of these areas were sampled, and all but Vonarskarð and Látrabjarg-Rauðisandur were sampled at several places.

### 3.2.2. A short introduction to the 48 scenic areas

Following is a very brief and non-exhaustive description of the scenic areas in this study, so that the reader has some idea of what the areas chosen for this study are like.

Þingvellir National Park, the first national park in Iceland, was established in 1930 and became a UNESCO World Heritage Site in 2004 ([thingvellir.is](http://thingvellir.is), n.d.) for its cultural value. It also has rich natural value. As a cultural, historical landscape it was the assembly place for the *Alþingi* (Parliament), which was established in around 930, and many major events in Icelandic history have taken place there. Geologically, Þingvellir is a rift valley and a unique site where one can visualize continental drift. Þingvellir's appearance (*ásýnd*) is protected alongside its natural and geological properties (Lög um þjóðgarðinn á Þingvöllum nr. 47, 2004). In the Nature Conservation Strategy, an enlargement of the national park is proposed, and landscape is listed as one of the main criteria for the proposal (Umhverfisstofnun, 2003).

Ásbyrgi, Hljóðaklettur, Hólmatungur, and Hafragilsfoss waterfall, in Jökulsárgljúfur canyon, were joined in the Jökulsárgljúfur National Park from 1973 (Reglugerð um þjóðgarðinn í Jökulsárgljúfum nr. 359, 1993) at the beginning of this study but has now been incorporated into the Vatnajökull National Park (Reglugerð um Vatnajökulþjóðgarð nr. 608, 2008). Each of these areas within the national park has its own characteristics. Ásbyrgi is a shallow hoof-shaped canyon, Hljóðaklettur has bizarre rock and cliff formations, left behind when a catastrophic flood stripped an ancient crater rim of its less-resistant material. Hólmatungur has rapids and various forms in the canyon's wall, and Hafragilsfoss is one in a sequence of several large waterfalls in the glacial river Jökulsá á Fjöllum. Rivers and canyons were some of the most prominent features in the most popular landscape postcards sold in Iceland in 2004 (Óladóttir, 2005).

Three samples were taken within Snæfellsjökull National Park, which was established in 2001 (Reglugerð um þjóðgarðinn Snæfellsjökull nr. 568, 2001). The glacier itself lies over a stratovolcano. The Snæfellsjökull sample site was taken from the south side of the glacier, and the Djúpalónssandur and Svörtuloft samples were also within the Snæfellsjökull national park, on the coast. The coast between

Hellnar and Stapi is a nature reserve close to the national park, known for its geological formations and a scenic hiking path.

The Mývatn lake and Laxá river area's biodiversity, geology and landscape are protected by special legislation (Lög um verndun Mývatns og Laxár í Suður-Pingeyarsýslu nr. 97, 2004). The area has exceptionally diverse bird life and is one of few known habitats in the world for marimo (*Aegagropila linnaei*), a globular growth form of green algae. The Mývatn area is also acknowledged as an internationally important wetland site and bird habitat under the Ramsar Convention on Wetlands (Umhverfisstofnun, 2003). The area is well vegetated and has prominent rolling lines due to pseudocraters and irregular forms due to lava pillars.

Þjórsárver became a nature reserve in 1981 and a Ramsar site in 1990. It is the largest isolated vegetated area in the highlands of Iceland, and the largest breeding ground of the pink-footed geese in the world. Its remoteness and difficult access leads to it being visited by few, making it a wilderness experience (Ólafsson, 2000; Umhverfisstofnun, 2002h).

Þórsmörk has been a site of special interest since 1975 (Náttúruverndarráð, 1975), and proposed as a nature reserve in the Nature Conservation Strategy 2004-2008. Its landscape is said to be unique, diverse and magnificent (*"einstakt, fjölbreytt og stórfenglegt landslag"*) in the Strategy (Umhverfisstofnun, 2003, Appendix 7). It is in the vicinity of glaciers, with some natural birch forests, and is a very popular destination for hiking and camping.

Herðubreiðarlindir is in the Herðubreiðarfriðland nature reserve in the highlands in northern Iceland and was protected 1974 (Umhverfisstofnun, 2002e). It is an oasis in the surrounding desert, with diverse vegetation in comparison to its rather high altitude. Iceland's popularly called "Mountain Queen", the national mountain Herðubreið, is a table mountain which the place gets its name from. Brytalækir, a vegetated freshwater spring area, lies at a similar elevation but is in the south of the country. Stóruð at Dyrfjöll, also in a similar elevation range, is a site of special interest in the east of Iceland (Náttúruverndarráð, 1975). Stóruð is a massive rock slide under the scenic Dyrfjöll mountains.

Landmannalaugar, Kaldaklof and Ljósártungur are parts of the Torfajökull glacier area. Landmannalaugar are part of the Friðland að fjallabaki nature reserve which was protected in 1979. The Torfajökull area is the largest rhyolite area in the country, characterized by very colorful volcanic bedrock and lava, geothermal heat

and diverse forms in its landscape. In the summertime this area, especially Landmannalaugar, has heavy tourist traffic (Umhverfisstofnun, 2002d; Ólafsson, 1990, 2000). Hveradalir, Grænafjörn and Reykjadalur are at Kerlingarfjöll, which is a geothermal area with colorful rhyolite and a multitude of forms. Kerlingarfjöll is a site of special interest with “magnificent landscape” (Náttúruverndarráð, 1978). Rhyolite and geothermal areas were among the most popular landscape postcards sold in Iceland in 2004 (Óladóttir, 2005).

Two samples were taken at Seltún, a geothermal area at Krýsuvík within the Reykjanes country park, which was established in 1975 (Umhverfisstofnun, 2002a). Þeistareykir is a geothermal site as well, somewhat vegetated and surrounded by lava fields, in northern Iceland. An environmental impact assessment is underway for its utilization for energy production (Þeistareykir, 2009). Grændalur valley and Hengill are geothermal sites and sites of special interests (Náttúruverndarráð, 1978).

Kverkfjöll, a mountain range which is also an active central volcano in the north of Vatnajökull glacier, is a nature reserve (Umhverfisstofnun, 2002f) and our sample was taken at Hveradalur valley. Kverkfjöll is one of the greatest geothermal areas in Iceland, and the one which lies at the highest altitude (Ólafsson, 1990). Nearby Krepputunga has diverse hyoclastite or tuff formations and is a site of special interest (Náttúruverndarráð, 1978; Ólafsson, 2000). Askja, a natural monument, and Dyngjufjöll mountains, in which she lies, are a central volcano. Askja was protected in 1978 (Umhverfisstofnun, 2002c).

The last geothermal area in the sample is Vonarskarð, which is a cleft between the glaciers Tungnafellsjökull and Vatnajökull. It was a site of special interest accompanied by Tungnafellsjökull glacier and Nýidalur valley due to, among other things, diverse landscape (Þorvarðardóttir, 1991).

Tröllifjall, Skálavatn and Fossavatn are all at Veiðivötn, or “the Fishing Lakes”. These are an assembly of over 50 crater lakes and springs on a long crater row (Ólafsson, 1990). Veiðivötn have been a site of special interest since the publication of the first nature conservation registry (Náttúruverndarráð, 1975) and are nominated as a nature reserve in the Nature Conservation Strategy 2004-2008 (Umhverfisstofnun, 2003, Appendix 7).

Lakagígar is a row of craters on a long fracture, most known for their catastrophic 1783 eruption which led to massive loss of livestock, hunger, and a decrease of 20% to the Icelandic population in only 2 years (Ólafsson, 1990). Vast

lava fields flowed from this eruption. Lakagígar are now within the Vatnajökull national park but were previously a part of Skaftafell national park (Reglugerð um Vatnajökulspjóðgarð nr. 608, 2008; Reglugerð um þjóðgarð í Skaftafelli nr. 319, 1984). Langisjór is a long, narrow lake lying between long repeated rows of hyoclastite mountains. In the beginning of this study, Langisjór was nominated by 4 connoisseurs but was not protected or nominated for protection in any way. In the newest Nature Conservation Strategy 2009-2013, however, Langisjór is nominated as an addition to the Vatnajökull National Park, due to its geologic features, especially the hyoclastite mountain ranges, its unique landscape and natural beauty (Tillaga til þingsályktunar um náttúruverndaráætlun 2009-2013, 2008). Other sampled areas which contain repeated hyoclastite mountain ridges were Möðrudalsfjallgarður and Jarlhettur.

Keldudalur, Lokinhamradalur, Rauðisandur, Kaldalón and the nature reserve at Vatnsfjörður are all valleys or fjords in the Western Fjords. The peninsula between Arnarfjörður and Dýrafjörður is a site of special interest and in this peninsula are Keldudalur and Lokinhamradalur, the latter of which is one of the most remote valleys in the country, and is surrounded by escarpments on three sides and seaward cliffs and a view to the ocean on the fourth side (Ólafsson, 1990). The area from Rauðisandur to Látrabjarg is proposed as a national park or nature reserve (*“Þjóðgarður (friðland)”*) in the Nature Conservation Strategy, having extensive bird cliffs, a diverse cultural landscape, and historical artifacts (Umhverfisstofnun, 2003, Appendix 3). Kaldalón is a fjord and proglacial valley with glacial remains. Vatnsfjörður, a forested fjord in the south of the Western Fjords, has been a nature reserve since 1975 (Umhverfisstofnun, 2002g). Skíða- and Svarfaðardalur valleys are surrounded by the majestic mountains of Tröllaskagi, or “Troll’s peninsula”. Geithellnadalur, a valley up from Álftafjörður, and Hvalnes in Lónsfjörður are in the East.

Jökulsárlón, Skaftafell and Gígjukvísl at Skeiðarársandur are all in the southeast. Jökulsá river is the shortest glacier river in Iceland, running out of Jökulsárlón proglacial lagoon, in which icebergs from the glacier Breiðamerkurjökull float, and directly into the Atlantic Ocean. The proglacial lagoon was one of the most popular Iceland landscape postcards sold in 2004 (Óladóttir, 2005). Skeiðarársandur is the largest active glacier outwash plain in Iceland (and probably the world) with a view to Iceland’s highest peak, Hvannadalshnjúkur.

Skaftafell, a national park since 1967 but now a part of the Vatnajökull national park, has many contrasts such as sands, lush vegetation, mountains, a glacier, and geological formations such as columnar basalt (Ólafsson, 1990; Reglugerð um Vatnajökulsþjóðgarð nr. 608, 2008; Reglugerð um þjóðgarð í Skaftafelli nr. 319, 1984). Only one sample was taken in the national park but more areas within could be added from the diverse landscapes of the park.

Finally, Dyrhólaey, the southernmost point of Iceland, is a promontory which rises about 120 m out of the sea on the coastline, and is a nature reserve with diverse bird life (Umhverfisstofnun, 2002b).

Of the 48 scenic areas, only five are inhabited by humans: the coast between Hellnar and Stapi, Dyrhólaey, Rauðisandur, Skíða- and Svarfaðardalur and Mývatn. Keldudalur, Lokinhamradalur and Geithellnadalur all had established farms but no longer support permanent inhabitation although some have summer residents. All other areas are in uninhabited areas of the country, but the accessibility is most often fairly good in summertime and some areas have summer cottages in their vicinity. Most of the areas are tourist attractions to a greater or lesser extent, and are popular for e.g. hiking (e.g. Landmannalaugar, Þórsmörk, Dyrfjöll), fishing (Þingvellir, Veiðivötn) and camping (e.g. Skaftafell, Ásbyrgi). Some of the sites' comparatively rich vegetation (on an Icelandic scale; e.g. Vatnsfjörður, Þjórsárver) or proximity to glaciers (e.g. Snæfellsjökull national park to Snæfellsjökull glacier, Kaldalón to Drangajökull glacier) make them attractive destinations.

Many of the areas are historical sites (Þingvellir is, for example, a World Heritage Cultural Site, due to its being the assembly grounds of the old Alþingi (Parliament) from 980 A.D., among other historical events) or are connected to folklore, old tales and songs. Geithellnadalur, for instance, was an assembly place of elves (Ólafsson, 1990) and Þjórsárver were feared because they were home to outlaws (Ólafsson, 2000). The uninviting black sands, difficult terrain, active volcanism and geothermal heat led to some of these sites being dreaded in the past, e.g. Lakagígar. The crater Víti ("Hell") in Askja does not have an inviting name. The place name Vonarskarð ("Hope's cleft"), whether or not this place name originates from this site or another, indicates a sense of relief for reaching this place, after travelling in dark and dangerous terrain (Ólafsson, 2000). Vonarskarð lies between Sprengisandur and Ódáðahraun, homes of outlaws and elves, even of royal kin, in

the past. These and other tales give the areas an atmosphere of for instance eeriness, mystery or pride. These historical and cultural connections are not used in this study.

The patchy geographic distribution of the scenic areas in Figures 4 and 5 should not be used to imply that there are no scenic areas in the west, northwest or northeast. Some areas mentioned by only one connoisseur were, for instance, in these areas of the country, such as Vatnsdalshólar, Björg and Borgarvirki, lakes and ponds in Skagi, and Blikalón at Melrakkaslétta. However, Óladóttir (2005) found that few to no Icelandic landscape postcards represented the northwest, western fjords, and northeast parts of the country. These areas may not be as diverse as other parts of the country, or their scenic areas less prominent or have received less attention in comparison to other areas in the country.

### 3.3. Results

#### 3.3.1. Geographical distribution of scenic areas

The geographical distribution of the nominated scenic areas was highly patchy (Figure 4), as was the distribution of the 48 sample sites (Figure 5). Most were situated in the volcanic zone or around the coast of Iceland. A number of regions were poorly represented or missing scenic areas altogether, notably the West, Northwest, Northeast and Mid-East (Figures 4 and 5).

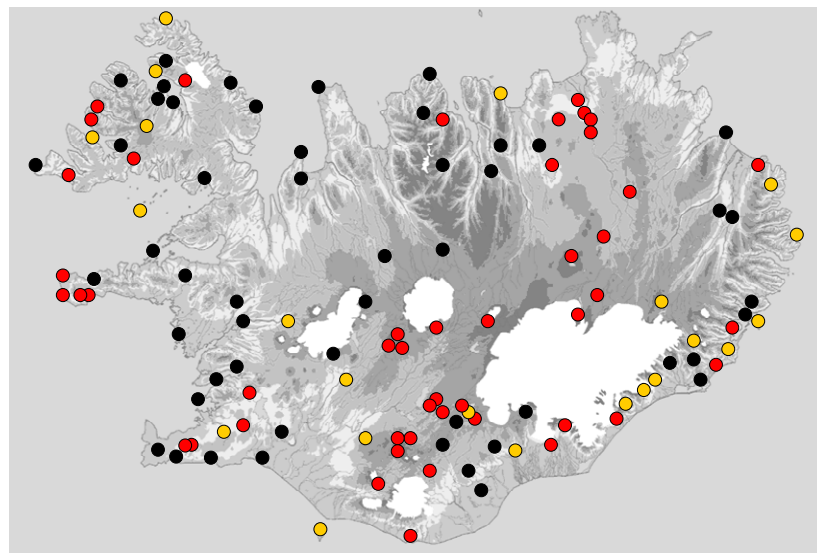


Figure 4: The geographical distribution of scenic areas in Iceland, compiled from four different sources (see full list in Tables 2 and 3). Red: Scenic areas sampled in this study. Yellow: Areas which should have been included but which for various reasons had to be left out. Black: Other areas designated as having landscape of value. Areas mentioned only once by one connoisseur (see Table 2) were not included on this map.

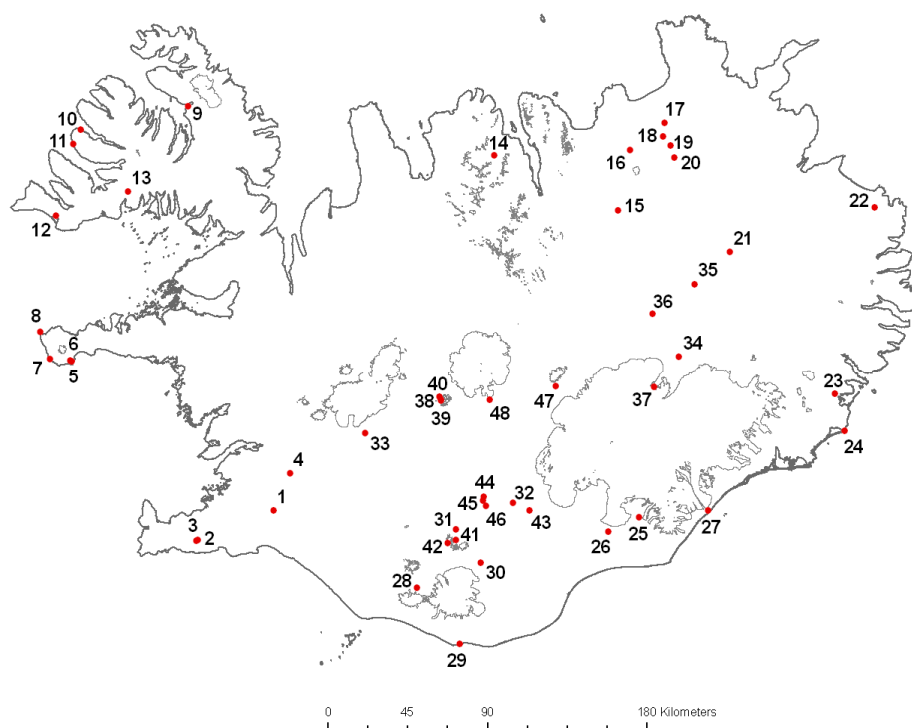


Figure 5: The scenic areas evaluated in this study. Place names are mentioned, such as “Mývatn”, but the results refer to *only* the place from which the assessment was made – not *all* of the Mývatn area, for example. 1: Grændalur valley. 2 and 3: Seltún 1 and 2, respectively. 4: Þingvellir national park. 5: The coast between Stapi og Hellnar. 6: Snæfellsjökull. 7: Djúpalónssandur. 8: Svörtuloft, Öndverðarnes. 9: Kaldalón and Drangajökull. 10: Keldudalur in Dýrafjörður. 11: Lokinhamradalur in Arnarfjörður. 12: Rauðisandur. 13: The nature reserve in Vatnsfjörður. 14: Skíða- and Svarfaðardalur valleys (shortened to Svarfaðardalur hereafter). 15: Mývatn. 16: Þeistareykir. 17: Ásbyrgi. 18: Hljóðaklettur. 19: Hólm Tungur – Katlar. 20: Hafragilsfoss. 21: Víðidalsfjall and Möðrudalsfjallgarður. 22: Stóruð at Dyrfjöll. 23: Geithellnadalur. 24: Hvalnes in Lónsfjörður. 25: Skaftafell, at Sjórnarsker. 26: Skeiðarársandur at Gígjukvísl. 27: Jökulsárlón at Breiðamerkursandur. 28: Þórsmörk, from Valahnúkur. 29: Dyrhólaey. 30: Brytalækir. 31: Landmannalaugar from Brennisteinsalda. 32: Langisjór. 33: Jarlhettur. 34: Krepputunga. 35: Herðubreiðarlindir. 36: Askja. 37: Kverkfjöll – Hveradalur. 38: Kerlingarfjöll – Hveradalir. 39: Kerlingarfjöll – Grænatjörn. 40: Kerlingarfjöll – Reykjadalur. 41: Kaldaklof. 42: Ljósártungur. 43: Laki. 44: Veidivötn – Fossavatn. 45: Veidivötn – Skálavatn. 46: Veidivötn – Tröllid. 47: Vonarskarð. 48: Þjórsárver – Arnarfellsmúlar. Figure: Andreas Zöhrer, 2009.

### 3.3.2. Classification of the sample of 48 scenic areas

The 21 attribute scores from the checklist in Figure 3 (excluding snow and repeated forms) were subjected to multivariate analyses (cluster analysis and principal component analysis) to classify the scenic sample, and see what attributes had most impact on the groupings. By drawing a line at 10% dissimilarity, ten groups could be discerned (Figure 6).



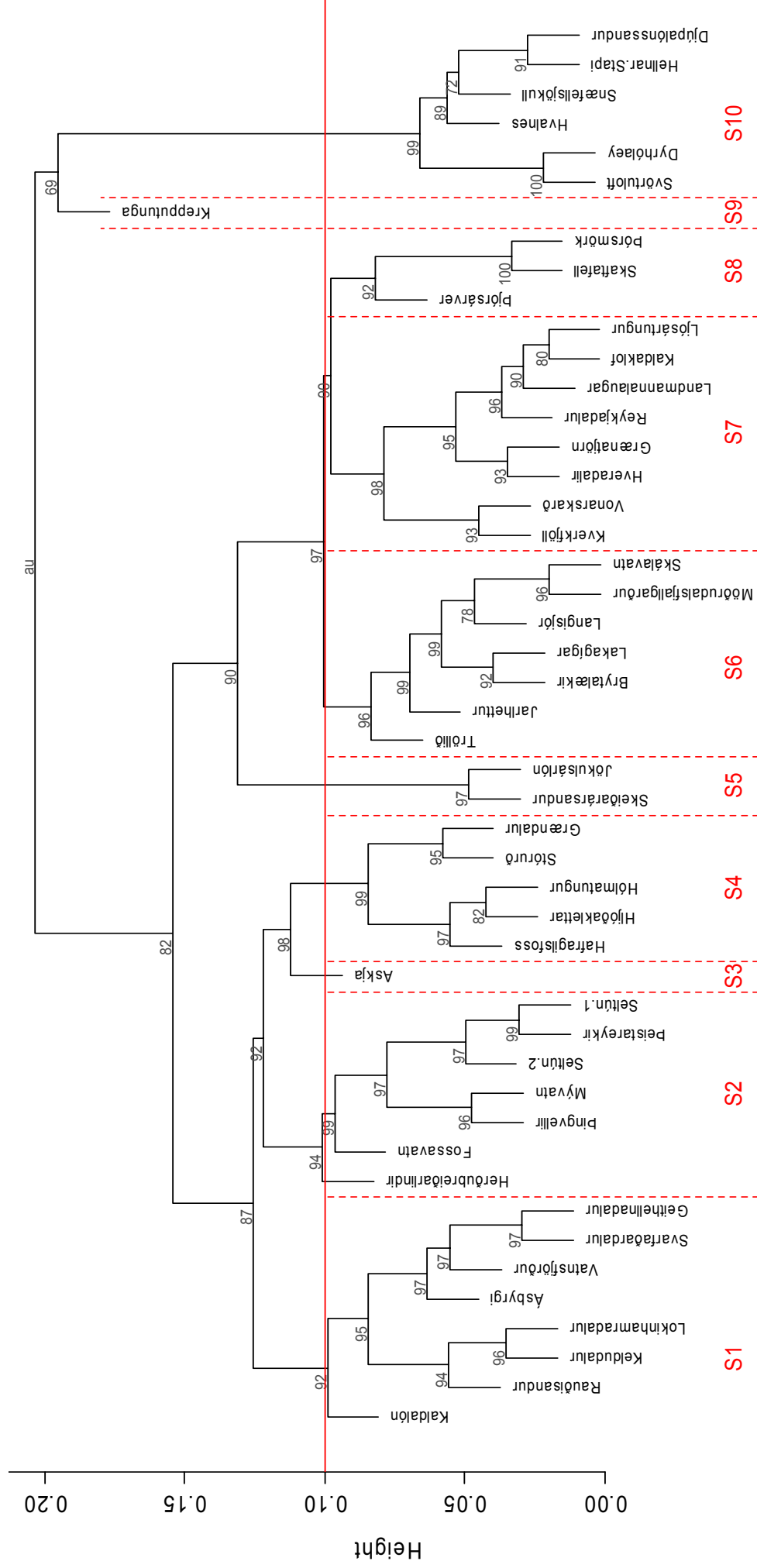


Figure 6: Dendrogram S (scenic) from a cluster analysis carried out with the average agglomerative method in conjunction with the uncentered distance measure, 10,000 bootstrap iterations, and based on 21 visual physical features (attributes, see section 2) of 48 scenic areas in Iceland. The groups were demarcated by the straight horizontal line at a 0.1 level of dissimilarity (height) and numbered from S1 to S10. See Table 5 for the names of the resulting groups. The gray numbers (“approximately unbiased”, au) at branch dividing points show bootstrap resampling p-values and indicate how strong the cluster is supported by data, on a scale of 0 to 1 (Suzuki & Shimodaira, 2006). The scenic areas’ common names, sometimes shortened, are used (see Figure 5).

Following the divisions in Figure 6 in more detail, the main attributes which accounted for the divisions at different stages in the hierarchy could be identified (see also a simplified overview in Figure 7).

The first division (from the top) in Figure 6 (see *a* in Figure 7) was where groups S-9 and S-10 separated from groups S-1 to S-8. The most obvious difference lay in water scores, with all sites in groups S-1 to S-8 having water and all sites in groups S-9 and S-10 lacking it. In groups S-9 and S-10, basic shape always scored 3 and elevation range got high scores, but in groups S-1 to S-8 these scores varied. Groups S-1 to S-8 had slightly higher scores for lines, forms and vegetation.

The outlier, Krepputunga (or “group” S-9, separation *b* in Figure 7) showed some distinct differences from group S-10, its closest neighbor. It had no straight lines (a score of 0) but very prominent rolling lines (score 5), while group S-10 had scores of 1 - 2 for both attributes. Krepputunga is inland, virtually devoid of vegetation, and had a more restricted color range and overall diversity than group S-10, which was vegetated and had the highest scores for sea in the scenic area sample.

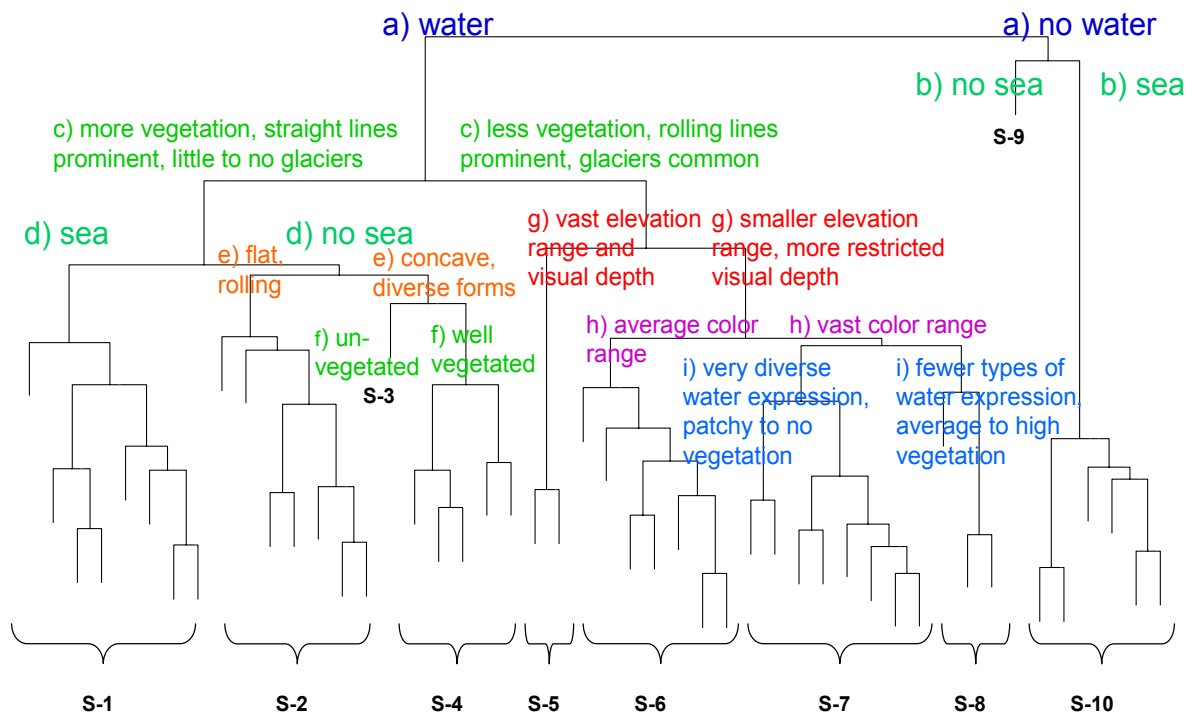
Turning to the groups on the left-hand side of Figure 6, the next main separation was that of groups S-1 to S-4 from S-5 to S-8 (*c*). Almost all attributes had scores which overlapped through these groups, but some trends could be discerned. Most noticeably, vegetation cover and vegetation diversity were lower in groups S-5 to S-8, which also had slightly fewer straight lines and forms, more rolling, angular, sinuous and diverse lines and forms and a larger pattern size. Groups S-1 to S-4 had on average a rougher surface texture and stronger water current. Glaciers were only present in one case in groups S-1 to S-4, but in three quarters of the sites in S-5 to S-8.

Next, group S-1 separated from groups S-2, S-3 and S-4 (*d*). The greatest difference lay in that sea was always present in group S-1 (with one exception: Vatnsfjörður), but not in groups S-2 to S-4 (with one exception, Seltún 2). Group S-1 had higher scores for straight lines, vegetation cover and vegetation diversity, in general, but lower scores for color range, texture diversity, water cover and water expression. Sites in group S-1 were all scenic fjords and valleys, plus a canyon with view to the sea (Ásbyrgi).

The differences between group S-2 and groups S-3 and S-4 (separation *e* in Figure 7) were that the basic shape was flatter, rolling lines more common but other

lines and forms less common in group S-2. Group S-2 also had more diverse vegetation. Groups S-3 and S-4 had a rougher surface texture, more diversity in patterns and texture, and stronger water current. “Group” S-3 contained one site, an outlier to group S-4. This single site, Askja, differed because it had no vegetation (f).

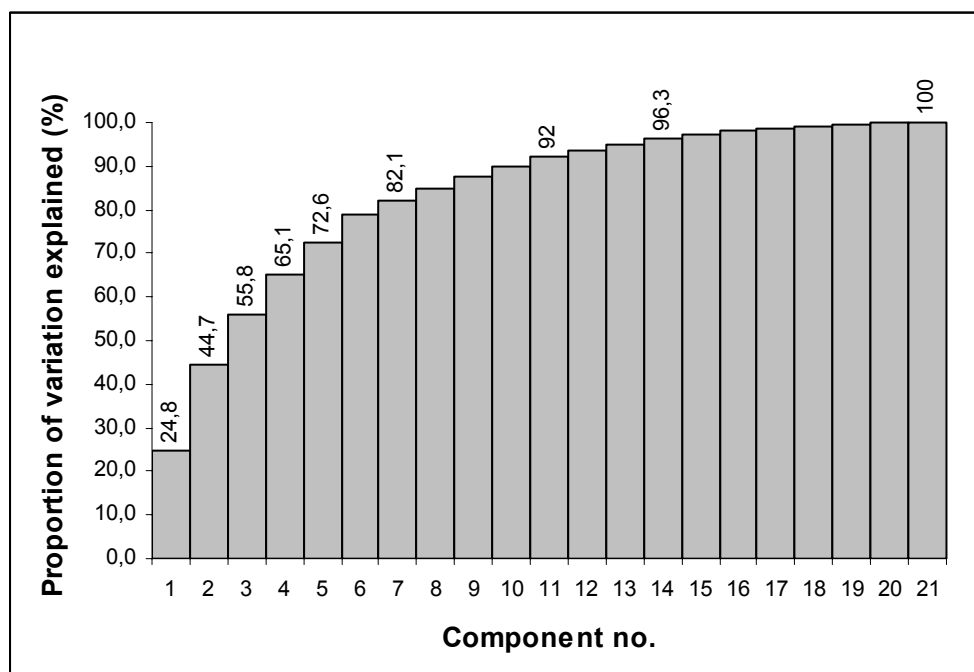
Four groups from the middle of Figures 6 and 7 remain to be discussed. Group S-5 was an outlier to groups S-6, S-7 and S-8 (g), with higher visual depth than all other sites in this set of groups, and a high elevation range and glacier cover. The next main split was where group S-6 left groups S-7 and S-8 (h). Group S-6 had more vegetation cover and vegetation diversity than the sites in groups S-7 and S-8 (with the exception of Þjórsárver in group S-8). Groups S-7 and S-8 had a very high color range. Finally, the last division to be discussed was when groups S-7 and S-8 divided, a little below the reference line of 10% dissimilarity. The scores in these two related groups were similar for most attributes, but S-8 had a greater visual depth than S-7, fewer straight lines, and more vegetation cover and diversity, in most cases (separation *i* in Figure 7). The pattern size was smaller (more fine-grained patches) in group S-8 as well. Group S-7 had more types of water expression, and all of these sites were geothermal areas.



**Figure 7: A simplified overview of the groups (S-1 to S-10) from the classification in Figure 6, and the main attributes identified to cause the divisions at each branch in the hierarchy (a to i). Other attributes also showed differences between groups, although not as strongly (see further discussion in text).**

### 3.3.3. Principal component analysis

It is common practice to use two or more multivariate methods together, to help interpret the results and decipher trends and relationships in complex data (Townend, 2002). A principal component analysis was performed for the 48 scenic sites and the 21 attributes. Eigenvalues from the principal component analysis indicate the total amount of variance in the data explained by each eigenvector, and together the components account for all of the variation in the data (Figure 8). Here, the first four components accounted for just under two thirds of the variation, which indicated moderate covariance between the attributes in the original data.



**Figure 8: Additive eigenvalues calculated from a principal component analysis of 21 visual physical landscape characteristics (attributes) at 48 scenic landscape sites in Iceland. Additive eigenvalues indicated the cumulative proportion of variation in the original data explained by each component (1 to 21). The first component explained the largest proportion of the variation, the second the second most, and so on, and the eigenvalues in sum added up to the total variation of the data.**

Loadings indicate the degree of influence of each attribute on each principal component, and here only a few showed moderate correlation (high absolute value on a scale of 0-1) for the first three components (Table 4). Attributes which are positively correlated to a component have scores which grow in line with that particular component, and if they are negatively correlated to a component their scores decrease in line with it. Most of the loadings seen here, however, were not

particularly high, and so the correlation wasn't very strong. In other words, attributes with low correlation to a component, such as basic shape in Table 4, did not show any distribution trends on biplots of the components (Figure 9). This means that sites with a convex basic shape (score of 4) were not situated any differently from sites with a concave basic shape (score of 1) with regard to this attribute.

On the first component axis, the attributes with the highest absolute value for its loadings were sea cover, water cover, water expression, rolling lines, sinuous lines, and water current (Table 4). On the second component, glacier, vegetation cover, water current, straight lines, rolling lines and vegetation diversity bore the highest loadings. On the third component, texture diversity, glacier cover, color range, pattern diversity, rolling lines and straight lines had the highest loadings. These loadings were usually not very high and so the correlation was only moderate.

**Table 4: Loadings for each of the 21 visual physical characteristics (attributes) on the first three components (comp.) of a principal component analysis for 48 scenic areas. The numbers are correlation coefficients and most are rather low. The strongest loadings (greatest absolute value) are shown in bold type.**

Attribute:	Comp.1	Comp.2	Comp.3
Basic shape	-0.084	-0.135	-0.060
Visual depth	-0.190	-0.139	-0.011
Elevation range	-0.202	-0.174	0.172
Straight lines/forms	-0.154	<b>0.327</b>	<b>0.282</b>
Rolling lines/forms	<b>0.331</b>	<b>-0.325</b>	<b>-0.292</b>
Angular lines/forms	0.173	-0.261	0.197
Sinuous lines/forms	<b>0.324</b>	-0.055	0.049
Diversity of lines/forms	0.157	-0.111	0.204
Vegetation cover	-0.065	<b>0.389</b>	-0.078
Vegetation diversity	-0.047	<b>0.309</b>	-0.048
Color range	0.153	-0.005	<b>0.321</b>
Pattern size	-0.080	-0.150	-0.128
Pattern diversity	0.150	0.036	<b>0.309</b>
Texture diversity	0.033	0.012	<b>0.427</b>
Texture roughness	-0.078	0.152	0.180
Water cover	<b>0.344</b>	0.117	-0.084
Water current	<b>0.258</b>	<b>0.375</b>	0.141
Water expression	<b>0.344</b>	0.155	0.093
Sea	<b>-0.492</b>	-0.036	0.200
Glacier	0.019	<b>-0.404</b>	<b>0.386</b>
Overall diversity	0.106	-0.001	0.239

Biplot ordination graphs showed the sample sites positioned according to their scores from the eigenvalue and eigenvector calculations (Figure 9). The influence of

each attribute was represented by a red arrow drawn from the origin of the plot; its length and direction showed the rate and direction of increase for that attribute (Bárðarson, 2009; Quinn & Keough, 2002). In these biplots, sites were numbered and colored according to the groupings in the cluster analysis of scenic areas only (i.e. Figure 6). “Groups” S-3 and S-9, which contained only one outlier site each, were not colored.

The scenic groups were separated from each other on the biplots in Figure 9, aggregating in clusters which corresponded to the results produced by the cluster analysis. On the first biplot in Figure 9, which plots components one and two, group 10 was situated to the far left and its attributes were thus negatively correlated to component one, where sea cover had the highest negative loading. Group 10 contained the scenic seascapes and so it fits that it should be situated to the left. On this biplot, groups were arranged on both the positive and negative sides of the second component: groups on the top of the figure having higher scores for vegetation cover, water current and straight lines, and groups on the bottom having more glacier cover and rolling lines. This is consistent with the scores that these groups bore for these attributes, and demonstrates which attributes are most important in separating groups from each other.

On the second biplot, which plots components one and three, sea decreased from left to right, having a strong negative loading on the first component, while the three water scores showed the opposite trend. Texture diversity and color range decreased from top to bottom, having a strong positive loading on the third. Groups 7 and 8 lie in the top half of the biplot, and these groups had some of the highest scores for these attributes.

On the third biplot, of components two and three, groups 1, 2, 3 and 4 were situated to the right, their attributes being positively correlated to component two, where vegetation, straight lines and water current bore high loadings. Rolling lines bore a moderately strong negative loading on both components two and three, and the sites which are clustered in the bottom left-hand corner have high scores for rolling lines, belonging to group 6. This is all consistent with and compliments the groups from the cluster analysis in Figure 6.



### **3.4. Discussion**

#### **3.4.1. Terminology and limitations to the approach**

The term “scenic area” in this section refers to the sample in this study. No attempt is made at concluding what does or does not constitute a “scenic” area or to define beauty in landscape in any way. My objective was to analyze this sample and its properties, but not to make a value judgment of the scenic area. Although an attempt will not be made to define “scenic” or “outstanding” landscape, or to exclude any areas at all from potentially being considered scenic or outstanding, it is possible to draw some general conclusions from this study, about what characterizes some of the acknowledged scenic areas in Iceland.

The Icelandic Landscape Project’s (ILP’s) classification method is new and it is still being developed and tested. Currently, the method is used by taking into consideration only some of the visual physical properties of the landscape, but there are many visual factors that are poorly accounted for. Individual landscape features have been somewhat neglected in landscape research in the past, while larger landscape units have received more emphasis (Hudson, 2000). Individual landscape features, such as waterfalls, cliffs, lava formations, and “irregular forms” (i.e. forms which are not straight, sinuous, rolling or angular) can be extremely prominent in the landscape but may be undervalued in the scoring system since they do not enter the assessment directly. Here, these features do register within the scores for diversity of lines and forms, bringing the score up, and waterfalls bring the score for water current to 5, but this is arguably not enough weight for such important factors. When asked to explain or describe the reasons for their choice of both most preferred landscape and least preferred landscape, out of a sample of 16 landscape photographs, single landscape elements were often mentioned (Kristinsdóttir, 2004).

Visual human impact, e.g. buildings, roads, disturbance, cultivation, or inhabitation, was also not included. These factors could all potentially be important for classifying and not the least analyzing all types of landscapes. Also, separating lakes from rivers, that is, using two attributes where we only have one now, might give a more precise classification. The method does not take any of the other dimensions of landscape into account, either, except the visual. Feelings such as mystery, sublimity, and peace, which landscapes awaken in us, do not enter our model. Although such factors may be of importance, actually, in prior studies, there



has not yet been much success in combining the objective and subjective dimensions of the landscape into transparent, repeatable assessment frameworks in Europe (Pedroli, Pinto-Correia, & Cornish, 2006).

The multivariate methods applied in this study are useful tools for analyzing large, complicated datasets (Townend, 2002). However, their results are not necessarily straightforward, but need interpretation as there is no one truth to landscape classification. An advantage of using the multivariate methods for landscape classification and research is the ease in which they allow the user to add or remove attributes and see what differences the attributes make. Attributes which are not yet included in our dataset could be added and tested. Thus, the multivariate method developed in the ILP is somewhat elastic since the tool can be gradually improved. The possibilities for improving the method, and checking if the improvements make a difference, are many.

### **3.4.2. The scenic groups**

From the score matrix and the principal component analysis's first two components (Table 4), it was apparent that water scores, sea, vegetation scores, color range, straight lines, sinuous and rolling lines were the most important attributes separating the major groups. Glaciers, texture diversity and pattern diversity also accounted for some variation between groups, but not as clearly.

Overall diversity, texture roughness, the diversity of lines and forms, elevation range, visual depth, and basic shape were not strong factors in determining differences among groups. Scores for the diversity of lines and forms and overall diversity were generally high (3-5), scores for texture roughness were generally similar, and scores for basic shape, elevation range and visual depth varied somewhat but did usually not result in any major separations.

The groups from Dendrogram S (Figure 6, Table 5) are visually quite heterogeneous, both with regards to sites within each group and also when comparing sites between groups, as those who have visited these areas know. Some of the groups have a clearer character than others, which may not have much in common other than having "a diversity of diversity".

**Table 5: The ten groups formed by the cluster analysis in Dendrogram S (Figure 6), their descriptive names, and the number of sites in each group.**

Group no. (as in Fig. 6):	Group description	No. of sites:
S-1	Scenic valleys and fjords	8
S-2	Vegetated flat to gently concave diverse areas with water	7
S-3	Askja – a geological <i>sui generis</i>	1
S-4	Running water, diverse forms, rough texture	5
S-5	Glacier outwash plains	2
S-6	Rolling highland areas	7
S-7	Geothermal areas	8
S-8	High diversity areas	3
S-9	Krepputunga, rolling, barren highland area	1
S-10	Scenic coasts	6

### 3.4.3. Group S-1: Scenic valleys and fjords



**Figure 10: Geithellnadalur, East Iceland: an example from group S-1. Straight lines are very prominent, texture is rough, and sea is visible in the other direction (behind the photographer). Photograph: The Icelandic Landscape Project.**

Group S-1 (Figure 10) contained scenic areas which are fjords, or valleys at the ends of fjords, and all but one (Vatnsfjörður) contained visible sea from the sample point. Ásbyrgi in this group is actually not a valley or fjord, but a canyon with visible sea in the far horizon (seen from our vantage point). Group S-1 had a concave basic shape and straight lines and forms were very prominent. These areas all had high

vegetation cover and high vegetation diversity, and their surface texture was rather uneven and rough. All of the sites had water, usually running water and even rapids. This groups' overall diversity was low to average, when compared with the sample of scenic areas only.

#### **3.4.4. Group S-2: Vegetated flat to gently concave diverse areas with water**



**Figure 11: Herðubreiðarlindir, central highland plateau: an example from group S-2. Patchy vegetation, fresh water and diverse patches are apparent. Photograph: The Icelandic Landscape Project.**

Group S-2 also contained patchily vegetated areas (having less vegetation cover than group S-1) with more water cover and higher overall diversity than group S-1. The diversity of lines and forms was low when compared to the whole scenic sample. These areas were either rather flat, or were shallow valleys or depressions, and patterns were diverse. The areas in this group were quite diverse and did not strongly resemble each other visually, even though they were clustered together. They separated from one another at comparatively high levels of dissimilarity (Figure 6). Herðubreiðarlindir (Figure 11) and Fossavatn at Veiðivötn are vegetated oases in the central highlands, and Seltún is a geothermal area with view to the sea. The two samples at Seltún were taken to see what difference some change in position would have on the assessment of the landscape. The two were clustered very close to one another and so this change did not have much impact. Mývatn (see Figure 44) and

Þingvellir are inland; both areas have very large lakes and prominent geological features in their landscapes; pseudocraters at the former and fissures at the latter.

#### **3.4.5. Group S-3: Askja**



**Figure 12: Askja, central highland: in a class of its own, S-3. Photograph: The Icelandic Landscape Project.**

“Group” S-3 contained a single outlier, Askja (Figure 12). Its unique features made it a rare type of landscape, the only one of its kind (*sui generis*), with a large body of water, a crater, diverse colors and patterns and virtually no vegetation.

#### **3.4.6. Group S-4: Areas with running water, diverse forms and rough texture**

Group S-4 contained Stóruð (Figure 13), Hafragilsfoss (Figure 14), Hljóðaklettur (Figure 47) and Hólmatungur, all from Jökulsárgljúfur national park, and the geothermal Grændalur valley (Figure 46). The visual attributes uniting these sites into one group were high scores for lines and forms (except rolling lines), and very diverse patterns and texture. The texture was rougher than average at all sites in this group (except Grændalur). All sites had water, and water current was very strong (except at Stóruð). Three of the sites had waterfalls, i.e. Hafragilsfoss, Hólmatungur and Grændalur, and Hljóðaklettur had rapids. Other characteristics of these sites were a concave basic shape and medium to high scores for vegetation cover. These



are the attributes which are taken into consideration in the method and which unite these sites, but visually, Stóruð, Grændalur and the three places at the national park differ a great deal.

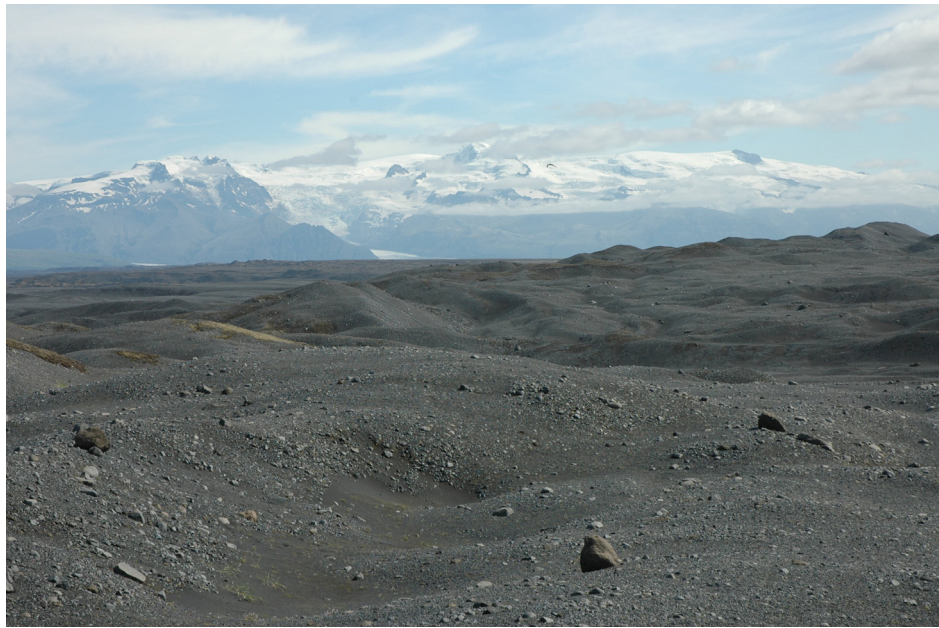


**Figure 13: Stóruð, East Iceland, an example from group S-4. It has diverse lines, forms, patterns, and texture. Photograph: The Icelandic Landscape Project.**



**Figure 14: Hafragilsfoss, North Iceland, an example from group S-4. Rough surface texture and running water with a strong current give this area its character. Photograph: The Icelandic Landscape Project.**

### 3.4.7. Group S-5: Glacier outwash plains



**Figure 15: Skeiðarársandur, South Iceland: an example from group S-5. A wide horizon, large patches, and a glacier are visible. Photograph: The Icelandic Landscape Project.**

The next group, S-5, contained two outliers to groups S-6, S-7 and S-8.

Skeiðarársandur (Figure 15) and Jökulsárlón (Figure 52) are both on the glacier outwash plains in the Southeast of Iceland, near Vatnajökull glacier. Elevation range is high, the maximum attained in Iceland ( $>2000$  m), as they are both in the vicinity of the highest mountain peak. Visual depth is high for the greatest part of the horizon: out to sea or across the seemingly never-ending sands. The diversity of lines and forms was high, but at the same time, pattern size was large, due to the extensive sands, and vegetation was very scarce.

### 3.4.8. Group S-6: Rolling highland areas

Group S-6 contained the scenic areas Langisjór (Figure 16), Tröllið at Veiðivötn, Jarlhettur, Brytalækir, Lakagígar (Figure 49), Möðrudalsfjallgarður (Figure 1) and Skálavatn at Veiðivötn. All of these sites are in the central highland at elevations above 600 m (except Jarlhettur, at 330 m), and their elevation ranges are in the range of 300 to 600 m. Rolling lines were very noticeable but straight lines barely present. Patterns were usually large and surface texture was homogenous and smooth in general. Water was always present and often a conspicuous feature. The vegetation at these sites varied very much, from an estimated 1-5% at Jarlhettur to 50-75% at



Lakagígar. These sites were not very similar visually, even though they shared the same scores for some attributes.



**Figure 16: Langisjór, central highlands: an example from group S-6. Water, glacier, scarce vegetation, a large patch size and rolling lines are noticeable attributes. Photograph: The Icelandic Landscape Project.**

#### **3.4.9. Group S-7: Geothermal areas**

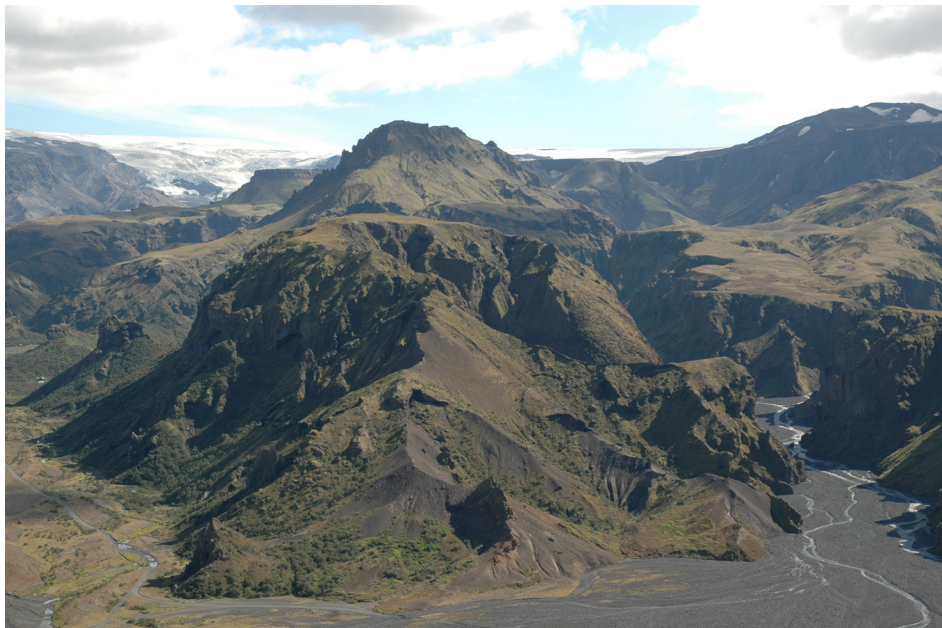


**Figure 17: Landmannalaugar, central highland: an example from group S-7. This area has a vast color range, diverse lines, forms, patterns and texture Photograph: The Icelandic Landscape Project.**

Group S-7 contained eight geothermal sites that were all at high altitudes (Figure 22): Hveradalur valley at Kverkfjöll, Vonarskarð, Hveradalir, Reykjadalur and Grænatjörn at Kerlingarfjöll, and Landmannalaugar (Figure 17), Kaldaklof and

Ljósártungur at the Torfajökull glacier area. These areas had high diversity in common: all lines and forms – except straight lines, patterns, texture and water expression were all very diverse and most often, these areas had the highest scores for these attributes in the entire sample. The color range was exceptionally wide. Vegetation, on the other hand, was low: 26-50% at Landmannalaugar, but always less than 25% at other sites.

#### **3.4.10. Group S-8: High diversity areas**



**Figure 18: Þórsmörk, South Iceland: an example from group S-8. Diverse forms and texture are prominent, and vegetation is moderate. Photograph: The Icelandic Landscape Project.**

The three sites in group S-8, Skaftafell, Þjórsárver and Þórsmörk (Figure 18), all had moderate visual depth. Angular lines and sinuous lines were noticeable, and the sites were colorful and moderately to well vegetated. Patterns were fine-grained and diverse, as was texture. Water and glacier were present at all three sites. Elevation range was very high at Skaftafell and Þórsmörk, but moderate at Þjórsárver.



#### **3.4.11. Group S-9: Krepputunga**



**Figure 19: Krepputunga, central highland, makes up group S-9. The area is completely unvegetated. Rolling forms, a narrow color range, and the presence of a glacier characterize the area. Photograph: The Icelandic Landscape Project.**

Group S-9 contained Krepputunga (Figure 19), a highland plateau area at an altitude of over 800 m. It was an outlier to the coastal areas, separating from them because of its lack of vegetation, straight lines, and small color range, and the absence of sea. It had a great amount of rolling lines, a great elevation range, and no running water apparent. It was visually quite different from the rest of the scenic areas in the sample.

#### **3.4.12. Group S-10: Scenic coasts**

The sites in group S-10 were the scenic seascapes: flat coastal areas with high mountains visible on one side and a wide view to the sea at the other, rough textures and average to low amounts of vegetation. Extensive sea cover united them in one group, but within the group, the areas often had very different appearances and characters: compare Figures 20, 21, and 35.



**Figure 20: Hvalnes, East Iceland: an example from group S-10. Texture is diverse. Photograph: The Icelandic Landscape Project.**

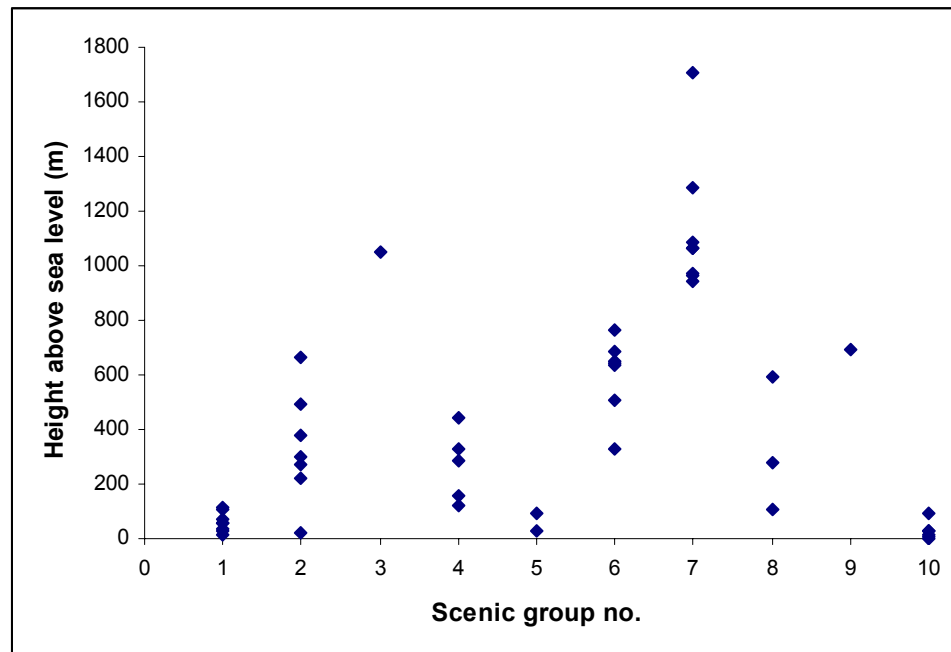


**Figure 21: Dyrhólaey, South Iceland: an example from group S-10. This flat coastal area has prominent geological features and a view to a glacier to the north. Photograph: The Icelandic Landscape Project.**

### **3.4.13. Altitudinal distribution**

The altitude of the sample sites for the scenic area groups was variable (Figure 22) (not to be confused with their elevation range which was given a score, see Figure 3). All sites in groups 1 (fjords) and 10 (coasts) were assessed at an altitude of <200 m a.s.l., while group 7 was  $\geq 900$  m (many of the highland areas were grouped

together, more visually similar to one another than to other sites). Most groups had sample sites at a range of altitudes.



**Figure 22: The altitude at sample sites in the groups from Dendrogram S (Figure 6). Sample size = 48 scenic areas.**

### 3.4.14. Visual diversity

Participants in the largest Icelandic landscape preference survey thus far described Icelandic landscapes most often by using the terms “diverse”, “pristine or original”, and “dramatic” (Kristinsdóttir, 2004). While we did not have any true measure for how pristine or dramatic our landscapes are, we did have several measures of diversity. The results clearly show a great deal of visual variation within the scenic sample. The sites had in common high scores for attributes which pertain to diversity: some for most of the attributes, while others had high scores for some specific ones but moderate to low for the others. The varying scores for many of the attributes and the high scores for diversity were what was found to characterize the scenic sample when taken as a whole. At the same time, however, this was what made many of the sites within groups visually quite different from the others. Diversity, variety and uniqueness are three of the most commonly mentioned features of landscapes of high scenic quality in recognized frameworks for protecting landscapes (e.g. Landscape Aesthetics, 1995; Tveit et al., 2006 and see sections 1.4 and 1.5).

Freshwater was present at all of the sites but seven – and all sites but one, if all forms of water are included, i.e. sea as well as freshwater. The appeal of water has been well documented (e.g. Herzog, 1985; Hudson, 2000; Landscape Aesthetics, 1995; Ode et al., 2009; Real et al., 2000; Tveit et al., 2006).

Vegetation cover and vegetation diversity differed enormously between the scenic areas: some areas had very little to no vegetation and others rich and diverse. Vegetation has usually been found to be a favored attribute abroad. It has been one of the attributes commonly used as a measure for naturalness and coherence in foreign landscape frameworks, and natural-looking landscapes are perceived as more attractive in perception studies (e.g. Arriaza et al., 2004; Landscape Aesthetics, 1995; Ode et al., 2009; Tveit et al., 2006). Despite the often scarce amounts of vegetation in Icelandic landscapes, Icelandic landscapes have been described and *perceived* as natural, pristine or original (Kristinsdóttir, 2004). Here would be an example where European criteria, i.e. that vegetation indicates naturalness and enhances visual quality, could not be taken up directly in Iceland. Many scarcely vegetated areas in Iceland are found to be appealing and sometimes perceived as natural.

## 4. Study 2: A comparison and classification of scenic and NSS sites in Iceland

### 4.1. Aims and research questions

The Nationwide Systematic Survey (NSS) of landscapes should consist of a cross-selection of most or at least all moderately common landscape types in Iceland. Do the scenic areas fit into these categories of landscape types, or do they stand apart? Is the Icelandic Landscape Project's (ILP's) newly developed methodology sensitive to any differences in visual attributes between a sample of 48 scenic areas and 112 other "ordinary" Icelandic landscapes from the nationwide systematic survey (NSS)?

### 4.2. Data base

The 112 NSS sites (see distribution in Figure 2) were collected in 2007 and 2008 for the Icelandic Landscape Project (Bárðarson, 2009; Thórhallsdóttir, 2009). For the scenic area sample, see section 3.2. See section 2 for methods.

### 4.3. Results

#### 4.3.1. Altitude

Over half of Iceland lies at an altitude of 400 m and above (Table 6), and the 25% of the country which can be considered inhabited is mostly limited to the coasts and lowlands below 200 m above sea level (Thórhallsdóttir, 2007a). The landscape points, both NSS and scenic, lay at a range of different altitudes (Table 6, see also Figure 53) and were assessed usually only at one point within each area.

**Table 6: Altitude ranges for Iceland as a whole (Statistics Iceland, 2009b), and the number and proportion of assessed landscape points (NSS sites and scenic areas) within the same elevation ranges.**

Elevation (m) above sea level	Iceland, km <sup>2</sup>	Proportion	Number of NSS sites	Proportion	Number of scenic areas	Proportion
0-200	24,700	0.24	56	0.50	20	0.42
201-400	18,400	0.18	13	0.12	8	0.17
401-600	22,200	0.22	25	0.22	4	0.08
>600	37,700	0.37	18	0.16	16	0.33
Sum	103,000	1	112	1	48	1

There was a significant difference in the altitudinal distribution between the NSS and the scenic areas (Chi-squared test,  $p = 0.0235$ , Table 6). A greater proportion of scenic areas was found in the highest altitude range of 601 m and above, compared to the NSS sites, but a smaller proportion in the 401-600 m group.

There was also a significant difference between the altitudinal distribution of both NSS sites ( $p=3.6*10^{-10}$ ) and scenic areas ( $p=0.016$ ) when compared to Iceland as a whole. 37% of Iceland is at an altitude of above 600 m, but only 16% of the NSS sites taken were in that range. A reason for this may be that only one glacier site was assessed in the ILP study, due to difficult accessibility, and all glacial sites are in an altitude of 601m or above. Most of the inaccessible sites that had to be left out were at high altitudes. Only 24% of Iceland is in the range of 0-200m, but 50% of the NSS sites sampled and 42% of the scenic areas were in that range. Again, this may be due to accessibility and thus a disproportional amount of samples were taken at a lower elevation.

#### **4.3.2. Relationship to bedrock diversity**

Bedrock types were mapped within a  $10 \times 10 \text{ km}^2$  grid were for Iceland as a whole (Figure 23), and the number of bedrock types compared for the scenic areas and NSS sites (Figure 24). No significant difference in the distribution of types of bedrock between the NSS and the scenic areas was found (Chi-squared test,  $p = 0.507$ ).



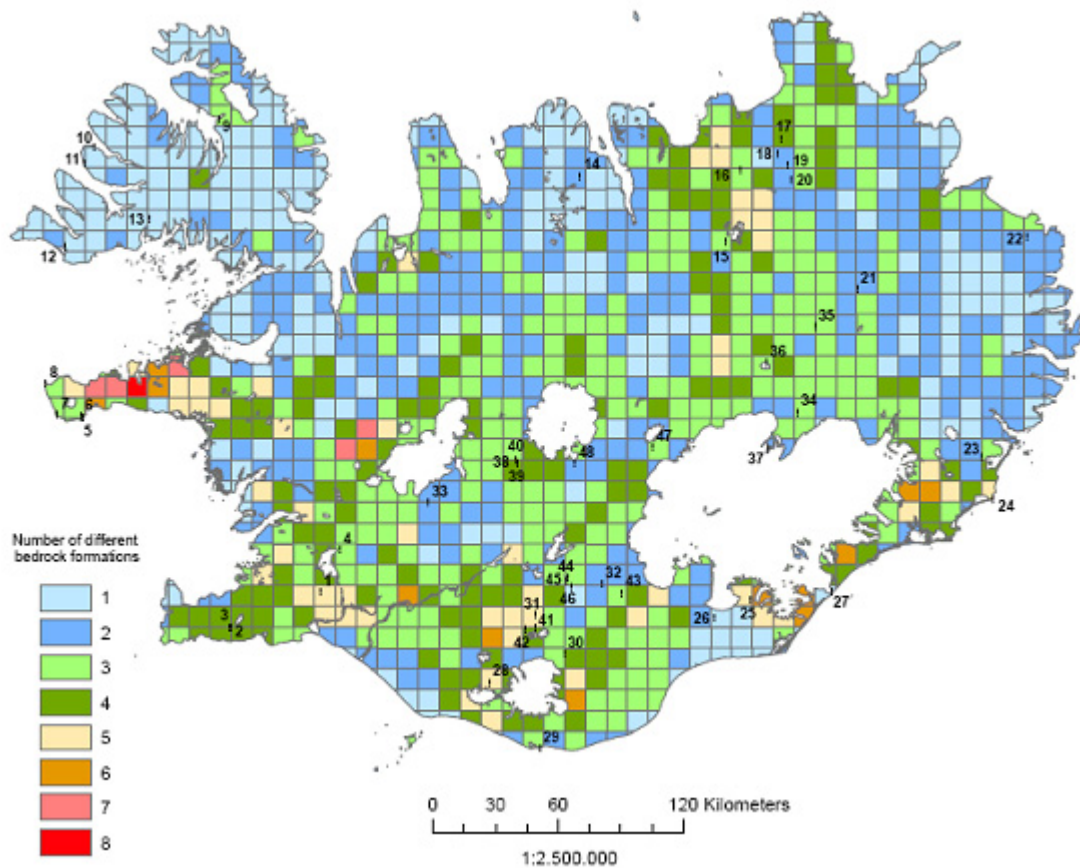


Figure 23: Distribution of variety of bedrock formations in Iceland. The 10x10 km<sup>2</sup> grid is the grid as in Figure 2 (Kristinsson & Jóhannsson, 1970). The highest bedrock diversity is in the Snæfellsnes peninsula (8 types), while low diversity characterized the oldest regions: the Western fjords, the central north and the east (1 type of bedrock pr. 10x10 km<sup>2</sup>). Scenic areas are marked with numerals corresponding to Figure 5. Figure: Andreas Zöhrer, 2009.

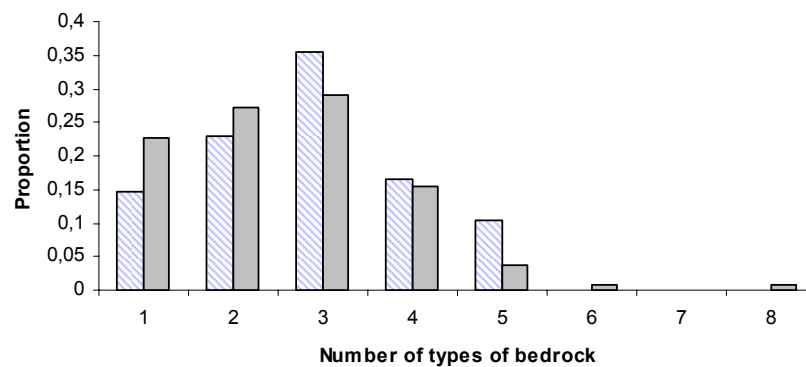


Figure 24: Comparison of the distribution of bedrock diversity among scenic areas (lined) and NSS sites (shaded) in 10x10 km<sup>2</sup> grids. The maximum number of bedrock types in a 100 km<sup>2</sup> grid was 8. A significant difference in the distribution of bedrock types between scenic and NSS sites was not found (chi-squared test,  $p=0.507$ ). Bedrock data courtesy of the Icelandic Institute of Natural History and Andreas Zöhrer 2009.

#### 4.3.3. Frequency distribution of attribute scores

Chi-squared tests detected significant differences between scenic areas and NSS sites for 14 out of the 21 attributes assessed and for most of these the difference was highly statistically significant, with 10 out of these 14 having significance levels of less than 0.001 (Table 7, Figure 25).

**Table 7: Results of Pearson's Chi-squared tests, comparing scores for the 21 visual physical features, or attributes, assessed in this study, between scenic areas and NSS sites. Statistically significant differences are shown in bold type ( $p < 0.05$ ).**

Attribute	Significance level
Basic shape	0.170
Visual depth	0.275
Elevation range	<b>0.015</b>
Straight lines/forms	0.271
Rolling lines/forms	0.260
Angular lines/forms	<b>&lt; 0.001</b>
Sinuous lines/forms	<b>&lt; 0.001</b>
Diversity of lines/forms	<b>&lt; 0.001</b>
Vegetation cover	<b>0.008</b>
Vegetation diversity	0.066
Color range	<b>&lt; 0.001</b>
Pattern size	<b>&lt; 0.001</b>
Pattern diversity	<b>&lt; 0.001</b>
Texture diversity	<b>&lt; 0.001</b>
Texture roughness	0.391
Water cover	<b>&lt; 0.001</b>
Water current	<b>0.038</b>
Water expression	<b>&lt; 0.001</b>
Sea	0.872
Glacier	<b>0.002</b>
Overall diversity	<b>&lt; 0.001</b>



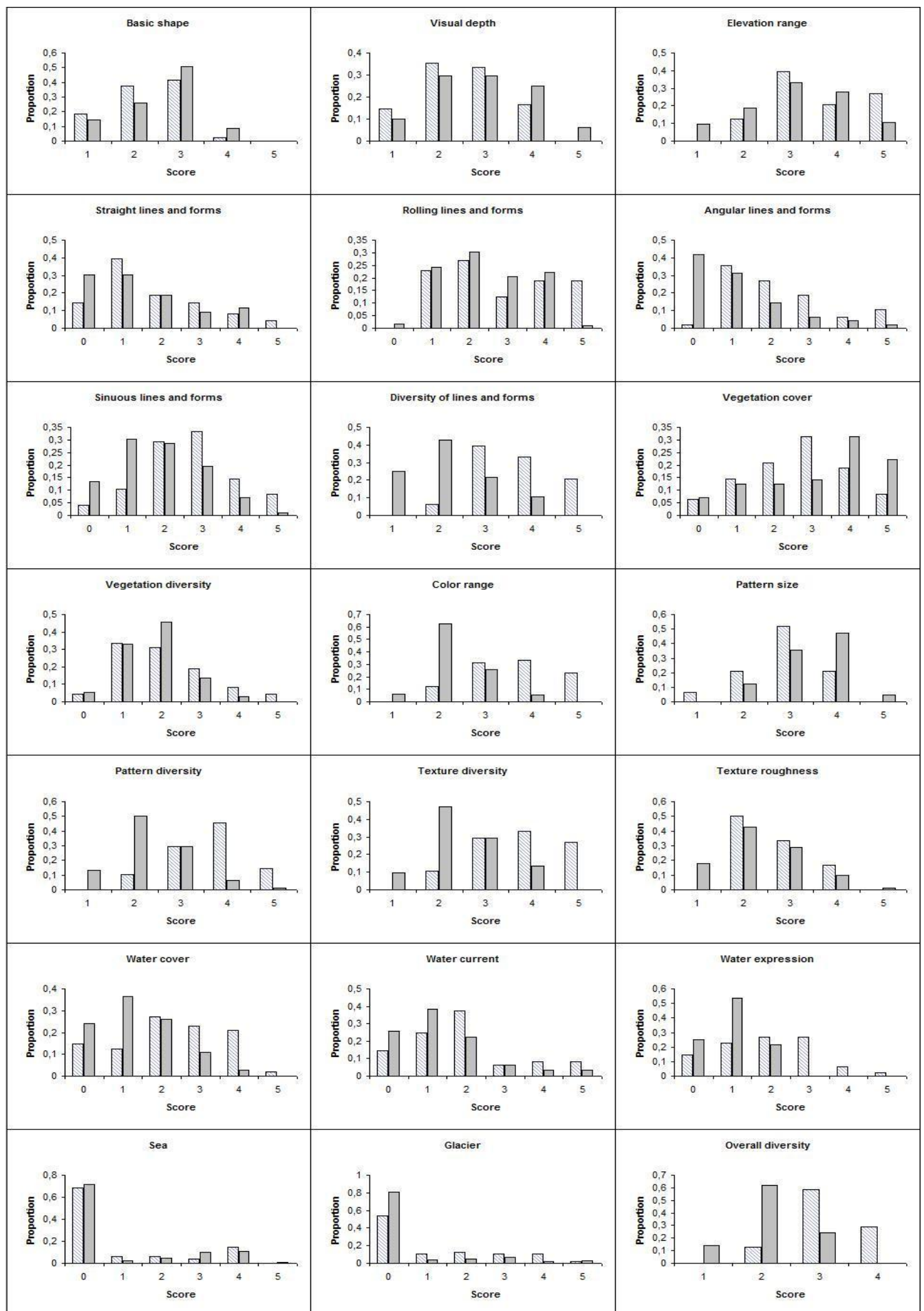


Figure 25: Histograms showing the distribution of scores for the 21 attributes assessed, for the 98 scenic areas (lined) and 112 NSS sites (shaded). The attributes' score (0-5 or 1-5) is shown on the x-axis and the proportion of the scores on the y-axis. 14 out of the 21 attributes had significantly different distributions between NSS and scenic sites, see Table 7.

#### 4.3.4. A classification of scenic areas and NSS sites in Iceland

In the ILP (Thórhallsdóttir, 2009), 112 NSS sites in a matrix including 21 attributes (all attributes in Table 7) were classified by cluster analysis, resulting in the formation of twelve landscape groups plus an outlier group (Figure 26, Table 8). Groups were demarcated at a 14% level of dissimilarity, resulting in groups of different sizes and containing areas of different similarity within. Groups XI and XII, which consisted of various types of usually well vegetated valleys, were large and contained areas which were more similar within the group than for instance groups II, IV and V, which were more heterogeneous and each site not as well replicated.

**Table 8: The groups formed with a cluster analysis (Figure 26) of 112 sites with 21 attributes in the ILP (Thórhallsdóttir, 2009), their names, sizes, and a short description of their characteristics.**

Group	Name	Size	Description
O	Glacier	1	The landscape from atop a glacier
I	Barrens with running water	4	Homogenous barrens with rivers.
II	Dry barrens	3	Very homogenous, dry barrens (with no surface water)
III	Rolling heathlands and semi-vegetated heathlands	13	Heathlands with patchy vegetation and some surface water and rolling shapes
IV	Plains with glaciers and high mountains	6	Homogenous, flat outwash plains with little vegetation, some running freshwater, with high mountains and glaciers
V	Dry, undulating highlands	5	Undulating, somewhat vegetated highlands without water, with high mountains and glaciers
VI	Outliers	4	Heterogeneous outlier sites
VII	Fjords	5	Fjords with high mountains, vegetated
VIII	Vegetated flat coastal areas	9	Vegetated, mostly flat coastal areas
IX	Sparsely vegetated coasts	5	Flat coastal areas with patchy and homogenous vegetation
X	Well vegetated but monotonous plains	14	Well vegetated plains with great visual depth but few landscape forms and mostly homogeneous vegetation
XI	Well vegetated heathlands and shallow valleys	21	Well vegetated heathlands and shallow valleys, with a low diversity of forms
XII	Well vegetated glaciated valleys	22	Valleys surrounded by often high mountains, some diversity in forms, vegetation, patterns and colors

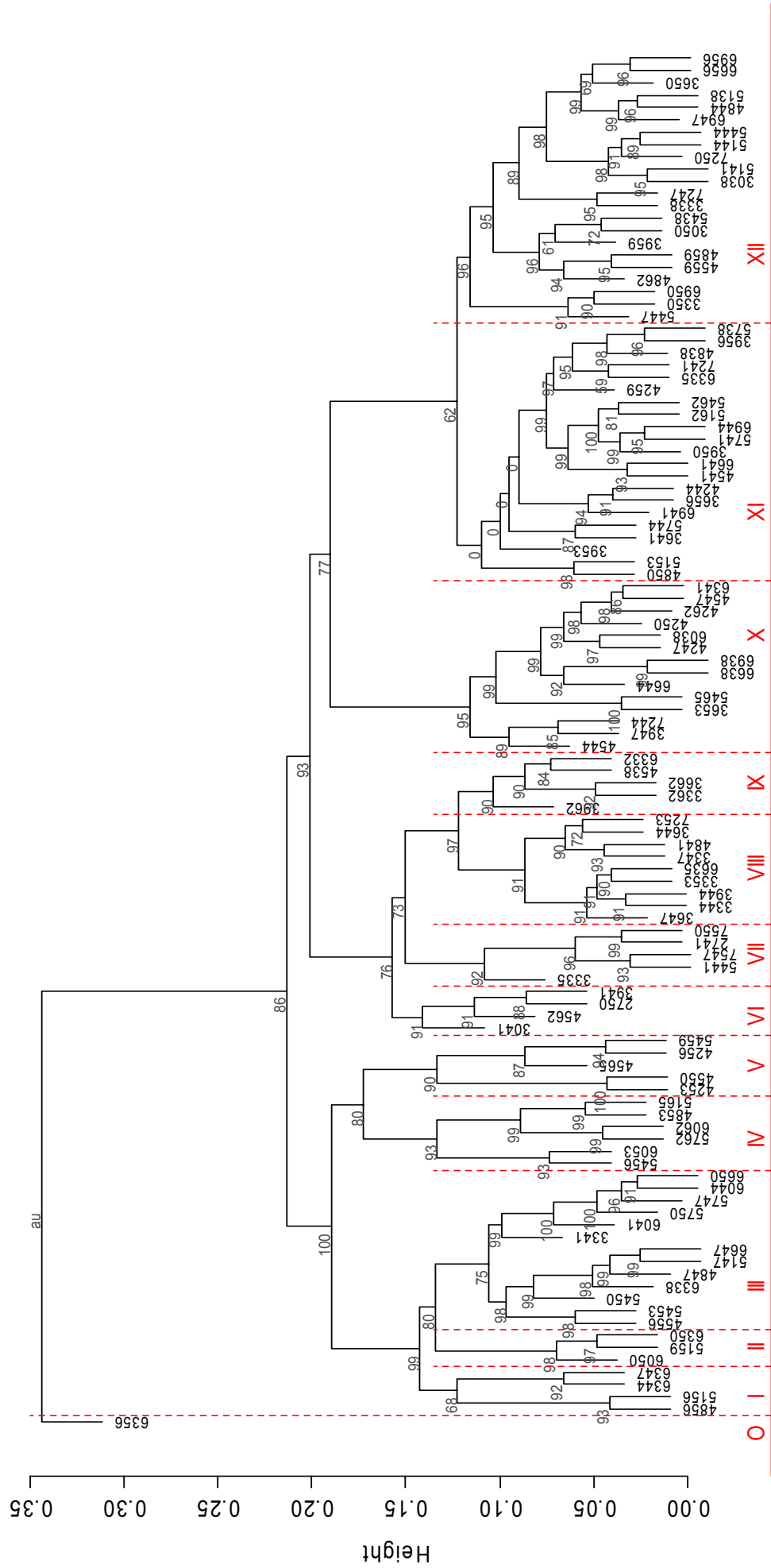


Figure 26: Dendrogram from the cluster analysis in Þórhallsdóttir (2009). It was carried out with the average agglomerative method in conjunction with the uncentered distance measure, along with 10,000 bootstraps, and based on 21 visual physical features (attributes; see list in Table 7) of 112 sites. Numbers at the end of each arm are codes for the names of each site, referring to landscape site grid-numbers, see Figure 2. The twelve resulting groups plus outlier group were demarcated at a 14% level of dissimilarity (height) and numbered from O to XII. See Table 8 for the names of each group. The grey numbers (“approximately unbiased”, au) at branch dividing points show bootstrap resampling p-values and indicate how strong the cluster is supported by data, on a scale of 0 to 1 (Suzuki & Shimodaira, 2006)

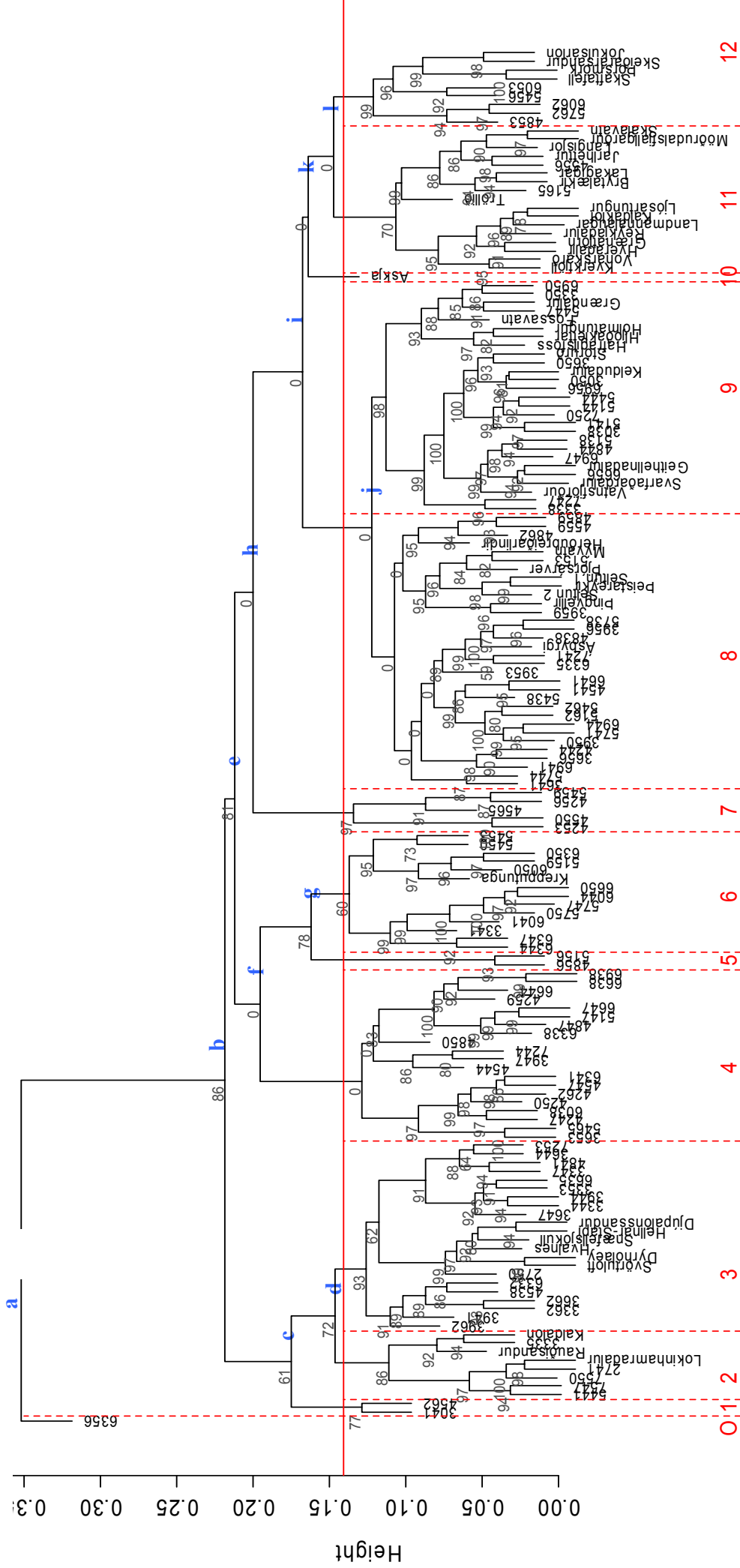


Figure 27: Dendrogram A (all sites), from a cluster analysis carried out with the average agglomerative method in conjunction with the uncentered distance measure, along with 10,000 bootstraps, and based on 21 visual physical features (attributes; see list in Table 7) of 48 scenic areas and 112 NSS sites. The groups were demarcated by the straight horizontal line at a 0.14 level of dissimilarity (height) and numbered from 1 to 12, with one outlier group (0). See Table 10 for the names of the resulting groups. The grey numbers (“approximately unbiased”, au) at branch dividing points show bootstrap resampling p-values and indicate how strong the cluster is supported by data, on a scale of 0 to 1 (Suzuki & Shimodaira, 2006). Numbers at the end of each arm are codes for the names of the NSS sites, referring to landscape site grid-numbers (see Figure 2). The scenic areas’ common names, sometimes shortened, are used (see Figure 5). Letters a-l refer to order of discussion (see text).

In this study, the 48 scenic areas were added to NSS sites, resulting in a sample of 160 sites, to see how they assembled within the groups. The cluster analysis was run in the same way (Figure 27).

By demarcating groups at a 0.14 level of dissimilarity in Dendrogram A in Figure 27, twelve new groups were formed. This resulted in some modifications of the original groups from the ILP (Table 9). Group O and group V in the ILP were the only groups which stayed completely unchanged, not losing or adding any sites, and correspond to groups O and 7, respectively, in Figure 27. The other groups changed to a varying extent. On the one hand, some groups' sites stayed united but now had added members. On the other hand, some groups split into smaller units and became parts of other groups. Scenic areas then joined groups in different amounts.

Group I split into two equal parts, one of which now formed the outlier group 5 and the other part which entered group 6 (Table 9). Group II's sites stayed together but also joined the new group 6. The remaining sites in the new group 6 came from group III, which mostly stayed intact in group 6, but four of its sites were moved to the new group 4 and one to the new group 11. Also, one scenic area entered group 6. Group IV, plus four scenic areas, made up the new group 12; one site from group IV, however, moved away from the rest and entered group 11. Group VI was an ill defined outlier group, and it split into two equal parts. One part now made up the new outlier group 1, while the other entered group 3. In group 3 were also all sites from the former groups VIII and IX, and 6 scenic areas. Group VII was yet another group which stayed intact, but grew with the addition of three scenic areas and is now called group 3. Group X stayed completely intact and now blended into the new group 4, where other NSS sites joined but no scenic areas. Sites from groups XI and XII stayed together for the most parts, but lost two and five sites to other groups, respectively (Table 9). Group XI now corresponded to group 8, and group XII to group 9; both had scenic additions, as well.

**Table 9: The modifications to the groups formed in the ILP (Figure 26) when 48 scenic areas were added to the sample of 112 NSS sites (Figure 27). Some groups stayed entirely unchanged, such as group V. Some groups stayed intact, such as group VII, but had additions to them, either scenic additions of other NSS sites which had moved between groups. Some groups split up, such as group III. See Tables 8 and 10 for the names of the groups from Figures 26 and 27, respectively.**

Group from ILP (Fig. 26)	No. of sites	Fate of group when scenic areas were added	Location of groups' sites in new classification (Fig. 27)
O	1	Unchanged	Group O
I	4	Split into two equal parts	Two sites made up group 5 (outliers to group 6), and two entered group 6
II	3	Intact	Became a part of group 6
III	13	Split into three parts	Nine sites entered group 6, four entered group 4 and one entered group 11
IV	6	All sites but one stayed together	Group 12. One site left for group 11
V	5	Unchanged	Group 7
VI	4	Split into two equal parts	Group 1 and group 2
VII	5	Intact	Group 2
VIII	9	Intact	Group 3
IX	5	Intact	Group 3
X	14	Intact	Group 4
XI	21	All sites but two stayed together	Group 8. Two sites left for group 4
XII	22	All sites but five stayed together	Group 9. Five sites left for group 8

Four of the new groups from Figure 27, plus the outlier group O, did not have any scenic areas within them (Table 10). Scenic areas joined all other groups, in varying amounts, from the proportion of 7% to 88%. Group 11 contained the most scenic areas, both proportionally as a group and numerically out of the whole scenic sample, or 15 out of the total of 48 scenic areas. “Group” 10 contained only one site, an outlier site which was a scenic area.

**Table 10: The groups formed from the cluster analysis in Dendrogram A (Figure 27), their descriptive names, sizes, the number and proportion of scenic areas within each group, and the most direct corresponding group from the ILP (Figure 26), if there was such an analogy.**

Group no. (Fig. 27)	Group name	No. of sites in group	No. of scenic areas in group	Scenic areas as proportion of total number in group:	Most direct analogy to ILP (Fig. 26), group:
O	Glacier	1	0	0.00	O
1	Outlier group to groups 2 and 3	2	0	0.00	VI
2	Fjords	8	3	0.38	VII
3	Coasts	22	6	0.27	VIII and IX
4	Vegetated, monotonous plains	20	0	0.00	X
5	Outlier group to group 6	2	0	0.00	I
6	Rolling barrens or patchily vegetated heathlands	14	1	0.07	II and III
7	Dry, undulating highlands	5	0	0.00	V
8	Well vegetated heathlands and shallow valleys	32	8	0.25	XI
9	Well vegetated glaciated valleys	27	10	0.37	XII
10	Askja, an outlier to groups 11 and 12	1	1	1.00	None
11	Diverse scenic areas	17	15	0.88	None
12	Diverse plains with glaciers	9	4	0.44	IV
Total		160	48	0.30	

Some of the larger groups from Figure 27 and Table 10 could be split into subgroups, which became especially apparent when compared to the groups from the ILP (Figure 26). For example, group 4 has a subgroup containing sites only from the old group X and another subgroup which is mixed, containing sites from three old groups, III, X and XI.

Next, the factors which controlled the partitioning in the dendrogram in Figure 27 will be identified by comparing the scores for the different attributes between groups, making the divisions and resulting groups' similarities more apparent.

Starting at the top of Figure 27 (a) and working one's way down, the first site to leave the sample was 6356, or "group" O, an outlier to the rest of the sample. This

sample was the only one representing the landscape of a glacier, taken from atop Vatnajökull glacier, and was unlike all others.

The next division in the dendrogram was where groups 1, 2 and 3 left the rest (*b*). The main differences were in scores regarding water and sea: groups 1, 2 and 3 having less freshwater cover, current and water expression than groups 4 to 12. Also, all sites in groups 1, 2 and 3 (except one: 4562) had scores of 3 or higher for sea, which was higher than scores for sea for almost all sites in group 4 to 12.

Next, group 1, an outlier group to groups 2 and 3, split from them (*c*). The two sites within it were not similar enough to make up a true landscape type but were more similar to one another than to any other site in the sample, and had clear differences from their sister groups. The two sites in group 1 did have in common less vegetation cover, vegetation diversity, diversity of forms, and higher scores for texture roughness, on average, when compared to groups 2 and 3.

Groups 2 and 3 contained seascapes. The main differences between the two (*d*) lay in scores for basic shape: group 2 had the concave shape of fjords, while group 3 had flatter coasts with more visual depth. Group 2 had higher scores for straight lines, angular lines and vegetation diversity when compared to group 3, as well. Three scenic fjords were in group 2, and six scenic seascapes in group 3. Three subgroups are apparent within group 3: the first containing all of group IX from the ILP (scarcely vegetated coastal areas) plus one site from group VI, the second containing the six scenic areas plus the other site from group VI (an outlier group), and the third containing all of group VIII (better vegetated coastal areas).

Turning back to groups 4 to 12 in Figure 27, the next main separation happened when groups 4, 5 and 6 left the rest of the sample (*e*). These two sets of groups were large, but there were some strong trends in the differences between them. Basic shape was flatter (i.e. scoring higher), visual depth was greater, elevation range less, and diversity of all lines and forms (excepting rolling lines, which scored similarly) was lower in groups 4, 5 and 6. Likewise, color range, the diversity of patterns and texture, and all scores for water and vegetation scored lower on average in groups 4, 5 and 6. Altogether, 38 scenic areas were clustered within the set of groups 7 to 12, but only one in the set of groups 4, 5 and 6.

Group 4 had considerably greater amounts of vegetation cover than groups 5 and 6 (average scores of 4.24, 0.1, and 0.86, respectively), but fewer rolling lines and less diverse lines and forms altogether (*f*). Within group 4, there was a subgroup



of vegetated, monotonous plains from group X before, and another which had blended sites from three previous groups: III, X and XI, i.e. heathlands and plains. The vegetation cover was higher in the former subgroup, but rolling lines more common in the second. Group 5 was a small outlier to group 6, with vague differences (*g*). Visual depth was greater, the elevation range smaller, and patterns and textures less diverse than what was most often seen in group 6. Also, the sites in group 5 had a smoother surface than most sites in group 6. There was one scenic area clustered within group 6, the undulating barrens or patchily vegetated heathlands.

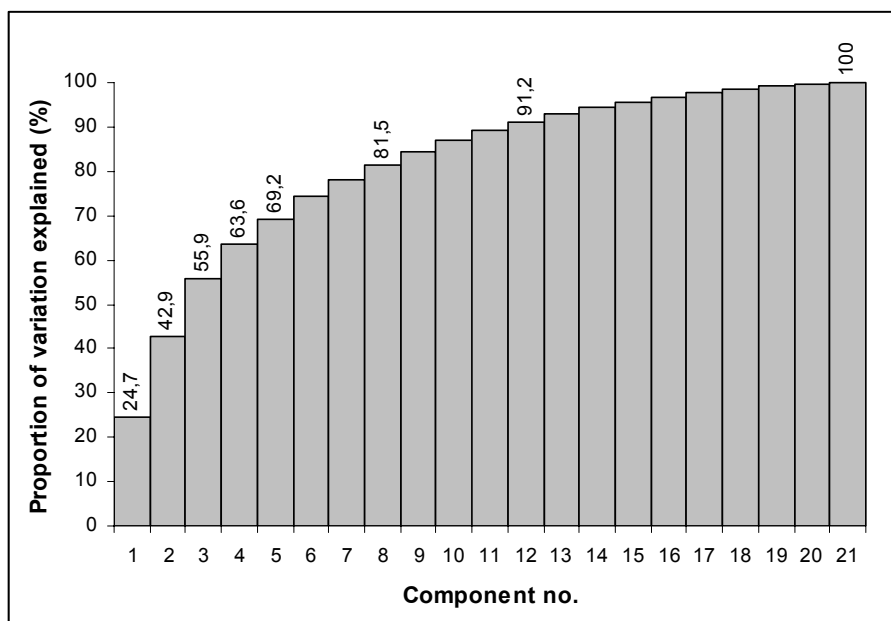
The remaining groups, numbers 7 to 12 (Figure 27 and Table 10) contained over half of the sample, or 91 sites out of 160, and also the majority of scenic areas, or 38 out of the total of 48. Group 7 was an outlier group to the rest (*h*). All scores seen in this group were seen in groups 8 to 12 as well, so what set group 7 apart was some, perhaps uncommon, combination of the sites' scores. Group 7 (dry, undulating highlands) had little to no water, but glaciers were always present. The elevation range was quite high in group 7, but forms and vegetation usually less diverse, the color range narrower, and the texture rougher than in groups 8 to 12.

Groups 8 and 9 next divided from groups 10, 11 and 12 (*i*). Again, many scores overlapped through these two large sets of groups, but some general trends could be discerned. Vegetation cover and vegetation diversity were what made the most difference; groups 8 and 9 scored higher for both attributes on average. They had lower scores for visual depth, rolling and sinuous lines, and the diversity of lines and forms, and higher scores for straight lines, but these differences were more subtle. Water and glacier were more prominent in groups 10, 11 and 12. Groups 8 and 9 split apart from one another below the reference line of 14% dissimilarity and are thus more homogenous as groups than the other groups (*j*). None the less, it was considered necessary here to split them into two groups, because of their sizes and their sites' origins: group 8 having sites mainly from group XI in the ILP and group 9 having sites exclusively from group XII. In general, group 9's sites are narrow, glaciated valleys while group 8 has shallow valleys or even flatter heathlands. Group 9 had more prominent straight and angular lines, a more diverse surface texture and usually more water current. Groups 8 and 9 contained eight and ten scenic areas, respectively. In both groups, many of the scenic areas were clustered together and were thus more similar to one another than to other sites in the groups.

The last groups to be discussed are groups 10, 11, and 12. “Group” 10 is an outlier to the other two and only contains one site, Askja, a scenic area (*k*). Askja was devoid of vegetation, had a deep basic shape, low visual depth and less diverse forms than groups 11 and 12, on average, and this combination of scores set it apart. Group 11, containing 15 scenic areas and 2 NSS sites, usually had a more concave basic shape, more rolling lines, less straight lines, a greater color range, more diverse patterns and water expression, and its overall diversity is higher than its sister group 12 (*l*). Group 12, which contained four scenic areas and 5 NSS sites, had a higher elevation range and higher scores for glacier cover and water current than group 11.

#### 4.3.5. Principal component analysis

A principal component analysis was then performed for the 48 scenic areas and 112 NSS sites and with the 21 attributes. Eigenvalues from the principal component analysis indicate the total amount of variance in the data represented by each eigenvector, and together the components account for all of the variation in the data (Figure 28). Here, the first four components accounted for 63.6% of the variance. This indicates only moderate covariance between the attributes in the original data.



**Figure 28: Additive eigenvalues calculated from a principal component analysis of 21 visual physical landscape characteristics (attributes) at 112 NSS sites and 48 scenic landscape sites in Iceland. Additive eigenvalues indicated the cumulative proportion of variation in the original data explained by each component (1 to 21). The first component explained the largest proportion of the variation, the second the second most, and so on, and the eigenvalues in sum added up to the total variation of the data.**

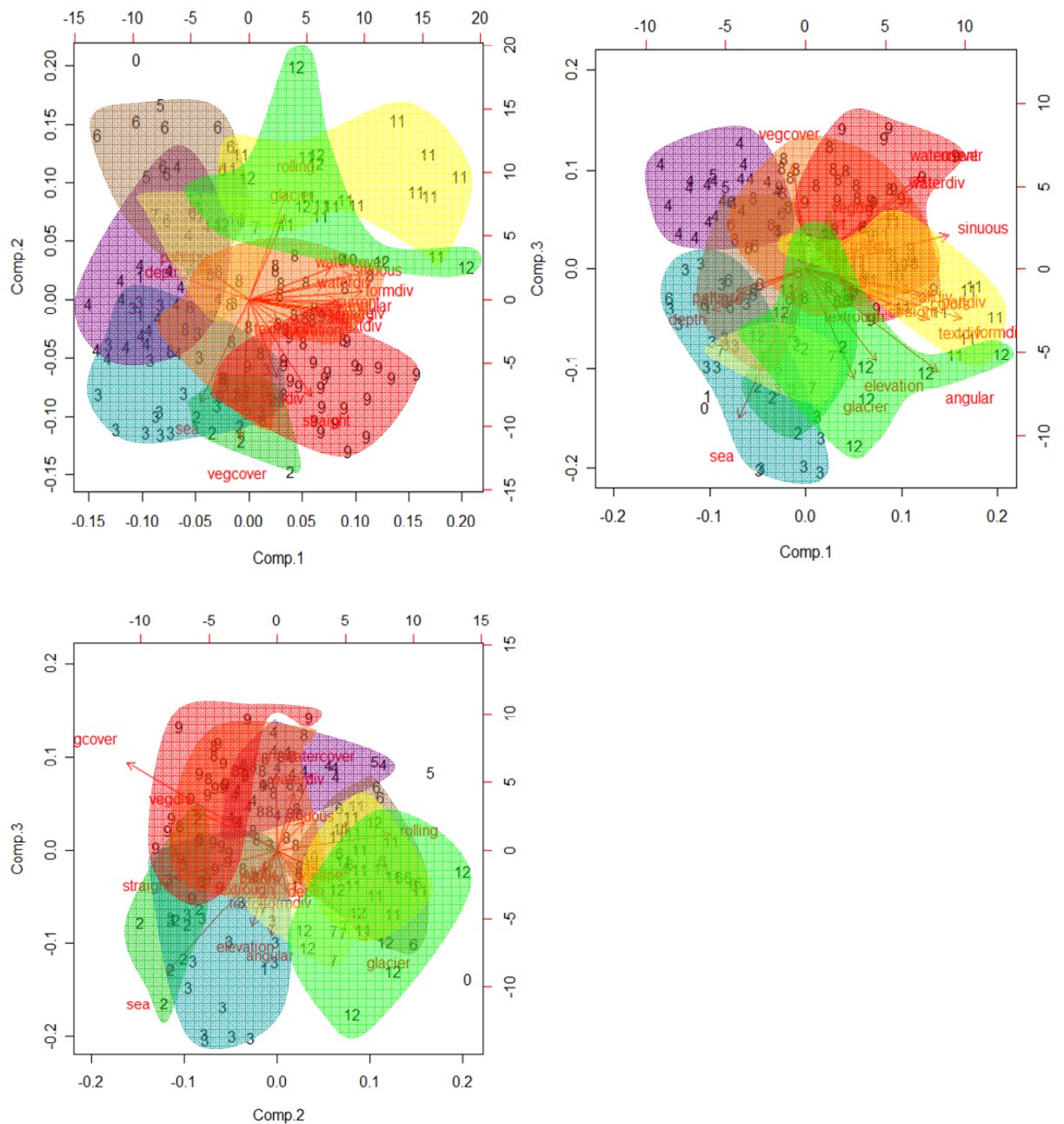
Loadings indicate the degree of influence of each attribute, and here only a few showed moderate correlation (high absolute value on a scale of 0-1) for the first three components (Table 11).

**Table 11: Loadings for each of the 21 visual physical characteristics (attributes) on the first three components (comp.) of a principal component analysis for 48 scenic areas and 112 NSS sites. The numbers are correlation coefficients and most are rather low. The strongest loadings (greatest absolute value) are shown in bold type.**

Attribute:	Comp.1	Comp.2	Comp.3
Basic shape	-0.148	0.132	-0.074
Visual depth	-0.210	0.083	-0.124
Elevation range	0.158	-0.088	<b>-0.287</b>
Straight lines/forms	0.194	<b>-0.364</b>	-0.106
Rolling lines/forms	0.117	<b>0.399</b>	0.059
Angular lines/forms	<b>0.296</b>	-0.018	<b>-0.321</b>
Sinuous lines/forms	<b>0.319</b>	0.093	0.105
Diversity of lines/forms	<b>0.350</b>	0.032	-0.154
Vegetation cover	-0.028	<b>-0.526</b>	<b>0.332</b>
Vegetation diversity	0.086	<b>-0.295</b>	0.156
Color range	0.259	-0.047	-0.083
Pattern size	-0.155	0.128	-0.067
Pattern diversity	<b>0.283</b>	-0.043	-0.080
Texture diversity	<b>0.277</b>	-0.074	-0.155
Texture roughness	0.088	-0.088	-0.117
Water cover	0.253	0.118	<b>0.290</b>
Water current	<b>0.270</b>	-0.003	<b>0.289</b>
Water expression	0.236	0.057	0.220
Sea	-0.149	<b>-0.387</b>	<b>-0.465</b>
Glacier	0.109	<b>0.314</b>	<b>-0.342</b>
Overall diversity	0.235	-0.050	-0.066

On the first component, loadings for the diversity of lines and forms, sinuous lines and forms, angular lines and forms, pattern diversity, texture diversity and water current had the highest absolute value and thus showed the strongest correlation. On the second component, vegetation cover showed the highest loading, and then rolling lines, sea, straight lines, glaciers and vegetation diversity. On the third component, sea, glacier, vegetation cover, angular forms, water cover and current, and elevation range bore the highest loadings.

Biplot ordination graphs showed the sample sites positioned according to their scores from the eigenvalue and eigenvector calculations on the first three principal components (Figure 29). Sites were given numbers and colored in accordance to their groups from cluster analysis A above. Groups O, 1, 5 and 10, the small outliers



**Figure 29: Biplots of the first three components: 1 and 2, 1 and 3, and 2 and 3 of the principal component analysis based on the 21 attributes of 160 landscape sites. Different colors represent the groups from Figure 14 and Table 10. Groups O, 1, 5 and 10 were not colored. Arrows indicate the direction and weight of each attribute. See text for more detail.**

groups, were not colored, as these groups were ill-defined. On the biplots, groups stayed together to some extent (forming “clouds”), but also overlapped and were sometimes somewhat dispersed. The variance between groups is rather small, so that the first three components separate them poorly, and many attributes are needed to characterize groups.

Some examples of what can be read from the biplots, especially with regards to the main scenic groups, will be given. On the biplot of components one and two, groups 8, 9, 11 and 12, the main scenic groups, are situated mostly in the middle or to the right hand side of the figure. Attributes which are positively correlated to component one, that is e.g. the diversity of lines and forms, pattern diversity, texture diversity, and water scores, should thus be prominent within these groups, and this fits to what we have already seen from studying the separations in the cluster analysis. Groups 8 and 9 are then more in the middle to bottom of the biplot of components one and two, while groups 11 and 12 are situated in the top half. Attributes which are positively correlated to component two should thus be prominent in groups 11 and 12, and these are e.g. rolling lines and glacier. Attributes which are negatively correlated to the second component, such as vegetation cover, sea, straight lines and vegetation diversity, should be more common in groups 8 and 9. Vegetation cover and vegetation diversity decrease from the bottom of the first biplot to the top of it.

The second biplot in Figure 29, showing components one and three, has even less defined separations between the groups. Sea has a strong negative loading on component three, and a moderate negative loading on component one, and group 3 is situated in the lower left-hand corner; its attributes are thus negatively correlated to components one and three and sea is prominent. Groups 9, 11 and 12 are more to the right of the figure, thus having attributes which are positively correlated to component one, so sites in these groups should be expected to have high scores for diversity of forms, pattern, texture and water scores. The three groups show some variance on component three, with group 9 being furthest to the top, thus having attributes positively correlated to component three, such as vegetation cover, and group 12 having attributes negatively correlated to component three but positively to component one, such as glacier and diverse lines and forms.

The third biplot in Figure 29, which shows components two and three, once again has a great deal of groups overlapping. Groups 8 and 9 are situated mainly in

the top half and a little to the left, thus having attributes which are positively correlated to component three but negatively to component two. These are attributes such as vegetation cover and diversity and water cover and current. Groups 11 and 12 are more to the right and a little to the bottom of the figure, meaning that its attributes should be positively correlated to component two and negatively to component three. This means that rolling lines, glaciers, angular forms, and a high elevation range should be common. Sea cover has strong negative loadings on both components 2 and 3, and thus decreases from the bottom left to top right. Groups are placed in accordance to this. This is all in accordance to what was seen from the score matrix when comparing groups from the cluster analysis. These results from the principal component analysis in general support the groupings from the cluster analysis.

#### **4.4. Discussion**

##### **4.4.1. Limitations to the comparison of NSS and scenic areas**

Landscapes are continuous entities, which usually do not have abrupt boundaries. However, when assessing and/or mapping landscapes, one must have some idea of where the landscape one is assessing ends or starts its (usually gradual) transition into another landscape (García-Quintana et al., 2005; Swanwick, 2002; Tyldesly, 2007). Landscapes are also hierarchical phenomena, with smaller landscapes within the larger (Brown et al., 2005), so it is important to set one's mind to what scale one is working with. The classification method developed for the Icelandic Landscape Project assessed landscape from the “point” at which the assessment was carried out. This starting point worked well for doing the nationwide systematic survey: the sample sites were pre-determined GPS points which one went to and did the survey from. The assessment was done considering everything visible seen from that point, even if “everything visible” straddled the boundaries of two landscapes and actually included landscapes of somewhat different character (maybe depending on what scale you chose to look at it). The method did not, however, directly address the problem of where a landscape begins or ends or the scale of the landscape in question. Given the scale resolution of the project and the patch size of the natural landscape units of Iceland, it was considered a safe assumption that the great majority of sample sites represented one landscape “type” and only a minority was

on the boundaries between two or more types. One outcome of the ILP will be a tool to define boundaries of the major landscape types. The present concern of the ILP was first and foremost the number and types of different landscapes that could be discerned within the NSS sample.

In the current study, we had to decide where within the scenic area we did the sampling – we did not have any fixed GPS point to go to. Some sort of boundaries had to be determined for each scenic site, and in some cases, more thought could have been put into this. The place of sampling was chosen to best represent the landscape in question, but due to the limited experience of the people in the field, some areas could have been better chosen and we often encountered the problem of “Where should we stop the car?” As examples of this, some sites, such as Heinabergsfjöll and Blábjörg, were sampled but left out in the final analysis because they didn’t represent well the landscape of the nominated scenic area (from Table 2). Planning the field survey better beforehand, and sampling more sites within each area to test how much of a difference the change in position made, could have helped us with some of these uncertainties and insights to how to further develop the method with regards to scale or boundaries (e.g. recommendations for the U.K. in Swanwick, 2002). When classifying and comparing the scenic areas on their own, or the NSS sites on their own, this should not be a problem since the methods were consistent within the sampling methods. When comparing the two, one must have this in mind because the approach to choosing the place of assessment differed.

#### **4.4.2. Correspondence to the ILP landscape groups**

What is the relationship between the ILP landscape groups (Figure 26) and the new groups formed with the addition of scenic areas (Figure 27)? When the scenic areas were added to the NSS sample and a cluster analysis performed in the same way as in the ILP, the ILP’s landscape groups turned out to be of varying strength or durability. Some of the groups stayed intact, but others divided (Table 9). On the whole, most of the new groups had an analogy to the ILP classification (Table 10).

There were two groups consisting of coasts and fjords, corresponding to the three groups containing seascapes before. Groups I, II and III were now united in one group (6) plus its outlier (5). Most of the other groups had direct NSS analogies

(Table 10), although sometimes a few NSS sites had moved between groups, and scenic areas had joined them.

Two groups, however, did not have any direct analogy to the ILP and these (groups 10 and 11) consisted almost entirely of scenic areas. Fifteen out of the 48 scenic areas virtually made up their own new group in the classification scheme, and “group” 10 was an outlier to it (and group 12), containing one scenic area. Thirty-eight out of the 48 scenic areas were in groups 8-12, which together made up one of the first main divisions from the top in the cluster analysis (Figure 27). Groups 8-12 contained 53.8% of the whole sample of 160 sites: 79% of the scenic areas and 48.9% of the NSS sites. Krepputunga was the only scenic area in the cluster of groups in the middle (i.e. groups 4, 5 and 6), while in the first main cluster (groups 1, 2 and 3), there were 9 scenic areas.

It is significant that the scenic areas stood apart and made up their own group which did not correspond to a classification without them. This method, with the visual attributes as defined, was able to measure at least some of the variation which sets scenic areas apart from “ordinary” landscapes in Iceland.

#### **4.4.3. Features of groups formed with NSS and scenic areas**

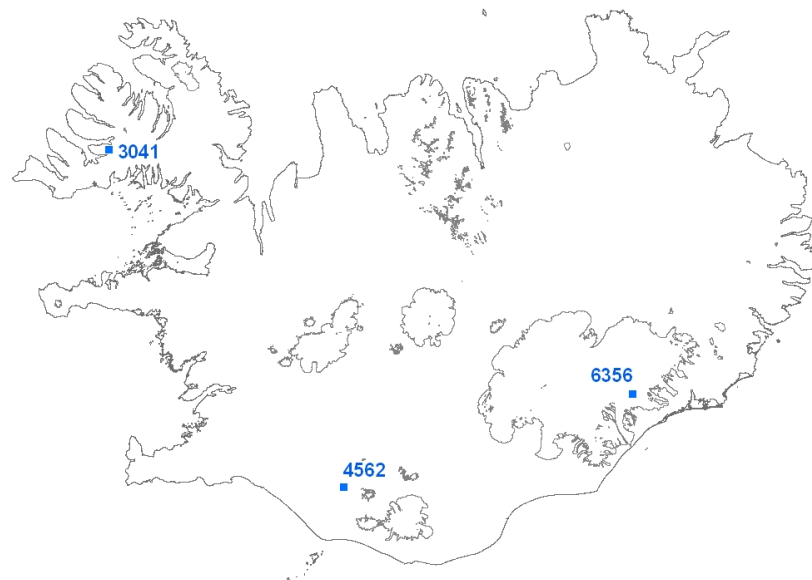
Following is a description of the new groups formed in the cluster analysis with 160 sites and 21 attributes (Dendrogram A in Figure 27, Table 10). The factors which set scenic areas apart from the rest of the sites, within each group, will be sought after as well. In this larger sample, most of the groups had a clear character (e.g. fjords were grouped together, coasts together, barren highlands together), clearer than in the classification of only scenic areas above (Dendrogram S in Figure 6). This is similar to what was found in the groupings for the 112 NSS sites on their own (Thórhallsdóttir, 2009).

#### **4.4.4. Groups O and 1: Glacier and outliers**

Group O (outlier) contained one site (6356, Figure 30) which was an outlier to all of the rest of the sample. This site was the only one taken atop of a glacier, Vatnajökull, and had a flat shape with great visual depth. Rolling and angular lines were common, but straight and sinuous lines absent, the color range was very low and the patch size very large, i.e. virtually only one large patch.



Group 1 (Figure 30) was an outlier group (to groups 2 and 3) and contained only two sites, Dynjandisheiði (3021) and Fjallabaksleið syðri (4562). They did not have enough in common to make up a real landscape type but are none the less more similar to each other than to any other site in the sample. They both had high scores for texture roughness (4 and 5), meaning that they have an uneven and coarse surface, which is rather uncommon in the sample. They also both had low diversity scores, low vegetation cover and lack of water in common. Dynjandisheiði has an unusual combination of high-altitude and low vegetation with high sea cover, and Fjallabaksleið syðri has moderate visual depth and a considerable elevation range, which is also rather uncommon (Bárðarson, 2009). The two sites constituted rare landscapes, at least within this sample and when using this method with these attributes. Another possibility is that these sites do not represent one landscape each, but straddle the boundaries of two different landscapes and thus come out as “hybrid sites”, having characteristics of two or more major landscape groups. To test this, we would need to revise the ILP sites to take landscape boundaries better into account.



**Figure 30: The location of NSS sites in groups O (6356) and 1 (4562 and 3041). For the meaning of the code number for the NSS sites, refer to Figure 2. Map: Andreas Zöhrer (2009).**

#### 4.4.5. Group 2: Fjords



**Figure 31: The location of sites in group 2. Scenic areas (red): Refer to Figure 5 for names. NSS sites (blue): Refer to Figure 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**

Group 2 contained eight fjords, three of which were considered scenic (Figure 31). Sites in this group were united by having a concave basic shape, narrow visual depth for about 270° of their horizon and a great visual depth for about 90° (out to sea). They had a high elevation range because of high mountains; they also had prominent straight lines and above average vegetation cover (when compared to the whole sample of 160 sites). These sites were rather diverse in forms, patterns and texture.

The three scenic areas in group 2 were Kaldalón (Figure 32), Lokinhamradalur and Rauðisandur, all from the Western Fjords. When comparing their scores to the NSS sites in the group (e.g. Figure 33), there were a few slight differences between scenic and “ordinary” fjords. Pattern and texture diversity scored a bit higher for the scenic fjords, and water expression was more diverse. Otherwise, the scenic fjords had similar scores to the other fjords and may perhaps be seen as a sort of “ideal” type (“eidos”) of Icelandic fjords.

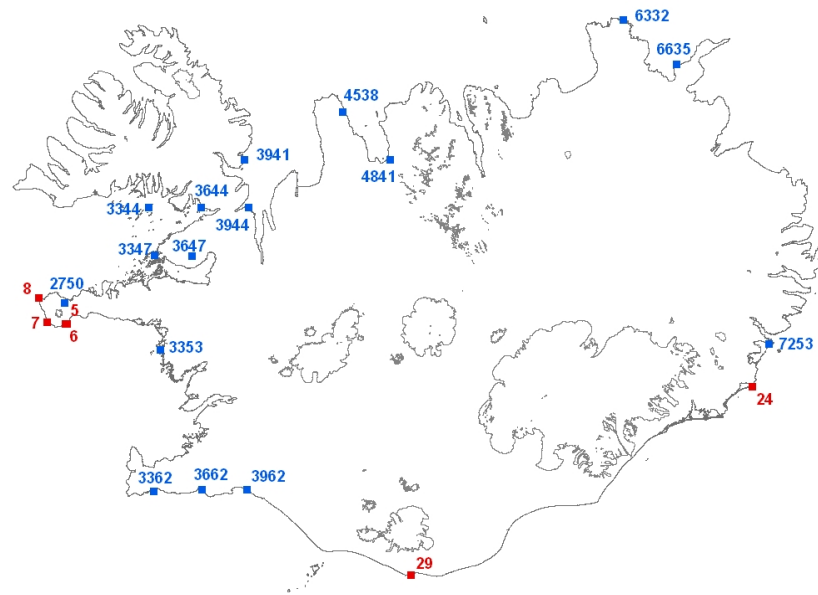


**Figure 32: Kaldalón, Western fjords: an example of a scenic area from group 2, fjords. Photograph: The Icelandic Landscape Project.**



**Figure 33: Site 2741, Fagridalur in Tálknafjörður, Western fjords: an example of a NSS site from group 2, fjords. Photograph: The Icelandic Landscape Project.**

#### 4.4.6. Group 3: Coasts



**Figure 34: The location of sites in group 3. Scenic areas (red): Refer to Figure 5 for names. NSS sites (blue): Refer to Figure 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**

The third group from Figure 27 contained 22 coastal areas, 6 of which were from the scenic sample (Figure 34). Sites in the group mainly had a flat basic shape and high sea cover on usually up to half of their horizon and sometimes even more than half. They were quite well vegetated but not very diverse with regards to vegetation types. Freshwater was present at only a few of the sites. The elevation range in this group scored from 1 to 5 and this very prominent attribute makes the areas quite diverse visually.

The scenic areas in this group were Svörtuloft, Snæfellsjökull, Djúpalónssandur, and Hellnar-Stapi (Figure 35), all from the Snæfellsnes peninsula, and Hvalnes (Figure 20) and Dyrhólaey (Figure 21), from the East and South of the country, respectively. When scores for the six scenic seascapes were compared to the scores of the NSS sites within group 3, there were obvious differences. The scenic seascapes had higher scores for the diversity of lines and forms, color range, pattern and texture diversity and overall diversity, but lower scores for vegetation cover. The scenic seascapes all also had a higher elevation range, and for 5 out of the



6 scenic areas this is due to the proximity to glaciers. Hvalnes also had a high elevation range although only high mountains but no glacier was visible from it.

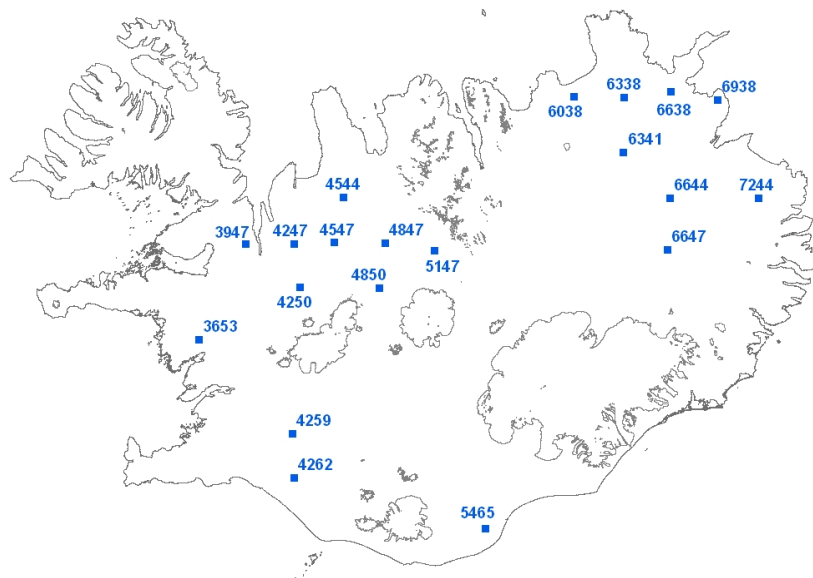
The NSS site most closely related to the scenic seascapes, and the only NSS member of that subgroup, was 2750, a site from the northern side of Snæfellsjökull glacier (the Snæfellsjökull scenic sample was from the southern side). It had some attributes more in common with the scenic areas than the rest of the NSS seascapes: its elevation range due to the presence of a glacier, its lower amount of vegetation, and higher pattern and texture diversity than the average NSS seascapes. All other scores are more in par with the NSS sites in group 3.



**Figure 35: The coast at Hellnar, at the Snæfellsnes peninsula: an example of a scenic area from group 3, coasts. Photograph: The Icelandic Landscape Project.**

#### **4.4.7. Group 4: Vegetated, monotonous plains**

Group 4 was the third largest group in the sample, and the largest group lacking scenic areas (Figures 36, 37). It consisted of vegetated, monotonous plains and heathlands, with a flat or slightly rolling basic shape and a small elevation range, in general. This group had the least diversity in lines and forms of all the groups in this study, and also the highest vegetation cover. Most of the sites in this group contained some calm water.

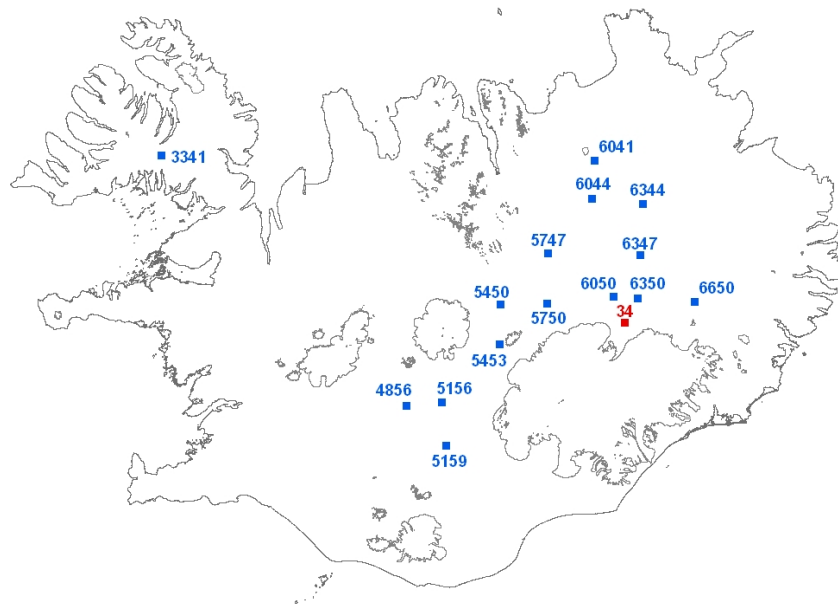


**Figure 36: The location of the NSS sites in group 4. Refer to Figure 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**



**Figure 37: Site 4262, East of Þjórsá river, South Iceland: an example of a NSS site from group 4, vegetated monotonous plains. Photograph: The Icelandic Landscape Project.**

#### 4.4.8. Groups 5 and 6: Rolling barrens or patchily vegetated heathlands (and outliers)



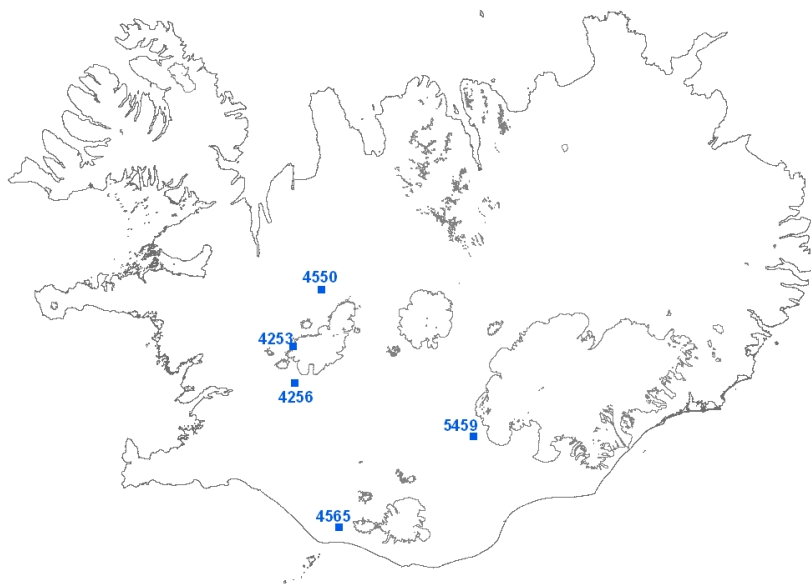
**Figure 38: Location of groups 5 (sites 4856 and 5156) and 6. Scenic area (red): Krepputunga. NSS sites (blue): Refer to Figure 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**

Group 5 was a small outlier group to group 6 (Figures 38 and 39). Group 5 contained two central highland plateau sites with a great visual depth, rolling lines but an otherwise small elevation range, little vegetation but considerable water. Its lines, forms, patterns and textures showed little diversity, but sinuous lines were rather common. Group 6 contained undulating barrens and patchily vegetated heathlands, with and without small amounts of water, and having a greater elevation range than its outliers. The total diversity was quite low. Out of the 14 sites in the group, there was only one scenic area, Krepputunga (Figure 19). It had a few attributes which set it slightly apart from the rest of the sites in the group. The only scores that it had, that no other site in the group had, were scores of 5 for elevation range and 2 for visual depth, so it was more enclosed than the other sites in the group. Krepputunga also scored 5 for rolling lines, which was higher than all but one (6350) of the other sites in the group, and 3 for the diversity of lines and forms, which was also a score only shared with one (6041) other site in the group.



**Figure 39: Site 5156, Illugaverskvísl at Sprengisandur, central highland: an example of an NSS site from group 5, an outlier to the rolling barrens or patchily vegetated heathlands group. Photograph: The Icelandic Landscape Project.**

#### **4.4.9. Group 7: Dry, undulating highlands**



**Figure 40: The location of the NSS sites in group 7. Refer to Figure 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**

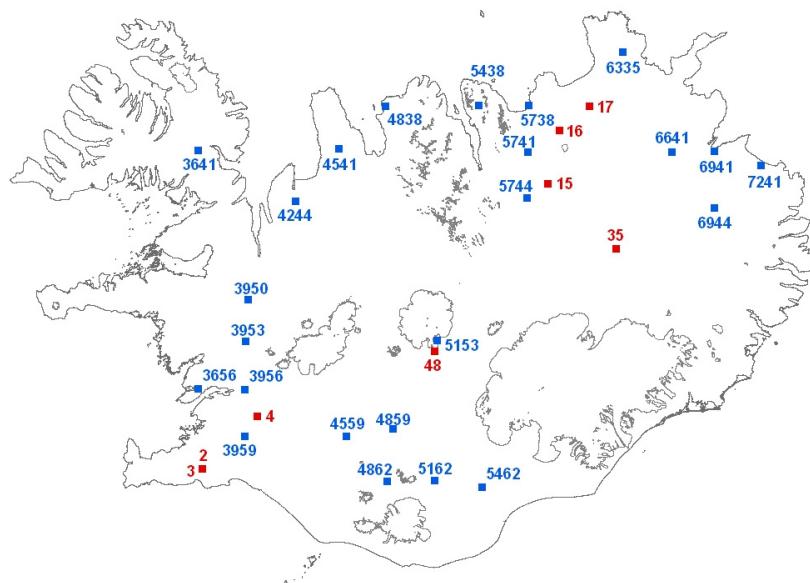
Group 7 was analogous to group V in the ILP, the dry, undulating heathlands (Figures 40, 41). It contained no scenic areas. The sites in this group had considerable amounts of glacier in their vicinity and a high elevation range. The texture was rough, patterns were coarse-grained and rolling lines prominent. All of these areas were in the central highland.





**Figure 41:** Site 5459, Innri-Tungnaárbotnar, central highland: an example of an NSS site from group 7, the dry, undulating highlands. Photograph: The Icelandic Landscape Project.

#### 4.4.10. Group 8: Well vegetated heathlands and shallow valleys



**Figure 42:** The location of sites in group 8. Scenic areas (red): Refer to Figure 5 for names. NSS sites (blue): Refer to Fig. 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).

The eighth group was the largest formed, with 32 sites, thereof 8 scenic (Figures 42, 43, 44). This group of well vegetated heathlands and shallow valleys was heterogeneous in its scores but in general, areas in this group had above average vegetation cover and diversity, a small pattern size and varied patterns, and were

colorful. Sinuous lines were common and water was present, although in varying amounts, at all sites but one (3953: Hálsasveit, Reykholtssdal). This group had a varying basic shape of quite concave to flat, and its total diversity was above average. The scenic areas in this group were Ásbyrgi in the former subgroup, and Þingvellir, Seltún 1 and 2, Þeistareykir, Þjórsárver, Mývatn (Figure 44) and Herðubreiðarlindir (Figure 11) in the latter subgroup. These are all vegetated and colorful areas, with varying amounts of water, usually calm. If scores for the scenic areas in group 8 were compared to the NSS sites' scores, differences were seen for angular lines, vegetation diversity, color range, patterns and texture. All these attributes were more common or more diverse at the scenic sites.

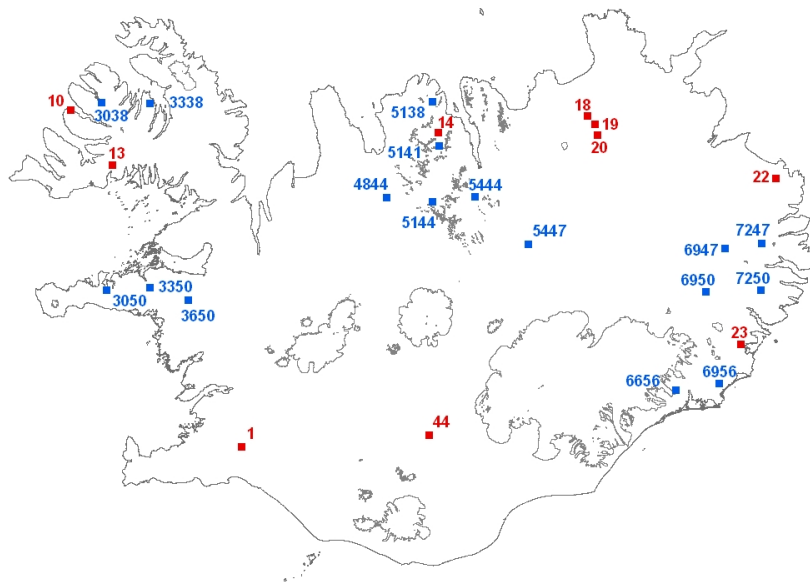


**Figure 43: Site 4838, Fell, Tröllaskaga, northern Iceland: an example of an NSS site from group 8, the well vegetated heathlands and shallow valleys. Photograph: The Icelandic Landscape Project.**



**Figure 44: Mývatn, northern Iceland: an example of a scenic area from group 8, the well vegetated heathlands and shallow valleys. Photograph: The Icelandic Landscape Project.**

#### **4.4.11. Group 9: Well vegetated glaciated valleys**



**Figure 45: The location of sites in group 9. Scenic areas (red): Refer to Fig. 5 for names. NSS sites (blue): Refer to Fig. 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**

Group 9, which consisted of sites which were (usually) well vegetated glaciated valleys, was also large, containing 10 scenic areas and 17 NSS sites (Figure 45). These were rather well vegetated and diverse valleys of various depth, usually narrow and having high mountains. The landscape was more enclosed than in most other groups. Straight and sinuous lines were present in above average amounts, but



rolling lines scored lower. The patterns were fine-grained, diverse, and the terrain unusually coarse in many cases. Water was always present, sometimes expressed in a few ways, and often having high current, rapids or even waterfalls.

The scenic areas in group 9 were Vatnsfjörður, Svarfaðardalur, Geithellnadalur (Figure 10), Keldudalur, Stóruð (Figure 13); Grændalur (Figure 46); Hafragilsfoss (Figure 14), Hljóðaklettur (Figure 47), Hólm Tungur; and Fossavatn at Veðivötn. When scenic areas and NSS sites were compared, there were many differences in the most common scores for attributes: the diversity of lines and forms, vegetation, colors, pattern, and texture being higher at the scenic areas, the texture being rougher, and the scenic areas usually containing more water with a stronger current and more types of water expression. The difference between the first three scenic areas in this group (i.e. in the former subgroup) and NSS sites in that same former subgroup was less striking than the scores for the scenic areas in the latter subgroup. The three scenic valleys Vatnsfjörður, Svarfaðardalur and Geithellnadalur blended quite well into their subgroup of “normal” valleys and fjords, maybe showing that they are some sort of ideal “eidos” forms of Icelandic valleys, similar to the “normal” ones but having some factors which set them a step above. Texture diversity and roughness were the most obvious differences.



**Figure 46: Grændalur, southwest Iceland: an example of a scenic area from group 9, the well vegetated glaciated valleys. Photograph: The Icelandic Landscape Project.**



Figure 47: Hljóðaklettar, northeast Iceland: an example of a scenic area from group 9, the well vegetated glaciated valleys. Photograph: The Icelandic Landscape Project.

#### 4.4.12. Groups 10 and 11: Diverse scenic areas (and an outlier)

“Group” 10 consisted of one single site, Askja (Figures 12 and 48), a geological *sui generis* in this classification scheme, not visually similar to any other site. Its visual depth was rather small, and forms, patterns and textures were diverse. It had a large body of water, and lacked vegetation completely.

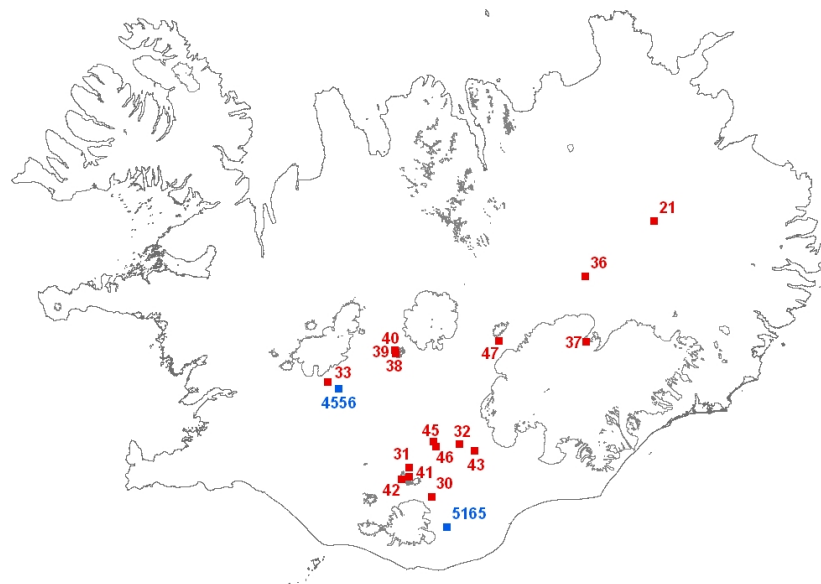
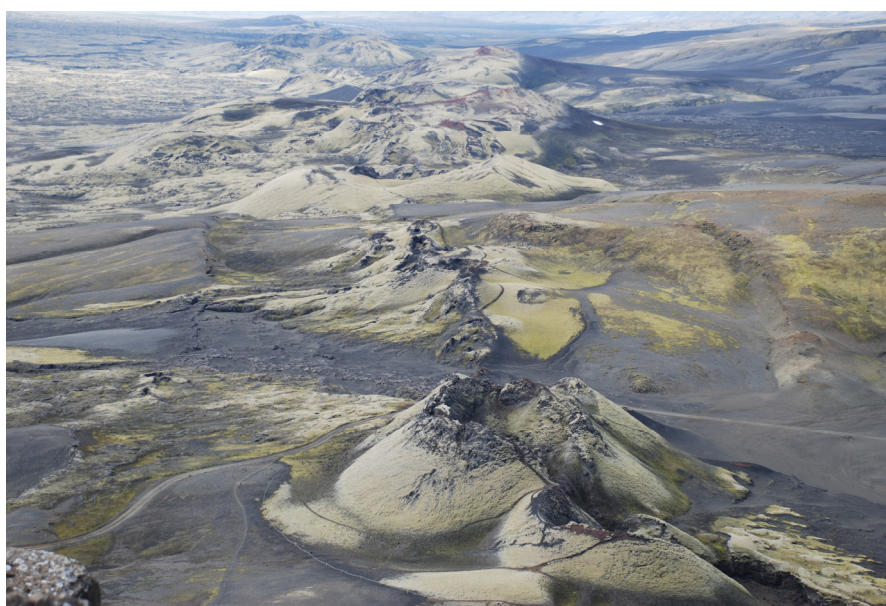


Figure 48: The location of sites in groups 10 (Askja, number 36) and 11. Scenic areas (red): Refer to Figure 5 for names. NSS sites (blue): Refer to Figure 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).

Group 11 was a group of almost exclusively scenic areas, or 15 out of the 17 sites in this group (Figures 48, 49, 50). This group was united by high scores for all factors which pertain to diversity, the overall diversity being the highest in this group among all others. All scores for lines and forms, except straight lines, were high, the color range was vast, the pattern size more fine-grained in comparison to other groups, and pattern and texture diversity high. Water was always present, often in diverse forms. A glacier was visible from all of these sites but five. Basic shape varied from concave to flat. Two subgroups can be noted within group 11, the former having higher scores for color range, texture diversity and overall diversity, with less visual depth. As noted, the scenic areas within group 11 had in common high scores for diversity but are still a very heterogeneous group visually. In the case of this group, high diversity scores unite the sites but are also what made them very variable visually.

The only two NSS sites in group 11 were 5165, Rjúpnafell, and site 4556, south of Kjalvegur (Figure 50). It would be interesting to see whether they could be considered scenic, although it is important to remember that the method can be used to analyze the properties of scenic areas, but not conversely to assume that areas bearing these same properties are necessarily scenic – there is more to it than just the absence or presence of some attributes, and other things, some difficult to measure, such as unity and coherence, are important as well.



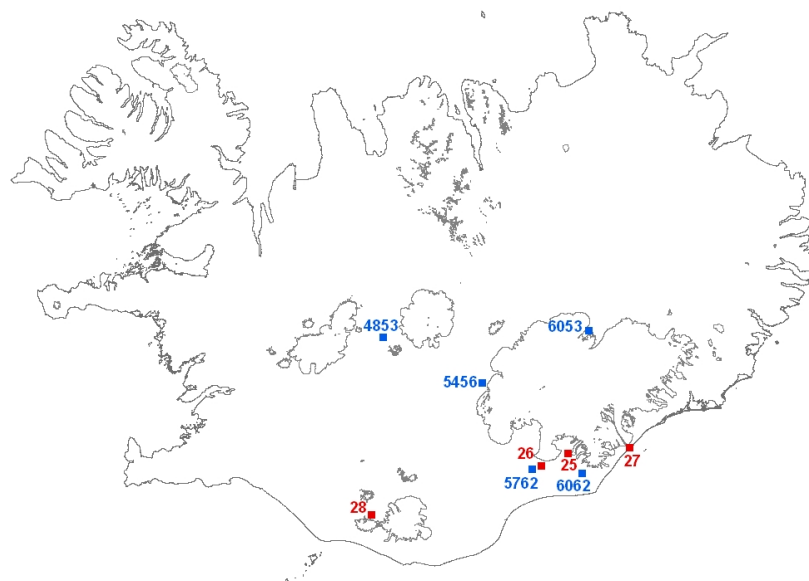
**Figure 49: Lakagígar, central highlands: an example of a scenic area from group 11, the diverse scenic areas. Photograph: The Icelandic Landscape Project.**





**Figure 50: Site 4556, Sunnan Kjalveggar, central highlands: an example of an NSS site from group 11, the diverse scenic areas. Photograph: The Icelandic Landscape Project.**

#### **4.4.13. Group 12: Diverse plains with glaciers**



**Figure 51: The location of sites in group 12. Scenic areas (red): Refer to Fig. 5 for names. NSS sites (blue): Refer to Fig. 2 for the meaning of the code numbers. Map: Andreas Zöhrer (2009).**

Finally, group 12, diverse plains with glaciers and high mountains, contained 9 sites, 4 of which were scenic (Figure 51). Basic shape again varied, but was usually flat. The elevation range was the highest, water always present, and glaciers always prominent. Forms were diverse and sinuous lines unusually common. The scenic areas in this group were Skaftafell, Þórsmörk (Figure 18), Skeiðarársandur (Figure

15) and Jökulsárlón (Figure 52). They all had a higher elevation range than the NSS sites, more angular lines, and a higher overall diversity than the NSS sites. They usually had higher scores, but sometimes overlapping, for straight lines, rolling lines, the diversity of lines and forms, colors, pattern diversity, texture diversity and water cover. Skaftafell and Þórsmörk also had higher scores for vegetation cover and diversity. Once again, the diversity scores show the most striking differences between scenic areas and NSS sites.

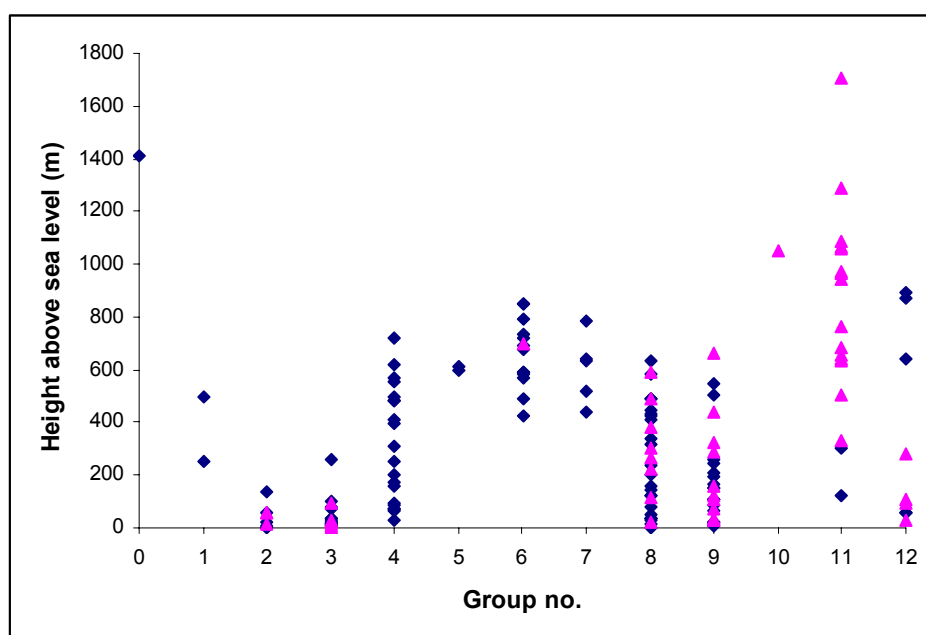


**Figure 52: Jökulsárlón, south Iceland: an example of a scenic area from group 12, diverse plains with glaciers. Photograph: The Icelandic Landscape Project.**

#### **4.4.14. Altitudinal distribution**

Comparing the altitude at which samples were taken, some of the groups' sample sites were situated at a low elevation, such as the coastal groups 2 and 3, while others were higher above sea level, such as groups 5, 6 and 7, highland groups (Figure 53). Most of the groups, however, had sites within a large range of altitude. The scenic group 11 has the widest altitude range its assessment points. (This is not to be confused with the elevation range of sites within groups.)





**Figure 53: The altitude at sample sites in groups from Dendrogram A (Figure 27). Group 0 refers to group O. Blue: NSS sites. Pink: Scenic sites. Sample size = 160; 112 NSS sites and 48 scenic sites.**

The elevation range of about 400-600 m is the most common elevation for heathlands, at the boundaries of the lowlands and highlands (Ólafsson, 2000). In this study, most of the areas in this elevation range were NSS sites (Figure 53). Groups 5, 6 and 7 were actually mainly in this elevation range or a little above it, and contained patchily vegetated heathlands and rolling barrens or highlands. These three groups only contained one scenic area. They were also some of the least diverse groups in the sample, along with group 4, which lacked scenic areas completely and had quite a few heathlands. Visual homogeneity and lack of scenic areas went together in these cases – opposite to e.g. group 11, where visual diversity was the highest but NSS sites proportionally few.

There were only four scenic sites sampled at this “heathland elevation range”: Stóruð at Dyrfjöll (Figure 13), Brytalækir, Herðubreiðarlindir (Figure 11) and Þjórsárver. However, not only heathlands are common in this elevation range, but also wetlands: many of Iceland’s biggest highland wetlands are in this elevation range, such as Tvídægri, Þjórsárver and Guðlaugstungur (Ólafsson, 2000). The three of the latter scenic areas in this study in this elevation range fit into such a description as well. At least three sites nominated as scenic were, however, heathlands, but only mentioned once and thus not included in the study: Gláma in

Dynjandisheiði heath, Fróðárheiði heath and Hálfván heath in the Western Fjords (Table 2).

#### **4.4.15. The scenic areas' differences from NSS sites**

The fact that scenic areas showed such a strong tendency to cluster together, even forming their exclusive group, demonstrates that they differed from the “common” landscapes of the NSS sites, and that the approach and methods used here were sensitive to those differences. The scenic areas were, at the same time, quite diverse among themselves, and their groupings did not necessarily make up true landscape types having the same “character”, but consisted of very diverse areas or areas with similar patterns of high diversity.

Recurrently, through the description of the groups and separations, the same attributes kept being the ones which separated scenic areas from the NSS sites. These were most obviously the scores which pertained to diversity. Also, from the Chi-squared test (Table 7, Figure 25), we saw that there were significant differences in scores for 14 out of the 21 attributes. All attributes which enter the overall diversity average score – except vegetation diversity – scored significantly higher, and as a result, so did overall diversity, which is significantly higher at the scenic areas in this study. The attributes which do not enter the overall diversity average score but also showed significant differences in the distribution of scores were angular and sinuous lines and forms, vegetation cover, pattern size, water cover, water current and glacier.

Vegetation diversity was not significantly different at the assessed scenic areas and NSS sites in Iceland and vegetation cover scores were significantly *lower* (Figure 25), which may be counterintuitive when compared to other countries. Vegetated and natural-looking landscapes are usually what is most valued elsewhere (e.g. Landscape Aesthetics, 1995; Sundell-Turner & Rodewald, 2008; Yang & Brown, 1992), and vegetation succession was used as an indicator of naturalness in Ode et al. (2009). Iceland has experienced massive vegetation loss and soil erosion, and here, many of the sites widely recognized as scenic were devoid of or almost devoid of vegetation. Icelandic landscapes are perceived as natural despite their scarce vegetation, so this would be different from what is common in frameworks

from abroad, where more diverse and coherent vegetation is often used to indicate more naturalness and scenic attractiveness.

Some of the scenic sites in this study are likely to have the geological factors more to thank for their designation than their vegetation. This may be different from what is often seen in other countries; the Icelandic scenic areas are usually not biological “hotspots”, although some are biologically diverse on an Icelandic scale. Another possibility may be that the method is not precise enough in its assessment of vegetation cover and diversity. GIS could potentially be used for mapping and measuring vegetation cover (and other attributes) more rigorously. GIS is used as a tool in landscape assessments in other countries to an increasing degree and can compliment field assessments. It can be used on a larger scale than field assessments, and is a consistent tool (Brabyn, 1996, 2005; Sundell-Turner & Rodewald, 2008; Swanwick, 2002). The third possibility is that the samples did not represent the country well enough or were somewhat skewed. For example, as was seen with the elevation of the sampled sites (Table 6), the NSS samples did not represent the highest altitudes well enough and so the sites that were sampled may have a disproportionate amount of vegetation.

Factors such as elevation range and the diversity of lines and forms, which showed significant differences between NSS and scenic areas – a higher elevation range and more diverse lines and forms at scenic areas – were also more linked to geology than vegetation with this assessment method. Areas with a great elevation range had high, usually “naked” mountains (or glaciers) where stacks of horizontal (straight lines and forms) and sharp (angular lines and forms) bedrock were visible, and the diversity of lines and forms, including the irregular forms, was usually due to geological formations. Glaciers were also significantly more often present at areas designated as having scenic landscapes than at the NSS sites.

Pattern size was more fine-grained at the scenic areas, meaning smaller-sized patches which usually leads to more diverse patterns. Patterns were significantly more diverse at scenic areas. Color range, pattern diversity and texture diversity all had higher scores in scenic areas, indicating more diversity at the scenic areas (Figure 25). These scores derive from various factors, such as the bedrock, landforms, topography, vegetation, snow and water in the landscape.

Water cover, current and expression were all more pronounced in scenic areas than in the NSS sites. Water is one of the factors most often mentioned as something

which people are attracted to (Dramstad et al., 2006; Herzog, 1985; Hudson, 2000; Landscape Aesthetics, 1995; Yang & Brown, 1992) and has also been found to be positively perceived in Iceland (Kristinsdóttir, 2004). Waterfalls appear to have universal appeal (Hudson, 2000), and rushing water and mountain waterscapes were preferred over swamps in a preference study on waterscapes by Herzog (1985). The higher current scores at scenic areas than NSS sites, indicating more rapids and waterfalls, point to a similarity here. Sinuous lines as well, which had significantly higher scores at scenic areas, were most often due to rivers, although they also got scores from geological or other features, such as cliffs, landslides and the coarse lava ropes at Snæfellsjökull.

There was no evidence that the following attributes were distributed differently at scenic areas and NSS sites: basic shape, visual depth, straight lines, rolling lines, vegetation diversity, surface texture roughness, and sea. All of these attributes, except basic shape, visual depth, and surface texture, however, did get moderate loadings in the PCA, and some of the groups' divisions from each other are due in part to these attributes, but none the less they did not separate the NSS sites from the scenic. Vegetation diversity was discussed above. The fact that sea showed a similar distribution of scores indicates that sites were probably situated similarly at or away from the coast; this happened by chance. The scores for surface texture may need to be revised so that their inclusion would account for more of the variance between sites, maybe by having two scores for it where there is now only one ("surface roughness"): both a qualitative one (how rough is the terrain) and a quantitative one (how much of the area is rough?). Most sites scored a 2 or a 3 for surface texture, so this attribute did not allow for much variation

Visual depth is an interesting case here and needs special consideration. In Appleton's theory (1975), a more open landscape provides a better view and more prospect and should thus be favored. It also provides more information, which is favorable in Kaplan and Kaplan's information theory (Kaplan & Kaplan, 1989). Visual openness has been found to be preferred, even cross-culturally, over a restricted view in preference studies (e.g. Han, 2007; Yang & Brown, 1992). For example, in a preference study by Herzog (1985), "spacious" waterscapes (spaciousness being explained as "the *feeling of spaciousness* that the scene conveys. Ask yourself how much room there is to wander around in." (Herzog, 1985, p. 229)) were more preferred than those more enclosed. Although scores for visual depth did

not differ significantly between the NSS and scenic areas because of this attribute, there was at least one case where a scenic area surely differed from NSS sites within its groups because of it. Krepputunga was the only scenic site within the cluster of groups 4, 5 and 6. One of the few factors that set it apart from other sites in its group was how enclosed it was in comparison to them: Krepputunga had a higher elevation range and a shorter visual depth. Landscapes with a near to medium horizon have been found to be more appealing, to Icelanders, than more open landscapes in Iceland (Kristinsdóttir, 2004). This goes against the theories and studies from abroad, that more open landscapes are more preferred. However, Icelandic landscapes are often extremely open, more so than in for example Europe where trees commonly close off the view, so what is considered an enclosed area here might be considered comparatively wide elsewhere.

Straight lines may be yet another example of an attribute which might be interpreted differently in Iceland than elsewhere. Bartel (2000) mentioned that the more straight lines present in the landscape, the greater the degree of human impact. Usually straight lines in our assessment referred to natural elements, such as horizontal layers of basaltic lava in Tertiary mountains, and human impact was not assessed.

Looking at what attributes were most important in determining the separations in the cluster analysis (Figure 27) and which had the highest loadings in the principal component analysis (Table 11), one finds that very many attributes are needed to explain differences between groups and sites, and many scores overlapped between groups. Some general trends could be discerned, but usually with exceptions in most groups. The most important attributes, altogether, seemed to be sea, freshwater, vegetation scores and the diversity of lines and forms, patterns and texture, according to the principal component analysis. These explained a larger part of the variation between sites than the other attributes.

In both principal component analyses, i.e. the one with the whole sample (section 4.3.5.) and the one with only scenic areas (section 3.3.3.), the first three components only explained about 56% of the variance; hence there is not much covariance between the attributes. Mostly the same attributes got high loadings on the first three components in both cases. These attributes included most of the lines and forms scores, vegetation and water scores, pattern and texture diversity, sea, and glacier, and color range, and elevation range, to a smaller extent.

Some of the differences seen between the principal component analyses were that the diversity of lines and forms bore a strong loading on component one in the case of the larger sample, but was not important for the scenic areas on their own. This is most likely because the scenic sample had higher scores for diversity at most sites, and so this factor did not account for much of the difference between sites, but the scores varied more when NSS and scenic sites were combined.

The striking difference between scenic and “ordinary” landscape sites in Iceland, due to diversity, may indicate that visual diversity, among other things, is a measure for scenic quality. This has been found in many studies (Dramstad et al., 2006; Ode et al., 2008; Tveit et al., 2006). In Kristinsdottir (2004), diverse Icelandic landscapes were more preferred over homogenous landscapes, and homogenous landscapes lacking water were the least preferred. Here, the scenic area sample has proven to be significantly more diverse from the NSS sites and to include more water as well. The national and international frameworks for the protection or management of landscapes, reviewed above, all acknowledged diversity or variety, as well as rarity and uniqueness, as some of the most important indicators of scenic beauty (Dudley, 2008; Landscape Aesthetics, 1995; Swanwick, 2002; Tyldesly, 2007). The ILP’s method gives us a tool to analyze landscape diversity, and also to find out which landscapes are rare or unique, or representative of different areas.

## 5. Conclusions

In the Icelandic Landscape Project (ILP), a classification scheme was developed based on some of the visual, physical attributes in the landscape as relevant for Icelandic conditions. Landscape classifications are tools for further research and evaluation (Pedroli, Pinto-Correia, & Cornish, 2006). This study exemplifies the possibilities that the ILP classification method offers for research on other aspects of the visual landscape. Here, scenic areas were compared to the ILP sample to see if they differed from one another and, if so, in what manner.

This study was the first of its kind in Iceland. The main results were that the method developed was able to discern a difference between scenic areas and “ordinary” landscapes. The differences lay in scores for water, glacier, elevation range, the diversity of lines, forms, patterns, and texture diversity, while vegetation diversity did not differ and vegetation cover was lower. Taken individually, the scenic areas were quite diverse: the high diversity scores that they had in common did not therefore unite them as being of one visual character, but rather underlined their variation. Even if one had the feeling that scenic areas were diverse beforehand, there *“is a value in verifying commonly held intuitions empirically”* (Herzog, 1985, p. 240). The results of the current study may lead us to a better understanding of what underlies scenic quality, be used for further work on evaluating it, and for building up guidelines with indicators for assessing e.g. landscape diversity and rarity.

This was an analysis of areas which many find beautiful, but not a value judgment of beauty. The results yielded insights into Icelandic landscapes and identified characteristics that contribute to scenic quality. This is not biconditional. We cannot be sure that areas containing these characteristics are surely scenic. Other aspects, not measured with this method or with the naked eye, are also important for scenic quality, e.g. sounds, smells, history, harmony, mystery, sublimity, and the wonder that the landscape brings. Also, as happened in this study, areas within the same group were sometimes, but not always, visually similar, and often quite different from one another. In the end each case would need to be assessed and evaluated separately, and the use of indicators could be a systematic and transparent way to do so.

Nature conservation authorities worldwide recognize the importance of protecting or taking care of exceptional landscapes, and commonly use terms such as diversity, naturalness, harmony, vividness, mystery, uniqueness and rarity to describe the landscapes of greatest value. Care must be taken in determining which areas are rare, exceptionally diverse, and exceptionally scenic, as these may be of great value. The ILP's method, used here, can give an indication of rarity, uniqueness, diversity, and representativeness. Perhaps it would be possible to create indicators for some of the other terms as well. Some ideas can be drawn from the example framework for assessing visual character above (Table 1) (Ode et al., 2008; Tveit et al., 2006). Human elements are left out in this methodology but could be valuable additions, and give indication for naturalness, disturbance, and historicity (as in Table 1). The single landscape elements, such as cliffs and waterfalls, which are not yet taken into account, would give some more indication for imageability as defined in the example framework, which is a type of representativeness, uniqueness or rarity. Landscapes are made up of so much more than what is visually or physically present. Some of the widely used terms for scenic quality, such as mystery, balance, harmony and vividness, are important for landscapes but difficult to measure. The contrasts common in Icelandic landscapes might also be important for the visual quality.

Any indicators taken up would need to be modified and localized to suit the unusual Icelandic conditions, for example Iceland's special cases of an often unusually wide visual range, lack of trees and sometimes sparse vegetation, obvious geological lines and forms, and often little visible human structures. But these terms and indicators could be worth studying better and maybe testing or applying in Iceland.

The multivariate methods used here have the advantage of being flexible: it is easy to add or remove attributes and see what impact that has. Human constructs and single landscape features could potentially be included and tested to see if their inclusion improved the method. Other corrections to the methodology, such as a better distinguishing between lakes and rivers and clearer scores for texture roughness, are also needed. One must also remember that statistics are only a tool and are never better than the underlying data. Indicators and classifications are generalizations and can not capture all of the complexities of landscapes (Brabyn, 2005).



Landscapes have value as *unique* resources, meaning that they cannot be exchanged or fully substituted by other landscapes if they are lost (Arler, 2006). The understanding and emphasis placed on different aspects of landscapes vary from time to time and place to place, and there is no universal methodology that fits for all landscapes everywhere, at all times. Studying people's preferences for the ILP landscape groups, that is, the evaluation part of the project has still to come. The goal is then to combine results from the classification and the evaluation phases.

There will always be some subjectivity to landscape assessment. This is the nature of the concept. In the United Kingdom's Landscape Character Assessment, the role for subjectivity is accepted and dealt with in a systematic and transparent way (Swanwick, 2002). Common sense must also be applied, not the least when nominating areas for nature conservation as scenic landscapes. If scenery is visibly pleasing, but ecosystem health is suffering, as is in many places in Iceland, other values must be weighed together with the aesthetic ones. Conversely, activities proposed to create ecosystem health, or sometimes "economic health", may have inverse effects on scenic diversity, and so care should be taken to manage landscapes, the economy and the ecosystems together, to enhance all. Holistic management is needed.

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