



Crop Wild Relatives

Inventories in Vatnajökull National Park 2021

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Cover photo: *Poa alpina* growing close to Dettifoss in north-eastern Iceland.

All photographs in the report: Magnus Göransson.

Contents

Introduction4

Objectives4

Results and discussion8

Recommendations and future activities12

Acknowledgements12

References13

Appendices14

Introduction

Crop wild relatives (CWR) are wild plant species that are closely related to crops. They are wild or naturalized populations of plants which can be utilized by plant breeders and researchers in the crucial work to adapt and improve our crops to feed a growing global population in the time of climate change. Examples of traits that can be found in CWRs include disease resistance genes and stress tolerance genes like drought resistance and cold resistance.

The Nordic work on crop wild relatives led by the Nordic Genetic Resource Centre (NordGen) was initiated in 2015 with two consecutive projects (*Ecosystem services: Genetic resources and crop wild relatives* 2015 – 2016, and *Wild genetic resources – a tool to meet climate change* 2016 – 2019 (Palmé et al. 2019)), and have from 2021 entered a third project period, *Conservation and sustainable use of genetic resources in the Nordic countries (Nordic PGR Conservation)* 2021 – 2024. The third phase was funded by the Nordic Council of Ministers as part of the Nature-based Solutions programme.

In the previous project phase, a common Nordic crop wild relative priority list was developed (Fitzgerald et al. 2018). The priority list was a first step towards evaluating the status of CWRs in the Nordic region. Criteria for taxa to be included on the list were to be sufficiently related to the crop to be practically utilized by means of modern plant breeding (minimum tertiary gene pool and/or taxon group 4, see Fitzgerald et al. (2018) for explanations), and that the crop should have a certain economic value globally to justify the inclusion of its CWRs.

Another outcome of previous projects was a modelling of CWR diversity and distribution in Nordic protected areas (Fitzgerald et al. 2019). In the study, 162 Nordic protected areas were ranked based on species observations of CWR taxa and an eco-geographical land characterization to identify the protected areas with the expected highest diversity both between and within CWR taxa.

Objectives

The aim of the activities in Vatnajökull National Park was to do an assessment of CWR species growing in the protected area and to identify populations suitable for *in situ* conservation. Potential threats to CWR populations should also be assessed, and recommendations given for long-term conservation.

Site selection

Inventories were carried out in Vatnajökull National Park in 2021. The Vatnajökull National Park was selected based on Fitzgerald et al. (2019) where it was the protected area with the highest ranking of CWR diversity in Iceland, and an overall eighth ranking on a Nordic level. The national park covers >14.000 km² (corresponding to approximately 15% of Iceland's area), hence it was necessary to select defined areas within the park to do the inventories. Selection was done based on species observation data in GBIF and an aim to cover diverse habitats, as well as consideration of the accessibility of the area. Skaftafell in the southeast, and Jökulsárgljúfur in the northeast were selected as suitable sites for the inventories (Figure 1). Skaftafell comprises southfacing slopes with old meadows, heathlands, and one of Iceland's oldest birch forests, Bæjarstaðaskógur. Jökulsárgljúfur stretches along the river Jökulsá from Iceland's largest waterfall Dettifoss northward to the canyon Ásbyrgi. The selected sites represent a wide range of habitats ranging from mature natural birch forests over heathlands and meadows to high altitude mountains and deserts (Figure 2).

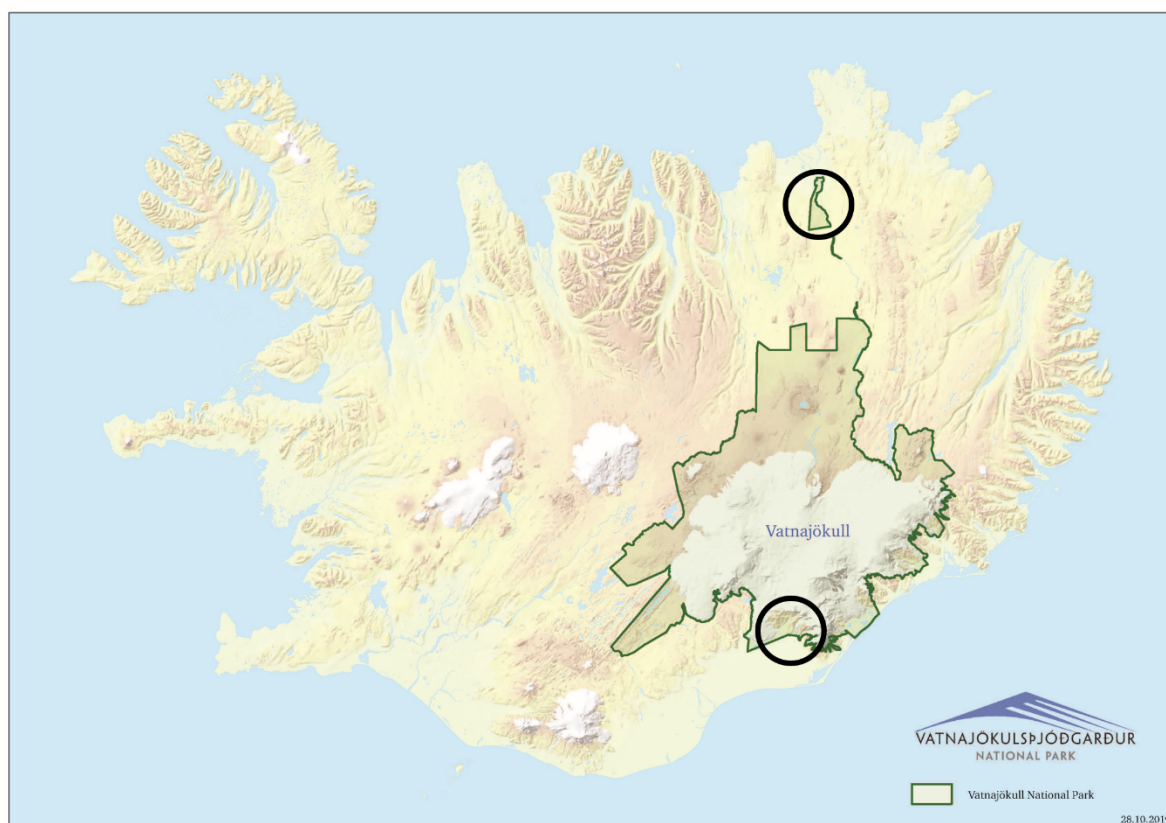


Figure 1. Map of Vatnajökull national park and the sites of the inventory, Skaftafell in the southeast and Jökulsárgljúfur in the northeast marked with black circles. Adapted with permission from <https://www.vatnajokulsthjodgardur.is>.





Figure 2. Examples of habitats found in Vatnajökull National Park: (A) mature birch forest in Bæjarstaðarskógur with *Rubus saxatilis*, (B) meadows in Skaftafell with *Carum carvi* in the foreground, and (C) an arctic desert with *Leymus arenarius* in Jökulsárgljúfur.

CWR taxa

A common Nordic CWR priority list was developed for five of the Nordic countries (Fitzgerald et al. 2018) consisting of 103 species and was used as a checklist in the inventory. Iceland has less vascular plant diversity than Scandinavia with an estimated 530 taxa forming self-sustaining populations, out of which 426 are considered as native (Wasowicz, 2020). 54 species are prioritized CWRs (Appendix 1, see also Fitzgerald et al. 2018), and many of those are temporary introductions escaping from cultivation and only surviving for a limited time in nature. The authors estimate that 26 CWR species are viable long-term in Iceland and were hence the primary subject of the inventories (marked in bold in Appendix 1).

Inventory

To select the most appropriate inventory sites within Skaftafell and Jökulsárgljúfur, respectively, we assessed previous observations of the CWR taxa reported to the Global Biodiversity Information Facility (GBIF, www.gbif.org). CWR taxa were recorded when present, and an estimation of the population status (location, latitude, longitude, population size, viability, potential threats) was done. All inventories reported were performed in the summer of 2021.

Results and discussion

During inventories in 2021, 16 CWRs were found (Table 1). Many of the taxa have viable populations with a large and dense distribution which was expected considering that they are among the most common species of the Icelandic flora (e.g. *Vaccinium uliginosum*, *Festuca rubra*, *Rubus saxatilis*, and *Leymus arenarius*). Species with a more scattered yet wide distribution included *Phleum alpinum* (Figure 3), *Poa alpina*, *Poa nemoralis*, and *Phleum pratense*. Others were rare, e.g. *Elymus alopec*, a distant relative to bread wheat and endemic to Iceland, which was reported for the first time in Skaftafell (Figure 4).



Figure 3. *Phleum alpinum* growing close to Dettifoss waterfall in Jökulsárgljúfur.

Table 1. CWR taxa found in inventories in Vatnajökull National Park in 2021.

Location	Taxa	Habitat	Population size	Viability	Threats
Skaftafell	<i>Leymus arenarius</i>	Sand	>10.000	Viable	
Skaftafell	<i>Poa pratensis</i>	Sand	>10.000	Viable	Invasive sp.*
Skaftafell	<i>Festuca rubra</i>	Sand	>10.000	Viable	Invasive sp.*
Skaftafell	<i>Poa nemoralis</i>	Emerging birch forest	>1.000	Viable	Invasive sp.*
Skaftafell	<i>Trifolium repens</i>	Emerging birch forest	>10.000	Viable	Invasive sp.*
Skaftafell	<i>Poa pratensis</i>	Emerging birch forest	>10.000	Viable	Invasive sp.*
Skaftafell	<i>Festuca rubra</i>	Emerging birch forest	>10.000	Viable	Invasive sp.*
Skaftafell	<i>Poa annua</i>	Emerging birch forest	>10.000	Viable	Invasive sp.*
Skaftafell	<i>Phleum alpinum</i>	Emerging birch forest	>1.000	Viable	Invasive sp.*
Skaftafell	<i>Rubus saxatilis</i>	Mature birch forest	>10.000	Viable	
Skaftafell	<i>Vaccinium uliginosum</i>	Mature birch forest/Heathland	>10.000	Viable	
Skaftafell	<i>Angelica archangelica</i>	Mature birch forest	>10.000	Viable	
Skaftafell	<i>Fragaria vesca</i>	Mature birch forest	>1.000	Viable	
Skaftafell	<i>Elymus alopecurus</i>	In stand of <i>Salix</i> spp.	2 plants	Highly vulnerable	Small population size
Skaftafell	<i>Phleum pratense</i>	Meadow	>500	Vulnerable	Risk of forestation
Skaftafell	<i>Poa pratensis</i>	Meadow	>10.000	Viable	
Skaftafell	<i>Poa trivialis</i>	Meadow	Few plants**		
Skaftafell	<i>Trifolium repens</i>	Meadow	>10.000	Viable	
Skaftafell	<i>Carum carvi</i>	Meadow	>10.000	Viable	Risk of forestation
Ásbyrgi	<i>Phleum alpinum</i>	Birch forest	>1.000	Viable	
Ásbyrgi	<i>Poa pratensis</i>	Birch forest	>10.000	Viable	
Ásbyrgi	<i>Vaccinium myrtillus</i>	Birch forest	>10.000	Viable	
Ásbyrgi	<i>Vaccinium uliginosum</i>	Birch forest	>10.000	Viable	
Ásbyrgi	<i>Fragaria vesca</i>	Birch forest	>1.000	Viable	
Ásbyrgi	<i>Festuca rubra</i>	Birch forest	>10.000	Viable	
Ásbyrgi	<i>Rubus saxatilis</i>	Birch forest	>10.000	Viable	
Ásbyrgi	<i>Poa alpina</i>	Sand	>1.000	Viable	
Jökulsárgljúfur	<i>Phleum alpinum</i>	Moist grass	>1.000	Viable	
Jökulsárgljúfur	<i>Poa alpina</i>	Dry sand	>1.000	Viable	
Jökulsárgljúfur	<i>Festuca rubra</i>	Dry sand	>10.000	Viable	
Jökulsárgljúfur	<i>Leymus arenarius</i>	Dry sand	>10.000	Viable	

*Invasive *Lupinus nootkatensis*.

**Found only one plant. Population size is likely to be larger.



Figure 4. *Elymus alopecurus*, a relative to bread wheat, was found for the first time growing in Skaftafell.

A viable population of *Carum carvi* was identified as a suitable population for long-term monitoring and *in situ* conservation (Figure 5). The small population of *Elymus alopecurus* (Figure 4) would be suited to study long-term to see whether it was a temporary introduction in Skaftafell or if it is the emergence of an expanded distribution of the species in Iceland (or if reported observations to GBIF are lacking from southern parts of Iceland).



Figure 5. Mature seeds on stands of *Carum carvi* growing by the old farm Sel in Skaftafell.

Two potential threats were identified for specific populations: the meadows in Skaftafell (Figures 2B and 5) are surrounded by natural birch forest which has the potential to invade the meadows if they are not maintained by grazing and/or mowing. Furthermore, the invasive *Lupinus nootkatensis* was observed as an immediate threat to populations of CWRs, primarily in low fertility habitats due to its ability to alter the nitrogen levels of the soil and its ability to outcompete many of the less competitive CWRs (Figure 6).



Figure 6. *Festuca rubra* habitat in Skaftafell with the invasive *Lupinus nootkatensis* growing along the edges.

Recommendations and future activities

General recommendations on management include actions focused on limiting further spread of the invasive *Lupinus nootkatensis* in the national park and actions to keep the old meadows open by grazing to preserve valuable habitats for CWR forage grass species. It would further be recommended to avoid resowing grass fields with exotic seed, to limit gene flow between exotic introductions and existing CWR populations.

One of the main goals with the activity was to increase awareness among park managers and the public about the importance of CWR. As a result of the collaboration with the inventories, an outdoor CWR exhibition will be displayed in Ásbyrgi during August 2022 and in Skaftafell in 2023. The data from the inventories will be made available in GBIF.

Acknowledgements

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Appendices

Appendix 1. Prioritized CWR appearing in Iceland: 54 species (Fitzgerald et al. 2018). Many of those are temporary introductions escaping from cultivation and only surviving limited time in nature. 26 CWR species are estimated by the authors as being viable long-term in Iceland and are marked in bold.

Genus	species
<i>Allium</i>	<i>schoenoprasum</i>
<i>Angelica</i>	<i>archangelica</i>
<i>Armoracia</i>	<i>rusticana</i>
<i>Avena</i>	<i>fatua</i>
<i>Barbarea</i>	<i>stricta</i>
<i>Barbarea</i>	<i>vulgaris</i>
<i>Carum</i>	<i>carvi</i>
<i>Dactylis</i>	<i>glomerata</i>
<i>Daucus</i>	<i>carota</i>
<i>Elymus</i>	<i>alopex</i>
<i>Elymus</i>	<i>kronokensis</i>
<i>Erucastrum</i>	<i>gallicum</i>
<i>Festuca</i>	<i>ovina</i>
<i>Festuca</i>	<i>rubra</i>
<i>Fragaria</i>	<i>moschata</i>
<i>Fragaria</i>	<i>vesca</i>
<i>Hordeum</i>	<i>jubatum</i>
<i>Lactuca</i>	<i>serriola</i>
<i>Leymus</i>	<i>arenarius</i>
<i>Lolium</i>	<i>multiflorum</i>
<i>Lolium</i>	<i>perenne</i>
<i>Malus</i>	<i>domestica</i>
<i>Medicago</i>	<i>lupulina</i>
<i>Medicago</i>	<i>sativa</i>
<i>Mentha</i>	<i>aquatica</i>
<i>Mentha</i>	<i>arvensis</i>
<i>Phleum</i>	<i>alpinum</i>
<i>Phleum</i>	<i>pratense</i>
<i>Poa</i>	<i>alpina</i>
<i>Poa</i>	<i>palustris</i>
<i>Poa</i>	<i>pratensis</i>
<i>Poa</i>	<i>trivialis</i>
<i>Raphanus</i>	<i>raphanistrum</i>
<i>Ribes</i>	<i>nigrum</i>
<i>Ribes</i>	<i>rubrum</i>
<i>Ribes</i>	<i>spicatum</i>
<i>Ribes</i>	<i>uva-crispa</i>
<i>Rorippa</i>	<i>islandica</i>
<i>Rubus</i>	<i>idaeus</i>
<i>Rubus</i>	<i>saxatilis</i>
<i>Rubus</i>	<i>spectabilis</i>
<i>Schedonorus</i>	<i>pratensis</i>
<i>Sinapis</i>	<i>arvensis</i>
<i>Solanum</i>	<i>nigrum</i>
<i>Trifolium</i>	<i>hybridum</i>
<i>Trifolium</i>	<i>medium</i>

<i>Trifolium</i>	<i>pratense</i>
<i>Trifolium</i>	<i>repens</i>
<i>Vaccinium</i>	<i>microcarpum</i>
<i>Vaccinium</i>	<i>myrtillus</i>
<i>Vaccinium</i>	<i>uliginosum</i>
<i>Vaccinium</i>	<i>vitis-idaea</i>
<i>Vicia</i>	<i>sativa</i>
<i>Vicia</i>	<i>villosa</i>

Appendix 2. Inventory data of CWR found in Vatnajökull National Park in 2021 (as presented in Table 1), including data on latitude and longitude.

Location	Latitude, N	Longitude, W	Taxa	Habitat	Size	Viability
Skaftafell	64.057437	-17.040756	Angelica archangelica	Mature birch forest	>10.000	Viable
Skaftafell	64.023038	-16.990394	Carum carvi	Meadows	>10.000	Viable
Skaftafell	64.019074	-16.982224	Elymus alopecurus	In stand of Salix spp.	2 plants	Highly vulnerable
Skaftafell	64.053545	-17.012296	Festuca rubra	Sand	>10.000	Viable
Skaftafell	64.05717	-17.02104	Festuca rubra	Emerging birch forest	>10.000	Viable
Jökulsárgljúfur	66.000991	-16.513076	Festuca rubra	Meadows	>10.000	Viable
Jökulsárgljúfur	65.820882	-16.392048	Festuca rubra	Dry sand	>10.000	Viable
Skaftafell	64.057766	-17.048532	Fragaria vesca	Mature birch forest	>1.000	Viable
Jökulsárgljúfur	66.001528	-16.514929	Fragaria vesca	Meadows	>1.000	Viable
Skaftafell	64.052097	-17.008449	Leymus arenarius	Sand	>10.000	Viable
Jökulsárgljúfur	65.820882	-16.392048	Leymus arenarius	Dry sand	>10.000	Viable
Skaftafell	64.057535	-17.038733	Phleum alpinum	Emerging birch forest	>1.000	Viable
Jökulsárgljúfur	66.001279	-16.51312	Phleum alpinum	Meadows	>1.000	Viable
Jökulsárgljúfur	65.816526	-16.387026	Phleum alpinum	Moist grass	>1.000	Viable
Skaftafell	64.023038	-16.990394	Phleum pratense	Meadows	>500	Vulnerable
Jökulsárgljúfur	66.000991	-16.513076	Poa alpina	Meadows	>1.000	Viable
Jökulsárgljúfur	65.820882	-16.392048	Poa alpina	Dry sand	>1.000	Viable
Skaftafell	64.057045	-17.020682	Poa annua	Emerging birch forest	>10.000	Viable
Skaftafell	64.05772	-17.022184	Poa nemoralis	Emerging birch forest	>1.000	Viable
Skaftafell	64.053545	-17.012296	Poa pratensis	Sand	>10.000	Viable
Skaftafell	64.05717	-17.02104	Poa pratensis	Emerging birch forest	>10.000	Viable
Skaftafell	64.023038	-16.990394	Poa pratensis	Meadows	>10.000	Viable
Jökulsárgljúfur	66.001279	-16.51312	Poa pratensis	Meadows	>10.000	Viable
Skaftafell	64.057794	-17.037982	Rubus saxatilis	Mature birch forest	>10.000	Viable
Jökulsárgljúfur	66.001528	-16.514929	Rubus saxatilis	Meadows	>10.000	Viable
Skaftafell	64.05772	-17.022184	Trifolium repens	Emerging birch forest	>10.000	Viable
Skaftafell	64.023038	-16.990394	Trifolium repens	Meadows	>10.000	Viable
Jökulsárgljúfur	66.001528	-16.514929	Vaccinium myrtillus	Meadows	>10.000	Viable
Skaftafell	64.057714	-17.048473	Vaccinium uliginosum	Mature birch forest/Heathland	>10.000	Viable
Jökulsárgljúfur	66.001528	-16.514929	Vaccinium uliginosum	Meadows	>10.000	Viable