

**Natural Conditions and the
Conservation Value of Natural Phenomena
North of the Glacier Vatnajökull – a Summary**

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Prepared for the Icelandic Ministry for the Environment

NÍ-03017

Reykjavík, Iceland, in October 2003



NÁTTÚRUFRAEÐISTOFNUN ÍSLANDS

SUMMARY

This summary report was compiled at the request of the Icelandic Ministry for the Environment for a committee on establishing a national park north of the glacier Vatnajökull. The committee originally requested that the Icelandic Institute of Natural History collect a summary of the main aspects of natural conditions of the region from Vonarskarð to Lónsöræfi. After the first draft was ready, in mid-January 2003, the institute was asked to add to the summary on the one hand the watershed of the river Jökulsá á Fjöllum from its origin to the river mouth and on the other hand the land belonging to Mývatnssveit and the river Laxá.

The first part [of the report] deals with the plateau north of Vatnajökull glacier, an area totalling around 9800 km². Apart from the highlands adjacent to the northeastern and eastern edges of Vatnajökull, the whole region lies within the youngest and most volcanic part of the country, the eastern volcanic zone. The eastern part of the interior plateau is where volcanic activity is most visible; here there are vast lava fields, dry and sparsely vegetated deserts. Towards the west and south precipitation increases, the bedrock becomes less permeable, and the flora and fauna become more prominent among natural characteristics. The area is uninhabited and land use is mainly in the form of tourism. About two-thirds of the area is either declared a reserve or is in the Nature Conservation Registry.

Knowledge of natural conditions in the highlands north of Vatnajökull differs with regard to individual areas and components of the conditions. Knowledge must be accounted good in the expanses that have been investigated most in connection with potential hydropower production in East Iceland, while the knowledge of other areas is generally very fragmented. The vegetation and the species composition of flora is in most places well or acceptably well known, whereas the knowledge of geology and bird life has more gaps. Biotic habitat types have been defined and mapped in around a quarter of the area. Having been little studied, terrestrial invertebrates are little known.

This report contains an assessment of the conservation value of sites of special natural interest (respecting landscape, vegetation cover, habitat types, rare species and important species) based on current sources. The assessment utilises methods that the Icelandic Institute of Natural History has developed in recent years in connection with the Master Plan for Utilisation of Renewable Energy Resources in Iceland and in connection with the suggested National Nature Conservation Strategy.

To facilitate discussion on nature and the conservation value of sites of natural interest (i.e., biological and geological sites), the highlands north of Vatnajökull glacier are divided into smaller units corresponding to sub-areas in the Regional Plan for the Central Highlands of Iceland. The following areas are dealt with:

- Tungnafellsjökull–Vonarskarð
- Headwaters of the river Skjálfandafljót
- Trölladyngja
- Askja–Dyngjufjöll
- Herðubreið
- Ódáðahraun
- Kverkfjöll–Krepputunga
- Brúardalir (excluding Arnardalur in this case)
- Möðrudalsöræfi–Arnardalur
- Snæfellsöræfi (Vesturöræfi–Snæfell–Kringilsárrani–Eyjabakkar)
- Hraun (including Múli)
- Lónsöræfi (including the mountainous area in the southeastern corner of the country).

Even if giving large and possibly heterogeneous areas an overall grade for conservation value is dubious, it can be stated briefly that nine of the above-mentioned areas included in the discussion have a high conservation value, and three of them (the headwaters of Skjálfandafljót, Brúardalir, Hraun) an intermediate value or less. The Pink-footed Goose is the characteristic bird of the interior north of Vatnajökull and the area as a whole has considerable international value for the reproduction of the species.

A separate chapter deals with rare organisms and geological phenomena that are known in the highlands north of Vatnajökull glacier. The registration of rare geological phenomena is still in the early stages, and this report contains only a preliminary list of such phenomena. On the plateau north of Vatnajökull glacier, ten rare species of vascular plants have been recorded, among them *Ophioglossum azoricum* (Adder's tongue), which is on the Red List; eleven very rare species of moss, among them six on the Red List; and twenty rare species of lichen, of which six are on the Red List and five have not been recorded in Iceland outside the region. Nine bird species on the Red List breed or have bred in the region.

The second half of the report deals with Lake Mývatn and the northernmost part of the municipality of Skútustaðahreppur, together with the river Laxá and the lower part of the river Jökulsá á Fjöllum—a total area of 1850 km². It is difficult to find a common denominator for these areas. On the one hand this includes one of the greatest glacial rivers of Iceland, its canyons as they have been moulded by catastrophic floods, and a vast estuary area. On the other hand, there is one of the most fertile lakes in the northern hemisphere, situated in the centre of volcanically scorched open spaces.

A summary of natural characteristics and the conservation value of sites of natural interest is presented for three defined areas:

- Mývatnssveit (Mývatn and vicinity) and Laxá
- Jökulsárgljúfur (both sides of the river)
- Öxarfjörður.

All these areas have a high conservation value, whether on a national or global scale, and every one displays in its own way priceless natural phenomena—biotic and abiotic. They have thus already been designated as reserves or are in the Nature Conservation Registry. The biota are of course lush and more diverse in the lowlands than in the highlands. Mývatn–Laxá and Öxarfjörður have international conservation value as breeding grounds and/or moulting areas for birds. Lake Mývatn is of fundamental value for at least six species of birds (affecting around or over half of the Icelandic population) and Öxarfjörður for three species (affecting 5–20% of the population).

In the three areas, seventeen vascular plant species have been found, of which six are on the Red List; two rare species of moss; and fifteen extremely rare species of lichens, including six on the endangered list. The bird life is abundant and diverse, particularly at Mývatn–Laxá and Öxarfjörður. A total of sixteen species on the Red List breed or have bred in the three areas.

In connection with preparing the National Nature Conservation Strategy the Icelandic Institute of Natural History has previously proposed that some of the areas that have been discussed here be protected because of their unique biota or geological interest. This is the case for Kverkfjöll–Krepputunga, Snæfellsöræfi and Öxarfjörður.

ÍSLENSKT ÁGRIP

Þessi yfirlitsskýrsla er tekin saman að beiðni umhverfisráðuneytisins fyrir nefnd um stofnun þjóðgarðs norðan Vatnajökuls. Nefndin óskaði upphaflega eftir því að Náttúrufræðistofnun Íslands tæki saman yfirlit yfir helstu þætti í náttúrufari svæðisins frá Vonarskarði til Lónsöræfa. Eftir að fyrstu drög lágu fyrir, um miðjan janúar 2003, var stofnunin beðin að bæta við yfirlitið annars vegar vatnasviði Jökulsár á Fjöllum frá upptökum til ósa og hins vegar Mývatnssveit og Laxá.

Fyrsti hluti fjallar um hásléttuna norðan Vatnajökuls, alls um 9.800 km². Að hálendinu við norðaustur- og austurjaðar Vatnajökuls undanskildu fellur allt svæðið innan yngsta og eldvirkasta hluta landsins, þ.e. eystra gosbeltisins. Á eystri hluta hásléttunnar er eldvirknin sýnilegust; þar eru víðáttumikil eldbrunnin, þurr og lítt gróin öræfi. Eftir því sem vestar og sunnar dregur eykst úrkoma, berggrunnur þéttist og gróður og dýralíf verða áberandi í náttúrufari. Engin byggð er á þessu svæði og landnytjar helst í formi ferðamennsku. Um tveir þriðju hlutar svæðisins eru ýmist friðlýstir eða á náttúruminjaskrá.

Þekking á náttúrufari á hálendinu norðan Vatnajökuls er misjöfn bæði hvað varðar einstök landsvæði og náttúrufarsþætti. Hún verður að teljast góð á þeim svæðum sem mest hafa verið til skoðunar vegna hugsanlegra virkjana á Austurlandi en er afar brotarkennd víðast annars staðar. Gróðurfar og tegundasamsetning flórunnar er víðast vel eða sæmilega þekkt en þekking á jarðfræði og fuglalífi er glöppóttari. Vistgerðir hafa verið skilgreindar og kortlagðar á um fjórðungi svæðisins. Smádýralíf er lítið rannsakað og því lítið þekkt.

Í skýrslunni er lagt mat á verndargildi helstu náttúruminja (landslags, gróðurþekju, vistgerða, sjaldgæfra tegunda og mikilvægra tegunda) eftir því sem efni standa til. Við matið er notuð aðferðafræði sem Náttúrufræðistofnun Íslands hefur verið að þróa á undanförunum árum í tengslum við Rammaáætlun um nýtingu vatnsafls og jarðvarma og í tengslum við náttúruverndaráætlun fyrir landið.

Til að auðvelda umfjöllun um náttúrufar og verndargildi náttúruminja (þ.e. lífríkisminja og jarðminja) er hálendinu norðan Vatnajökuls skipt í smærri einingar sem samsvara deilissvæðum í Svæðisskipulagi miðhálandis Íslands. Fjallað er um eftirfarandi svæði:

- Tungnafellsjökull–Vonarskarð
- Drög Skjálfandafljóts
- Trölladyngja
- Askja–Dyngjufjöll
- Herðubreið
- Ódáðahraun
- Kverkfjöll–Krepputunga
- Brúardalir (hér er Arnardalur undanskilinn)
- Möðrudalsöræfi–Arnardalur
- Snæfellsöræfi (Vesturöræfi–Snæfell–Kringilsárrani–Eyjabakkar)
- Hraun (ásamt Múla)
- Lónsöræfi (að viðbættu fjallendinu á SA-horni landsins).

Þótt vafasamt sé að gefa stórum og e.t.v. misleitum svæðum heildareinkunn fyrir verndargildi, þá má í stuttu máli segja að nú af framangreindum svæðum sem tekin eru til umfjöllunar hafi hátt almennt verndargildi en þrjú þeirra (Drög Skjálfandafljóts, Brúardalir, Hraun) miðlungshátt eða minna. Heiðagæs er einkennisfugl hálendisins norðan Vatnajökuls og svæðið í heild sinni hefur verulega alþjóðlega þýðingu fyrir viðkomu tegundarinnar.

Í sérstökum kafla er fjallað um sjaldgæfar lífverur og jarðminjar sem þekktar eru á hálendinu norðan Vatnajökuls. Skráning sjaldgæfra jarðminja er stutt á veg komin og hér er aðeins birtur bráðabirgðalisti yfir slíkar minjar. Á hásléttunni norðan Vatnajökuls hafa fundist tíu sjaldgæfar háplöntutegundir, þar á meðal naðurtunga sem er á válista, ellefu afar sjaldgæfar mosategundir, þar af sex á válista, tuttugu sjaldgæfar fléttutegundir, þar af sex á válista og fimm sem ekki hafa fundist utan svæðisins. Níu fuglategundir á válista verpa eða hafa orpið á svæðinu.

Í seinni hluta skýrslunnar er fjallað um Mývatn ásamt nyrsta hluta Skútustaðahrepps og Laxá og neðri hluta Jökulsár á Fjöllum, alls um 1850 km² lands. Erfitt er að finna augljósan samnefnara fyrir þessi svæði. Annars vegar er um að ræða eina stærstu jökulá landsins, gljúfur hennar mótuð af hamfara-hlaupum og víðáttumikil ósasvæði. Hins vegar eitthvert frjósamasta stöðuvatn á norðurhveli jarðar, mitt í eldbrunnum víðáttum.

Yfirlit yfir náttúrufar og verndargildi náttúruminja er gefið fyrir þrjú afmörkuð svæði:

- Mývatnssveit (Mývatn og nágrenni) og Laxá
- Jökulsárgljúfur (beggja vegna árinna)
- Öxarfjörður.

Öll hafa þessi svæði hátt verndargildi hvort sem er á lands- eða heimsvísu og skarta hvert á sinn hátt ómetanlegum náttúruminum, lífandi og dauðum, enda ýmist friðlýst nú þegar eða á náttúruminjaskrá. Lífríkið er eðlilega gróskumeira og fjölbreyttara á láglandi en hálendi. Mývatn–Laxá og Öxarfjörður hafa alþjóðlegt verndargildi sem varpland og/eða fellisvæði fyrir fugla. Mývatn hefur afgerandi þýðingu fyrir a.m.k. sex fuglategundir (um eða yfir helmingur stofns) og Öxarfjörður fyrir þrjár tegundir (5–20% stofns).

Á svæðunum þremur hafa fundist sautján sjaldgæfar háplöntutegundir, þar af sex á válista, tvær sjaldgæfar mosategundir og fimmtán afar sjaldgæfar fléttutegundir, þar af sex á válista. Fuglalíf er mikið og auðugt, einkum við Mývatn–Laxá og Öxarfjörð. Samtals sextán tegundir á válista verpa eða hafa orpið á svæðunum þremur.

Í tengslum við undirbúning náttúruverndaráætlunar hefur Náttúrufræðistofnun Íslands áður lagt til að sum þeirra svæða sem hér hafa verið til umfjöllunar verði friðuð vegna einstaks lífríkis eða jarðminja. Þetta á við um Kverkfjöll–Krepputungu, Snæfellsöræfi og Öxarfjörð.

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1 INTRODUCTION

This summary report was compiled at the request of the Icelandic Ministry for the Environment in accordance with a letter dated 21 November 2002, reading as follows:

"A committee on establishing a national park north of Vatnajökull, appointed by the Minister for the Environment on 14 October 2002, is now working on a proposal for establishing a protected area north of the glacier. The committee has been assigned the task of preparing suggestions for the extent of the protected area and the degree of protection. Clearly, preparations for establishing the protected area call for the committee to cooperate with the Icelandic Institute of Natural History regarding natural conditions in the area.

The committee requests that the Icelandic Institute of Natural History compile a summary of the major natural features of the area from Vonarskarð to Lónsöræfi. This overview must cover geological phenomena, vegetation, animal life and habitat types, as well as phenomena in the area landscape which are accounted unique by regional, national or global standards and which there is reason to protect or conserve, and must explain the reasons.

The committee requests that the Icelandic Institute of Natural History prepare this summary according to a more detailed agreement with the Ministry for the Environment; however, the summary must be finished around mid-January 2003."

After preparing the first draft, the Icelandic Institute of Natural History was asked in mid-January 2003 to add to the summary on the one hand Jökulsá á Fjöllum from its origin to its estuary and on the other hand Mývatn and Laxá.

A direct comparison of highlands and lowlands with regard to natural conditions, especially biota, is difficult and in some ways doubtful. In the lowlands all environmental conditions are more favourable than in the highlands and the biota accordingly more diverse and lush. What is considered an "important plant oasis" within otherwise sparsely vegetated deserts might be "ordinary" and rather trivial in the lowlands. For this reason it was decided to prepare the report in two parts, a highlands section and a lowlands section respectively, but with a common introduction and conclusion.

Because of the tight financial and time limitations allotted to the report, it must not be considered an exhaustive informational document but rather the first step toward a coordinated survey of natural conditions, of sites interesting from the viewpoint of nature, and of research on nature in areas north of Vatnajökull, which are receiving ever-increasing attention because of hydroelectric power production and tourism.

Skarphéðinn G. Þórisson of the East Iceland Environmental Research Institute read this report in manuscript form and made numerous improvements.

2 MATERIALS AND METHODS

The summary of natural conditions in the sub-areas is drawn from numerous reports and explanatory documents that have been prepared due to the plans for hydroelectric power stations, the Master Plan for Utilisation of Renewable Energy Resources in Iceland, the nature protection plan from 2002 and development plans. In addition, the report is in part based on unpublished manuscripts and databases of the Icelandic Institute of Natural History.

When assessing conservation value it is proper to consider Icelandic laws on nature conservation and the international agreements to which Iceland is a party. The Icelandic Institute of Natural History has stressed during the assessment of the conservation value of a particular area that diverse data must be available, such as a map of habitat types, a list and map of rare organisms, a distribution map of important birds and mammals, a list and map of rare and special geological formations, and a description and evaluation of the landscape entity that the area belongs to (Sigmundur Einarsson et al. 2000). This information is far from being available for every sub-area covered in the survey, so that it has been necessary to build on the opinions of experts at the Icelandic Institute of Natural History in many cases where the following factors are assessed:

- appearance of the land (landscape, vegetation cover)
- geological sites of interest
- habitat types
- rare plant species (plants, birds, terrestrial arthropods)
- important species (i.e., species that variously are a prominent part of area nature, have their main home in Iceland or play an important economic, social or cultural role).

For each factor the conservation value is classified as "high", "intermediate" or "low" (Sigmundur Einarsson et al. 2000).

3 NATURAL CONDITIONS IN THE HIGHLANDS NORTH OF VATNAJÖKULL

3.1 Description of the region

Landscape and landscape entities

The district located north and northeast of Vatnajökull, which is covered in the first part of the report, has an area of approximately 9800 km² (Figure 1). It is mainly a plateau situated 600–900 m above sea level. Rising from the plateau are individual mountains and mountain ranges. The main part of the district is within the eastern rift zone (volcanic belt) and rests on the youngest bedrock in Iceland, which is from the Holocene (younger than 10,000 years) and latter part of the Ice Age (younger than 0.8 million years old). The easternmost part of the region, however, extends over bedrock from the earlier half of the Ice Age (0.8–3.3 million years), whereas the most southerly and easterly parts enter Late-Tertiary bedrock (older than 3.3 million years) (Figure 2). The climate of the region, particularly the northwestern part, has quite continental characteristics. The greatest difference between summer and winter temperatures in the whole of Iceland is here, 14–16°C (Icelandic Meteorological Office,

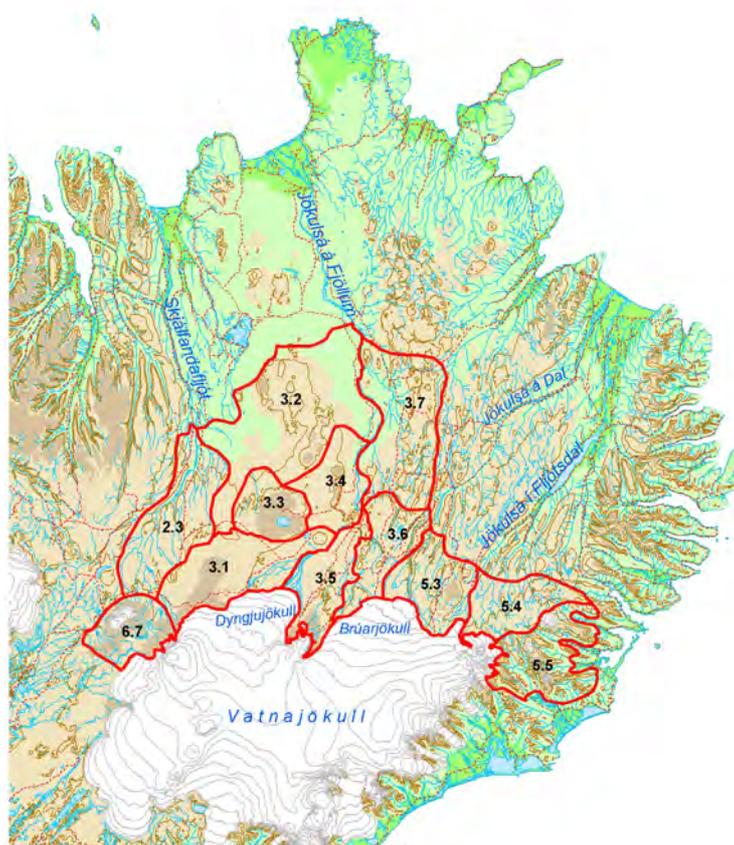


Figure 1. Boundaries of the highland region included in the summary and the division into sub-areas according to the Regional Plan for the Central Highlands of Iceland (Einar Sæmundsen et al. 1999).

unpublished temperature maps); the region also incorporates the driest areas of the country, with an annual precipitation below 400 mm. Nonetheless, the annual precipitation increases enormously towards the east and south, reaching over 3000 mm on Hraun and part of Lónsöræfi (Markús Á. Einarsson 1976).

To simplify the discussion of their natural characteristics, the highlands north of Vatnajökull are divided into units that correspond to sub-areas in the Regional Plan for the Central Highlands of Iceland. Although this division is in part subjective, it is insofar as possible grounded on landscape, vegetation, volcanic sites and lava, and occasionally on major rivers (Einar E. Sæmundsen et al. 1999). The survey includes fully or partially the following sub-areas defined in the Regional Plan for the Central Highlands of Iceland (with the number of each sub-area in brackets):

- Tungnafellsjökull–Vonarskarð (6.7)
- Headwaters of the river Skjálfafljót (2.3)
- Trölladyngja (3.1)
- Askja–Dyngjufjöll (3.3)
- Herðubreið (3.4)
- Ódáðahraun (3.2)
- Kverkfjöll–Krepputunga (3.5)
- Brúardalur (in this case excluding Arnardalur) (3.6)
- Efra-Fjall (here using the name Möðrudalsöræfi–Arnardalur for this area) (3.7)
- Vesturöræfi–Snæfell (applying here the name Snæfellsöræfi for this area, which encompasses Kringilsárrani and Eyjabakkar) (5.3)
- Hraun (including Múli) (5.4)
- Lónsöræfi (including the mountainous area in the southeastern corner of Iceland) (5.5).

The appearance of these extensive reaches of terrain is far from being uniform, but rather changes from west to east, roughly in the following manner:

- The western and northern part, between the rivers Skjálfafljót and Jökulsá á Fjöllum, is characterized by volcanic activity and vast permeable, dry lava fields and volcanic sands with very little continuous plant cover. Plant oases are found in the uppermost part of the valleys and along rivers and streams.
- The central part, Brúaröræfi, between the rivers Jökulsá á Fjöllum and Jökulsá á Dal, is characterized toward the west by volcanic activity and lava fields, but in the eastern part by Ice Age landscape, where the round form of valleys and ridges is conspicuous.
- The area between the rivers Jökulsá á Dal and Jökulsá í Fljótsdal includes the uppermost sections of the extensive, well-vegetated heath lands of East Iceland, which reach from the glacier to the coast. Here there are biologically rich wetland areas and abundant bird life, while the area is furthermore the second-leading reindeer habitat in the country.
- Farther towards the east, Múlinn takes over and still farther on Hraun, a rocky, glacially eroded plateau with many small lakes, ponds and run-off rivers, as this is an area of heavy precipitation.
- The easternmost part is the mountainous area in Lónsöræfi and the neighbouring highlands, where deep valleys cut into the rim of the highland plateau and great diversity dominates the landscape and geological formations.

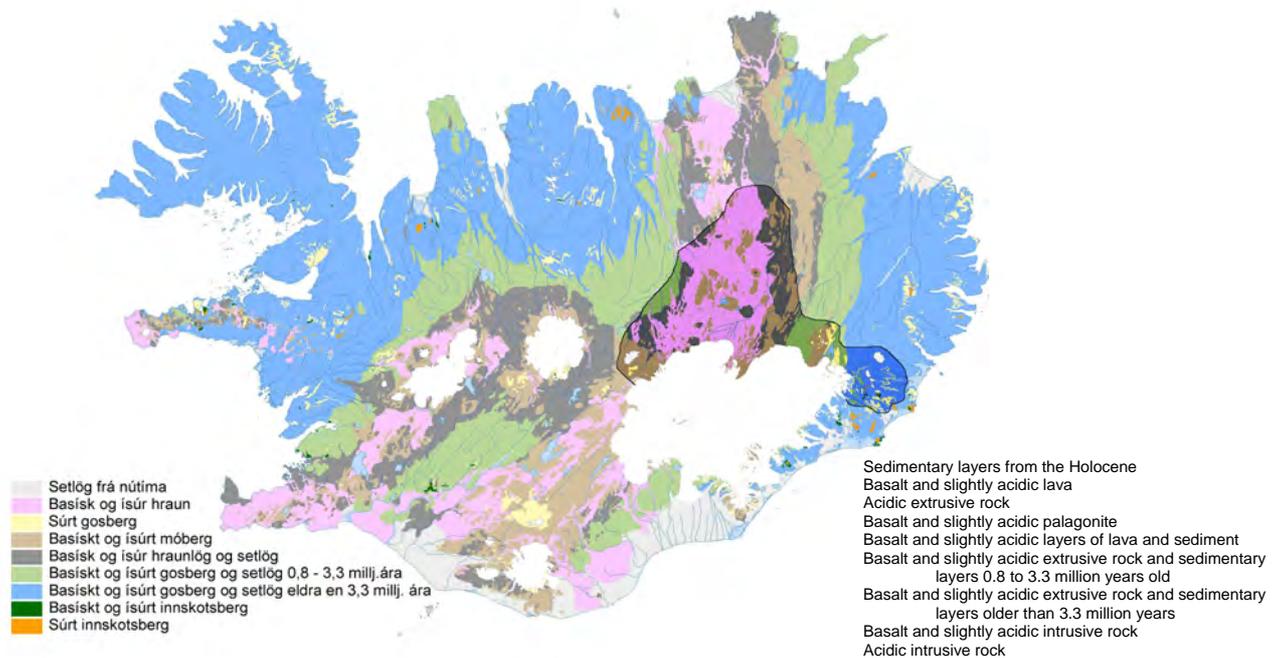


Figure 2. Geological map of Iceland, with the highlands north of Vatnajökull shaded in the figure.

Land use

The traditional utilisation of the highlands north of Vatnajökull is mostly for livestock grazing and tourism, along with reindeer and ptarmigan hunting. Around 6000 sheep roam this territory, although it is felt that these will decline in number during coming years because of reductions in traditional farming (Stefán Benediktsson 2002). The number of tourists visiting the region in 2002 lay in the range of 20,000 to 26,000 (Stefán Benediktsson 2002).

Figure 3 shows the areas north of Vatnajökull that enjoy formal protection or are on the Nature Conservation Registry (Nature Conservation Council of Iceland 1996). The central part lies within the Mývatn and Laxá area, which was protected by a special act in 1974. Four areas are protected as reserves: Hvannalindir in Krepputunga (1973), the Herðubreið reserve (1974), Kringilsárrani in Brúaröræfi (1975) and Lónsöræfi (1977). Askja in Ódáðahraun is a natural monument (1978). The Nature Conservation Registry includes the following areas: Tungnafellsjökull and Nýidalur (sub-area 6.7), Gæsavötn by Gæsaþnjúkur (sub-area 3.1), Laufrönd and Neðribotnar (sub-area 2.3), Kverkfjöll and Krepputunga (sub-area 3.5), Fagridalur and Grágæsadalur in Brúaröræfi (sub-area 3.6), Snæfell, Vesturöræfi and the canyon Hafrahvammagljúfur (sub-area 5.3), Hofsdalur, Tunga (Hofstunga), Hofsa, Geithellnadalur (Múladalur) and Þrándarjökull (sub-area 5.5). Figure 4 shows the proposals of the Icelandic Institute of Natural History for protected areas according to the plan for nature conservation (Ólafur Einarsson et al. 2002, Helgi Torfason and Ingvi Atli Sigurðsson 2002). On the whole, approximately two-thirds of the region is either formally protected or is on the Nature Conservation Registry.

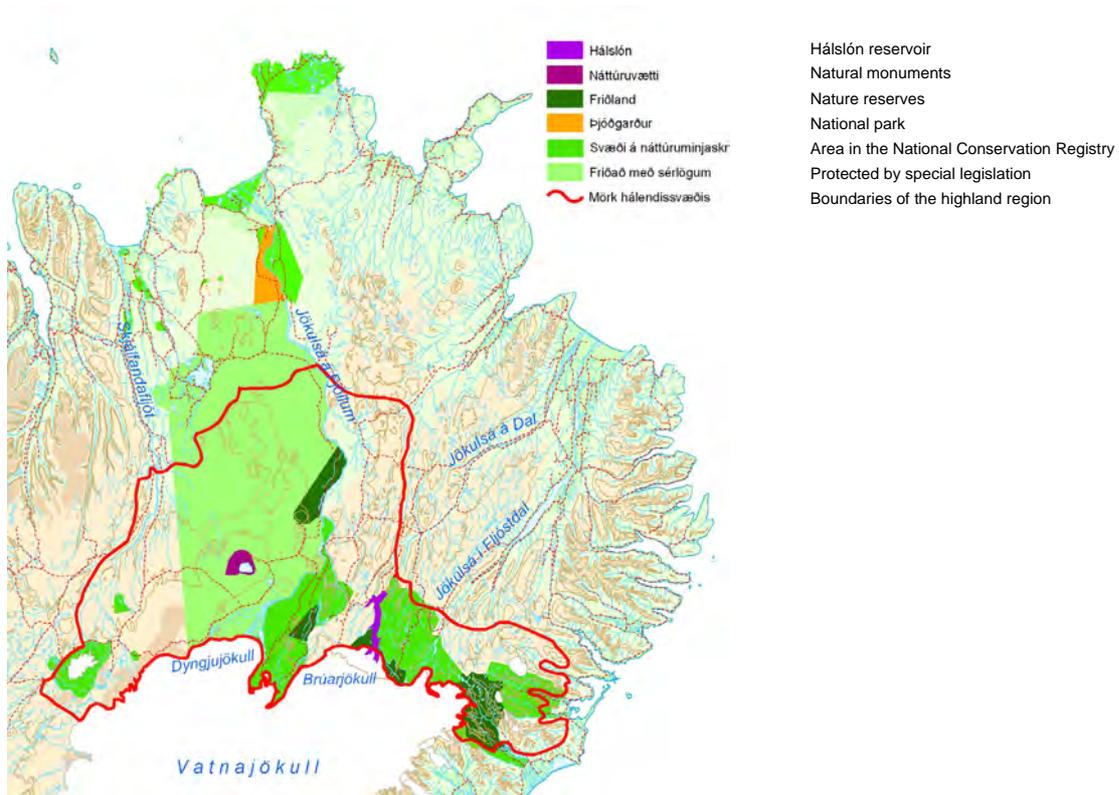


Figure 3. Protected areas north of Vatnajökull and areas in the Nature Conservation Registry (Nature Conservation Council of Iceland 1996).

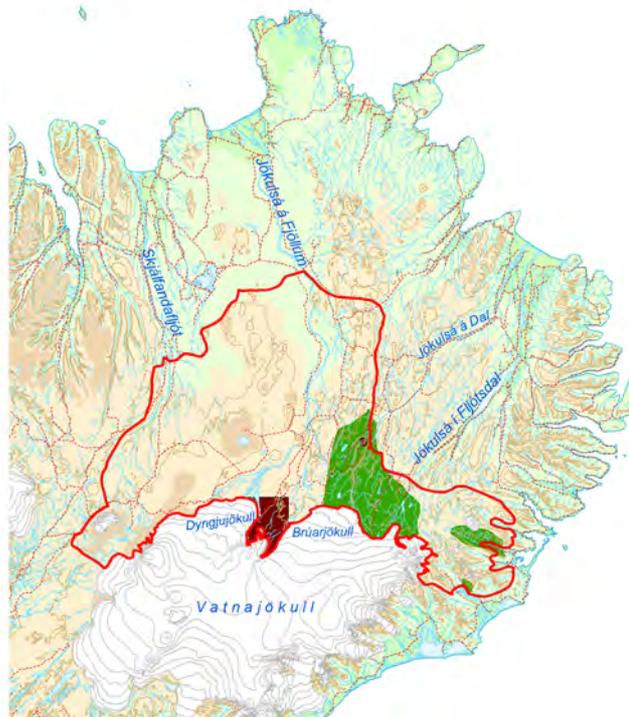


Figure 4. Areas that the Icelandic Institute of Natural History recommends for protection because of remarkable biota (green) or geological phenomena (maroon) (Ólafur Einarsson et al. 2002, Helgi Torfason and Ingvar Atli Sigurðsson 2002).

Knowledge of natural features

Geological research has been conducted on part of the highlands north of Vatnajökull because of the proposed hydroelectric power plants; nevertheless, this research is by no means exhaustive for the region as a whole. While several university and institutional essays exist on particular areas (Askja, Herðubreið, Fagradalsfjall, Brúardalur, Eyjabakkar, Lónsöræfi, etc.), there are often no clear connections between them and other research, in addition to the fact that the research of students and the research of experts are not always comparable. Geological maps on a scale of 1:500,000 exist for the entire country (Haukur Jóhannesson and Kristján Sæmundsson 1998) and provide an important source for assessing geological phenomena and area conservation value. Currently, work is in progress at the Icelandic Institute of Natural History on producing a geological map of East Iceland on a scale of 1:250,000. Maps on a scale of 1:50,000 are available for a number of places (Askja–Dyngjufjöll, Herðubreið, Möðrudalsöræfi–Arnardalur, Brúardalur, Snæfellsöræfi, Hraun, Lónsöræfi).

Vegetation maps exist for all of Iceland on a scale of 1:500,000 (Guðmundur Guðjónsson and Einar Gíslason 1998). Vegetation maps on a scale of 1:40,000 were prepared for two-thirds of the country in the 1960s and 1970s (Figure 5). These maps, along with floristic investigations (i.e., the recording of vascular plants, mosses and lichens), have created the foundation for knowledge of the region's vegetation. Since 1999 the Icelandic Institute of Natural History has worked towards defining and mapping habitat types in the highlands of Iceland while simultaneously developing methods of assessing the conservation value of varying habitat types and other natural phenomena. This work has been carried out in connection with the Master Plan for Utilisation of Renewable Energy Resources in Iceland and because of proposals for a nature protection plan (Sigmundur Einarsson et al. 2000, Helgi Torfason and Ingvar Atli Sigurðsson 2002, Ólafur Einarsson et al. 2002). Habitat type is a unit for natural conditions that are similar with regard to various aspects, that is, the structure of the environment, abiotic environmental factors, the species composition of vegetation, dominant plant species, stage of plant succession, and composition of the animal community. For habitat type classification, the Icelandic Institute of Natural History has built on methods developed for the Habitat Directive of the European Community and the Bern Convention, adapting them to the biota of Iceland (Sigurður H. Magnússon 2003). As yet habitat types have only been mapped in a small part of the highlands (Figure 5).

There is considerable knowledge of bird life in those areas that have been investigated in connection with planned hydroelectric power stations and on account of the Master Plan (Figure 6). Major expanses have, however, received little or no study. The knowledge of terrestrial arthropods is even more fragmented than that of birds.

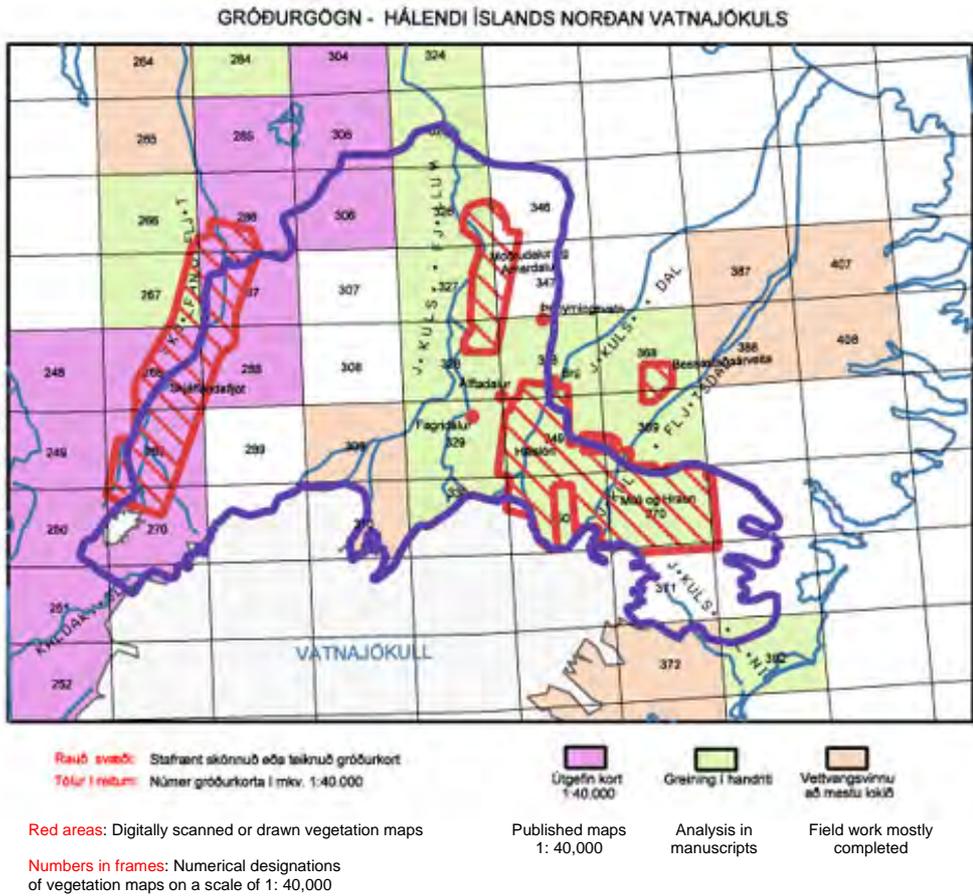


Figure 5. Mapping of vegetation north of Vatnajökull – status in January 2003. Maps of habitat type have been prepared or are being compiled for the areas hatched in red.

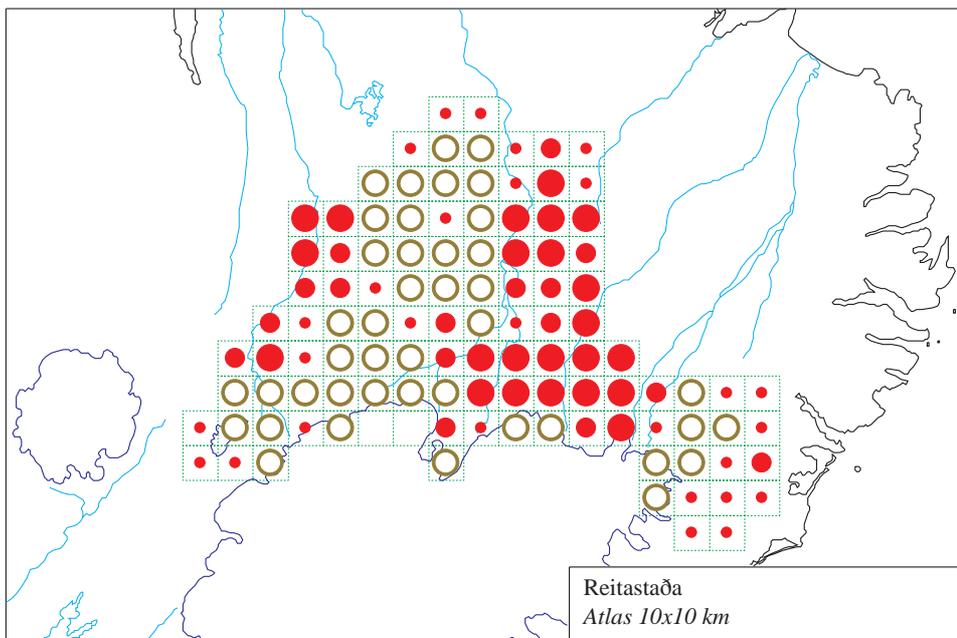


Figure 6. Knowledge of bird life in the interior north of Vatnajökull. Explanations: open circle = no investigations, large dot = good knowledge, medium dot = moderate knowledge, small dot = few investigations.

On the whole, it can be stated that the degree to which natural characteristics of the highlands north of Vatnajökull are known varies (Table 1). In the areas that fall within the impact zone of the hydroelectric power plants that have been planned now and previously for East Iceland, the natural characteristics have been thoroughly investigated and information on this is published in many reports. Knowledge of nature in other areas is fragmentary and in some areas little or none. The best known areas are Snæfellsöræfi, Brúardalir and Möðrudalsöræfi–Arnardalur, while the least known are Trölladyngja, Tungnafellsjökull–Vonarskarð and Ódáðahraun.

Table 1. Assessment of natural conditions north and east of Vatnajökull. The numbers in parentheses refer to the code numbers of sub-areas according to the Regional Plan for the Central Highlands of Iceland (Figure 1; Einar E. Sæmundsen et al. 1999). The assessment is based on the following scale: 5 = very well known / best known; 4 = quite well known; 3 = moderately well known; 2 = rather little known; 1 = little or nothing known / least known.

Area / Natural aspects	Size (km ²)	Geology	Vegetation	Flora	Birds	Invertebrates	Total
Tungnafellsjökull–Vonarskarð (6.7)	480	1	2	2	1	1	7
Headwaters of Skjálfandafhljót (2.3)	1007	1	4	3	3	1	12
Trölladyngja (3.1)	1027	1	1	2	1	1	6
Askja–Dyngjufjöll (3.3)	455	4	2	3	1	1	11
Herðubreið (3.4)	559	2	2	4	3	1	12
Ódáðahraun (3.2)	1898	1	2	3	2	1	9
Kverkfjöll–Krepputunga (3.5)	584	3	2	4	3	3	15
Brúardalir (3.6)	582	5	4	4	4	4	21
Möðrudalsöræfi–Arnardalur (3.7)	1197	4	4	4	4	1	17
Snæfellsöræfi (5.3)	643	5	5	5	5	5	25
Hraun (5.4)	564	4	4	4	1	1	14
Lónsöræfi (5.5)	808	4	1	3	2	1	11

3.2 Natural conditions and conservation value of individual areas

3.2.1 Tungnafellsjökull–Vonarskarð (6.7)

Tungnafellsjökull and Vonarskarð boast for instance a central volcano, geothermal area, glacial sands and beautiful desert landscape. Limited studies have been undertaken in this area.



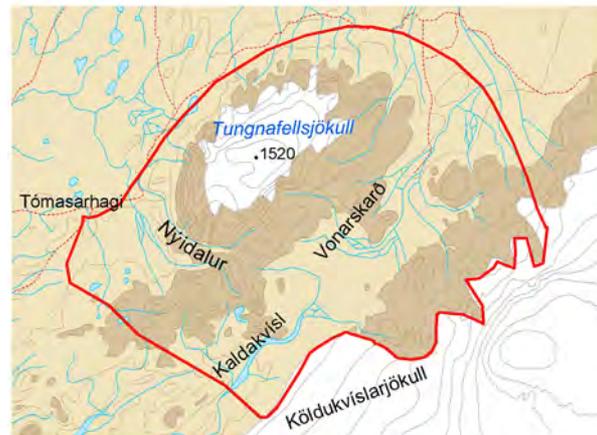
*Tindrar úr Tungnajökli,
Tómasarhagi þar
algrænn á eyðisöndum
er einn til frásagnar.
Jónas Hallgrímsson*

(lines about this spot by
Iceland's national poet, Jónas
Hallgrímsson)

Photo. Dieter Graser 1994.

This area, 480 km² in extent, is limited to the south by a line drawn from Köldukvíslarjökull westwards to the road Sprengisandsvegur. The northwestern bounds are along Sprengisandsvegur and the northeastern margin by Háaalda and Gæsavötn (see map).

The central volcano and the mountain cluster Tungnafellsjökull (1520 m) tower over the plateau, surrounded by a collar of lower mountains and ridges. Rocky stretches of gravel characterise the surface texture of the land. In Vonarskarð there are sandy flats and low gravel banks along Kaldakvísl. This is the location of the watershed between South and North Iceland: the northernmost source of Kaldakvísl and the southernmost source of Skjálfandafljót.



Tungnafellsjökull is a central volcano that has not erupted since the Holocene, excepting two minor eruptions northeast of the mountain. Signs of eruption are on the one hand Tunguhraun from the crater Bokki and on the other hand the line of craters named Dvergar, which has an unusual orientation (i.e., east-west). Only insignificant lava flows have originated in Dvergar. There is rhyolite in Tungnafellsjökull and considerable geothermal activity appears as sources of steam by the rhyolite mountain Skrauta and as pools of hot water and warm springs on the eastern slopes of the mountain cluster and in Vonarskarð. Below the glacial tongues of Tungnafellsjökull there are glacial moraines and in reality the entire area is greatly influenced by glacial action. In Vonarskarð there are extensive sands and small stretches of glacial deposits. The geology of the area is rather poorly known and good geological maps are still lacking.

Near the road west of Tungnafellsjökull it is easy to see and examine large gravel polygons, so called frost polygons that can reach many metres in diameter.

A vegetation map is available for most of the area on a scale of 1:40,000. According to it over 90% of the terrain is sparsely vegetated land (<10% vegetation cover). Patches of vegetation where mosses, grasses, sedges, low bushes and snow-patch vegetation grow are however rather widely distributed in Tómasarhagi and Nýidalur. There they reach to 1100 m elevation above sea level, and stands of *Archangelica*, for instance, grow unusually high up on the south slopes. The area's animal life has not been explored in an organised fashion. Bird life is probably scattered.



Photo Helgi Torfason.

Principal points of natural interest

Dvergar are an outstandingly unique row of craters because of their orientation and limited lava flow. Beautiful glacial moraines are located by valley glaciers coming from Tungnafellsjökull. In the south extents of Vonarskarð there is a geothermal area needing further investigation; among the plants that have been encountered there is Adder's tongue (*Ophioglossum azoricum*), which is a rare vascular plant (Table 14). By Tungnafellsjökull, three species of lichens have been found that are not known from other parts of the country: *Acarospora badiofusca*, *Rhizocarpon chioneum* and *Umbilicaria rigida* (Table 16). Two rare species of moss have also been found here: *Bryum cryophilum* and *Sanionia georgico-uncinata*. One bird species on the Red List (Icelandic Institute of Natural History 2000), the Harlequin Duck (*Histrionicus histrionicus*), breeds in Vonarskarð.

The conservation value of particular characteristics of nature that can be assessed is considered high (Table 2). Tungnafellsjökull is in the National Conservation Registry (Nature Conservation Council 1996) due to "diverse landscape with beautiful, special oases of vegetation."

Table 2. Assessment of the conservation value of natural aspects by Tungnafellsjökull and in Vonarskarð.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Diverse landscape: rhyolite mountains, beautiful craters, glacier and gravel banks at rivers
	Vegetation cover	High	Vegetation in Tómasarhagi, Nýidalur and on the slopes of Tungnafellsjökull is conspicuous in the otherwise sparsely vegetated terrain
<i>Geological phenomena</i>		High	Central volcano, geothermal energy, craters and glacial phenomena, frost polygons
<i>Habitat types</i>		Not assessed	Research is needed
<i>Rare species</i>	Plants	High	The only site where three species of lichens have been found and one of the very few spots for two moss species
	Birds	Not assessed	Research needed
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species and populations</i>	None known	Probably low	Research needed

3.2.2 Headwaters of Skjálfandafljót (2.3)

*The land by the upper headwaters of Skjálfandafljót is characterized by eroded Ice-Age terrain. Its conservation value is not considered particularly high, although the area constitutes an important breeding ground for the Pink-footed Goose (*Anser brachyrhynchus*) nowadays and the Snowy Owl (*Nyctea scandiaca*) in earlier days*



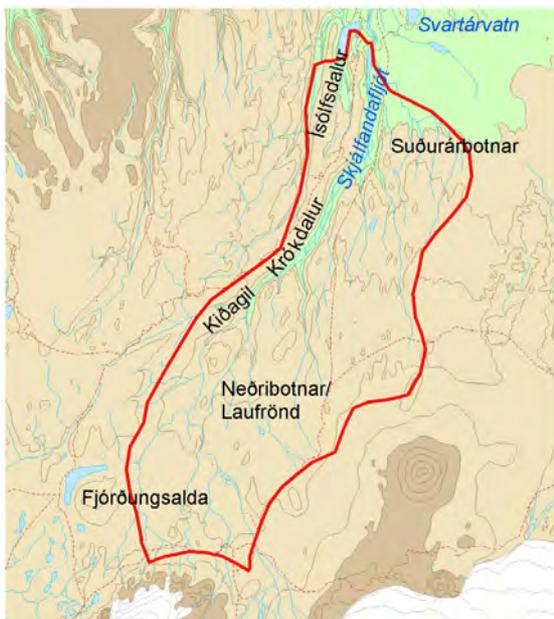
Photos: Sigurður H. Magnússon 2002.



While the land along Skjálfandafljót is in many places much hurt by wind erosion, there are beautiful sloping bogs in Mjóidalur.

This area, 1007 km² in size, extends over the easternmost catchment area of Skjálfandafljót, from the roots of Tungnafellsjökull in the south to the uppermost farms in Bárðardalur (Svartárkot) in the North. In the eastern part the area is demarcated by the lava fields from Trölladyngja and Frambruni in Ódáðahraun (see map).

The texture of the land is characterised by glacially eroded lava fields, sands, gravel expanses with varying amounts of larger rocks, and rocky hills. The land is dry and there is little water discharge on the surface in the eastern part. Spring water is predominant in the side rivers of Skjálfandafljót, the main ones being Hrauná, Öxnadalsá, Krossá, Sandmúladalsá and Sandá, in addition to Suðurá and Svartá in Bárðardalur.



The geology of the area has been investigated rather little, perhaps because it has no known significant geological phenomena. The boundary between the palagonite formation and dolerite formation lies through the area (0.78 million years old). Lava flows that have emerged from the vicinity of Askja have run into the area from the east; in some places, beautiful springs appear by them as well as in the upper reaches of ravines. Geothermal heat (around 40° C) occurs by the more northerly Hitalaug ytri ([also called] Hitalaug nyrðri) at an elevation of 690 m and the more southerly Hitalaug syðri ([also called] Hitalaug efri) at an elevation of 780 m (some 37° C), but otherwise there is little geothermal water in the area.

A vegetation map of the area was reconstructed by the Icelandic Institute of Natural History in 2000–2001, in connection with a thorough vegetation survey (Guðmundur Guðjónsson et al. 2001). According to this survey the area as a whole is sparsely vegetated or unvegetated (81%), although the vegetation is rather diverse. Vegetation is mainly found in the valleys and the uppermost reaches of valleys in sheltered and humid conditions. In many places there are signs of major wind erosion. Moor land with *Salix* and scrub is the most common plant community (24%) but small-scrub heath (16%), moss vegetation (15%) and grassland (14%) are also widely distributed. Wetlands constitute 13% of the vegetated ground. The bird life is well known and in many places both abundant and diverse; for example, there are populous communities of Pink-footed Geese in Krókdalur and along the tributaries of Skjálfandafljót.

Principal sites of natural interest

In Ytra-Fljótsgil by the river Skjálfandafljót, there is considerable birch scrub around and above 550 m in altitude. It is the only site where birch scrub has been discovered this far inland in North Iceland, perhaps the last remnants of woodlands that previously existed in Krókdalur. In Laufrönd there is a plant oasis worthy of interest. By the warm springs Hitalaug ytri and Hitalaug syðri there are vascular plant species growing in geothermally warm ground that usually do not grow at such a high elevation above sea level nor this far inland, among them Yarrow (*Achillea millefolium*), Lesser Twayblade (*Listeria cordata*), Northern Yellowcress (*Rorippa islandica*), Alpine Cinquefoil (*Potentilla crantzii*), Grass of Parnassus (*Parnissia palustris*) and Jointed Rush (*Juncus articulatus*). Four species of birds on the Red List (Icelandic Institute of Natural History 2000) breed regularly in the area: the Harlequin duck (*Histrionicus histrionicus*; widely distributed), Goosander (*Mergus merganser*; several places), Gyrfalcon (*Falco rusticolus*; four sites) and Raven (*Corvus corax*; several locations). This area also contains the best-known nesting site for the Snowy Owl (*Nyctea scandiaca*), in earlier times.

The conservation value of the landscape and sites of natural interest is generally considered rather low; however, the area along Skjálfandafljót is an extremely important breeding ground for the Pink-footed Goose (*Anser brachyrhynchus*; Table 3). Laufrönd and Neðribotnar are in the National Conservation Registry (Nature Conservation Council of Iceland 1996), with the following comment: "A lush environment of ponds and spring-fed bodies of water, 700–800 m above sea level. Unique bird life." Three rare species of vascular plants are found in the area: Nard Sedge (*Carex nardina*), Alpine Cat's Foot (*Antennaria alpina*) and Snow Fleabane (*Erigeron humilis*) (Table 14).

Table 3. Assessment of the conservation value of natural aspects by the headwaters of Skjálfandafljót.

Category	Phenomenon	Conservation value Reasons	
<i>Appearance of land</i>	Landscape	Low-average	Typical Ice-Age landscape
	Vegetation cover	Average	Eroded areas of vegetation are frequently prominent in the landscape; considerable vegetation in Íshólsdalur and Mjóidalur
<i>Geological phenomena</i>		Low	Geothermal energy, recent lava fields, glacial formations
<i>Habitat types</i>		Work progressing on classifying habitat types	Fieldwork partly completed; interesting plant oases by Laufrönd and in Ytra-Fljótsgil
<i>Rare species</i>	Plants	Low	
	Birds	Average	Areas where Snowy Owl is most likely to breed
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species and populations</i>	Pink-footed Goose	High	Thousands of pairs

3.2.3 Trölladyngja (3.1)

Land scorched by eruptions, glacial sands and wide open spaces. Here the landscape and geological phenomena play the leading role, whereas the vegetation cover is small. Limited research has been conducted on natural conditions in the area.

This area, with a surface of 1027 km², is bounded by Jökulsá á Fjöllum to the east, Upptýppingar and Dyngjufjöll to the north-east, Gæsavatnaleið to the northwest, and Vonarskarð and the edge of Dyngjujökull to the south (see map).



Photo: Dieter Graser 1994.

The land is almost entirely a single rough lava shield where Trölladyngja, one of the largest shield volcanoes in Iceland, the dolerite shield volcanoes Urðarháls and Vaðalda, and the table mountains Kistufell and Hrímalda protrude above the remaining landscape. Tremendous lava flows have occurred in all directions from Trölladyngja, although mostly towards the west and north.

Farthest south, by the source of Jökulsá á Fjöllum, there are sands and mudflats. The land is dry and very permeable, so that there is almost no discharge on the surface. There are areas of springs by Svartá, beneath the hill Vaðalda.

Two powerful volcanic systems lie in the volcanic zone towards the north from Vatnajökull: Dyngjuháls and a system connected with Askja. They are both scorched by lava and while no historical lavas are known within the more westerly system in this area, there has been much activity there, both during the Ice Age and the Holocene. Dyngjuháls is composed of many rows of craters. Because of the altitude above sea level and rough weather conditions the lava fields are unvegetated and very young in appearance. The ground has sunken immensely at Urðarháls, which originated as a crater during the last warm period or Ice Age. The crater is dozens of metres deep and the walls so steep that there is no way of descending into it without a rope. There are giant craters to the south and north of Trölladyngja, from which lava flows have run to the west. Toward the east of Urðarháls and north of Dyngjujökull there are extensive sands. Holuhraun is a lava field that appears young, and is situated at the edge of the glacier. There is a warm spring by Gæsavötn but otherwise there is little geothermal heat at the surface.

Only a small part of the area has been mapped with regard to vegetation as it has sparse or no vegetation and there are only isolated patches of vegetation in hollows where moisture is found. The fieldwork in relation to the vegetation maps was conducted by the headwaters of Jökulsá á Fjöllum in 1969. While vegetation with vascular plants is very limited, expanses of the light grey-coloured lichens *Stereocaulon vesuvianum* and *Stereocaulon arcticum* characterise the land. The area is often referred to as the greatest desert of Iceland and hence also of Europe. There is a remarkable plant oasis by Svartárlindir under the southwest side of Vaðalda. The bird life has hardly been explored, but is most likely rather unvarying. There is a major breeding area of the Pink-footed Goose by Svartá, and the Great Black-backed Gull (*Larus marinus*), which is on the Red List (Icelandic Institute of Natural History 2000), also nests there.

Principal points of natural interest

The landscape in the Trölladyngja area is outstandingly spectacular. To the south is Dyngjujökull, with broad sands lying between it and Askja. On Dyngjuháls, rows of craters appear one after the other, while Trölladyngja looms in the northwest. The greatest geological formation is Urðarháls—unrivalled in the country as the only crater from the Ice Age or a warm period that has been little eroded.

The conservation value of biotic factors is considered low (Table 4); it should be mentioned, however, that the area has been little studied. Its conservation value is comprised above all in the appearance of the terrain, the open spaces and geological phenomena; Einar E. Sæmundsen et al. (1997) speaks of "the unique open spaces and gigantic landscape."

The Gæsavötn lakes are in the National Conservation Registry (Nature Conservation Council of Iceland 1996), the rationale for this being "spring lakes and a highland oasis, around 920 m above sea level."



Photo: Dieter Graser 1994.

Table 4. Assessment of the conservation value of natural aspects in the Trölladyngja area.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Volcanically scorched land and glacial sands, stark contrasts, open spaces and gigantic landscape
	Gróðurþekja	Low	Very little continuous plant cover
<i>Geological phenomena</i>		High	Trölladyngja, Urðarháls, young crater rows, glacial sands below Dyngjujökull
<i>Habitat types</i>		Not assessed	
<i>Rare species</i>	Plants	Low	No recorded rare species
	Birds	Presumed low	Limited research
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species and populations</i>	None known	Probably low	Research needed

3.2.4 Askja–Dyngjufjöll (3.3)

Magnificent, colourful landscape with alternating light-toned tephra, black lava fields and volcanically scorched mountains. Geological aspects most prominent and the geology well known.

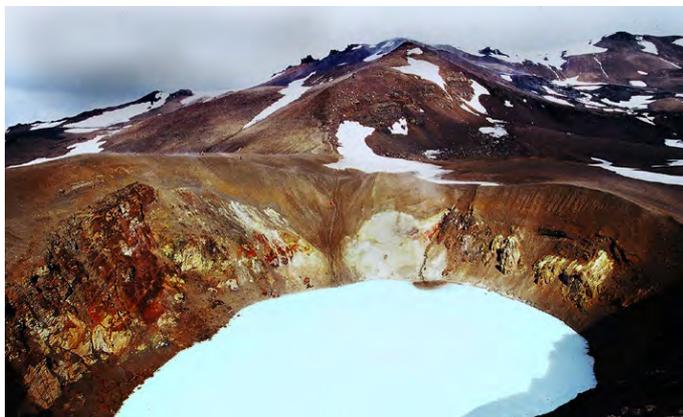


Photo: Snorri Baldursson 2002.

This area, 455 km² in extent, covers Dyngjufjöll, the more northerly Dyngjufjöll ytri and Dyngjufjalladalur (see map).

The land is arid, with little surface water apart from Öskjuvatn, and the rock permeable, so that water channels have hardly developed other than perhaps Drekgil on the northeastern slopes of Askja. The landscape is characterised by multicoloured lavas, tephra, geothermal heat and magnificent mountainous terrain.

Dyngjufjöll is an active central volcano and a massive cluster of mountains, composed mostly of palagonite and rising more than 1500 m above sea level. Askja itself is a caldera formed in the Holocene, within which 2–3 smaller calderas are situated. Öskjuvatn in the southeastern part of the caldera was formed in a massive tephra eruption in 1875. The same eruption formed the explosion crater Víti, believed to have been the origin of the acid tephra that was dispersed to the northeast and east in 1875. Öskjuvatn is the deepest lake in the country (220 m) and by far the largest one situated at an elevation of over 1000 m. Askja has erupted many times since the end of the Ice Age and is one of the most active volcanoes in the country. Historical eruptions are known from 1875, 1921–1929 (a series of eruptions) and 1961 (Ólafur Jónsson 1945, Sigurður Þórarinnsson 1993). In the eruption of 1875, both Askja and Sveinagjá, located somewhat north of Askja, erupted. Askja is one of the largest and most famous volcanoes in the country; moreover, nowhere in the country are caldera depressions more visible than here. There is little acid rock in Askja. Excluding tephra from the eruption of 1875, there is only one acid lava field by the northwestern side of the caldera. Vikraborgir, where the vehicle track ends near the margin of the caldera, consists of craters from 1961. The greatest geothermal heat is found by the southeastern part of Öskjuvatn, where small steam openings with sulphur are found. Hot mud springs are sometimes visible in Víti, depending on the water table at each time.

A vegetation map of the Askja area has been prepared (in manuscript). The land is arid and the cover of vascular plants generally little, while lichen vegetation is widely distributed in lava fields. Rather diverse vegetation (approximately 60 species) grows on the slopes of several palagonite peaks (Kattbekingur, Tvíburatindur, Einstæðingur), where such flowering plants as Wood Crane's Bill (*Geranium sylvaticum*), Hawkweed (*Hieracium* spp.), Dandelion (*Taraxacum* spp.), Mountain Avens

"I take it as true that Askja is the weirdest place in this weird country. And I think I know that there are few places on the whole planet Earth as magnificent and terrific as this one, and I know that anyone who has once seen it with their own eyes will never, ever forget it." (reported to have been said by Pálmi Hannesson, former rector of MR, Reykjavík Gymnasium.



(*Dryas ocopetala*), Bog Bilberry, *Vaccinium uliginosum* and Yarrow (*Alchemilla millefolium*) may be found. The material in these mountains binds moisture in the soil better than the surrounding lava fields; it is first and foremost the extremely permeable surface ground that is the reason for the poor vegetation in this area. Noteworthy flora appears in a geothermal area at an elevation of 1200 m in the southeastern corner of Askja. Adder's Tongue is present there, along with various other species that are otherwise only encountered in more lowland reaches. Bird life has been rather little investigated, but is likely fairly poor.

Principal points of natural interest

The principal natural phenomena are the central volcano Askja, with Öskjuvatn and the explosion crater Víti. In addition, there are young crater rows and craters, such as the crater row south of Askja (with around 30 km² of lava from 1924–1929), Båtshraun (1921), Mývetningahraun (1922–1923), the island in Öskjuvatn (1926) and Vikraborgir (1961). There are signs of geothermal activity in Víti and on slopes above Öskjuvatn. Three rare species of vascular plants are encountered there: Alpine Cat's Foot (*Antennaria alpinai*), Small Adder's Tongue (*Ophioglossum azoricum*) and Snow Fleabane (*Erigeron humilis*) (Table 14), and three very rare species of moss: *Atrichum angustatum*, *Atrichum tenellum* and *Bryum vermigerum* (Table 15). The last species has not been found elsewhere in Iceland. Two species of birds on the Red List (Icelandic Institute of Natural History 2000), the Raven (*Corvus corax*) and Gyrfalcon (*Falco rusticolus*), have bred in the area.

The declaration of protection for Askja in 1978 and the attraction of the area for travellers lend witness to conservation value that is indisputable on a national and global scale because of the volcanic activity and spectacular landscape. The protected area follows the high rim of the caldera all around, while the southern part of Dyngjufjöll, Dyngjufjöll ytri, and Dyngjufjalladalur lie outside the protected area. The conservation value of area biota is considered average (Table 5).

Table 5. Assessment of the conservation value of Dyngjufjöll and Askja.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Magnificent, colourful landscape with alternating light-toned tephra, black lava fields and volcanically scorched mountains
	Vegetation cover	Low	
<i>Geological phenomena</i>		High	Central volcano Askja, explosion crater Víti, caldera Öskjuvatn, young hills formed by eruptions, lava fields, signs of geothermal activity, clearly visible caldera depressions
<i>Habitat types</i>		Not assessed	Research needed—primarily on flora in the geothermal slopes of Öskjuvatn
<i>Rare species</i>	Plants	Average	Three very rare species of moss, one of which has not been found elsewhere in Iceland
	Birds	Probably low	Limited research
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species</i>		Probably low	Limited research

3.2.5 Herðubreið–Herðubreiðarlindir (3.4)

The area is sought after as land for outdoor recreation and undoubtedly has a high conservation value on a national scale because of the picturesque landscape and lush oases of vegetation.



“Herðubreiðarlindir has been known for a long time as one of the most beautiful oases of the central highlands, whose clear blue springs and still ponds are surrounded by lush vegetation and are like a paradise in the centre of desert sands and wind-eroded lava fields.” (Eyþór Einarsson 1978, p. 5)

Photo: Dieter Graser 1998.

This area, 559 km² in size, encompasses the protected area associated with Herðubreið in addition to Herðubreiðartögl towards the south (see map). Everything is covered with lava, with palagonite mountains rising from the broad lava fields and sand deserts



Herðubreið (1682 m), a table mountain of palagonite, reigns over the plateau. Rough lava fields, often covered with light tephra from Askja (from the eruption 1875), may be seen towards the south, while closer to Jökulsá there is sediment deposited during glacial floods. The area is arid, the lava fields extremely permeable, and surface discharge small. Significant areas of springs are situated by the sources of Lindaá and Grafarlandaá. By Jökulsá á Fjöllum there are signs of ancient catastrophic floods, sands and tephras

Despite the biota of the area not having been investigated systematically, natural conditions at Herðubreiðarlindir and Grafarlönd must be considered rather well known. No vegetation map has been published, but data are available in a manuscript at the

Icelandic Institute of Natural History. The vegetation of the protected area associated with Herðubreið has been described and the list of vascular species published (Eyþór Einarsson 1978). Plant oases by rivers and streams are characterised by constantly changing semi-bogs, new *Salix* shoots, and rushes. In a few places there are stands of *Archangelica* and flowers. The bird life is fairly well known and is rich and diverse by the areas of springs at Herðubreiðarlindir and Grafarlönd.

Principal points of natural interest

The principal natural phenomena in the area are the symmetrically-shaped table mountain Herðubreið (elected by Icelanders in the autumn of 2002 as their national mountain) and unusually lush plant oases in Herðubreiðarlindir and Grafarlönd. Four rare species of vascular plants have been found: Nard Sedge (*Carex nardina*), Alpine Cat's Foot (*Antennaria alpina*), Serrated Wintergreen (*Orthilia secunda*) and Snow Fleabane (*Erigeron humilis*) (Table 14), and one rather rare lichen species, *Peltigera ponojensis*, that has as yet not received an Icelandic name (Table 16). Eight bird species on the Red List (Icelandic Institute of Natural History 2000) have bred there: Greylag Goose (*Anser erythropus*), Pintail (*Anas acuta*), Harlequin Duck (*Histrionicus histrionicus*), Goosander (*Mergus*

merganser), Gyrfalcon (*Falco rusticolus*), Great Black-backed Gull (*Larus marinus*), Snowy Owl (*Nyctea scandiaca*) and Raven (*Corvus corax*) (Table 17).

The area is sought after as land for outdoor recreation and undoubtedly has a high conservation value on a national scale because of picturesque landscape and lush plant oases, so that it was declared a protected area by an act in 1974. The conservation value of the biota is considered average (Table 6).

Table 6. Assessment of the conservation value of natural aspects of the Herðubreið area.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	The mountain Herðubreið—a symmetrically-shaped table mountain—often called "The Queen of the highlands", imposing volcanic landscape
	Vegetation cover	High	Unusually lush highland oasis in Herðubreiðarlindir and Grafarlönd characterises the landscape
<i>Geological phenomena</i>		High	Herðubreið, young craters and lava fields, tephra fields and aeolian sand
<i>Habitat types</i>		Not assessed	Research needed
<i>Rare species</i>	Plants	Low	No very rare species
	Birds	High	Eight species on the Red List
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species and populations</i>	Pink-footed Goose	Average	Pink-footed geese breed quite frequently in Grafarlönd



Photo: Snorri Baldursson 2002.

3.2.6 Ódáðahraun (3.2)

Ódáðahraun is the country's greatest lava expanse and a tremendous vastness. The conservation value of the landscape and geological phenomena is considered high. Research is limited.

"Ódáðahraun is a huge, varied and magnificently beautiful area. When I was a youth, I got to know parts of it as a sheep herder in the autumn [more than one autumn], though above all in a rather small area northwest of Dyngjufjöll and south of Suðurá. I consider this area to be the most beautiful location that I have been to. Few things equal the rough lava and the plant oases by Suðurá and its islets. I also feel that water in the springs emerging from beneath the lava by the river is the best water I have ever consumed. Perhaps this stems from how thirsty I was when I drank it for the first time after having chased sheep down from Dyngjufjöll. Later I realised that Ódáðahraun is a unique area, not only for this country but the whole world." (*Ingólfur Á. Jóhannesson, 1996*).



Photos: Dieter Graser 1998.

Suðurá and Dyngjufjalladalur

This area, 1898 km² in size, extends over Ódáðahraun and part of Mývatnsöræfi. It is bounded to the south by Dyngjufjöll and the perimeter of the protected area by Herðubreið, to the west by Frambruni and Bláfjall, to the north by Búrfellshraun, and to the east by Jökulsá á Fjöllum (see map).

The area is a continuous expanse of lava and rather flat, except for the central part, where palagonite mountains (Eggert, Herðubreiðarfjöll, Hrúthálsar) and shield volcanoes (Kollóttadyngja, Kerlingardyngja, Ketildyngja) rise from the plateau. Rough, sand-strewn lava fields are typical for the texture of the terrain. The land is xeric, with the lava fields not retaining much water and there being almost no surface discharge.

The Askja fracture zone lies through Hrúthálsar, comprising rows of craters, faults and open rifts. In Hrúthálsar metamorphosis is present due to a geothermal field, although geothermal heat has now disappeared at the surface. Rhyolite appears at a small location on the north slopes of Eggert. North of Askja there are beautiful shield volcanoes. Further north is Ketildyngja along with the geothermal area Fremri-Námur, and rhyolite shows up in low mountains north of there. Bláfell, Heilagsdalsfjall and Búrfell are table mountains of palagonite. The eruption of 1875 occurred in both Askja and Sveinagjá. The lava field Nýjahraun flowed from there.

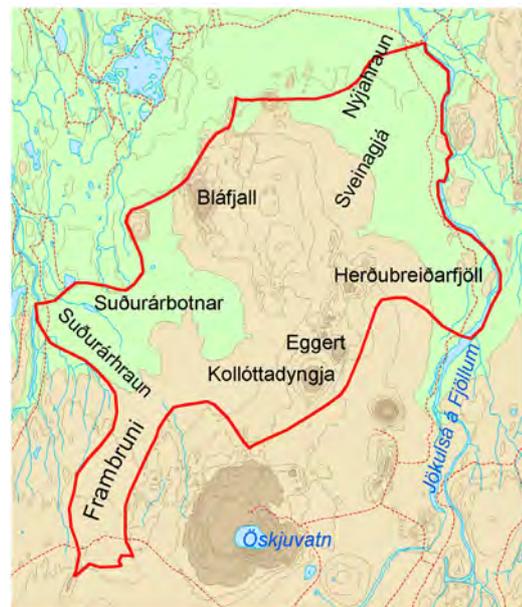




Photo: Guðmundur Guðjónsson 2002.

Typical spring in Ódáðahraun.

Vegetation maps have been published showing the north and west parts of the area. For the east part, vegetation maps exist in manuscript form; on the other hand, the middle of the area has not been mapped. This extensive territory is for the most part sparsely vegetated wilderness. Where any vegetation thrives at all, scrubland is the most common plant community. There is unusually little continuous moss growth; this can

probably be ascribed to limited precipitation and the extreme permeability of the ground. In Heilagsdalur, below the east side of Bláfjöll, there is a small, completely vegetated area with damp soil. The bird life in this area is not well known.

Principal points of natural interest

At the geothermal area in Fremri-Námur, sulphur was taken in earlier times. There are indications of geothermal activity on Hnúthálsar. The area displays beautiful shield volcanoes, crater rows and extensive lava fields. Three bird species on the Red List (Icelandic Institute of Natural History 2000) have nested here: Harlequin Duck (*Histrionicus histrionicus*) by Suðurá, Gyrfalcon (*Falco rusticus*) at four aeries, and Raven (*Corvus corax*) at several sites. It is primarily the landscape and geological phenomena that contribute conservation value to this area (Table 7).

Table 7. Assessment of the conservation value of natural aspects in Ódáðahraun.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Untouched landscape, extensive lava fields, desert
	Vegetation cover	Low	Little continuous plant cover
<i>Geological phenomena</i>		High	Great lava expanses, shield volcanoes (Kollóttadyngja, Ketildyngja, Kerlingardyngja, etc.), geothermal areas
<i>Habitat types</i>		Not assessed	
<i>Rare species</i>	Plants	Low	No rare species
	Birds	Probably low	Limited research
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species</i>	None known	Probably low	Limited research

3.2.7 Möðrudalsöræfi–Arnardalur (3.7)

Vast plains dotted with tuff ridges and crags and by sparsely vegetated areas that alternate with plant oases. Natural conditions are well known. The conservation value is moderately high.



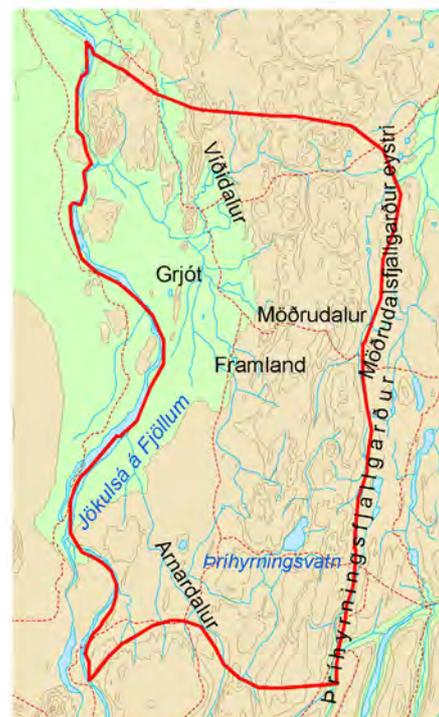
Photos: Guðmundur Guðjónsson 2002.



The landscape is characterised toward the east by lengthy ranges of palagonite mountains, containing valleys and depressions, and toward the west by extensive sands and dolerite expanses with occasional low mountains, palagonite ridges and glacially eroded shield mountains of dolerite. The bedrock is dolerite lava and palagonite, while eroded craters rise from the sand desert in the northern part of the area. Westwards from Mýnnisfjallgarður there are glacial remains from around 10,000 years ago. Great sands accumulated in front of the glacier, but where the glacier itself was positioned the land now lies lower (resulting in outwash plains with a missing upper end connection). Arnardalsalda is an eroded dolerite shield volcano, and Þorlákslindir are located south of it, productive springs with water at approximately 9° C—the only sign of geothermal activity in this area. East of Arnardalsalda there are hills formed by eruptions during a late glacial epoch, the red ash and slag of which are visible from far away. There are no young volcanic formations in the area. There are sites of considerable springs in Arnardalur and several further sites by Þríhryningsvatn, in spite of the area otherwise staying rather dry because of permeable bedrock and little precipitation.

The biota has been investigated well, particularly in Möðrudalur and Arnardalur, except for terrestrial invertebrates. A variety of vegetation maps have been prepared in connection with hydroelectric power plants for East Iceland; the first of the maps were those for Arnardalur in 1968 (see Sigurður H. Magnússon et al. 2002). Because of the Master Plan, the Icelandic Institute of Natural History has prepared a vegetation map of the entire research area on a scale of 1:50,000, exact vegetation maps (1:25,000) in two parts of Möðrudalur and Arnardalur, and has classified the area into land and habitat types. Around 85% of the mapped area consists of sparsely vegetated habitat types, of which gravelly

This area, covering 1197 km², is bounded by the rivers Kreppa and Jökulsá á Fjöllum to the west. The northern boundary is by Geldingafell north of Möðrudalur, the eastern limits by the mountain ranges named after Möðrudalur and Þríhryningur, and the southern margin at the river Álftadalsá (see map).



grounds (three sorts) are far and away the most common (around 75% of the total). In vegetated land, snow beds and heath lands (4.5%), *Salix* moors (2%), moist habitat (1.4%) and scrub-bog habitat (1.4%) are most common (Sigurður H. Magnússon et al. 2002). Extensive bird research has been conducted on account of the planned hydroelectric power stations in East Iceland (Kristinn H. Skarphéðinsson and Skarphéðinn Þórisson 1993) and the Master Plan (Sigurður H. Magnússon et al. 2002). This research has been concentrated first and foremost on Möðrudalur and Arnardalur. In studies during the summer of 2001, 26 species of nesting birds were encountered in Möðrudalur and 13 species in Arnardalur. Sources have been verified on the breeding of at least 35 species. The Pink-footed Goose (*Anser brachyrhynchus*) is by far the most common and in fact a dominant species throughout the area. The size of its population is estimated as no less than 2500 pairs.

Principal points of natural interest

The principal natural phenomena on Möðrudalsöræfi and in Arnardalur are among other points the plant oases of Framland in Möðrudalur, Bæjarlönd by Jökulsá á Fjöllum, a former lake site and springs in Arnardalur, the channels remaining from catastrophic floods on Möðrudalsöræfi, and the ancient crater rows or crags that characterise the landscape in Möðrudalur. In Arnardalur



In Arnardalur.

Photo: Hörður Kristinsson.

One rare species of vascular plant, Alpine Cat's Foot (*Antennaria alpina*) has been found in the area (Table 14) and seven lichen species (Table 16), one of which, *Sarcosagium campestre*, is found nowhere else in Iceland. Eight bird species on the Red List (Icelandic Institute of Natural History 2000) have nested here: Great Northern Diver (*Gavia immer*), Greylag Goose (*Anser anser*), Pintail (*Anas acuta*), Harlequin duck (*Histrionicus histrionicus*), Goosander (*Mergus merganser*), Gyrfalcon (*Falco rusticolus*), Great Black-backed Gull (*Larus marinus*) and Raven (*Corvus corax*) (Table 17). The area breeding population of the Pink-footed Goose (*Anser brachyrhynchus*) is considered to have international conservation value as it constitutes around 5% of the breeding population of the Icelandic Pink-footed Goose (*Anser brachyrhynchus*). The conservation value of other aspects is considered to be average.

Table 8. Assessment of the conservation value of natural aspects in Möðrudalur–Arnardalur.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	Average-high	Unique landscape; vast plains spotted by tuff ridges and by sparsely vegetated areas that alternate with plant oases
	Vegetation cover	Average	Very well vegetated oases in an otherwise sparsely vegetated area
<i>Geological phenomena</i>		High	Palagonite mountains; crater rows, channels remaining from catastrophic floods in Möðrudalur, Þorlákslindir, dunes
<i>Habitat types</i>		Average	Area only partly evaluated. Scrub-bog habitat, fens and marshes with <i>Carex lyngbyei</i> which all have a high conservation value
<i>Rare species</i>	Plants	Average	Some rare species whereof all but one can also be found in other parts of Iceland
	Birds	High	Eight species on the Red List
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species and populations</i>	Pink-footed Goose	High	The area is of international conservation value as a breeding ground—an estimated 5% of the Icelandic Pink-footed Goose population breeds here.

3.2.8 Kverkfjöll–Krepputunga (3.5)

Spectacular landscape shaped by the interaction of glaciers, as well as volcanic and geothermal activity. A rather well-researched area. High conservation value.

"In some places there are saw-toothed rows of peaks one after the other like shark teeth and in some places cliff edges, mounds, pinnacles and cones; between them there are countless low spots, depressions, hollows, the beginnings of valleys, small sand flats and ravines." (Thorvaldur Thoroddsen 1884 Ferðabók I).



Kreppa. Photo: Snorri Baldursson 2002.



This is a wedge-shaped, 584 km² area between Jökulsá á Fjöllum and Kreppa (see map).

The central volcano Kverkfjöll (highest peak 1929 m) is in the southernmost part of the area and is mostly hidden by glacier. Leading from there towards the northeast is a collection of palagonite ridges and peaks, Kverkfjallarani. While lava fields from the Holocene cover some of the area, basalt bedrock eroded by glaciers and water courses becomes visible along the eastern margins. Kverkfjallarani is intensely scorched by volcanic activity and many lava flows have run through it, spilling onto the surrounding plain. To the west and north, Krepputunga is covered by lava fields and glacial river mud that turn into aeolian sands where the land is more arid. A volcanic fissure lies through the western part of the mountains

erupted during the Holocene when glaciers were larger. This is spectacular, awe-inspiring landscape, which for a long time was one of the least frequented locations in Iceland, since it is enclosed by barely passable glacial rivers.

There is little surface runoff, the bedrock is permeable, and water channels hardly formed, except for the two glacial rivers farther north. Considerable areas of springs are present in Hvannalindir and Krepputunga. A powerful geothermal area is located at a high elevation on and by the glacial margin in Hveradalir. Geothermal heat appears especially as steaming hot springs and more comfortably warm springs in the so-called Jökulsig (Gengissig) east of Hveradalur. At Hveragil in the east part of the mountains there are many warm springs and some beautiful lime precipitates.

The whole area has been surveyed with regard to mapping vegetation in 1978. Vegetation maps remain unpublished but exist in manuscript at the Icelandic Institute of Natural History. A rather extensive nature survey took place in Krepputunga and in Hvannalindir in 1980–1982 due to plans for a hydroelectric power plant for East Iceland (Kristbjörn Egilsson and Einar Þórarinnsson 1988, Erling Ólafsson 1988). In general, the area is bare in appearance except by river channels and in places where *Stereocaulon vesuvianum* and *Stereocaulon arcticum* have managed to grow in the sand-strewn lava fields. The largest plant oasis is in Hvannalindir by springs and forks of the river Lindaá, where there

is a lush *Archangelica* stand at the edge of the lava field, while sandy patches of *Salix* and marginal areas of various kinds are found farther from the lava margins. The vegetation of Hvannalindir is for the most part protected by isolation from sheep and reindeer grazing, even if there is considerable grazing by geese. Although the terrestrial invertebrate fauna of Hvannalindir presents few species, it is nonetheless unique in many ways. Assorted species that are rare elsewhere in the highlands are encountered there, along with several lowland species (Erling Ólafsson 1988). Around 30 species of birds have been seen in Hvannalindir, and eight species breed there regularly or irregularly. The Pink-footed Goose (*Anser brachyrhynchus*) is the most common nesting bird in Hvannalindir. In the summer of 1981, a total of 184 nests were found there (Kristinn H. Skarphéðinsson 1983).

Photo: Snorri Baldursson 2002.



Stereocaulon vesuvianum and *Stereocaulon arcticum* (lichens) form at many spots a greyish blue tinge on the lava fields in Krepputunga

Principal points of natural interest

The principal points of natural interest in the area are majestic geological formations along the edge of Vatnajökull, connected to the central volcano in Kverkfjöll, as well as craters, crater rows and lava flows stemming from them, such as Lindahraun in Hvannalindir. A major geothermal field is found in Hveradalir, situated at the highest altitude of any in Iceland. In Hveragil there are extensive lime precipitates and unique formations of pillow lava. Hvannalindir contains an isolated highland plant oasis with noteworthy sites of cultural interest. The highest locations discovered for several vascular plants are in Kverkfjöll, at an elevation of 1620 m above sea level: Pigmy Buttercup (*Ranunculus pygmaeus*), Purple Saxifrage (*Saxifraga oppositifolia*) and Alpine Hair-grass (*Deschampsia alpina*) (Eyþór Einarsson 1977). Two bird species on the Red List (Icelandic Institute of Natural History 2000) breed in Hvannalindir: Pintail

(*Anas acuta*) and Harlequin Duck (*Histrionicus histrionicus*) (Table 17).

The conservation value of the area is indisputable, especially because of the landscape and points of geological interest (Table 9). Hvannalindir was protected by law in 1973, and Kverkfjöll and Krepputunga are in the National Conservation Registry (Conservation Council of Iceland 1996) on account of "... magnificent landscape with active volcanoes and a variety of geological formations." In the proposals of the Icelandic Institute of Natural History for protecting the country's geological phenomena in relation to the National Nature Conservation Strategy (Helgi Torfason and Ingvar Atli Sigurðsson 2002) it is suggested that Kverkfjöll and Kverkfjallarani be protected.

Table 9. Assessment of the conservation value of natural aspects of the Kverkfjöll area.

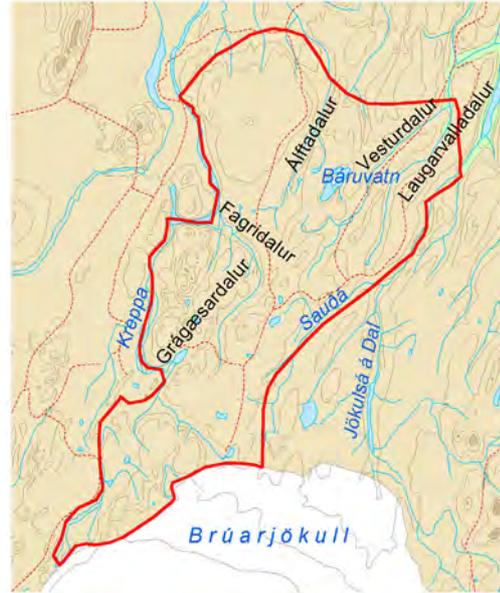
Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Spectacular landscape shaped by the interaction of glaciers, as well as volcanic and geothermal activity
	Vegetation cover	Low	Vegetation is not a noticeable aspect of the landscape
<i>Geological phenomena</i>		High	Powerful geothermal area visible on the surface, craters and crater rows. Lime precipitates and hot springs in Hveragil.
<i>Habitat types</i>		Not assessed	Research needed. Interesting plant oasis in Hvannalindir
<i>Rare species</i>	Plants	Low	
	Birds	Probably low	Limited research
	Terrestrial invertebrates	Not assessed	Research needed
<i>Important species and populations</i>	Pink-footed Goose	Average	The Pink-footed Goose is a common nesting bird in Hvannalindir.

3.2.9 Brúardalir¹ (3.6)

A typical glacially eroded highland landscape with well-vegetated, low valley swags between wind-blown ridges. Natural characteristics here are well known. Average conservation value.

The area is a plateau of 582 km², eroded by glacial ice and rivers. It is bounded to the south by Brúarjökull, Kreppa to the west, Álftadalsfjall to the north, and Sauðá and Jökulsá á Dal to the east (see map).

The bedrock is composed of palagonite formations and lava strata from the latter part of the Quaternary (< 0.8 million years old) and has been polished by glaciers and rivers into its current appearance. Rocky glacial detritus and sands partially cover the area. The leading characteristics of the landscape are low ridges, mountain ridges and shallow valleys and on the whole the landscape has no stark forms. Álftadalsfjall is a shield volcano from a warm period of the Ice Age, with palagonite ridges extending southwards from it. The main valleys are Grágæsadalur, Fagridalur, Álftadalur, Sauðárdalur, Vesturdalur and Laugarvalladalur. The bedrock toward the west is permeable but denser towards the east, where some formation of river channels has occurred. Glacial moraines stand by Brúarjökull and there is sediment from a lagoon in Laugarvalladalur. Warm springs are found, for instance in Laugarvalladalur (70°C), by Vesturdalslækur, by Sauðá and more widely still, although the temperature is generally low. There is some surface discharge and rivers with mixed sources in runoff rivers and spring-fed rivers. The proximity to the glacier or glacier tongues is very influential on the appearance of the land.



Sauðárdalsfoss. Photo: Kristbjörn Egilsson.

The biota has generally been well studied (Kristbjörn Egilsson and Einar Þórarinsson 1988, Erling Ólafsson 1988, Kristbjörn Egilsson and Hörður Kristinsson 1992), and the area closest to Jökulsá á Dal thoroughly investigated (cf. 3.2.10). The western part of the area is rather poorly vegetated, while half of the eastern part is classified as vegetated land (i.e., >10% plant cover), where the commonest plant communities are small-scrub moor, *Salix* moor, sedge moor and moss growth. Gravel with rocks comprises around 90% of the sparsely vegetated or barren land. In Grágæsadalur there is a small patch of vegetation surrounding Grágæsavatn lake and containing vegetation that grows on river flats, as well as moor-land vegetation including Crowberry (*Empetrum nigrum*), Stiff Sedge (*Carex biglowii*), and Bluish Willow (*Salix callicarpaea*). In the upper end of Fagridalur valley there is a much more extensive "incredibly well vegetated and diverse" plant community (Kristbjörn Egilsson and Einar Þórarinsson 1988) which is divided approximately half and half into drylands and wetlands. The most dominant vegetation types in the drylands are *Salix* patches with Crowberry

¹Arnardalur (see 3.2.7) and Arnardalur (see 3.2.7) and Kringilsárrani (see 3.2.10) are a part of Brúardalir according to common language traditions; here, however, the definition has more to do with research on characteristics of nature.

(*Empetrum nigrum*), Stiff Sedge (*Carex bigelowii*) and/or Montane Liverwort (*Anthelia juratzkana*), whereas in the wetlands assorted sedge mires are most common. Twenty-five species of nesting birds have been confirmed in Brúardalur and 35 bird species have been observed there in all (see Sigmundur Einarsson et al. 2000). Golden Plover (*Pluvialis apricaria*), Snow Bunting (*Plectrophenax nivalis*), Pink-footed Goose (*Anser brachyrhynchus*), and Whooper Swan (*Cygnus cygnus*), are the most common nesting birds. The terrestrial invertebrate life has been explored rather thoroughly in the Fagridalur and Grágæsadalur valleys. Fagridalur is "... obviously one of the oases in the highlands which is richest in the number of species", as regards terrestrial invertebrate fauna. This valley is characterised by a number of spider species, even though these species are usually not so diverse in the highlands (Erling Ólafsson 1988, p. 57).

Principal points of natural interest

There are warm and slightly warm springs at several sites but high temperatures are found nowhere except in Laugarvalladalur. Fagridalur contains a highland oasis of unusual biological richness, with respect to both vegetation and terrestrial invertebrates. A total of 14 rare species of plants are found in that area, including five vascular plant species (Table 14), two moss species (Table 15) and seven species of lichens (Table 16), one of which, *Collema polycarpon*, has been found nowhere else in Iceland. Seven bird species on the Red List (Icelandic Institute of Natural History 2000) have bred there: Great Northern Diver (*Gavia immer*) in Grágæsadalur, Pintail (*Anas acuta*), Harlequin Duck (*Histrionicus histrionicus*) and Goosander (*Mergus merganser*), all nesting rarely; Gyrfalcon (*Falco rusticolus*) at one aerie, Greater Black-backed Gull (*Larus marinus*) in Fagridalur; and Raven (*Corvus corax*) at several sites (Table 17).

The conservation value of the area is generally considered moderately high (Table 10) and yet high due to rare plants. Fagridalur and Grágæsadalur are in the Nature Conservation Registry (Conservation Council of Iceland 1996) on the grounds that they are "rich plant oases approximately 600 m above sea level" and display "a wealthy fauna of terrestrial invertebrates along with a scenic landscape." In the proposal of the Icelandic Institute of Natural History for the conservation of species and areas in relation to the National Nature Conservation Strategy (Ólafur Einarsson et al. 2002) it is suggested that the eastern part of Brúardalur (counting also Álftadalur, Vesturdalur and Laugarvalladalur) be conserved as a part of a larger area that should also encompass Snæfellsöræfi (see 3.2.10). In the suggestions of the Icelandic Institute of Natural History for the conservation of geological phenomena in Iceland in relation to the National Nature Conservation Strategy (Helgi Torfason and Ingvar Atli Sigurðsson 2002), it is proposed that Laugarvalladalur be protected due to geothermal activity and unique lime precipitates.

Table 10. Assessment of the conservation value of natural aspects of Brúardalur.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	Average	A typical glacially eroded highland landscape
	Vegetation cover	Average	Laugarvalladalur is fairly well vegetated; Fagridalur oasis incredibly well vegetated
<i>Geological phenomena</i>		Average	Geothermal areas in Laugarvalladalur and elsewhere
<i>Habitat types</i>		Average	Only the eastern part of the area has been evaluated
<i>Rare species</i>	Plants	High	Many rare species
	Birds	High	Many species are on the Red List
	Terrestrial invertebrates	Average	Diverse species of terrestrial invertebrates in Fagridalur and in highland oases
<i>Important species and populations</i>	Reindeer	Average	Laugarvalladalur is an important migration route for reindeer
	Pink-footed Goose	Average	The Pink-footed Goose is a fairly common nesting bird

3.2.10 Snæfellsöræfi (Vesturöræfi–Snæfell–Eyjabakkar) (5.3)

Diverse landscape, geological formations and biota. A well-researched area. Has a high conservation value.

The area is 643 km² in surface area and lies between Sauða in Brúardalur and Jökulsá á Dal to the west, Jökulsá í Fljótsdal to the east and Hrafnkelsdalur to the north. A plateau on a pile of basalt strata from the latter part of the Tertiary period of Earth's history and the beginning of the Quaternary. The landscape is varied, marked by wind-eroded gravelly reaches, moor land, river gorges, sediment terraces, and wetland areas, in addition to the central volcano Snæfell (1833 m), towering some 1100 m over the plateau. The bedrock is dense and tight. This area is the location of runoff rivers, the major rivers being Hölkná, Sauða in Vesturöræfi, Grjótá and Langá.



Detailed studies have been carried out on Snæfellsöræfi due to environmental assessment in relation to two major hydroelectric power plants and associated reservoirs, i.e. Fljótsdalur Power Plant, with water diverted from Eyjabakkar (a concept that has now been abandoned) and Kárahnjúkar Power Plant, with water diverted from Háslón and Ufsarlón and from Múli and Hraun. Few other highland areas have been surveyed or are known to a like degree in respect to natural conditions (e.g. Hjörleifur Guttormsson et al. 1981, Jón Gunnar Ottósson et al. 1999, Sigmundur Einarsson et al. 2000, Árni Hjartarson 2001, Sigurður H. Magnússon et al. 2001, Hilmar Malmquist et al. 2001, Skarphéðinn G. Þórisson and Inga Dagmar Karlsdóttir 2001).

Many interesting geological phenomena appear in this area (see for example Bessi Aðalsteinsson 1974, Helgi Torfason 1989, Helgi Torfason and Bessi Aðalsteinsson 1992, Árni Hjartarson and Elsa Vilmundardóttir 1998). The central volcano of Snæfell was active during the Ice Age, even though whether it is still active is being debated. Palagonite formations are prominent, above all the Kárahnjúkar peaks, which erupted rather late in the Ice Age and dammed the valley south of Kárahnjúkar (here this valley will be called Hjalladalur). The layers of sediment thus formed are particularly unique, among other things because of the proximity of the glacier and their obvious origin. When the glacial tongue Brúarjökull surged approximately 10 km forward in the year 1890, it pushed up massive "folds" of soil and rocky glacial detritus in Kringilsárrani and Vesturöræfi and on Eyjabakkar. There is geothermal activity in a few places by Töðuhraukar in Kringilsárrani and at Lindur, although it has not been investigated much.



Photo Dieter Graser 1998.

The vegetation of Snæfellsöræfi comprises part of a continuity, though broken at many points, stretching from Héraðsflói to the margins of Vatnajökull. Vegetation maps on a scale of 1:20,000 are available in manuscript and published maps exist of the Eyjabakkar area, where lush flood plains exemplify extraordinarily varied vegetation, with the Eyjabakkar flora totalling at least 319 species. Maps of plant communities and of habitat types have been prepared for Hjalladalur and the immediate vicinity, where an estimated 57% is considered vegetated land, mostly arid terrain. The most common habitat types are moor land (22%), gravelly ground (21%), snow beds and heath land (16%) and Dryas heath land. The flora of Hjalladalur and its vicinity accounts for at least 472 species (137 species of vascular plants, 175 species of moss, 124 lichen species and

36 species of fungi). Expansive, biologically rich wetland areas stretch through Vesturöræfi. The bird life is diverse, with at least 24 breeding species. The typical bird for Snæfellsöræfi is undoubtedly the Pink-footed Goose (*Anser brachyrhynchus*), of which some 2200 pairs nest there, while around 10,000 birds moult their flight feathers at Eyjabakkar. Approximately half of Iceland's reindeer population (about 1500 animals) roams in the summer ranges of Snæfellsöræfi, which are also the calving grounds for a portion of that herd. In Hjalladalur, 290 species of terrestrial invertebrates have been encountered.

Principal points of natural interest

The area presents numerous natural phenomena. The main ones are as follows: the central volcano Snæfell, Iceland's highest mountain standing outside glaciers; river channels with waterfalls and gorges; a grand succession of waterfalls in the river Jökulsá í Fljótsdal; remarkable sediment layers from the end of the Ice Age in Hjalladalur, forming along with Dimmugljúfur a continuum of geological history; the folds of earth in Kringilsárrani, on Vesturöræfi and at Eyjabakkar (rare phenomena on a global scale, according to Jón Gunnar Ottósson et al. 1999); continuous vegetated terrain from the coast to the glacier; flood plains on Eyjabakkar; rare habitat types; spring and summer grazing grounds as well as calving areas for reindeer; and untouched wilderness. Sixteen rare plant species have been found in Snæfellsöræfi: five species of vascular plants (Table 14), two moss species (Table 15) and nine species of lichens (Table 16). *Arthonia glebosa* is considered rare on a global scale. Of the terrestrial invertebrates, 37 species are accounted rare on a national scale and six worldwide. Five bird species on the Red List (Icelandic Institute of Natural History 2000) breed in the area (Table 17).

The conservation value of the area is unequivocal (Table 11). A section of the area (i.e., Kringilsárran) is a reserve pursuant to a 1975 act on account of its importance for reindeer and due to indications of the progression of surging in the glacial tongue Brúarjökull. So as to preserve species and areas, the Icelandic Institute of Natural History proposes in respect of the National Nature Conservation Strategy that Snæfellsöræfi, in addition to the eastern part of Brúardalur along with Kringilsárrani, be protected due to 'International conservation value, unique landscape and uncommon geological formations, diverse and species-rich habitat types, and biota' (Ólafur Einarsson et al. 2002).

Table 11. Assessment of the conservation value of natural aspects of Snæfellsöræfi.

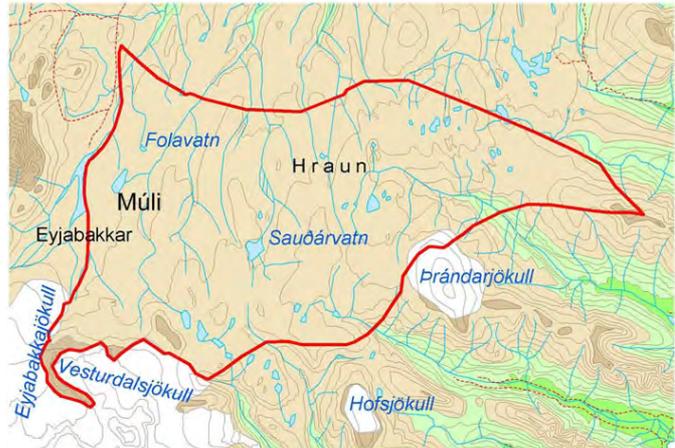
Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Snæfell, Dimmugljúfur, waterfalls, Kárahnjúkar, the river channel and surroundings of Jökla
	Vegetation cover	High	Unusually continuous highland vegetation
<i>Geological phenomena</i>		High	Sediment terraces left by an ancient glacial lagoon, jökulhlaup channel and gorge, glacial moraines, "folds" of soil and young glacial formations
<i>Habitat types</i>		High	Snow beds and heath land (a habitat characterised by diverse species) abound, wetland areas in Vesturöræfi
<i>Rare species</i>	Plants	High	At least 16 rare species of plants grow in the area
	Birds	Average	Five species on the Red List
	Terrestrial invertebrates	High	Very diverse, many lowland species stretch into the highland
<i>Important species and populations</i>	Reindeer	High	Around 1500 animals (approximately half of the country's reindeer population roams the area during spring and summer)
	Pink-footed Goose	High	Some 2200 pairs nest in the area (4.3% of the population); around 10,000 birds moult their flight feathers at Eyjabakkar (3–4% of the population).

3.2.11 Hraun² (5.4)

Hraun is a glacially eroded, wet, rocky plateau. The westernmost part, immediately adjacent to Eyjabakkar (Múli) has been studied well. The conservation value is not considered high.

The area, 564 km² in size, is bounded by a line drawn from the source of Jökulsá í Lóni to Þrándarjökull and Hornbrynja in the east. From there it is drawn along the rim of the highlands to the river Jökulsá í Fljótsdal, proceeding on the west side of the easternmost fork of that river to Eyjabakkajökull (see map).

This is a massive plateau reaching an altitude of around 900 m in the east and southeast, but sloping gently towards the northwest down to about 600–700 m at a location named Múli.



Area geology and hydrology, particularly toward the west, are well known due to the targeted hydroelectric development first of Hraun and later of the Hraun Diversion for Kárahnjúkar Power Plant (see for instance the bibliography of Hilmar Malmquist et al. 2001). Hraun bedrock is in general composed of dense, ancient, impervious basalt strata. Glaciers have eroded the landscape into shallow valley reaches between low ridges and elongated hills.



Photo: Hilmar Malmquist 2001.

While terrain with large rocks, stony hills and stretches of gravel characterises the texture of Hraun, the view to Snæfell is elegant.

The geology of the area is rather unvarying, with the exception of locations by the edge of the glacier, which are always interesting, and a rhyolite area by Geldingafell, east of Eyjabakkajökull. There are several slightly warm springs in the area, but they have not been investigated much. Hraun belongs among the areas in Iceland with the highest precipitation, particularly in refer-

ence to the southeastern part of the island. The main runoff rivers are Kelduá and its tributaries, Fellsá, Ytri-Sauðá and Innri-Sauðá, and Grjótá. Several rather small lakes and numerous ponds dot the expanse of Hraun.

The vegetation and aquatic biota in the western part of Hraun were thoroughly surveyed in connection with the proposed Hraun Diversion (Hilmar Malmquist et al. 2001, Kristbjörn Egilsson et al. 2001); however, the eastern part is less well known. The whole area of Hraun has nevertheless been described through a vegetation map on a scale of 1:20,000 and the remaining areas have been loosely surveyed by botanists (see Kristbjörn Egilsson et al. 2001). The vegetation of Múli around Folavatn has been

² Including Múli.

thoroughly examined and classified into habitat types (Sigurður H. Magnússon et al. 2001). The vegetation there is fairly continuous, with the most common habitat types being those of *Anthelia* moss, of moor land and of snow beds and heath land, of mire, and of gravelly ground. The upper reaches of Múli are semi-vegetated with snow-bed vegetation dominant, but proceeding up and east the terrain becomes more sparsely vegetated. There is considerable bird life by Folavatn, but it has not been studied in a systematic way. Devoid of fish, the rivers and lakes display rather unvarying and unproductive biota. Invertebrate life has only been investigated in the lakes, of which Folavatn presents noteworthy invertebrate fauna. Although avian life remains almost entirely unexplored, it is most likely scattered except around Folavatn on Múli, where there are significant breeding grounds of the Long-tailed Duck (*Clangula hyemalis*). Múli is of importance for reindeer in the autumn and extending into the winter. The animals also keep somewhat to the eastern part of Hraun in the autumn (Skarphéðinn G. Þórisson, verbal information 2003). No species on the Red List (Icelandic Institute of Natural History 2002) is known in this area.

Principal points of natural interest

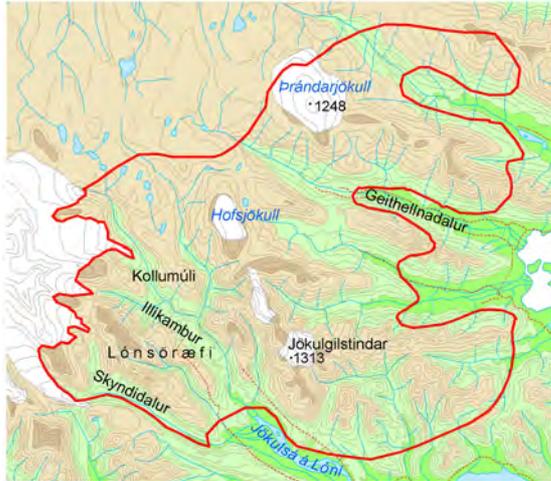
On the whole the conservation value of area geological phenomena is rather low (Table 12), with the exception of the rhyolite at Geldingafell and recent glacial remains by Vatnajökull and Þrándarjökull. The conservation value of the Hraun biota has been assessed in connection with the power plant for Hraun and Hraun Diversion. Hákon Aðalsteinsson (1995) does not consider the ponds and lakes in Hraun to have a high conservation value due to how poor they are. In contrast, Hilmar Malmquist et al. (2001) consider the aquatic systems of Múli and Hraun to have a generally high conservation value as part of uninhabited, untouched open spaces. The conservation value of Folavatn is estimated still higher than it would otherwise be, as it is part of the aquatic system of Eyjabakkur and as it has "the uniqueness on a national scale of being suited to host fish with regard to depth, size and fertility, and yet remains without fish." The conservation value of vegetation in the upper extents of Múli is moderately high. Two extremely rare species of moss, *Peltolepis quadrata* and *Sanionia georgico-uncinata* (Table 15), and one rare lichen species, *Aspicilia simoënsis* (Table 16), have been encountered. No species on the Red List has been recorded as yet, although it is likely the Harlequin Duck, *Histrionicus histrionicus*, breeds somewhat in the area.

Table 12. Assessment of the conservation value of natural aspects in the Hraun area.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	Low–average	Glacially eroded, rocky expanses
	Vegetation cover	Low	Common highland vegetation
<i>Geological phenomena</i>		Low	Rhyolite area by Geldingafell, moraines at the glaciers and slightly warm springs in the western parts of Hraun
<i>Habitat types</i>		Average. Only partially researched	Snow beds and heath-land habitat (rich in species) predominant in Múli
<i>Rare species</i>	Plants	Average	Two very rare species of moss
	Birds	Low	
	Terrestrial invertebrates	Average. Only known to be found in lakes	Interesting population of terrestrial invertebrates in Folavatn
<i>Important species and populations</i>	None known	Probably low	Research needed

3.2.12 Lónsöræfi (5.5)

In Lónsöræfi and the mountainous area to the east the landscape is diverse, praised for its beauty. Geologically, this is one of the most remarkable areas in the country; as for the biota, its conservation value is considered to be moderately high.



This area of 808 km² is bounded by Hnúta and Práandarfjökull along its northern perimeter to the upper ridges of Hamarsdalur. From there the boundary follows the edge of the highlands through Lónsheiði in the south to the limits of the reserve in Lónsöræfin in the southwest (see map).

This is mountainous terrain, severed by deep valleys, so that it is not strictly speaking entirely a highland area. Whereas the northern part rests on solid bedrock, the southern and eastern parts have ancient central volcanoes with plutonic intrusions and the frequent appearance of geothermal metamorphosis. Scree-covered, eroded slopes, cliff belts and vegetated valley basins are typical of the

landscape. Lónsöræfi is among the most important areas in Iceland geologically, because it offers diverse rock formations, intrusions, burned-out geothermal areas, rock strata at different levels on top of older rock, more recent glacial formations, and stark erosion. It appears that a continuous chain of central volcanoes lies from Snæfell all the way to Austurhorn. As the east is reached from Lónsöræfi, another central volcano awaits which derives part of its name from Lón; in Flugustaðadalur there is a third one and a fourth in Álftafjörður. The peaks of Jökulgilstindar (1313 m) form a highland ridge stretching to the east from Lónsöræfi, and the valleys situated north of these peaks are Flugustaðadalur, Hofsdalur and finally Geithellnadalur.

This area displays a great deal of precipitation and high surface runoff. While there are few lakes and ponds, there are many rivers—most carrying some glacial water—that converge and descend into the southernmost fjords on the east coast (the rivers Hamarsá, Geithellnaá, Hofsaá, Jökulsá í Lóni and Skyndidalsá).



Photo Dieter Graser 1998.

Mapped in 1974–1979 (Helgi Torfason 1979), the area is entailed in the geological map for central East Iceland currently being prepared at the Icelandic Institute of Natural History. Dalsheiði is one of the area's noteworthy geological phenomena, formed in a sub-glacial eruption around 800,000 years ago as lava flowed down an eroded valley and almost reached the sea. One of the most obvious unconformities in the country is in Múlatindar, where horizontal layers in the ground lie above eroded and strongly slanting lava strata at the edge of a four to five-million-year-old caldera. Here the caldera depression is buried in younger formations, so that this scene might be compared to Askja itself, if 1000 m of rock were to be piled on top of it and then sliced away, unveiling the internal structure in ravines and cuts. Massive intrusions of gabbro and granophyre appear in Kjarrdalsheiði and in Sviptungnahnúkur. Acidic lava layers and ignimbrite layers, along with dikes of acidic rock and intense metamorphosis through hot water, lend glorious colours to Lónsöræfi. Framhlaup in Stórsteinar is one of the few such

phenomena in the area. Although most rhyolite areas in Iceland boast imposing natural beauty, there are few places in which geohistory is more vivid than in Lónsöræfi.

The vegetation in the greater part of the area has been mapped; this vegetation map is ready in manuscript. No other systematic research on the biota has been conducted in this section of the highlands. On the other hand, the distribution of plants is rather well known. Lónsöræfi constitutes high mountainous terrain, generally with little vegetation, although some plant life thrives in the lower valleys, for example birch scrub. Approximately 195 species of vascular plants have been recorded in the reserve of Lónsöræfi. This diversity is achieved among other things because parts of the reserve extend well below the highland rim. Mosses and animal life are basically unexplored.

Principal points of natural interest

Many special, even unique geological phenomena belong to this area, such as an easily observable fraction of a caldera, acidic rock dikes (intrusions; see figure), and basalt intrusions and veins, besides massive intrusions. Deep erosion has permitted a peek deep down into the pile of geological layers. Diverse vegetation (e.g. natural birch scrub) is found in the valleys. Four rare species of vascular plants are encountered: Spring Quillwort (*Isoetes echinospora*), Serrated Wintergreen (*Orthilia secunda*), Lance-leaved Moonwort, and Snow Fleabane (*Erigeron humilis*) (Table 14). At Austurskógar in Lón (just outside the reserve and below the upper edge of the highlands), eight rare lichen species have been registered.

The conservation value of the area is undisputed (Table 13), as half of it (Lónsöræfi) was protected by law in 1977 and the other half (i.e., Hofsdalur, Tunga, Geithellnadalur and Þrándarjökull) is in the Nature Conservation Registry (Nature Conservation Council of Iceland 1996) with the note, "Lush valleys with prospering scrub and woodland patches surrounded by colourful, high mountains." In the suggestions of the Icelandic Institute of Natural History for protecting species and areas in relation to the National Nature Conservation Strategy (Ólafur Einarsson et al. 2002), it is proposed that Austurskógar in Lón and Geithellnadalur be protected on account of birch woodlands that have been fairly little disturbed and grow in company with unique vegetation and rare species of lichens. Avian life has received little investigation, apart from life in the valleys, where there are for instance five species occupying the Red List (Icelandic Institute of Natural History 2000): Greylag Goose (*Anser anseri*), Harlequin Duck (*Histrionicus histrionicus*), Goosander (*Mergus Merganser*), Gyrfalcon (*Falco rusticolus*; nine aeries) and Raven (*Corvus corax*) (Table 17).

Table 13. Assessment of the natural conservation value of Lónsöræfi.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Diverse mountain landscape, abundant colours
	Vegetation cover	High	Lush vegetation in valleys characterises the landscape.
<i>Geological phenomena</i>		Very high	Álftafjörður, Lón, Flugustaðadalur and Lónsöræfi used to have central volcanoes. Plutonic intrusions in Kjarrdalsheiði and other places, dolerite formations, glacial surging, rock strata in Múlatindar and other areas.
<i>Habitat types</i>		Not evaluated	
<i>Rare species</i>	Plants	Average	Some rare vascular plants
	Birds	Not evaluated	Limited research
	Terrestrial invertebrates	Not evaluated	Research needed
<i>Important species and populations</i>	None known	Probably low	Research needed

3.3 Rare geological formations and organisms

3.3.1 Geological formations

A variety of geological formations are found in the highlands north of Vatnajökull, ranging in age from several decades (the last eruption in the area occurred at Askja in 1961) to 10–11 million years. A list of a few such phenomena follows. The tradition of assessing rare geological phenomena and for prioritising with regard to conservation value is shorter than that concerning biological phenomena (Helgi Torfason and Ingvar Atli Sigurðsson 2002). It is therefore necessary to maintain some reservations in respect to the following list of items.

Geothermal heat

High-temperature geothermal areas are found in Vonarskarð, Kverkfjöll, Askja and Fremri-Námur.

- At Hveragil in Kverkfjöll the geothermal temperature reaches as high as 60° C, with extensive calcium deposits.
- Fremri-Námur has a geothermal area in a crater on a shield volcano, and considerable amounts of sulphur.

Low-temperature geothermal areas are evident in quite many places, e.g.:

- Laugarvellir: a hot spring of 70° C mineral water; extensive crusts of calcium, which are rarely present in low-temperature areas
- Laugarfell: north of Snæfell; a warm spring at 52° C—the warmest spring throughout a broad area
- Lindur

Volcanic activity

- Dyngjuháls: severely scorched by volcanic forces; beautiful crater rows
- Trölladyngja: a massive, large shield volcano; probable source of numerous eruptions
- Askja:
 - Large caldera along with other smaller ones; the most remarkable caldera depression in Iceland
 - Öskjuvatn, the history of which is known and dated; unique in the country's geological history
- Víti, an explosion crater

Glacial phenomena including glacial erosion and landslides

- Ground folded by the surging glacier into Töðuhraukar
- Landslide at Stórsteinar
- Dimmugljúfur canyon, carved out by the river Jökulsá á Dal
- Terraces of sediment in Hjalladalur

Volcanic activity under glaciers

- Herðubreið: a table mountain of superbly beautiful symmetry; a majestic peak in general
- Dalsheiði: a very clear example of an eruption and lava flow under a glacier

Intrusions

- Plutonic rock
 - Gabbro in Kjarrdalsheiði
 - Granophyre in Sviptungnahnúkur

Calcium deposits by Laugarvellir.



Photo: Helgi Torfason.

3.3.2 Vascular plants

Few rare vascular plants have been found in the highlands north of Vatnajökull—an observation that can be applied to the Icelandic highlands as a whole. However, large expanses remain insufficiently investigated for it to be possible to assert that the following list is exhaustive. Areas that merit particular interest and require further investigation are for example the geothermal fields in the southern reaches of Vonarskarð, as well as geothermal vegetation by the southeast corner of Öskjuvatn (at an elevation of around 1150–1200 m). In Ytra-Fljótsgil by Skjálfandafljót there is considerable birch scrub at around 550 m above sea level. This is the only site where birch has been located this far inland in North Iceland—perhaps the last remnants of woodlands previously existing in Krókdalur.

The following ten species of vascular plants considered rare on a national scale have been found in the area. Nonetheless, only one of them is on the Red List (Icelandic Institute of Natural History 1996):

- Snow Fleabane (*Erigeron humilis*), Alpine Cat's Foot (*Antennaria alpina*), Nard Sedge (*Carex nardina*) and Alpine Whitlowgrass (*Draba oxycarpa*), are all rather rare alpine species with continental distribution patterns (i.e., growing inland far from the sea). These species primarily appear in the northeastern highlands, and are widely distributed there.



- *Small Adder's Tongue³ (*Ophioglossum azoricum*; see photo), is a geothermal species occurring at two sites: in Vonarskarð and by Öskjuvatn.
- Thick-headed Sedge (*Carex macloviana*) is a continental species with a distribution that is restricted more to the lowlands than the highlands. The site where it is found in Þorláksmýrar is unusually far into the highlands for this species.

Photos left and below: Hörður Kristinsson 1999.

- Common Water Starwort (*Callitriche hermaphroditica*) is found in the Snæfell area submerged in small ponds. Although it grows under similar conditions at Þjórsárver, it is also rare there.
- Spring Quillwort (*Isoetes echinospora*) has been found in Lónsöræfi. It grows in bodies of water at many spots in the mountains of North Iceland, but rarely very far from the sea.
- Lance-leaved Moonwort (*Botrychium lanceolatum*) has been found in Víðidalur in Lónsöræfi.
- Serrated Watergreen (*Orthilia secunda*; see photo) grows mostly in moor land and among scrub in the lowlands. It was recently found unexpectedly at Herðubreiðarlindir, the only site where it has been discovered so far from the coast in the highlands. It is also found in valley woodlands inside Lónsöræfi but at a much lower elevation above sea level.



³ Species marked with an asterisk are assigned to the Red List (Icelandic Institute of Natural History 1996).

Table 14. Rare species of vascular plants in the highlands north of Vatnajökull. The numbers signify the number of entries for each species in the database of the Icelandic Institute of Natural History. In some instances several entries are given for one and the same site.

Species/Area	Tungnafellsjökull– Vonarskarð	Headwaters of Skjálfandafjót	Trölladyngja	Askja–Dyngjufjöll	Herðubreid– Herðubreidarindir	Ódáðahraun	Möðrudalsöræfi– Arnardalur	Kverkfjöll– Krepputunga	Brúardalur	Snæfellsöræfi	Hraun	Lónsöræfi
<i>Isoetes echinospora</i>												1
<i>Carex nardina</i>		5			7			9	11	7		
<i>Antennaria alpina</i>	3	3		4	1		4	6	1			
<i>Draba oxycarpa</i>	9								1	9		
<i>Orthilia secunda</i>					1							2
<i>Callitriche hermaphroditica</i>										2		
<i>Carex macloviana</i>										2		
<i>Botrychium lanceolatum</i>									1			4
<i>Ophioglossum azoricum</i>	1			2								
<i>Erigeron humilis</i>	1	2		6	2				3	1		1

3.3.3 Mosses

There are eleven very rare moss species in the highlands north of Vatnajökull (Table 15), as follows:

- **Atrichum angustatum*:⁴ Geothermal species. Found not only by the southeast corner of Öskjuvatn but also in Landmannalaugar and in the Hengill area.
- **Atrichum tenellum*: Geothermal species. Found by the southeastern corner of Öskjuvatn. Has otherwise only been found at Laugarvatn.
- *Bryum cryophilum*: High alpine species. Found by Tungnafellsjökull. Has otherwise only been found in the highlands by Eyjafjörður.
- **Bryum mitidulum*: Mountain species. Found only by the conflux of the rivers Sauðá and Jökulsá á Dal on Snæfellsöræfi. Has otherwise only been found around Ljótipollur south of Tungnaá.
- **Bryum vermigerum*: Found at a single site in Iceland, in Öskjuhraun not far from Drekgil.
- *Campylinum laxifolium*: Mountain species. Found at only one location in the country, in Fagradalur.
- *Peltolepis quadrata*: Alpine species. Found by Fólavatn on Múli. Has been found at only one other Icelandic location, in Esjufjöll in Vatnajökull.
- **Philonotis marchica*: Geothermal species. Found in Laugarvalladalur in Snæfellsöræfi. Has been found at three other places—at Jarðbaðshólar by Mývatn, Reykir in Fnjóskadalur, and Hveragerði.
- *Sanionia georgico-uncinata*: Alpine species. Found by Geithellnavatn and in Nýidalur by Tungnafellsjökull. Has also been found on morenes in Breiðamerkurjökull, by Lakagígar and on Kaldbakur by Eyjafjörður.
- *Schistidium platyphyllum*: Northerly riverbank species. Found by Arnardalsá. Has been found at several other sites—by Svartá in Þjórsárver and by Orravatnsrústir, Hraunþúfugljúfur and Torfufell in Eyjafjörður.
- **Schistidium venetum*: Alpine species. Found in three locations on Snæfellsöræfi. Has otherwise been found by Kaldbakur in Hreppar, by Lakagígar and in Grænifjallgarður.

⁴ Species marked by an asterisk are on the Red List (Icelandic Institute of Natural History 1996).

Table 15. Extremely rare moss species in the highlands north of Vatnajökull. The numbers signify the number of entries for each species in the database of the Icelandic Institute of Natural History. In some instances several entries are given for one and the same site.

Species/Area	Tungnafellsjökull– Vonarskarð	Headwaters of Skjálfandafjót	Trölladyngja	Askja–Dyngjufjöll	Herðubreið– Herðubreiðarlindir	Ódáðahraun	Möðrudalsöræfi– Arnardalur	Kverkfjöll– Krepputunga	Brúardalur	Snæfellsöræfi	Hraun	Lónsöræfi
<i>Atrichum angustatum</i>				1								
<i>Atrichum tenellum</i>				1								
<i>Bryum cryophilum</i>	1											
<i>Bryum mitidulum</i>										1		
<i>Bryum vermigerum</i>				1								
<i>Campylinum laxifolium</i>									1			
<i>Peltolepis quadrata</i>											1	
<i>Philonotis marchica</i>									1			
<i>Sanionia georgico-uncinata</i>	1										1	
<i>Schistidium platyphyllum</i>							1					
<i>Schistidium venetum</i>										3		

3.3.4 Lichens

Twenty rare lichen species have been found in the highlands north of Vatnajökull (Table 16). It stands out that rare species are noted exclusively in areas which have been thoroughly studied (i.e., Möðrudalsöræfi–Arnardalur, Brúardalur, Snæfellsöræfi and Hraun, and by Tungnafellsjökull and in Herðubreiðarlindir, which were research stations during the first effort to register the lichen flora of Iceland, 1967–1968). In other areas, where lichens have been less thoroughly examined, no rarely spotted species came to light. The detection of further species in the future is therefore likely.

These 20 species can be divided into three categories according to how rare they are. In the first category are very rare species, which are only known within the area and have not been found outside it:

- *Acarospora badiofusca*: Found only in Nýidalur by Tungnafellsjökull, at an elevation of around 8000–900 m [sic].
- *Collema polycarpon*: Found only in a geothermal area at the brink of Sauðárgljúfur gorge by Jökulsá á Dal.
- *Rhizocarpon chioneum*: A calcium-loving lichen that has only been found on hot-spring crusts in the geothermal area of Vonarskarð.
- **Sarcosagium campestre*:⁵ Found only on tephra deposits east of Kreppa, west of Arnardalur.
- **Umbilicaria rigida*: Found only on cliffs by the southwest margin of Tungnafellsjökull, at an elevation of around 1500 m.

⁵ Species marked with an asterisk are on the Red List (Icelandic Institute of Natural History 1996), although crustose lichens were only to a small extent included in that list.

In the second category are species that exist in the area and are also found in one or several places outside it:

- *Arthonia glebosa* (see photo): Quite common on the terraces of sediment by Jökulsá á Dal (recorded there in five places) but found in only two places outside the area: on Bóndhóll by Þeistareykir and by Hringsdalur on Látraströnd.

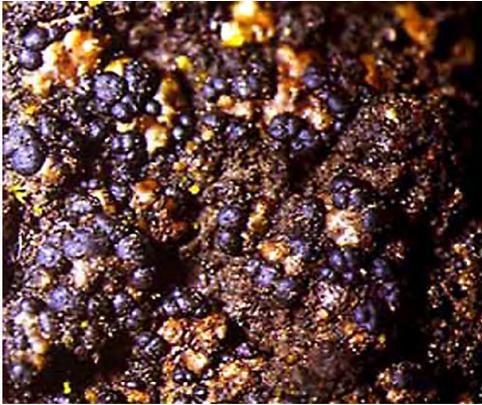


Photo: Hörður Kristinsson.

- *Aspicilia simoënsis*: Found within the area at a single spot by Grjótá northwest of Snæfell. Apart from this found in only three places in East Iceland.
- *Endocarpon pulvinatum*: Found in a geothermal area at the brink of Sauðárgljúfur by Jökulsá á Dal, but in only one place outside the area, on cliffs beside Lagarfljót by Vallanesháls.
- *Mycobilimbia tetramera*: Found in two places in the vicinity of Snæfell but in only two other locations in Iceland, by Kollsvík north of Látrabjarg and in Þjórsárver. This species can only be identified through microscopic observation and may be more common than these few findings indicate.
- *Polysporina lapponica*: Found south of Möðrudalur opposite Bæjaröxl, near the borders of the area. Known from two other sites in Iceland, although its distribution is likely to be much greater.
- *Protothelenella sphinctrinoides*: Found in four places within the area, in Arnardalur and by Þorlákslindahryggur, by Laugará near Snæfell, and on Jökulöldur in Kringilsárrani. Outside the area the species has only been found in three places—on Tindastóll by Skagafjörður, in Þjórsárver, and by Hellisárbotnar in Síðumannaafreittur. Therefore, it seems to be most common in the area north of Vatnajökull.
- *Tephromela melaleuca*: Found in quite a few places within the area, e.g. in Arnardalur, by Þorlákslindir and Þorlákslindahryggur, by Miðdegistindar south of Möðrudalur, and beside Folavatn on Hraun. Aside from this area the species has only been found in Þjórsárver.

The third category contains rather rare species that are found both within and outside the area:

- *Brodoa oroarctica*: Quite common in two small areas in the eastern part of the country, one of which comprises the uppermost extent of Fljótsdalsheiði by Snæfell, Folavatn on Múli and Hraun. The other area lies much farther north on both sides of Jökuldalur.
- **Cladonia imbricaria*: Found at two places in the area, on Grjótáreyrar by Snæfell and in Arnardalur. Found in four other places in Iceland, of which three are in the highlands.
- **Leciophysma finmarckicum*: Seems rather abundant in Vesturöræfi and Brúaröræfi, but is found at only four places elsewhere in the country.
- **Lobothallia alphoplaca*: Found in Arnardalur on Möðrudalsöræfi and next to Miðtungu by Svínafellsjökull in Hornafjörður. Known at five other places in the country. This species is entered in the Red List (Icelandic Institute of Natural History 1996) under the older name of *Physcia phaea*.
- *Mycobilimbia microcarpa*: Found at two sites within the area, west of Arnardalsfjöll and on Vesturöræfi opposite Kringilsá. Has been found at four other Icelandic locations. This species can be identified only through microscopic examination and is therefore likely to be found at further points in future years.
- *Peltigera ponojensis*: Found at two places within the area, by Herðubreiðarlindir and in Sauðárgljúfur by Jökulsá á Dal. Has been discovered at nine other places in the country and is therefore rather rare on a national scale.
- **Phaeophyscia endococcina*: Found in two places within the area, in Nýidalur by Tungnafellsjökull and at Dimmugljúfur along Jökulsá á Dal. Is found in several other places farther west in North Iceland, as well as by Lagarfljót in Hérað.

- **Phaeorrhiza nimbosa*: Found at quite a few locations within the area in addition to seven locations outside it, although only in the interior highlands. This species has a place on the Red List (Icelandic Institute of Natural History 1996) since it had only recently been found when the list was drawn up. Upon updating the list, this species should probably be omitted because of how common it is.

Table 16. Rare lichen species in the highlands north of Vatnajökull. The numbers signify the number of entries for each species in the database of the Icelandic Institute of Natural History. In some instances several entries are given for one and the same site. Only part of these rare species have received Icelandic names.

Species/Area	Tungnafellsjökull– Vonarskarð	Headwaters of Skjálfandafljót	Trölladyngja	Askja–Dyngjufljöll	Herðubreið– Herðubreiðarlindir	Ódáðahraun	Möðrudalsöræfi– Arnardalur	Kverkfjöll– Krepputunga	Brúardalur	Snæfellsöræfi	Hraun	Lónsöræfi
<i>Acarospora badiofusca</i>	1											
<i>Arthonia glebosa</i>									3	2		
<i>Aspicilia simoënsis</i>										1		
<i>Brodoa oroarctica</i>										1	4	
<i>Cladonia imbricaria</i>							1			1		
<i>Collema polycarpon</i>									1			
<i>Endocarpon pulvinatum</i>									1			
<i>Leciophysma finmarckicum</i>									2	8		
<i>Lobothallia alphoplaca</i>							1					
<i>Mycobilimbia microcarpa</i>							1			2		
<i>Mycobilimbia tetramera</i>										1		
<i>Peltigera ponojensis</i>					1				1			
<i>Phaeophyscia endococcina</i>	1								1			
<i>Phaeorrhiza nimbosa</i>	3								1	5		
<i>Polysporina lapponica</i>							1					
<i>Protothelenella sphinctrinoides</i>							2			2		
<i>Rhizocarpon chioneum</i>	1											
<i>Sarcosagium campestre</i>							1					
<i>Tephromela melaleuca</i>							5				1	
<i>Umbilicaria rigida</i>	1											

3.3.5 Birds

In Table 17 there is an overview of bird species on the Red List (Icelandic Institute of Natural History 2000) that breed in the highlands north of Vatnajökull. Most species on the Red List breed in Möðrudalsöræfi–Arnardalur or in Herðubreiðarlindum, for a total of eight species. The fewest species on the Red List breed by Tungnafellsjökull, Trölladyngja and on Hraun including Múli. There are a total of 30 falcon aeries in the area. The Pink-footed Goose (*Anser brachyrhynchus*) is the only important species breeding in the region north of Vatnajökull (Table 17), and is a very common nesting bird by Skjálfandafljót, at Möðrudalsöræfi–Arnardalur, and on Snæfellsöræfi, though it is rare around Tungnafellsjökull and in Ódáðahraun. The distribution of the Pink-footed Goose's breeding areas in Hraun or Lónsöræfi is unknown.

Table 17. Bird species on the Red List (the Icelandic Institute of Natural History 2000) which are known to breed in the highlands north of Vatnajökull.

Species/Area	Tungnafellsjökull– Vonarskarð	Headwaters of Skjálfandafljót	Trölladyngja	Askja–Dyngjufljöll	Herðubreið– Herðubreiðarlindir	Ódáðahraun	Möðrudalsöræfi– Arnardalur	Kverkfjöll– Krepputunga	Brúardalur	Snæfellsöræfi	Hraun	Lónsöræfi
<i>Gavia immer</i>							√		√			
<i>Anser anser</i>					√		√					√
<i>Anas acuta</i>					√		√	√	√	√		
<i>Histrionicus histrionicus</i>	√	√			√	√	√	√	√	√		√
<i>Mergus merganser</i>		√			√		√		√	√		√
<i>Falco rusticolus</i> (30 aeries)		√		√	√	√	√		√	√		√
<i>Larus Marinus</i>			√		√		√		√			
<i>Nyctea scandiaca</i>		√			√							
<i>Corvus corax</i>		√		√	√	√	√		√	√		√
Total	1	5	1	2	8	3	8	2	7	5	(0)	5
Important species												
<i>Anser brachyrhynchus</i>	Rare	V. com.	Rare		Com.	Rare	V. com.	Com.	Com.	V. com.	?	?



The Harlequin Duck (*Histrionicus histrionicus*) breeds at numerous points in the highlands north of Vatnajökull but is nowhere common.

Photo: Jóhann Óli Hilmarsson.

4 ASPECTS OF NATURE BY JÖKULSÁ Á FJÖLLUM AND MÝVATN-LAXÁ

4.1 Area description

The lowland areas selected for the present discussion (i.e., Jökulsárgljúfur canyon, Öxarfjörður, Mývatnssveit and Laxá) are connected with the highlands north of Vatnajökull on the one hand along Jökulsá á Fjöllum and on the other hand along the lava field Laxáhraun yngra from Ketildyngja and also along Laxáhraun yngra from Þrengslaborgir and Lúdentsborgir (Figure 7).

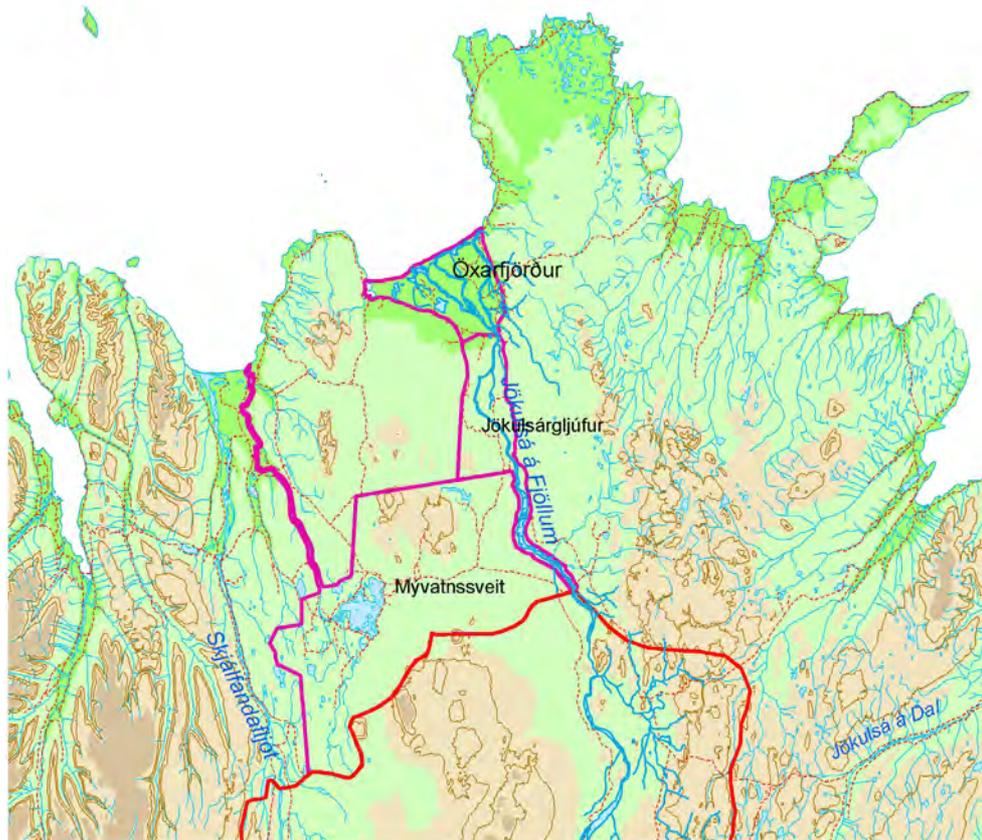


Figure 7. Areas in the lowlands of Northeast Iceland connected with the highlands north of Vatnajökull: Jökulsá á Fjöllum down to the estuary (Jökulsárgljúfur and Öxarfjörður), Mývatnssveit and Laxá.

Jökulsá á Fjöllum

Jökulsá á Fjöllum has its source in Dyngjujökull and Brúarjökull (Kreppa and Kverká rivers) and runs to the sea at Öxarfjörður. Water in the river is mostly of glacial origin, even though several spring-fed tributaries converge with it, such as Lindaá in Hvannalindir, Lindaá in Herðubreiðarlindir, Grafarlandaá and Skarðsá, in addition to smaller rivers and streams in Jökulsárgljúfur canyon. The length of the river from source to estuary is around 206 km, the average rate of flow is 210–220 m³/sec., and the catchment area spans 7800–8200 km². Jökulsá á Fjöllum is the second longest river in the country and the one that has the largest catchment area; nonetheless, it assumes fourth place as regards the average rate of flow (although sources do not fully agree on the discharge figures and the size of the catchment area; see Sigrún Helgadóttir 1997).

The land along Jökulsá á Fjöllum from its source to estuary was shaped after the Ice Age by at least two catastrophic floods, evidence of which is frequently very clearly visible, e.g. north of Kverkfjöll

and westwards to Vaðalda, where there are indications of the flood courses and where massive boulders remain on the windswept sands. The volume of water filled Jökulsárgljúfur canyon, eroding and washing away layers of lava and earth materials, and spreading over the moor lands south of Kelduhverfi. The water flow is considered at its peak to have reached up to 200 thousand cubic metres per second, which sufficed to carve out the cliff fortress of Ásbyrgi. What caused these tremendous, catastrophic floods has not been exhaustively studied, but it is considered likely that volcanic activity in Vatnajökull played a role. South of Jökulsárgljúfur, Jökulsá runs through recent lava fields and broad glacial sands. The landscape from Möðrudalur south to Vatnajökull is particularly special. Palagonite ridges from the Ice Age form a jagged mountain range in the east, while low, eroded palagonite ridges, glacial sands and glacial rock detritus from the end of the Ice Age form rounded-off mounds and depressions to either side of Jökulsá. Rising in the west are major volcanoes such as Askja and the palagonite table mountain Herðubreið, interspersed with large shield mountains and wide-spreading Holocene lava fields. In the south appear Kverkfjöll and the glacial outwash materials in front of Dyngjufjökull, with Vatnajökull in the background. These areas have been discussed earlier in the text.

In this part the river will be traced from the highlands to its mouth in Öxarfjörður. For the sake of convenience, the area is divided into two sections, firstly the Jökulsárgljúfur canyon itself, and secondly the river estuary in Öxarfjörður. Since Jökulsá á Fjöllum remains unspoiled and unharnessed by human beings, the opportunity still exists to protect a giant river from its source to its estuary and hence put on reserve "assets which cannot be evaluated in terms of money, but measured by hours of pleasure" (Sigurður Þórarinnsson 1978).

Mývatnssveit and Laxá

The land of Skútustaðahreppur all the way to the glaciers, in addition to Laxá with its islets and tributaries down to the river estuary by Skjálfaflói, is protected by a special act, No. 36/1974 (see Figure 3, the pale green area). A large portion of the area that law No. 36/1974 pertains to lies inside the highlands, in sub-areas discussed in the earlier half of this report: Trölladyngja (3.1), Askja–Dyngjufjöll (3.3), Herðubreið–Herðubreiðarlindir (3.4) and Ódáðahraun (3.2). This part will focus on the lowlands of Skútustaðahreppur, i.e. Mývatn and its surroundings, especially south and east of the lake (see 4.2.1).



Dettifoss. Photo: Snorri Baldursson 1984.

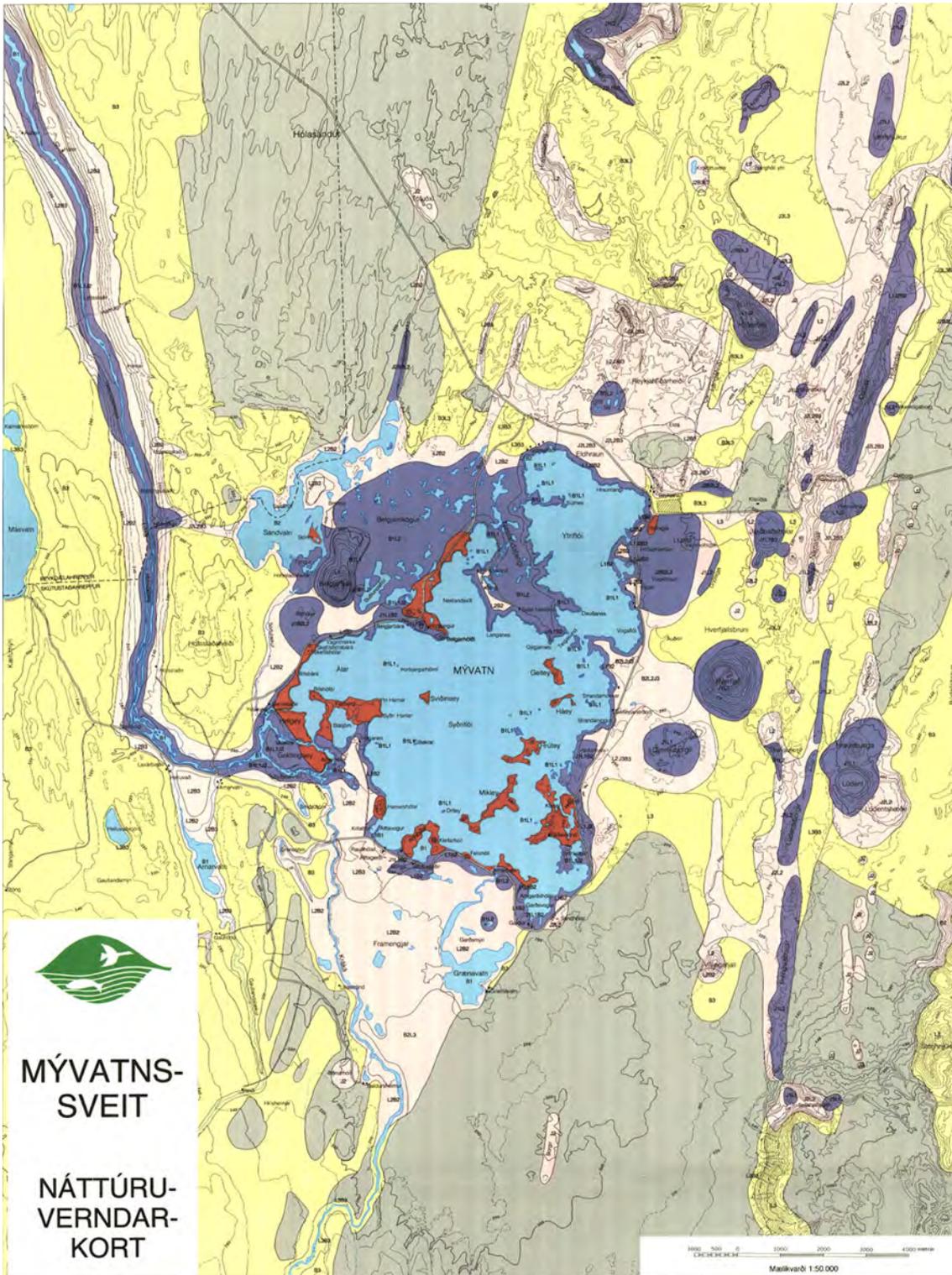
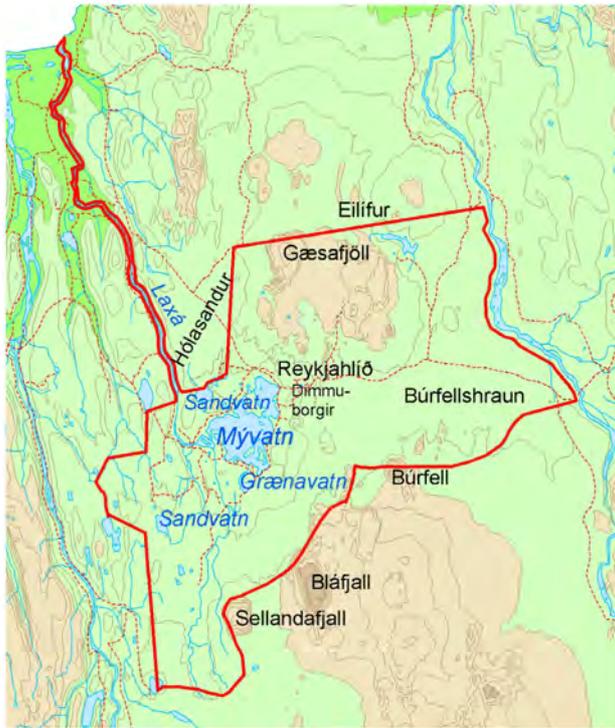


Figure 8. Nature conservation map of Mývatnssveit. Key: maroon areas = Conservation Category 1a (landscape and points of natural interest in Category 1), purple areas = Conservation Category 1b (landscape and points of natural interest in Category 1), pink areas = Conservation Category 2 (landscape and points of natural interest in Category 2), yellow areas = Conservation Category 3 (landscape and points of natural interest in Category 3), grey areas = Conservation Category 4 (denuded expanses) (cf. Nature Conservation Council 1987 and Chapter 4.2.1).

4.2 Aspects of nature and the conservation value of individual areas

4.2.1 Mývatnssveit⁶ and Laxá

Mývatn and its vicinity are unique among areas of their sort for their diverse geological phenomena, landscape and biota. Conservation value on a global scale.



The area, around 1350 km² in extent, includes the more lowland reaches of Skútustaðahreppur in addition to Laxá. The eastern boundary is along Jökulsá á Fjöllum, the northern perimeter passes through Eilífur, and the western margin lies along Hólasandur, Másvatn, Kálfborgarvatn and Sandvatn (see map).

Much has been written on the nature found at Mývatn and in its vicinity. In the following general overview, information was partially obtained from the website of the Mývatn Nature Research Station (Árni Einarsson 2003), where there is also a detailed list of references.

The land around Mývatn to the south, east and north is shaped by volcanic activity, while to the west there are wetlands and moor lands.

Volcanic activity east and south of Mývatn since the Ice Age is divided into two periods. The first one, the Lúdent Period, began in the late Ice Age and extended considerably into

postglacial time. The tephra crater Lúdent and Ketildyngja (see the discussion on Ódáðahraun in Chapter 1.2.6) are from this time. The lava of Laxárhraun eldra ran from Ketildyngja all the way to Mývatnssveit and onward down Laxárdalur and Aðaldalur. The latter period derives its name from Hverfjall (Hverfell) and began with a major tephra eruption that formed the mountain around 2900 years ago. Around 200 years later, the lava of Laxárhraun yngra emerged from Þrengslaborgir and Lúdentborgir east of the lake, to flood over the Mývatn of that time, then down Laxárdalur and out into the sea through Aðaldalur. Laxárhraun yngra formed the modern Mývatn with Ytriflói and Syðriflói, along with adjacent areas. The pseudocraters by Mývatn were formed by steam eruptions when the lava poured out into the lake which blocked it. Dimmuborgir and the lava pinnacles by Kálfaströnd and Höfði are the remains of emptied lava ponds from Laxárhraun yngra. To the north there are two fracture zones. The more easterly zone connects to Námafjall and Krafla and the more westerly one to Þeistareykir. Between them rises the table mountain Gæsafjöll. The high-temperature area in Krafla is being utilised for the production of electricity but still retains unharmed geological phenomena, such as Víti and Leirhnjúkur. Víti was formed in an explosive eruption at the beginning of the Mývatnseldar eruption series (1724–1729), although the crater row itself lies west of Leirhnjúkur and the lava flowed south into Mývatn. The eruption fissure of the eruption series Kröfluedar (1975–1984) lies slightly farther east, and the lava from there streamed mostly to the north. These eruption sites are well known all around the world, because Kröfluedar and the research connected with that series of eruptions received avid attention. To the southeast of Mývatn stands the table mountain Bláfjall, which is from the Ice Age, and northeast of it the range of Bláfjallsfjallgarður, which consists of palagonite ridges and mountains formed in eruptions under the glaciers of the Ice Age, with rough

⁶ Generally speaking the geographical term Mývatnssveit refers to the inhabited area around Mývatn and the lake's nearest vicinity, but may also refer to the district of Skútustaðahreppur (Nature Conservation Council of Iceland 1987).

Holocene lavas lying in depressions in between. This eruption zone is severely scorched by lava and ash from Mývatn all the way south of Askja; in fact, the very name of Mývatnsöræfi implies an arduous terrain, covered with sand and hardly vegetated.

The core of the area, Mývatn, lies at an elevation of 278 m above sea level and is on the western margin of the eastern eruption zone (see Figure 2). Among the largest lakes in Iceland with a surface area of 37 km², Mývatn has a coastline cut by exceptionally frequent inlets. The lake is shallow, with the greatest depth at 4.2 m and an average depth of close to 2.5 m. Laxá, one of Iceland's biggest spring-fed rivers, flows from Mývatn. Nearly all the water discharged into Mývatn comes through springs along the lake's eastern shores. The only river running into Mývatn, Grænilækur, originates in Grænavatn lake, which also derives most of its water from springs, in a similar manner to Mývatn.



Photo: Ólafur Hrafn Nielsen 2002.

Ten to fifteen pairs of the Gyr Falcon (*Falco rusticolus*) base their livelihood on Mývatn and Laxá. The figure shows a half-grown Gyr Falcon nestling.

Mývatn is the most fertile freshwater lake in the country. Its biological wealth is based on nutrient-rich spring water, high rates of sunshine in this area, and the favourable depth of the water. In Ytriflói there are carpets of sessile aquatic plants, while in Syðriflói Green Algae are most apparent, e.g. *Cladophora aegagropila*, which in two spots in the lake grows in rather large spheres that might be

termed "lake balls" (*kúluskítur*). Blue-green bacteria in the plankton cause the lake water to become greenish and murky in appearance, particularly during mid-summer (called "a loosening of clay"). Nonetheless, miniscule diatoms provide the nutritional foundation for benthic animals, of which just over 50 species are known, most of them lying at the bottom. The greatest biomass among the benthic animals is ascribed to chironomid larvae; over 40 species of chironomids are known in Mývatnssveit, despite only a few being very common. Miscellaneous other benthic animals are attributed to Mývatn, among them slugs, crustaceans, leeches, bivalves, annelids, flatworms and the hydroid *Hydra*. The bottom of Laxá river is completely dominated by simuliid larvae, which have adjusted to life in running water and derive their nutrition from planktonic algae and other organic particles carried downstream from Mývatn. The abundance of fish has made Mývatn one of the best-known fishing lakes in the country. The Arctic Char (*Salvelinus Alpinus*) is the most important game fish. Brown trout (*Salmo trutta*) stay mostly in Ytriflói and in Laxá, which is without a doubt the best trout-fishing river in Iceland. Laxá in the stretches associated with Aðaldalur valley belongs among the most famous rivers for trout fishing.



Lake Mývatn. Photo: Snorri Baldursson 2002.

Conditions in the proximity of Mývatn are conducive to vegetation. Birch is most conspicuous toward the north and east, while bog land and moist grassy areas are common toward the west and the south. Islands and islets in Mývatn and Laxá are vegetated by birch, *Salix* and flowering plants. Lichens are particularly prominent, especially the yellow-red species of *Xanthoria*, the species *Flavocetraria nivalis*, and the yellow-green *Alectoria ochroleuca*.

Terrestrial invertebrate life in the area has not been researched much. The swarms of midges make conditions favourable for spiders, as evidenced by a greater number of spiders in Mývatnssveit than is known elsewhere in the country. Around 58 species of birds have bred by Mývatn and Laxá, among them all the duck species in Iceland (totalling 16), with the sole exclusion of the Shelduck (*Tadorna tadorna*). Few places in the world can boast more species of breeding ducks. The surroundings of Mývatn and Laxá serve as the principal home territories of several Icelandic bird species: Slavonian Grebe (*Podiceps auritus*), Gadwall (*Anas strepera*), Tufted Duck (*Aythya fuligula*), Scaup (*Aythya marila*), Common Scoter (*Melanitta nigra*) and Barrow's Goldeneye (*Bucephala islandica*), and there are more Harlequin ducks (*Histrionicus histrionicus*) on Laxá than on any other river in Iceland. Barrow's Goldeneye (*Bucephala islandica*) is truly the typical bird for Mývatn.

Principal points of natural interest

Mývatn with the neighbouring wetland areas and the river Laxá is world-renowned for its diverse biota and unique ecology. The attraction of Mývatnssveit stems however not least from its distinctive landscape and geological phenomena, many of which are unique among their type. On the nature conservation map for Mývatnssveit (Nature Conservation Council of Iceland 1987), the points of natural interest in the area are classified into four categories (Figure 8). The first category contains points of natural interest that are for instance considered outstanding examples of certain geological phenomena, provide a basis for the existence of particular animal populations, boast an especially diverse biota, or strongly shape the appearance of the landscape. The list accounts for 38 points of natural interest in Category 1 and 24 in Category 2. It would take too much space to recount them all here, but the following geological phenomena in Category 1 can be mentioned: Hverfjall, a gigantic, beautifully shaped tephra crater; the crater rows Lúdentborgir and Þrengslaborgir; the lava pinnacles of Dimmuborgir and Klasar; the pseudocraters by Syðriflóí—in particular the Skútustaðagígar, which are among the largest and most nicely formed in Iceland; the lava fissures Stóragjá and Grjótagjá; the fields of hot springs at Jarðbaðshólar, Hverarönd and Leirhnjúkur; and many more (Figure 8). There are also plenty of biological phenomena. Ten rare species of vascular plants grow by Mývatn and Laxá (Table 21), among them five species on the Red List (Icelandic Institute of Natural History 1996): Common Moonwort (*Botrychium lunaria*), Hudson Bay Sedge (*Carex heleonastes*), Small Adder's Tongue (*Ophioglossum azoricum*) Herb-Paris (*Paris quadrifolia*) and Fleshy Stitchwort (*Stellaria crassifolia*). Nine extremely rare lichen species have been found in Mývatnssveit (Table 22), four of which have not been found elsewhere in the country: *Aspicilla supertegnes*, *Caloplaca chrysodeta*, *Fulgensia bracteata* and *Phaeophyscia constipata*. One species of moss, *Polytrichum hyperboreum*, has only been found in Iceland inside Mývatnssveit. Seventeen of 32 bird species on the Red List (Icelandic Institute of Natural History 2000) breed or have bred in the area (Table 23), rendering Mývatn and Laxá of fundamental importance for those bird species that are endangered or threatened. Quite a number of rare spider species are found by Mývatn and Laxá: *Dictyna arundinacea* (the only site where it is found), *Robertus lyrifer*, *Walckenaeria atrotibialis* and *Wabasso questio* (two locations), *Maso sundevalli*, and *Tetragnatha extensa* (rare outside Mývatnssveit).

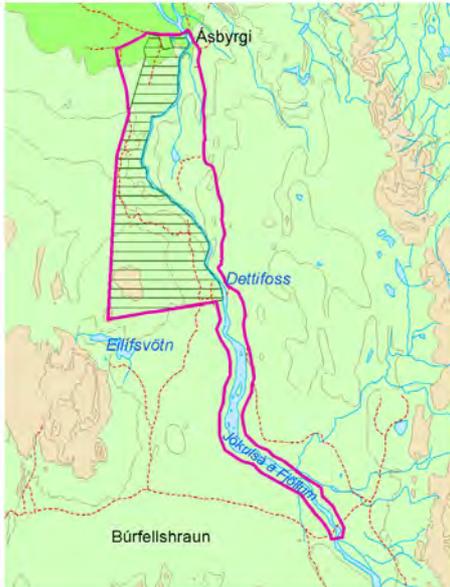
The conservation value of Mývatn, Laxá and their vicinity is undisputed on a national and global scale; for example, the land of Skútustaðahreppur all the way to the glacial ice was protected by a special act in the year 1974. The year before, 1973, the craters of Skútustaðagígar had been protected as natural monuments. In 2001 the Minister for the Environment appointed a committee to re-examine Act No. 36/1974 on the conservation of Mývatn and Laxá considering altered administrative procedures and a fresh legal framework in the area of conservation. The committee handed in its work in February 2002, suggesting through its majority that the actual nature conservation area the laws cover be significantly curtailed and that the sole targets be Mývatn and Laxá including islands, islets and tributaries, in addition to neighbouring wetland areas. The laws would thus not pertain to a number of extraordinary geological phenomena north and east of the lake. In a provisional stipulation to the draft for the bill, the Environment and Food Agency of Iceland is requested to begin preparations immediately for announcing the protection of the points of natural interest in Skútustaðahreppur that fall outside the boundaries described above. In the opinion of the Icelandic Institute of Natural History it is extremely urgent that this declaration of protection be finished parallel to the new legislation.

Table 18. Assessment of the conservation value of natural aspects around Mývatn and Laxá.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Diverse landscape: lake, ponds of lava, lava formations, pseudocraters
	Vegetation cover	High	Lush wetland areas, islets, birch woodland and cultivated areas characterise the landscape.
<i>Geological phenomena</i>	Volcanoes	High	Rows of craters in Þrengslaborgir, pyroclastic craters such as Hverfjall and Lúdent, ancient ponds of lava such as Dimmuborgir, fissures with geothermal heat, geothermal fields at Námaskarð and other places, etc.
	Lava formations		
	High-temperature areas		
	Glacial remains		
<i>Habitat types</i>		Not evaluated	Research needed
<i>Rare species</i>	Plants	High	Fifteen rare species of vascular plants and ten very rare species of lichens
	Birds	High	Seventeen species on the Red List
	Terrestrial invertebrates	High	Six rare species of spiders and at least one rare species of crayfish
<i>Important species and populations</i>	Many	High	Around or over half the populations of the following bird species breed by Mývatn and Laxá: Slavonian Grebe (<i>Podiceps auritus</i>), Gadwall (<i>Anas strepera</i>), Tufted Duck (<i>Aythya fuligula</i>), Greater Scaup (<i>Aythya marila</i>), Common Scoter (<i>Melanitta nigra</i>) and Barrow's Goldeneye (<i>Bucephala islandica</i>). In addition, Mývatn is an important moulting area for most of these species, as well as for the Whooper Swan (<i>Cygnus cygnus</i>).

4.2.2 Jökulsárgljúfur

One of the most magnificent river canyons in the country, with waterfalls, protective cliffs and rich vegetation. Half of the canyon has been declared protected as a national park.



This area is around 265 km² in extent and is delimited by a strip some 500 m wide along Jökulsá á Fjöllum down to the border of the national park by Dettifoss. From there the bounds lie along the edge of the national park and the road to Vesturdalur north to Highway 85. In the east the perimeter follows Highway 864 (see map).

Much has been written on the natural aspects of Jökulsárgljúfur, although here support is above all sought in the overviews by Sigrún Helgadóttir (1997) and Theodór Gunnlaugsson et al. (1975).

The landscape of Jökulsárgljúfur receives its traits from the interplay of fire, water and ice. The gorge itself is a spectacular natural construction of sheer cliffs, water channels, protective cliffs, crater plugs and lava formations. Birch woodland and scrub yield a milder expression to the terrain. Where Jökulsá á Fjöllum tumbles down from the rim of the highlands into Jökulsárgljúfur, there is a series of

waterfalls—Selfoss, Dettifoss and Hafragilsfoss—composing "a combination that has few rivals throughout the globe" (Sigurður Þórarinnsson 1978).

The actual canyon of Jökulsárgljúfur, around 30 km long, was carved by Jökulsá á Fjöllum through catastrophic floods since the end of the Ice Age, along with the river's relentless activity during the past 10,000 years. Lava has flowed from two fissure eruptions since the Ice Age and passed down the canyon, on the one hand from a 6-km crater row that curves from Rauðhóll by Hljóðaklettur south to Stallar, and on the other hand from an terrifically long row of craters that is associated with Sveinar and Randarhólar and transects the gorge slightly below Hafragilsfoss. Two or more catastrophic floods in Jökulsá á Fjöllum 2500 to 4000 years ago rushed through these lava fields and crater rows, determining the most basic factors in the landscape of the canyon. Above Rauðhólar the floods rinsed cinder and tephra away from the crater row and left behind the mere crater plugs where Hljóðaklettur are now located (Theodór Gunnlaugsson et al. 1975).

Vegetation maps of Jökulsárgljúfur are available in manuscript at the Icelandic Institute of Natural History. No research on habitat types has been carried out for the area. The Icelandic Forestry Service has prepared a survey of the country's birch forests, including those in Jökulsárgljúfur (Ása Aradóttir et al. 1995). The vegetation of Jökulsárgljúfur is diverse, with alternating birch woodlands, moor land, gravelly terrain and outcropping bedrock, springs, streams and bogs. Whereas small-scrub moors are the most common vegetation type in Jökulsárgljúfur, woods and scrub contribute most to the appearance of the landscape (Sigrún Helgadóttir 1997). The avian life in Jökulsárgljúfur is quite well known, although the studies have above all been conducted in connection with the annual monitoring of the gyrfalcon population (Ólafur K. Nielsen, oral communication). Around 40 bird species have bred in the area.

Principal points of natural interest

The most extraordinary points of natural interest in Jökulsárgljúfur are geological formations—the canyon, volcanoes and major waterfalls. Dettifoss is considered to have more water than any other fall in Europe and few places show such clear signs of catastrophic floods as Jökulsárgljúfur. Four rare vascular plants (Table 21) are found in Jökulsárgljúfur, among them two on the Red List (Icelandic Institute of Natural History 1996): Hudson Bay Sedge (*Carex heeonastes*) and Herb-Paris (*Paris*

quadrifolia). Six very rare lichen species have been found there (Table 22), and one of them, *Chaenotheca cinerea*, has not been found elsewhere in the country. The moss *Rhodobryum roseum* grows in Jökulsárgljúfur and in three other places in Iceland. Nine bird species on the Red List (Icelandic Institute of Natural History 2000) have bred there: Great Northern Diver (*Gavia immer*), Slavonian Grebe, (*Podiceps auritus*), Greylag Goose (*Anser anser*), Pintail (*Anas acuta*), Harlequin Duck (*Histrionicus histrionicus*), Goosander (*Mergus merganses*), White-tailed Eagle (*Haliaeetus albicilla*), Gyrfalcon (*Falco rusticolus*), Great Black-backed Gull (*Larus marinus*) and the Raven (*Corvus corax*) (Table 23).



Photo: Snorri Baldursson 1984.

Jökulsárgljúfur have an undoubted conservation value on a national and global scale mainly as a consequence of various geological formations. West of the river, Jökulsárgljúfur was declared protected as a national park in 1973 and the canyon east of the river is in the Nature Conservation Registry (1996). In 1996 the series of waterfalls Hafragilsfoss, Dettifoss and Selfoss, along with adjacent areas, were declared protected as sites of natural interest. In a conservation plan for Jökulsárgljúfur, Sigrún Helgadóttir (1997) explains the possible means of enlarging the national park so as to achieve the original goal of protecting the entire canyon and not in the least to correlate the national park boundaries with ecological and geological standards. The most conservative suggestion

aims at adding a strip of land east of the river in addition to all of Ásbyrgi, so that the canyon and its principal geohistorical phenomena form a visual whole. Another suggestion proposes adding the mud-flats and estuary areas of the river Jökulsá to an enlarged national park, thus creating an entity of geological and cultural history, as well as encompassing important biological points of interest in Óxarfjörður. The third suggestion, in addition to the enlargements already mentioned, proposes protecting a larger area east of the river to provide the national park with some breathing space toward the east.

Table 19. Assessment of the conservation value of natural aspects in Jökulsárgljúfur.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	High	Diverse landscape: canyon, protective cliffs, potholes, lava and rock formations
	Vegetation cover	High	Flourishing birch woodland, lush river banks and flowering slopes strongly characterise the landscape
<i>Geological phenomena</i>	Crater rows, basalt columns, waterfalls, rock strata of many kinds	High	Canyon, protective cliffs, potholes, signs of catastrophic floods, rows of craters that have been cut apart, such as Rauðhólar
<i>Habitat types</i>		Not evaluated	Research needed
<i>Rare species</i>	Plants	Average	Four rare species of vascular plants and six very rare lichens
	Birds	High	Nine species on the Red List, eight Gyrfalcon aeries
	Terrestrial invertebrates	Not evaluated	Research needed
<i>Important species</i>	None	Low	The area is not considered to have a decisive significance for any species.

4.2.3 Öxarfjörður

Öxarfjörður is the flat estuary of Jökulsá á Fjöllum. The wetlands there comprise an important bird territory with international conservation value.



The boundaries of the area, which is around 239 km² in size, run along Sandá (Brunná) from the river mouth south to Randir and to the junction on Highway 85. From there they lead to Eyvindarholt and follow the highway to the west and the north of Lón.

The land is flat estuary terrain, consisting of sands with little vegetation and of gravelly ground farthest north, although more vegetation appears closer to the sea, where there are still inhabited farms despite the abandoning of most traditional farming. Jökulsá á Fjöllum branches through these expanses, and its largest fork, Bakkakvísl, divides the area into Vestursandur and Austursandur.

The bedrock is covered over with loose, deep layers of earth, ancient marine deposits, and sediment from the river Jökulsá. This area is frequently cracked, lying in the same fissure zone as Krafla. Hefty movements and changes occurred in the rifts of Öxarfjörður at the beginning of the spate of activity initiated around Krafla in 1975. A great deal of geothermal heat is present by Bakkahlaup through the middle of the area. This geothermal heat evidences itself in the form of hot and warm springs that reach temperatures of up to 90° C (Ministry of Industry 1994).

The fieldwork for vegetation mapping has been completed in Öxarfjörður, although the task of synthesising this work into a map still remains. Experimental drilling has been conducted in the area to serve geothermal investigations (Ministry of Industry 1994) and for the same purpose a pilot study was conducted by Bakkahlaup of vegetation and bird life (Hörður Kristinnsson and Ólafur K. Nielsen 1998). The flora is quite well known. The most common types of terrain are nearly barren sands and gravel flats, with sand-strewn patches of *Salix* and well-vegetated moor lands containing small scrubs of *Salix* and dwarf birch (*Betula nana*), as well as cultivated land. In the most northerly reaches of Ássandur there is a land reclamation fence where the Soil Conservation Service of Iceland has sown Lyme-grass (*Leymus arenarius*), Nootka Lupin (*Lupinus nootkatensis*) and other plants. The avian life is extraordinarily diverse and rich; up to 56 species have bred there, of which somewhat under 50 breed annually.

Principal points of natural interest

The main geological phenomena, besides geothermal areas, relate to the fissure zone and changes that occurred to it during the Kröflueldar eruption series. Five rare species of vascular plants grow in Öxarfjörður (Table 21), one of which, Devil's-bit Scabious (*Succisa pratensis*), is on the Red List (Icelandic Institute of Natural History 1996). No rare lichen or moss species has been found in the area. Öxarfjörður has an international conservation value due to its diversity of birds. Fifteen bird species on the Red List (Icelandic Institute of Natural History 2000) have bred there: Great Northern Diver (*Gavia immer*), Slavonian Grebe (*Podiceps auritus*), Greylag Goose (*Anser anser*), Gadwall (*Anas strepera*), Pintail (*Anas acuta*), Northern Shoveler (*Anas clypeata*), Common Scoter (*Melanitta nigra*), Barrow's Goldeneye (*Bucephala islandica*), Gyrfalcon (*Falco rusticolus*), Water Rail (*Rallus aquaticus*), Grey Phalarope (*Phalaropus fulicarius*), Common Gull (*Larus canus*), Great Black-backed Gull (*Larus marinus*), Short-eared Owl (*Asio flammeus*) and Raven (*Corvus corax*) (Table 23). Ducks nest a great deal by Vikingavatn, where breeding species include such rare species as Gadwall (*Anas*

strebera) and Common Scoter (*Melanitta nigra*). Breeding populations of Slavonian Grebe (*Podiceps auritus*), Greylag Goose (*Anser anser*) and Great Skua (*Stercorarius skua*) are considered to have conservation value on an international scale. Iceland's second-largest breeding grounds for the Slavonian Grebe (*Podiceps auritus*)—with around 100 pairs, almost one-fifth of the population—are situated around Víkingavatn. Two to three hundred pairs of Great Skua (*Stercorarius skua*), as much as 5% of the population, and an unusual abundance of the Red-throated Diver (*Gavia stellata*)—amounting to many dozen pairs, perhaps 2–4% of the population—breed on the sands in the central part of Öxarfjörður. Numerous Greylag Geese (*Anser anser*) also breed on the sands (hundreds of pairs; possibly 5% of the population), in addition to thousands of the greylags moulting their flight feathers there. The proposal of the Icelandic Institute of Natural History for the protection of species and areas in respect of the National Nature Conservation Strategy (Ólafur Einarsson et al. 2002) suggests that Öxarfjörður be protected.

Table 20. Assessment of the conservation value of natural aspects in Öxarfjörður.

Category	Phenomenon	Conservation value	Reasons
<i>Appearance of land</i>	Landscape	Low	Flat estuary area that seems to possess little unique status
	Vegetation cover	Average	Sandy patches of <i>Salix</i> , heath with small scrubs and cultivated land dominate the terrain near the sea.
<i>Geological phenomena</i>		Low	Comparable geological layers are found at the surface in many places
<i>Habitat types</i>		Not evaluated	Research needed
<i>Rare species</i>	Plants	Low	Four rare species of vascular plants
	Birds	High	Fifteen species on the Red List
	Terrestrial invertebrates	Not evaluated	Research needed
<i>Important species</i>	<i>Podiceps auritus</i> <i>Anser anser</i> <i>Stercorarius skua</i>	High	The area is of international conservation value as a breeding ground for Slavonian Grebe (<i>Podiceps auritus</i> ; up to 20% of the breeding population), Great Skua (<i>Stercorarius skua</i> ; up to 5%) and Greylag Goose (<i>Anser anser</i> ; up to 5%), in addition to thousands of greylag geese moulting their flight feathers in the area

4.3 Rare organisms

4.3.1 Vascular plants

Table 21 presents an overview of rare vascular plant species in Mývatnssveit and along Laxá, as well as in Jökulsárgljúfur and Öxarfjörður. Ten species grow by Mývatn, four in Jökulsárgljúfur and five in Öxarfjörður.

Table 21. Rare species of vascular plants around Mývatn and Laxá, and in Jökulsárgljúfur and Öxarfjörður. Upon selecting species, rather more rigid standards were applied than for the comparable list and table concerning the highlands north of Vatnajökull (see Chapter 3.3.2). For this reason species such as Serrated Watergreen (*Orthilia secunda*) and Thick-headed Sedge (*Carex macloviana*) did not earn entry into the list, even though they are found at many places in these areas. The numbers signify the number of entries for each species in the database of the Icelandic Institute of Natural History. In some cases there are several records for one and the same site (e.g., Herb-Paris (*Paris quadrifolia*) in Stóragjá). An asterisk (*) denotes species on the Red List (Icelandic Institute of Natural History 1996).

Species/Area	Mývatn-Laxá	Jökulsárgljúfur	Öxarfjörður	Remarks
<i>Isoetes echinospora</i>	1			A rather rare aquatic plant growing in deep ponds that do not dry out in the summer. Has been found at Sandvatn in Mývatnssveit.
<i>Antennaria alpina</i>	13	5		Rather rare species which grows inland and is hence more common around Mývatn than generally elsewhere. Grows there in a very scattered fashion, nowhere in great quantity. Has been encountered by Jökulsá á Fjöllum at two locations: in Ásbyrgi and by Hafragil.
<i>Athyrium filix-femina</i>	1			Rather rare fern – very rare in North Iceland. A considerable stand of it grows in Stóragjá by Mývatn.
<i>Botrychium lanceolatum</i>	6			Rare species with an extremely scattered distribution—rarely more than a few plants at each locale. Found at three sites by Mývatn: Grímsstaðir, Bjarnarflag and Hrutey.
<i>Botrychium minganense</i>	2			Recently detected species in Iceland. Only found by Jarðbaðshólar and at Bjarnarflag in Mývatnssveit. Also known to exist at several places in Meðalland.
* <i>Botrychium simplex</i> var. <i>simplex</i> and var. <i>tenebrosum</i>	10			Only found by Jarðbaðshólar and in Bjarnarflag, Mývatnssveit – both varieties.
<i>Callitriche hermaphroditica</i>	24		7	An aquatic plant that always grows submerged in water. Has been found in Mývatn and Grænavatn. Has also been found in Laxá at quite a few locations. Grows there in still inlets and lava depressions. In Öxarfjörður it grows in the catchment area of Litlá (geothermal effects), from that river's source down to Árnaneslón.
<i>Carex brunnescens</i>	4	1		A dryland sedge that has been found in three places by Mývatn. Also found in Svínadalur by Jökulsá á Fjöllum.
* <i>Carex heleonastes</i>	1	3		One source tells of Hudson Bay Sedge at Framengi by Mývatn. A very rare sedge that is otherwise only known at Kvíar by Jökulsá á Fjöllum and on Fljótshéiði in South Þingeyjarsýsla.

Table 21. Continued.

Species/Area	Mývatn–Laxá	Jökulsárgljúfur	Öxarfjörður	Remarks
<i>Galium trifidum</i>	7			A very tiny aquatic herb most often growing among mosses in bottom vegetation, accompanied by robust sedges. It has been found at two sites by Mývatn (Framengi and Slútnes), as well as in wetlands along Laxá by Núpar and Laxamýri, and where Mýrarkvísl flows out into Laxá.
* <i>Knautia arvensis</i>			5	A rare species in Iceland, probably an old migrant. Has grown in Fjöll and Garður and at Grásiða in Kelduhverfi, along with Ferjubakki in Öxarfjörður. All sources on it are old, the latest one from 1963.
<i>Lathyrus palustris</i>			6	Rather rare in Iceland. Found in several places by the lower end of Jökulsá on the east side, Öxarnúpur, Ærlækur and Skinnastaður. Has also been found at Ás in Kelduhverfi.
* <i>Ophioglossum azoricum</i>	8			Grows only around geothermal heat. Found by Bjarnarflag and in Jarðbaðshólar by Mývatn as well as by Krafla. There is probably more of it by Mývatn than elsewhere in the country.
<i>Ruppia maritima</i>			1	Grows in somewhat brackish (semi-brackish) water by the sea. Found in Lón.
* <i>Paris quadrifolia</i>	47	4		Well-known sites are in Stóragjá and on Slútnes by Mývatn. In addition, there is one source on Herb-Paris at Kálfaströnd, probably in a lava fissure. Additionally, Herb-Paris grows at numerous spots on islets in the river Laxá, all the way from Hofsstaðir to Mýrarsel, which is not far from the sea. Herb-Paris has been found at a single location in Ásbyrgi, in woodland under cliffs, and in Auðbjargarstaðabrekka by Lón.
* <i>Stellaria borealis</i>	4			Has only been found on Slútnes and on Neslandatangi. Grows as bottom layer vegetation in damp scrub land.
<i>Vaccinium microcarpum</i>	16			Grows above all in acidic mires with a great deal of moss, most often in among <i>Sphagnum</i> mosses. Has been found at several places in Mývatnssveit (i.e., Belgjarskógur, Neslandatangi, Slútnes, Slý, Grímsstaðir, Álftagerði, Skútustaðir and Hrutey). There is no information on Small Cranberry along Laxá, unless it possibly exists in Aðaldalshraun by Knútsstaðir.
<i>Zannichellia palustris</i>	8		6	Aquatic plant found mostly in brackish lagoons and narrow arms of water by seaside marshes, but also sometimes by warm springs and otherwise in shallow water. Has been found in Mývatn by Reykjahlíð and Vogar. By Jökulsá á Fjöllum, Horned Pond weed is found only in the river basin of Litlá, all the way from Keldunes down to Árnanes.

4.3.2 Mosses

The bryophyte flora around Mývatn has been little researched. Only one rare species is known from this area, *Polytrichum hyperboreum*, found on Framengi in 1969. This is the only location in the country where this species has been found. Only male plants were observed and it is therefore uncertain whether the species has succeeded in surviving and multiplying itself at the location of discovery.

Moss samples from Jökulsárgljúfur kept in the Icelandic Institute of Natural History indicate that the moss flora there is rather diverse, even though systematic investigations on bryophytes there have not been carried out. There is no awareness of any species in Jökulsárgljúfur that is directly endangered, although several species have been found there that are rather rare for Iceland. Most worth mentioning is *Rhodobryum roseum*, which has been found at four Icelandic sites in all. Only a few plants have been detected at each of these sites.

Öxarfjörður has also not been specifically surveyed with regard to mosses. No rare species of moss are known to be there.

4.3.3 Lichens

Table 22 displays an overview of very rare lichen species growing by Mývatn–Laxá and in Jökulsárgljúfur and Öxarfjörður. Ten species grow by Mývatn and Laxá and six in Jökulsárgljúfur, whereas no rare species of lichen is known to exist in Öxarfjörður.

Table 22. Very rare lichen species by Mývatn–Laxá and Jökulsárgljúfur (none found in Öxarfjörður). Numbers show records for each species in the database of the Icelandic Institute of Natural History; in some cases there is more than one record for the same site. Species marked with an asterisk (*) are on the Red List (Icelandic Institute of Natural History 1996).

Species/Area	Mývatn–Laxá	Jökulsárgljúfur	Öxarfjörður	Remarks
<i>Aspicilla supertegnes</i>	1			Has only been found once on birch by Mývatn. Nothing is otherwise known about its distribution in Iceland.
* <i>Bryoria fuscescens</i>	4			A fibrous lichen growing on branches and tree trunks in old birch woodlands in Iceland, but transferring rather quickly onto cultivated trees. Has been found in the woods near Hafurshöfði.
<i>Caloplaca chrysojeta</i>	1			A rare crustose lichen that grows on overhanging and vertical rock. Has been found in Mývatnssveit on the lava field between Kálfaströnd and Geiteyjarströnd.
<i>Caloplaca soropelta</i>	1			A rare lichen that grows on guano-rich bird tussocks. Has been found in the lava field between Kálfaströnd and Geiteyjarströnd.
<i>Chaenotheca cinerea</i>		1		Only found in one place in Iceland, in the lower reaches of the ceiling in a cave in Hjóðaklettur. On the Red List in the other Nordic Countries.
* <i>Cladonia cryptochlorophaea</i>	1			A fruticose lichen which grows on soil and has been found in only a very few places in Iceland. In Mývatnssveit it was found in Markhraun between Kálfaströnd and Geiteyjarströnd.
<i>Cliostomum corrugatum</i>		1		A crustose lichen that grows on birch and has been found in only two locations in Iceland. Will possibly be found in considerably more places later. Has been found in Hólmatungur on birch.
<i>Diploschistes muscorum</i>	1			A crustose lichen that has been found at only two sites in Iceland, including the area between Kálfaströnd and Geiteyjarströnd by Mývatn.
<i>Fulgensia bracteata</i>	2			A crustose lichen that is conspicuous in appearance. Only found at one location in Iceland, in Markhraun in Mývatnssveit.
<i>Peltigera ponojensis</i>		2		Rather rare and fairly large foliose lichen of the Peltigeraceae. Found in Hólmatungur.
* <i>Phaeophyscia constipata</i>	2			A rare, small foliose lichen growing mostly on bird tussocks. Has not been found anywhere in the country outside Mývatnssveit, where it is at Kálfastrandarstrípur, in Reykjahlíð and by Sandbotnafjall.
* <i>Phaeorrhiza nimbose</i>	1	1		A crustose lichen that grows on soil. Found in the lava field between Kálfaströnd and Geiteyjarströnd and in Hólmatungur. Has been found at further locations since the Red List was composed.
* <i>Stereocaulon uliginosum</i>		1		A fruticose lichen that grows now. Found in Kvíar by Jökulsá á Fjöllum. Rare on a global scale.
* <i>Umbilicaria hirsuta</i>	1			A rare species of the Umbilicariaceae that grows on cliffs. Has been found by Helluvað in Mývatnssveit.
<i>Zahlbrucknerella calcarea</i>		1		A crustose lichen that grows on damp cliff walls by Dettifoss. Has also been found at one other location in the country. The distribution pattern of the species is uncertain.

4.3.4 Birds

Table 23 provides a summary of the 16 bird species on the Red List (Icelandic Institute of Natural History 2000) that breed around Mývatn–Laxá, in Jökulsárgljúfur and at Öxarfjörður. The vicinity of Mývatn and Laxá is world-famous for its bird life, and was the first area that Icelandic authorities decided to place on the Ramsar Directory of Wetlands of International Importance. Öxarfjörður is also an area of international importance for bird life and is on the list of BirdLife International for Important Bird Areas.

Table 23. Birds on the Red List (Icelandic Institute of Natural History 2000) that breed around Mývatn–Laxá, in Jökulsárgljúfur and at Öxarfjörður. The assessment of how common the particular species is as a breeding bird (infrequent, rather common, common, etc.) should be examined in comparison to other areas and in consideration of the fact that all these species are under threat.

Species	Mývatn–Laxá	Jökulsárgljúfur	Öxarfjörður	Remarks
<i>Gavia immer</i>	Sparse	Sparse	Very sparse	Five to ten pairs breed by Mývatn and in its vicinity. Has bred at Hafursstaðavatn by Jökulsárgljúfur. Two pairs have bred by Víkingavatn in Kelduhverfi.
<i>Podiceps auritus</i>	Common	Sparse	Common	Mývatn is the main breeding location for the Slavonian Grebe (<i>Podiceps auritus</i>) in Iceland, with as many as 300 pairs in recent years. Although a few pairs breed by Ástjörn, the numbers of Slavonian Grebe there have decreased sharply. The other main breeding area for Slavonian Grebe in Iceland is by Víkingavatn, where up to 100 pairs have bred in recent years.
<i>Anser anser</i>	Common	Fairly common	Common	Breeds in many places by Mývatn and Laxá (hundreds of pairs). Also breeds at many spots along Jökulsá á Fjöllum. A common breeding bird in Öxarfjörður (hundreds of pairs); in addition, thousands moult their flight feathers there.
<i>Anas strepera</i>	Fairly common		Very sparse	The major Icelandic breeding sites of the Gadwall (<i>Anas strepera</i>) are by Mývatn and Laxá, with a total of some 150 pairs. Has bred by Víkingavatn.
<i>Anas acuta</i>	Fairly sparse	Sparse	Fairly common	Breeds by Mývatn (dozens of pairs) and Laxá. A few pairs breed in Jökulsárgljúfur. Scattered breeding spots in Öxarfjörður.
<i>Anas clypeata</i>	Very sparse		Very sparse	A few pairs breed by Mývatn. Has bred by Víkingavatn and Arnarnes.
<i>Aythya ferina</i>	Very sparse			A few birds are spotted annually by Mývatn and breed there on occasion.
<i>Histrionicus histrionicus</i>	Common	Fairly common		A common nesting bird by Laxá, especially in Mývatnssveit, where numbers total around 200 pairs. Scattered breeding spots by springs and streams in Jökulsárgljúfur.
<i>Melanitta nigra</i>	Common			The main Icelandic breeding grounds of Common Scoter (<i>Melanitta nigra</i>) are by Mývatn (about 300–400 pairs in recent years), in addition to scattered nesting by Laxá.
<i>Bucephala islandica</i>	Common		Very sparse	Nearly the entire Icelandic population (400–500 pairs) breeds by Mývatn and Laxá. Has bred by Lón in Öxarfjörður, where it is a regular migrant in winter.
<i>Mergus merganser</i>	Fairly common	Sparse		Ten to twenty pairs breed by Mývatn and Laxá; hundreds of birds overwinter there. A few pairs breed in Jökulsárgljúfur. Does not breed in Öxarfjörður but is a common migrant there during the winter.
<i>Haliaetus albicilla</i>	Bred previously			Bred by Mývatn until the end of the 19th century.

Table 23. Continued.

Species	Mývatn–Laxá	Jökulsárgljúfur	Öxarfjörður	Remarks
<i>Falco rusticolus</i>	Sparse			Around twenty aeries are known in the vicinity of Mývatn and Laxá; while some of them are outside the defined boundaries, the birds from them hunt for food inside the area. Eight aeries are known in Jökulsárgljúfur; since 1981, 5–8 per year have been inhabited. While there is no Gyrfalcon aerie in Öxarfjörður, Gyrfalcons from as many as 12 aeries in the vicinity seek food there.
<i>Rallus aquaticus</i>	Bred previously		Bred previously	Breeding occurred in Mývatnssveit until the late 20th century. Was breeding at scattered sites in Öxarfjörður until nearly 1960; occasional birds are observed in winter.
<i>Phalaropus fulicarius</i>			Bred previously	Bred by Víkingavatn past the turn of the century in 1900 and has been spotted in Austursandur during the breeding season in recent years.
<i>Larus canus</i>			Sparse	Breeding on the increase in Öxarfjörður (dozens of pairs).
<i>Larus marinus</i>	Bred previously	Sparse	Fairly common	Breeding by Mývatn until recent years– is under aggression there. Has bred at two sites in Jökulsárgljúfur, but has now vanished. Breeds in many places on the sands in Öxarfjörður, although numbers are on the decline.
<i>Asio flammeus</i>	Sparse	Sparse	Sparse	Several pairs breed by Mývatn and in the neighbourhood of Laxá down to the river mouth. One or two pairs are annual breeders in and near Ásbyrgi. A few pairs breed in Öxarfjörður.
<i>Corvus corax</i>	Sparse	Sparse		Two to four pairs of Raven (<i>Corvus corax</i>) breed by Mývatn, although this bird suffers aggression and its numbers have declined. At least eight traditional aeries are known in Jökulsárgljúfur, but a stark reduction has occurred in recent years so that now only two or three sites are inhabited. There is no raven aerie in Öxarfjörður, despite ravens from a few aeries in the vicinity hunting for food there.

5 CONCLUSION

This summary of nature and the conservation value of points of natural interest in the highlands north of Vatnajökull and in associated lowland areas by Mývatn and Jökulsá á Fjöllum ranges over a total of 11,600 km² of territory. For the sake of convenience this area was divided into fifteen smaller units and sub-areas. All the sub-areas except Hraun and Lónsöræfi (counting also the mountainous terrain east of there) lie partly or entirely within the eastern eruption zone.

If the whole eruption zone north of the glaciers is considered, excluding Mývatnssveit, Kelduhverfi, Jökulsá á Fjöllum, and such geothermal areas as the ones at Krafla, Námafjall and Þeistareykir, the land involved is almost utterly uninhabited and uninhabitable and offers no known energy sources nor earth materials of value.

On the other hand, many have maintained that the eruption zone north of Vatnajökull has few rivals in the world with respect to diverse and valuable points of natural interest, landscape, and untouched open spaces. There are few places in which it is possible to approach such strong, diverse volcanic activity, few places in which the interplay of fire, water and ice in the formation of land is as clear, and few places in which geohistory lies as open and easily legible and geological phenomena as clearly discernable (among other things due to the paucity of vegetation). Combined with the remarkable geological phenomena are biological oases such as Eyjabakkar, Herðubreiðarlindir, Jökulsárgljúfur and Mývatn.

This summary supports that opinion. While it is dubious to give sprawling, often rather heterogeneous sub-areas an average grade for the conservation value of dissimilar natural aspects, there is no danger in asserting that twelve of the fifteen areas included in the discussion have a high general conservation value, while three of them have a moderately high or lower conservation value. Along the middle of the eruption zone, geological phenomena and landscape take precedence, while biological phenomena are added on in marginal areas. Among the geological phenomena, several central volcanoes deserve mention, along with numerous eruption fissures, shield volcanoes and table mountains, vast lava fields, flood channels, canyons, sediment terraces, folded earth from glacial surges, high-temperature areas, low-temperature areas, and glacial remains.

The Pink-footed Goose (*Anser brachyrhynchus*) is the characteristic bird for the highlands north of Vatnajökull. Around half of the sub-areas, especially those which Skjálfandafljót and Jökulsá á Fjöllum run through, have international conservation value regarding the Pink-footed Goose (*Anser brachyrhynchus*). In the lowlands, Mývatn-Laxá and Öxarfjörður have international conservation value as breeding grounds and/or moulting areas for birds. Mývatn is of fundamental importance for the survival of Slavonian Grebe (*Podiceps auritus*), Gadwall (*Anas strepera*), Tufted Duck (*Aythya fuligula*), Scaup (*Aythya marila*), Common Scoter (*Melanitta nigra*) and Barrow's Goldeneye (*Bucephala islandica*). The entire biota of Mývatn occupies a unique position on a global scale. Several species of vascular plants (*Erigeron humilis*, *Antennaria alpina*, *Draba alpina*, *Carex nardina*) and many lichen and bryophyte species are largely confined to the highlands north of Vatnajökull.

While drastic, varied events have marked the interaction of land, natural forces, and Iceland's human population for 1100 years, and while the vegetation cover in the eruption zone is in many places badly eroded and perhaps only vaguely reminiscent of what it was like previously, the land north of Vatnajökull still possesses the magic of wilderness. The magic of wilderness is a limited and valuable quality in a densely populated world.

The Icelandic Institute of Natural History has previously proposed that some of the areas discussed here be declared protected because of their unique biota or geological phenomena (Ólafur Einarsson et al. 2002, Helgi Torfason and Ingvar Atli Sigurðsson 2002). The ideas for a large national park north of Vatnajökull fit these proposals very well.

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