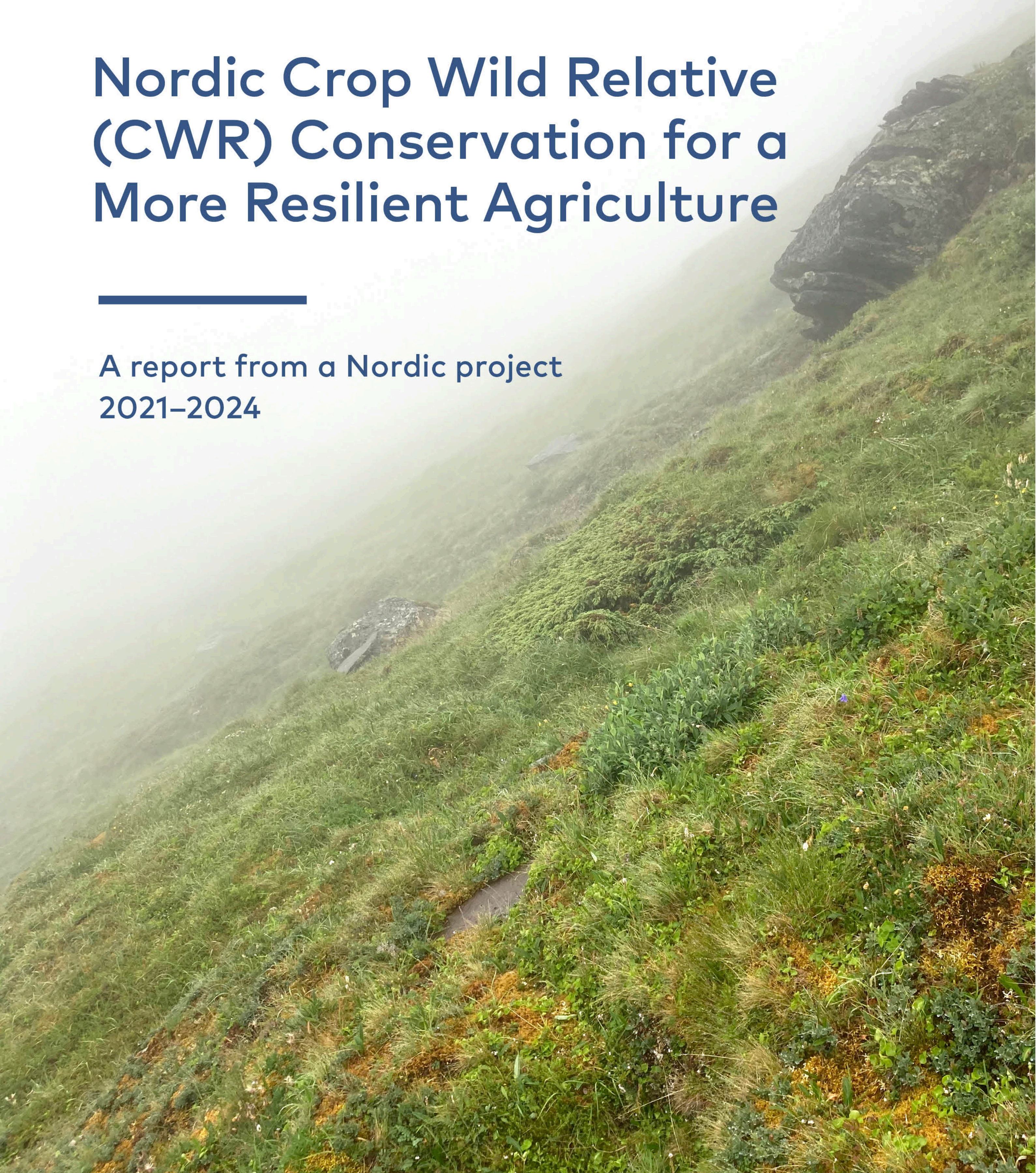
Nordic Council of Ministers

Nordic Crop Wild Relative (CWR) Conservation for a More Resilient Agriculture

A report from a Nordic project 2021–2024



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This publication is also available online in a web-accessible version at:
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Summary

This report summarises the findings from a Nordic project with the long-term goal to contribute to a more sustainable and resilient agriculture by enhancing the conservation of Nordic Crop Wild Relatives (CWR) and facilitating their use. In this manner, the project improves long-term access to genetic resources that can be used to adapt agricultural plants to climate change and other future challenges. Activities include 1) species distribution modelling under different climate change scenarios, 2) inventories to determine presence and status of CWR populations in selected protected areas, 3) seed collection for long-term *ex situ* conservation and access from NordGen, 4) genetic diversity analysis in selected CWR, 5) Nordic cooperation and networking activities, and 6) communication and knowledge exchange. In conclusion, the project has enhanced the conservation and access to Nordic CWR, and increased the knowledge on their diversity, status, distribution, and impact due to climate change. It has strengthened the scientific foundation for conservation efforts and inspired national actions. In addition, Nordic cooperation on this topic has improved, and communication has reached a diverse set of stakeholders, including conservation professionals, policymakers, scientists, and the interested general public.

1. Introduction

This report summarises the findings from the project "Conservation and sustainable use of genetic resources in the Nordic countries", which forms part of the Nordic Council of Ministers' Nature-based Solutions programme. The project is a collaboration among all Nordic countries and focuses on Crop Wild Relatives (CWR). Its long-term goal has been to contribute to a more sustainable and resilient Nordic agriculture by enhancing the conservation of Nordic CWR genetic resources and facilitating their use. In this way, the project improves long-term access to genetic resources that can be used to adapt agricultural plants to climate change and other future challenges. In addition, the project has aimed to achieve Nordic-wide synergy in this field and to enhance Nordic communication and cooperation.

What is a Crop Wild Relative?

A Crop Wild Relative (CWR) is a wild species / population that is closely related to a cultivated crop. It can be a wild species within the same genus as a crop (for example the wild species *Phleum alpinum* L., which is related to the cultivated forage grass timothy, *Phleum pratense* L.), a defined subspecies within the same species as the crop (for example wild *Allium schoenoprasum* subsp. *sibiricum* (L.) Hartm. and cultivated chives, *Allium schoenoprasum* L.), or wild populations of the same species as the crop (for example wild *Allium fistulosum* L. and cultivated welsh onion, also *A. fistulosum*). For more examples, see Figure 1. In rare cases, also closely related species within a different genus than the crop are regarded as CWR, if they have proven useful in pre-breeding or in the development of new crop cultivars.

CWR are not biologically different from other wild species but due to their close relationship, crop traits can be transferred from the CWR to the crop. Studies show that CWR contain traits such as drought tolerance and pest and disease resistance that are lacking from the related crop and can be used to adapt the crop to for example climate change and a more environmentally friendly agriculture.

1.1 Context of the study

The effects of climate change are becoming increasingly apparent around the world, and the impact is expected to be severe in the Nordic countries, particularly in Arctic areas (Rantanen et al. 2022; Aðalgeirsdóttir et al. 2024). This will affect ecosystems, challenge long-term conservation of biodiversity and have both direct and indirect effects on us as individuals and on human society. A major challenge will be food security, where the impact of climate change has already been observed in many areas, including the Arctic (IPCC 2023). It is now more urgent than ever to adapt agriculture to climate change, while at the same time minimising its impact on the environment and climate. One of the approaches available to achieve these goals is to develop new, climate-adapted plant cultivars and cultivation systems, and CWR can provide raw material (genetic variation) needed to develop these cultivars. CWR have been recognised for a long time as important sources of valuable traits for improving cultivated plants in general, as well as variation relevant for climate change adaptation in particular (Maxted et al. 2012; Dempewolf et al. 2014).

The value of CWR and their conservation has been recognised globally and is for example mentioned in the sustainable development goals (UN 2015, Target 2.5) and in plans and strategies connected with the Convention of Biological Diversity (e.g. UNEP 2022). Additionally, the importance of access to CWR has been emphasised (Maxted and Brehm 2023) and the recently updated Kalmar Declaration on access and rights to genetic resources supports facilitated access to CWR via NordGen (Nordic Council of Ministers 2024). However, it is clear that CWR are today neither adequately conserved nor sufficiently accessible (Engels and Thormann 2020; Maxted and Brehm 2023) and that actions are urgently needed. With that in mind, the goals of the current project were developed to target the conservation and access to Nordic CWR.

Figure 1. A few examples of Nordic Crop Wild Relatives (CWR): *Fragaria vesca*, a relative of wild strawberry (*Fragaria × ananassa*); wild *Schedonorus pratensis*, the same species as the cultivated forage grass Meadow fescue; *Trifolium arvense*, a CWR to red clover (*Trifolium pratense*) which is an important forage crop in the Nordic countries; *Daucus carota* ssp. *carota*, a CWR of the cultivated carrot (*Daucus carota* subsp. *sativus*). Photos by Magnus Göransson, Linn Borgen Nilsen and Kristina Bjureke.

2. Nordic CWR priority list and list of wild food plants

2.1 Updated CWR priority list

The Nordic countries have a large number of CWR in their flora. A previous study used a broad definition of CWR, resulting in a comprehensive checklist including over 2,700 Nordic CWR taxa (Fitzgerald et al. 2017; Palmé et al. 2019). These are related to food and forage crops as well as medicinal, ornamental, and forestry species. Based on this checklist, a priority list was developed (Fitzgerald et al. 2018) so that conservation efforts could be focused on the most relevant species. It was decided to include only CWR related to food and forage crops. Further prioritisation was based on the following two criteria: socioeconomic value of the crop that the CWR is related to and potential utilisation value of the CWR for breeding. The resulting list included mainly CWR related to crop categories of fruit and berries (36%), vegetables (29%) and forages (27%).

In 2021, an update of the list was made (Fitzgerald et al. 2023), and 19 new CWR species were added to the priority list, which now includes 103 species. This update was made by consulting Nordic scientists and plant breeders regarding what species that would be valuable to add. The additional species included taxa related to both food and fodder crops, such as *Raphanus raphanistrum* L. (CWR to radish), *Leymus arenarius* (L.) Hochst. (CWR to wheat), *Apium graveolens* L. (CWR to celery), and *Phleum alpinum* L. (CWR to timothy). In addition to the added taxa, data on occurrence, taxonomy and gene pool affinity was updated and, information on invasiveness and threat categories from Nordic countries was added. In total, 20 of the taxa are red-listed in at least one of the Nordic countries

The work described below (inventory, seed collection, selection of species for climate change modelling, and genetic analysis) was initially based on the first version of the priority list, but in some cases includes also species from the updated list.

2.2 Wild Food Plant list

Wild food plants (WFP) are edible wild species used for food (see examples in Figure 2). As CWR and WFP conservation often go hand in hand, the project initiated a Nordic-level co-operation on WFP. The first step was to create a Nordic list of wild food plants.

For doing so, we decided to define WFP as non-cultivated species of wild plants that grow spontaneously in their natural habitat and are used as human food. WFP can be found growing in very diverse habitats across the Nordic region. Some of them also grow on disturbed habitats or spontaneously on agricultural or urban land.

Historically WFP, such as wild berries, have been widely used in the region and the tradition of berry picking still continues today. Other WFP have been used as vegetables, or even as a bread substitute during years of famine and war. Even though many foraged wild species are similar throughout the Nordic region, there are also differences in the traditional use of WFP between the countries.

Data from Nordic sources (Bjarnadóttir and Hilmarsson 2018; Ellena 2012; Evira 2016; Lundström 1917; Plantelisten 2024; Rautavaara 1980a; Rautavaara 1980b; Stryamets et al. 2015; Svanberg 2012; Svanberg and Ægisson 2012; Teixidor-Toneu 2022) and European sources (EU 2023; EU 2024; EuroFIR-NETTOX 2007; Irving 2009; THIE 2023) were collected to find information on both historical and present human food use of Nordic plant species. The taxa with indigenous or naturalised status (SLU Artdatabanken 2024; Elven et al. 2022; Kurtto et al. 2019; Hartvig et al. 2015; Wasowicz 2020) in at least one Nordic country as well as having human food use were selected to form the Nordic wild food plant inventory. The inventory also contains additional data, such as national IUCN red list categories (Artsdatabanken 2021; Hyvärinen et al. 2019; Wasowicz and Heiðmarsson 2019; Moeslund et al. 2023; SLU Artdatabanken 2020) and invasive status in each country (Artsdatabanken 2023; EU 2022; Luke 2024; Náttúrufræðistofnun 2024; Strand et al. 2018; Skipper et al. 2020).

The number of species in the Nordic WFP inventory is 368 in total and with subspecies and varieties 624 taxa (Fitzgerald et al. 2024b). Altogether 90 taxa are listed as threatened in at least one Nordic country and 110 as invasive in at least one of the Nordic countries. Additional data on toxicity (HUS 2024; Swedish Poisons Information Centre 2024) includes information on whether the entire plant is toxic or only some parts of it are. In some cases, the plant is listed as toxic but is edible when used and prepared correctly, or it can be used as food to a reasonable extent.

The list includes edible plants of different uses. Medicinal plants were not included if their use was solely medicinal and not food. On the other hand, herbal teas, food decorations and spices were included along with plants used for example as vegetables, berries or bread flour substitutes. The taxa come from 75 different families and 237 genera showing the large variation of Nordic wild food plants. This WFP list should not be considered as static but rather aimed to be updated as more data becomes available, in a similar way to the CWR list.

Figure 2. Examples of Nordic wild food plants: Empetrum nigrum can be used to make jams and juices; *Vaccinium myrtillus* is widely collected during late summer in the Nordic countries, it is both a CWR and WFP; *Polypodium vulgare* roots are often eaten by children as they have a liquorice-like taste; young shoots of *Picea abies* are used in making syrup in early spring. Photos. Heli Fitzgerald.

3. Climate change and species distribution modelling

3.1 Aims and background

The aim of this part of the project was to model the effect of climate change on crop wild relative species distributions for conservation planning purposes. Nordic CWR *in situ* conservation planning started during previous Nordic projects (Palmé et al. 2019; Fitzgerald et al. 2019). National CWR *in situ* conservation planning was also undertaken in several Nordic countries (Phillips et al. 2016; Weibull and Phillips 2020; Fitzgerald et al. 2023). Protected areas were identified which were complementary to each other and had a high number of CWR species and ecogeographic diversity.

However, as climate change is predicted to cause changes in habitats and species distributions, the selected *in situ* sites may not necessarily hold sufficient CWR diversity in the future. An example of an *in situ* site with high CWR diversity at present shown in Figure 3. Therefore, the modelling of climate change effects on CWR distribution presented here provides a first step in finding out which sites would be suited for long-term *in situ* conservation of CWR while climate change advances.

Figure 3. Reindeer grazing in Oulanka National Park, Finland. The CWR species composition is likely to change in the future, particularly in the northern parts of the Nordic countries. Photo: Virva Lyytikäinen.

3.2 Climate change in the Nordic region

The expected changes in the Nordic climate by 2100 include heavier rainfall, rising winter temperatures, a reduction of snow cover and soil frost, reduced winter sunlight, heat waves and periods of drought (Ruosteenoja and Jylhä 2021). Due to arctic amplification, changes occur faster in the Arctic than in the rest of the world (Serreze et al. 2009). In the Nordic region, the areas most affected are the ones north of the Arctic Circle. In recent decades, the warming of the Arctic has been four times faster than in other parts of the world (Rantanen et al. 2022). Therefore, the climate related risk for arctic ecosystems is significantly higher than in other regions (IPCC 2023).

Some examples of the effects of these changes to the Nordic environment include flooding and rising water levels resulting from heavier rainfalls, melting of glaciers (Figure 4) and areas with permafrost such as palsa mires (Verdonen et al. 2023), rising treelines resulting in the spread of forests upwards and northwards to tundra ecosystems (Kullman 2021), and spread of new species from outside of the region which may become invasive. Additionally, the fragmentation of habitats due to climate change and human activity will restrict the ability of indigenous and naturalised species to migrate to new areas and their ability to survive.

Figure 4. Glacier in Vatnajökull National Park, Iceland. Photo: Magnus Göransson.

3.3 Species distribution modelling

Species distribution modelling can be used in conservation planning for modelling both the current potential distribution of species and future distributions to find areas where the growing conditions will remain suitable for each species to thrive in the future.

The modelling was done for a majority of the species from the updated Nordic CWR priority list (Chapter 2). Two different climate scenarios (socio-economic pathway scenarios) out of five available ones were selected for the year 2100: the SSP2, and SSP5. SSP2 is a 'middle of the road' scenario with approximately 2.7 °C estimated warming by 2100 with low CO_2 emissions cut to net zero around 2075. SSP5 is the worst-case scenario 'Fossil-Fueled Development' with estimated warming of 4.4 °C with very high CO_2 emissions tripling by 2075. As the world is considered to have already gone past the possibility to stay within SSP1, the SSP2 was chosen as a mild scenario and SSP5 the worst case, to represent different future possibilities.

CMIP6 (IPCC 2021) downscaled future climate projections of species-specific climate variables along with edaphic and geophysical variables were used in the modelling. The current distribution was based on national observation data downloaded mainly from GBIF (GBIF 2024). For each species, a predicted present-day distribution map and two future suitable habitat maps were created based on the selected scenarios. These could then be compared to find the predicted change in distribution.

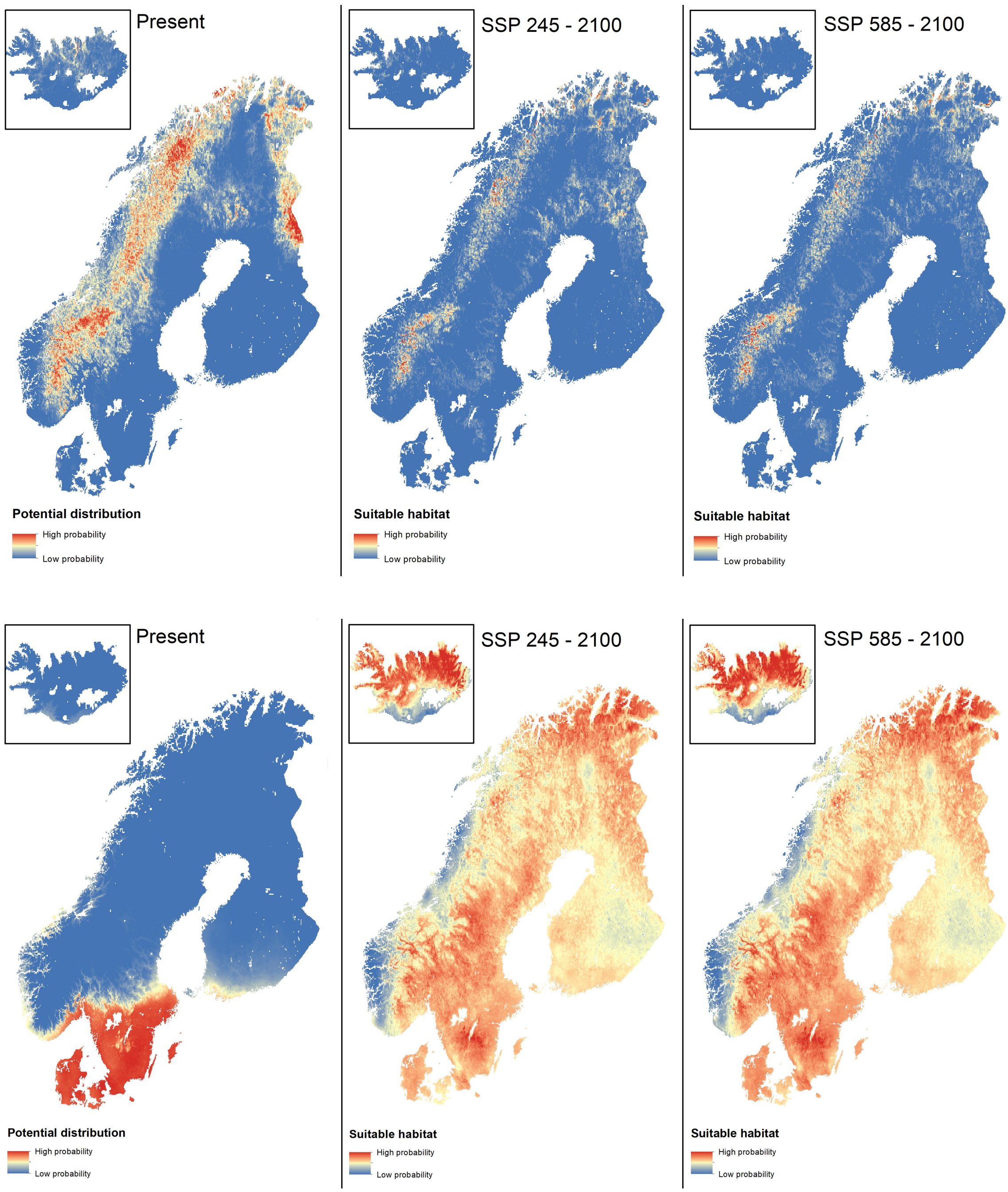

Figure 5. Examples of the present potential distribution and future predicted suitable habitat maps, showing both a mountainous species' reduction in future habitat conditions (*Elymus kronokensis* – top) and a southern species' increase in suitable future habitat conditions (*Prunus avium* – bottom) (Fitzgerald et al. 2024a).

3.4 Results and recommendations

The results of the analysis show that suitable habitats will in general shift northwards and to higher altitudes. This will lead to range reductions in both future models for approximately half of the target species. The other half of the target species shows an expansion of suitable habitats. It is, however, unlikely that all populations will be able to shift to new sites with better suited environmental and climatic conditions when their present habitats become unsuitable. Therefore, species that according to the models show a range expansion as well as a large shift in distribution area, might in fact experience a decrease their distribution area if their migration ability is not efficient enough. Taken together, large reductions in species ranges are expected, and some of the species may face higher threat levels or even extinction. Detailed results and maps of the analysis can be found in Fitzgerald et al. (2024a).

The species most vulnerable to the effects of climate change usually include those with poor resilience to changes, small populations, threatened species (van Treuren et al. 2020; Wrobleski et al. 2023) and species with restricted possibilities of movement such as mountainous species. The current analysis shows similar results, since the mountainous (Figure 5) and threatened CWR species appear to be at the highest risk of range reduction under investigated climate scenarios. On the other hand, suitable habitats for species growing on urban, disturbed or agricultural lands are, on average, expected to expand in the future.

Specific recommendations based on the climate change modelling results (for additional recommendations, see Chapter 9):

- Establishing and maintaining sufficient networks of interconnected protected areas that will support the survival of target species and provide migration options to new suitable habitats.
- Establishing active *in situ* monitoring of populations and undertaking seed collecting missions for *ex situ* conservation of those species predicted to face large range reductions in the future.
- Conducting further analysis to identify complementary protected areas for long-term survival *in situ*.

4. Genetic diversity in Nordic CWR

4.1 Aims and background

The need for conservation of CWR biodiversity is not limited to the conservation of prioritised species but also comprises conservation of the genetic diversity contained within the species. High levels of within-population genetic diversity facilitate the adaptation to a changing world and is thus important for successful long-term *in situ* conservation. Conservation of a large amount of genetic diversity is also important from a plant breeding perspective since the usefulness of the preserved diversity is rarely known *a priori*. Conservation of within-species diversity is thus central for both plant survival and utilisation. Within-species diversity need not be evenly distributed across the range of a species, and rare, unique variants can code for important local adaptations. The distribution of the within-species diversity should ideally also be taken into consideration when planning CWR conservation.

The aim of this part of the project was to gain a better general understanding of the distribution of genetic diversity within selected CWR taxa (within and among populations) in order to more efficiently conserve it for the future, as well as to make species specific recommendation with the same aim.

4.2 CWR species selection and genotyping

As part of the project, we have carried out genetic characterisation of the following six Nordic CWR: *Carum carvi L.* (caraway); *Vaccinium vitis-idaea* L. (lingonberry); *Schedonorus (Festuca) pratensis* (Huds.) P. Beauv. (meadow fescue); *Corylus avellana* L. (hazel); *Fragaria vesca* L. (wild strawberry); *Vaccinium myrtillus* L. (bilberry/European blueberry).

The species were chosen to represent different types of plants (herbs, shrubs, grasses and bushes) and species reproducing both primarily through inbreeding and through outcrossing. Since outreach and education on CWR was an important part of the project, we also prioritised species which we expected to be well-known by the general public and have a clear utility value.

Populations from all species were sampled across their Nordic range and DNA was extracted from multiple individuals per populations. *C. carvi*, *V. vitis-idaea*, *S. pratensis* and *C. avellana* were genotyped using a Genotyping-by-Sequencing approach while *F. vesca* and *V. myrtillus* were genotyped using microsatellite markers.

For the species that were genotyped with the Genotyping by Sequencing approach, *C. carvi* was sequenced alone while the individuals from the remaining species were combined and sequenced together using a different setup that generates a larger amount of data. Unfortunately, for these species we were unable to retrieve part of the sequencing data, resulting in datasets that contained a high proportion of missing data, i.e. each locus was only genotyped in a subset of the individuals within the species. This makes it difficult to characterise the populations genetically in depth, but we can still make some preliminary conclusions for these species. Genotyping using microsatellites was carried out by visiting internship students. Due to the limited time available for the student who carried out the genotyping, these results are currently incomplete.

4.3 *Carum carvi*

From *C. carvi* we genotyped 198 individuals from 16 populations (see Figure 6). Within-population genetic diversity was lowest in a Danish population from Selsø (He = 0.23) and highest in a Norwegian population from Nordmarka, Oslo (He = 0.33). Genetic diversity was neither correlated with latitude nor with longitude and the populations did not show any evidence of inbreeding.

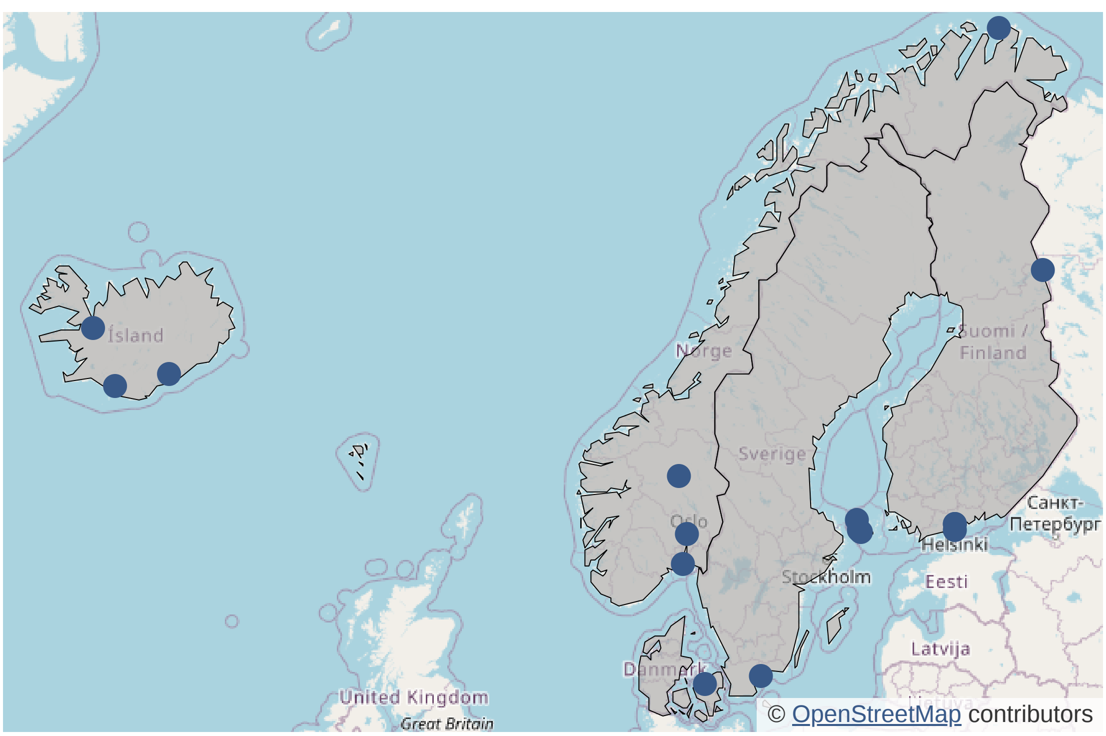

Figure 6. Map showing the locations of the studied *Carum carvi* populations.

The genetic diversity within the Nordic populations of *C. carvi* could be divided into three main groups (see Figure 7) and showed an east-westerly distribution. An exception was the northernmost Norwegian population Skjø, which we believe has been a human introduction. The analysis of the Icelandic population Fljótshlíð Hlíðarendi supported the written narrative of *C. carvi* being originally introduced to Iceland to this location, but with a long history as a naturalised species. Based on the genetic analysis we could make conservation recommendations that would result in conservation of all three genetic clusters and populations with a high level of within-population genetic diversity. We suggested prioritised conservation of the populations Fljótshlíð Hlíðarendi, Iceland; Søndre Ekornholmen, Norway; Äppelö, Åland; Oulanka, Finland and Lebesby Skjøtningberg, Norway.

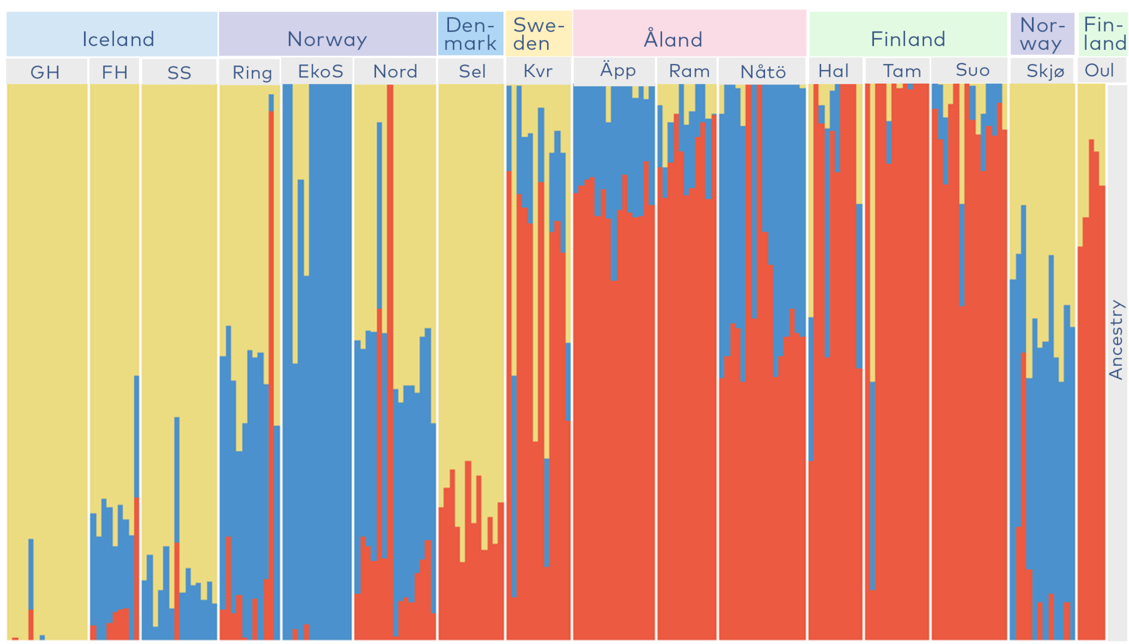

Figure 7. Clustering of the genetic diversity of the studied *Carum carvi* populations. Each vertical line represents the ancestry of an individual where the different colours show the proportion of the genome of that individual belonging to each of three genetic clusters. White lines separate the studied populations

4.4 *Vaccinium vitis-idaea*

From *V. vitis-idaea* we genotyped 284 individuals from 23 populations. The within-population genetic diversity of *V. vitis-idaea* was somewhat higher than that of *C. carvi* and with the lowest diversity in the Danish population Melb (He = 0.24) and the highest diversity in Stormossen, Djurvik on Åland (He = 0.40, Figure 8). Icelandic populations tended to contain less within-population diversity than populations from the other Nordic countries. With the exception of a population in northern Sweden, there was little evidence of inbreeding. The data supported a human introduction of some of the Icelandic populations (Rauðavatn, Reykjavik and Þrastarskogur, Suðurland).'

Based on our preliminary analysis, we suggest focusing on the most genetically diverse populations of each country and Åland: Himmelbjerget, Denmark; Oulanka, Finland; Öxnadalur, Iceland; Syltefjord, Norway; Ingarö, Sweden and Stormossen, Åland. This should encompass the full east-western and south-northern ranges of the Nordic region, and the genetic clusters tentatively identified. Additional genotyping of a subset of the populations is currently underway.

Figure 8. *Vaccinium vitis-idaea* at the collecting site at Stormossen, Djurvik on Åland. Photo: Virva Lyytikäinen.

4.5 *Schedonorus (Festuca) pratensis*

From *S. pratensis* we genotyped 115 individuals from eight populations in Finland, Denmark, Norway and Iceland. The within-population genetic diversity was higher for *S. pratensis* than *C. carvi*, but similar to that of *V. vitis-idaea*. The highest diversity was found within a Finnish population from Nuuksio, Lehtimäki (He = 0.38) while the lowest was found in a Danish population from Femmøller (He = 0.32). For several populations, active avoidance of inbreeding seemed to be in place. Analyses of a subset of the data with the genetic loci and individuals with the least amount of missing data, comprising of five populations, tentatively suggested a genetic differentiation between the Icelandic population from Petursey, Suðurland and the other Nordic countries, consistent with an ancient natural colonisation or a human introduction sourced from outside of the Nordic region.

Based on our preliminary analysis, we suggest focusing on the genetically most diverse populations, Nuuksio, Lehtimäki from Finland and Kattrup from Denmark as well as Petursey, Suðurland from Iceland with its differing genetic background. In addition, we recommend further genetic studies to evaluate the genetic diversity of this species in depth.

Figure 9. *Schedonorus pratensis* at the collecting site at Petursey, Suðurland in Iceland. Photo: Magnus Göransson.

4.6 *Corylus avellana*

For *C. avellana*, 178 individuals from 14 populations were genotyped from all the Nordic countries except Iceland, where the species does not grow. Of the four species genotyped with genotyping-by-sequencing, *C. avellana* had the highest within-population genetic diversity, higher than all three other species. In contrast with the other species, within-population genetic diversity was significantly correlated with latitude and more southern populations contained more genetic diversity than populations from more northern latitudes. The highest within-population diversity was observed in a Danish population from Kattrup (He = 0.42) and the lowest in a Norwegian population from Øyer, Innlandet (He = 0.34). As in *S. pratensis*, active inbreeding avoidance seemed to occur in some populations.

No clustering of the genetic diversity could be detected with the data available suggesting that conservation of the most genetically diverse populations, regardless of their geographic origin should ensure conservation of a maximum amount of genetic diversity. We tentatively suggest Kattrup and Mols from Denmark, Tønsberg, Færder municipality from Norway, Tvärminne, Hanko from Finland and Ingarö, Värmdö from Sweden (Figure 10) as populations to focus on until more data is available.

Figure 10. *Corylus avellana* at the collection site at Ingarö, Värmdö in Sweden. Photo: Anna Palmé.

4.7 *Fragaria vesca*

For *F. vesca* 95 individuals from nine populations were genotyped (for an example see Figure 11). As in *C. avellana*, genetic diversity decreased with latitude with the highest level of diversity in a Danish population from Kattrup and the lowest in an Icelandic population from Ásbyrgi. Our data tentatively suggested the presence of three genetic groups and conservation efforts should hence ideally include the most diverse populations from each group. Additional genotyping is currently underway and until the results from these become available the Icelandic population from Borgarfjörður, the Danish population from Kattrup and the Finnish population from Nåtö on Åland are the most interesting populations from a conservation perspective.

Figure 11. *Fragaria vesca* growing in the collection site in Abisko in Sweden. Photo: Mora Aronsson.

4.8 *Vaccinium myrtillus*

For *V. myrtillus*, 93 individuals from six populations from Finland, Iceland and Sweden were genotyped. The results suggested the highest levels of within-population diversity in a Finnish population from Nuuksio and the lowest in a Swedish population from Abisko (Figure 12). High levels of inbreeding were suggested for the Finnish population from Oulanka. With the available data the different populations cannot be grouped into any genetic clusters, suggesting the identity of a population may be of lesser importance than its genetic diversity. Additional genotyping is currently underway.

Figure 12. Collection of *Vaccinium myrtillus* in Abisko, Sweden. Photo: Mora Aronsson.

5. CWR inventories in protected areas

5.1 Aims and background

The aim of this part of the project was multifaceted. Firstly, it sought to evaluate various methods for inventory of Crop Wild Relatives (CWR) and to pinpoint sites with significant occurrences of CWR. Secondly, it served as a foundation for identifying the seed collection localities (see Chapter 6). Thirdly, it provided guidance on future site management and identified populations suitable for long-term *in situ* conservation.

The inventory was conducted across all Nordic countries: one area in Norway and Åland, two in Sweden, Iceland, and Finland and four in Denmark. The inventories took place between 2021 and 2023.

5.2 Norway

The inventory in Norway was carried out in Færder National Park (NP) in 2021 (Figure 13). The area was selected as previous studies showed that it contains a high CWR diversity, and it was recommended for the establishment of a genetic reserve. From earlier inventories, seven islands were selected (of 227 larger than 0.1 ha) as targets for the inventory. These seven islands include 30% of the land area in the NP and 90% of the vascular plants known from the NP (Pedersen 2024).

Fieldwork was carried out during 2021 during a total of 31 days (180 work hours). A 100x100 m grid (out of UTM zone 32) was used and 580 (out of 660) squares were visited. GPS position was recorded for all species on the CWR list, and the population size was estimated.

5.3 Iceland

In Iceland the inventory was done in Vatnajökull national park in 2021. The area was selected out of the highest ranking in CWR diversity in Iceland (Fitzgerald et al. 2019). Two smaller areas were chosen within the park, Skaftafjell in the south and Jökulsárgljúfur in the north. The sites were selected to cover as many of the vegetation types in the NP as possible (Göransson 2021).

The fieldwork was done during 15 man-days in 2021. Known sites (from GBIF and national databases) for taxa on the CWR priority list were targeted and other taxa from the list were recorded. Information on location, latitude, longitude, population size, viability and potential threats was collected.

5.4 Sweden

In Sweden, the inventory was carried out during two different years: in southern Sweden during 2021 and in the north during 2022. The southern area, Kristianstad Vattenrike, was chosen for several reasons. It includes the only Nature Reserve (NR) in the area with genetic preservation mentioned in its management plan (Lyngsjö NR), many NR in the area with diverse vegetation, and a large number of CWR priority species. Kristianstad Vattenrike is a Biosphere Reserve, and the management board is interested in developing the CWR engagement. Four NR were selected for inventory: Lyngsö (as mentioned above), Fjälkinge backe, Degerberga backar and Sånnarna. Together they contain most of the targeted species in the area (Aronsson 2022). In the north of Sweden, the Abisko-Torneträsk area was selected as it is far north, has well known biodiversity and allows for reasonable logistical costs. Five areas were selected based on the presence of species from the CWR priority list: South of Kopparåsen, Gearggevaggi, Gohpasjohhka, Abisko National Park and Boarrasacohkka. Abisko is a national park and the other four are inside Natura 2000 sites. Abisko NP and Gohpasjohhka were only visited for recording a single species (*Elymus mutabilis*) (Aronsson 2023).

The inventory in southern Sweden was carried out during three days in July and in northern Sweden during four days in July and one in August (together with leaf sampling for genetic analyses). The methods used differ between the north and the south. In the south, all parts of the NR were visited, except some parts that were too heavily grazed. In the north, the same method as in Iceland was used, with a focus on known sites for the rarer species and registration of all more common taxa on the walks between known positions. Information on location, population size, threats and viability were collected.

Figure 13. A scene from the inventory on an island in Færder National Park in Norway. Oddvar Pedersen is plotting the coordinates from various CWR plant species. Photo: Kristina Bjureke.

5.5 Finland

In Finland the inventory was conducted in 2022 in Oulanka and Nuuksio National Parks. These areas were chosen based on a national gap analysis and were identified as the most CWR species-rich complementary conservation areas. Additionally, they are excellent representatives for their ecogeographic zones (Fitzgerald et al. 2022).

The inventory took place in July in Oulanka and in August in Nuuksio. Given the extensive size of both national parks, smaller specific areas were selected for detailed study. In Oulanka, a 10x10 km square with the highest CWR diversity was chosen, while in Nuuksio the Myllypuro river valley was selected due to its known high CWR diversity. Within each selected area, 100x100 m squares were designated based on the known presence of CWR taxa – 14 in Oulanka and 5 in Nuuksio. All CWR taxa within these squares were catalogued, with details such as coordinates, number of individuals, population size, area covered, habitat, viability, and threats meticulously recorded.

5.6 Denmark

The inventory in Denmark was carried out in 2023 in four different sites: Husby, Stråsø, Mols, and Kattrup. The sites were selected to represent a west to east gradient across Denmark, but did also include diverse habitats and environmental conditions (Thulesen Dahl et al. 2023).

At each site, a number of points were randomly generated and selected for the survey. The CWR species were detected within circular plots with a 15 metre radius. In total, 212 plots were visited with a minimum and maximum of visited plots between 14 and 75 plots per site, depending on the total size of the site. For each species found in the plots, number of individuals, viability, threats, and status were registered. The work was done during 30 field days primarily between June and August, while a few sites were also visited in May (1 day) and October (2 days).

5.7 Åland

In Åland, the Nåtö-Jungfruskär Nature Reserve was chosen for the inventory, which was conducted during the summer 2023. Nåtö-Jungfruskär was selected as it is currently known to be the most CWR species rich area in Åland (Fitzgerald et al. 2023).

A specific area in the northwestern part of the nature reserve was targeted for the inventory, in anticipation of focusing future CWR *in situ* conservation efforts there. The area was divided in 100x100 m squares based on the Finnish Uniform Coordinate System grid. All squares in the reserve that included a terrestrial component (44 squares) were inventoried. All taxa from the CWR priority list were evaluated for the number of individuals, population size and its coordinates, status, viability, and threats. The fieldwork was conducted in July.

5.8 Result

The number of targeted taxa found in each country varied between 16 and 56 (see Table 1). In total, 89 of the taxa in the CWR priority list were identified during the inventory. A few species were found in all countries, such as *Festuca rubra* L., *Poa pratensis* L., *Trifolium repens* L. and *Vaccinium myrtillus* L. Some taxa were not covered, such as *Lactuca sibirica* (L.) Benth. ex Maxim. or *Lactuca tatarica (L.) C. A. Mey.*, mostly because of local distribution outside any of the inventoried sites, or because the taxa were too rare to be captured, like *Phleum phleoides* (L.) H. Karst. or *Trifolium montanum* L.

5.9 Lessons learned

All tested methods, site selections and strategies seem to have given a relevant result. The sites varied widely in size from Sånnarna in Sweden (0.44 km^2) to Vatnajökull in Iceland (14,967 km^2).

Targeting areas with a known population and searching for other populations in the surroundings is suitable for large sites, and when one or a few species are prioritized for the work in an area. Randomised sampling strategy is suitable for small to medium sized areas with rather common CWR taxa that are evenly distributed. Total inventory is suitable for very small sites. When only a part of a large site is inventoried, it could bias the results.

The majority of the observed CWR taxa have viable populations. The inventory gives a good starting point for restauration and/or management planning and highlights relevant threats and pressures. The inventory also gives information on other important features such as red-listed and invasive alien plants.

The timing of inventory is important and varies between years because of weather, climate, and grazing regime, and can be costly for remote sites. In grazed areas some CWR species could be favoured by the grazing, and some not.

5.10 Recommendations

- Continue to identify areas of particular interest for *in situ* conservation.
- Obtain a better understanding of the threats to CWR.
- Build on the knowledge obtained from the inventory and conduct in depth studies on the management needs of CWR in targeted protected areas.
- Inclusion of CWR in management plans.
- Management plans should include actions both inside and in the surroundings of the protected areas, to address issues regarding genetic pollution and invasive alien species.
- Establish a long-term monitoring system on priority CWR, that also includes other relevant features such as red-listed and invasive alien plant species.
- Establish a link between *in situ* and *ex situ* conservation in seedbanks and botanical gardens.
- Avoid resowing grass fields with exotic seed, or using exotic seed in habitat restoration activities, to limit geneflow between exotic introductions and existing CWR populations.
- Communicate the results of the inventory and importance of CWR *in situ* work to make it more known.

5.11 Cost estimates

The actual costs for the inventories vary for many reasons, some areas are close to universities and towns, and travel costs are normally low, other areas are more remote and require days for simply travelling to and from the location. The size of the inventoried area varies among the locations and so does the effort needed to travel around the area (need for boats, availability of roads, etc.) as well as the number of species occurring in each site (see Table 1), which in turn affects the time spent in each location and therefore the costs. Who is doing the work is also an important factor. An expert is more expensive than a student per hour, but a student often has to spend more time on determination of species than a skilled expert, and also needs tutoring/guidance.

The following are therefore very rough estimates and includes not only the inventory work in the field but also planning, design and coordination of the inventory, as well as data management and writing of a report. With this in mind, we estimate the cost to be between DKK 0.03 and 1.79 per square meter that was inventoried. Different definitions of "population" were used in the inventories, but rather similar approaches were applied in Denmark, Finland, Åland and Norway, where the cost varied from DKK 83 to 856 per population inventoried (see Table 1). The high cost in Iceland (DKK 7,933 /population) is strongly affected by the high travel costs over a large area and the low number of CWR taxa but also by the way "population" is defined for the purpose of this calculation.

Table 1. An overview of the inventories conducted within the project as well as the costs. As different approaches were used for conducting inventories in each country, direct comparisons of costs are not straightforward. In addition, self-funding or other data sources were used in some cases, and the costs for these could not always be included for this calculation (see footnotes).

Country	Name of the protected area(s) (PA)	No sites	Area of the PA(s) (km^2)	Area inventoried (m^2)	No species	No populations/ observations	Cost	Cost (DKK) per population	Cost per m^2 (DKK/m^2)
Denmark	Husby, Stråsø, Mols, and Kattrup	4	54.8	466,200	56	1,643[1]	835,000 DKK[2]	508	1.8
Iceland	Vatnajökull national park (Skaftafjell and Jökulsárgljúfur)	2	14,967	1,750,000	16	30[3]	238,000 DKK	7,933	0.14
Finland	Oulanka and Nuuksio National Parks	2	323	190,000	33	216[4]	185,000 DKK	856	0.97
Norway	Færder National Park	1	340 (incl. sea)	4,500,000	52	3,080[5]	256,000 DKK[6]	83	0.06
Sweden	Kristianstad Vattenrike and Abisko-Torneträsk	2	615	7,032,000	40	322[7]	185,000 DKK	574	0.03
Åland	Nåtö-Jungfru-skär Nature Reserve	1	5.6	440,000	29	367[8]	185,000 DKK	504	0.42

1. Denmark: Each taxon occurrence within an observation plot was counted as a "population".
2. Denmark: The inventory data from 306 of the 518 observation plots was produced within another project, and therefore not included in this cost estimate. Only the analysis of this data is included.
3. Iceland: Populations in Vatnajökull National Park were registered as presence/absence of the taxa in each sub-location/landscape type visited.
4. Finland and Åland: Total number of CWR observations within plots. Each taxon occurrence within an observation plot was counted as a "population".
5. Norway: Taxon occurrences within an observation plot (Count of unique species x square in 100 x 100 meter grid = 3,080). 218 populations (7,914 observations).
6. Norway: This cost only includes the field work (travel cost and salary) in Norway. The writing of the report and other follow-up activities were self-funded.
7. Sweden: Swedish definition of population concerning vascular plants is a group of individuals separated from another group of individuals of the same species with more than 100 meters.
8. Finland and Åland: Total number of CWR observations within plots. Each taxon occurrence within an observation plot was counted as a "population".

6. CWR seed collection and *ex situ* conservation

6.1 Aims and goals

The goal of this part of the project was to enhance the *ex situ* conservation of CWR in the Nordic region. This initiative serves a dual purpose: firstly, to offer a safeguard for conservation should any adverse events impact the wild population, and secondly, to facilitate the utilisation of these genetic resources. In the former case, the seeds can be used to reintroduce the natural population, reinforce it, or they can be used for assisted migration if the original location is no longer suitable for the species. The conserved seeds will be available to various users such as researchers, plant breeders and educators. Consequently, the overarching goal is to reinforce the long-term conservation of CWR while simultaneously enhancing food security by providing genetic resources for developing cultivars that are adapted to future challenges, such as climate change.

6.2 Seed collection

Botanists from all the Nordic countries were involved in collecting seeds from CWR species during the first three years of the project period (2021–2023).

From the Nordic CWR priority list (see Chapter 2), a subset of taxa was selected for seed collection. The selection was based on criteria such as if the taxa were already conserved *ex situ*, possibility to sample adequate number of seeds and individuals, and whether the species is native, naturalised, or temporary (in which case it was not collected) in the area. This resulted in a list of 47 taxa selected for seed collection and of these, 16 were prioritised. In some cases, additional CWR taxa were collected, if they occurred at the same locations as the ones prioritised. In the first year of the project (2021) we focused on collecting seeds from plant species in the protected areas where CWR inventories had been done. Necessary permits were obtained, and the aim was to collect seeds in protected areas in a responsible way and to make them accessible to researchers and plant breeders. Another focus was to collect seeds from the same populations where leaves had earlier been sampled for genetic analyses (e.g. *Carum carvi*, *Vaccinium vitis-idaea*, and *Schedonorus pratensis*, see Chapter 4). In the second year (2022) we looked for gaps in the Nordic region where few or no seeds of CWR had been collected previously. There were fairly large areas where many of the prioritised taxa had not been collected. Examples include islands like Öland, Gotland and Åland in the Baltic

Sea, the west coast of Norway, the very north of Scandinavia, and the east, north and west fjords of Iceland. We regularly discussed and decided which plant species and areas should be our current priority.

Before our collection trips, we consulted different national digital platforms for occurrences of the species. When collecting seeds, we noted details like scientific name of the plant species, locality, habitat, number of individuals, date, and geographic coordinates. We documented all plant species and their habitats with photos.

The seed sampling was conducted in such a way that the survival of the natural population was not endangered. It is also important to collect the seeds when mature, and to keep them in appropriate postharvest conditions. In addition, it is essential to check the population to avoid seeds that are escapees from cultivation, both from agriculture and from sown road verges.

In total 151 separate seed samples were collected and donated to NordGen (see Figure 14). Of these, some were re-samplings to increase seed amounts, some were samples that were later merged to create one gene bank accession, and some contained few or immature seeds. The final number of conserved accessions is therefore lower than this number (see Chapter 6.3).

In addition, seed samples from threatened species from Finland and Norway were collected within the framework of the project, but not sent to NordGen. In Norway, CWR species that are included in the Norwegian red list (Artsdatabanken 2021), are stored in the Norwegian National Seed Bank (Bjureke & Bruholt 2024). This affects the following species: *Phleum phleoides* (L.) H.Karst. (CR) (Færder NP), *Malus sylvestris* (L.) Mill. (VU) (Færder NP, Jomfruland and Hurum), *Rubus caesius* L. (NT) (Færder), *P. phleoides* (VU) (Oslo) and *Lactuca sibirica* (=*Mulgedium sibiricum)* (VU) (Troms). A total of seven accessions from Norwegian threatened species were collected. In Finland, the species included in the Finnish red list (Hyvärinen et al. 2019) are conserved at the Finnish Museum of Natural History seedbank. One accession of *Trifolium montanum* (VU) from Åland, Finland was collected.

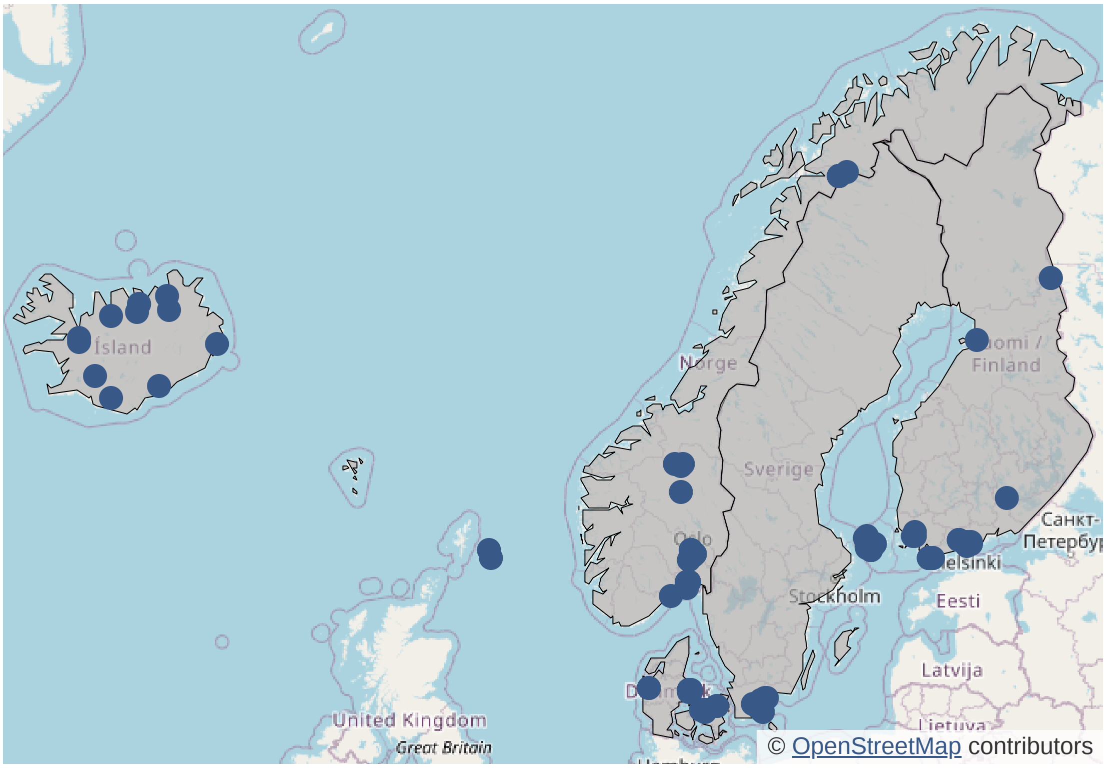

Figure 14. Locations where seeds of crop wild relatives were collected for conservation at NordGen within the framework of the project.

6.3 Seed conservation and access

After a rough cleaning in the respective countries, all seeds were handed in to the seed gene bank at NordGen (Alnarp, Sweden) for further processing and storage, except the few accessions from threatened species from Norway and Finland. The threatened accession from the Åland islands was processed and stored long-term in the seed bank at the Finnish Museum of Natural History, and those from Norway in the Norwegian National Seed Bank in Oslo.

At NordGen, all seeds were threshed, cleaned and dried. Seed experts made visual evaluations regarding seed health and taxonomy, and a sample from each accession was used to make a germination test to determine seed viability. In addition, hundred grain weight was estimated, and seed number was determined based on this and the total seed weight.

The aim of the seed collection was to conserve as many of the collected samples as possible long-term and to make them accessible via the Nordic Baltic Genebanks Information System (GENBIS). Here, seed samples can be ordered for use in for example plant breeding, research and education. However, there is a set of minimum requirements for the inclusion of accessions for long-term conservation at NordGen (Appendix A). These requirements are set up to assure that the seed collection is done legally and in a manner that does not harm the natural population, that documentation is adequate for users, and that seed quality and amount is satisfactory and sampled diversity (number of individuals) is adequate for long-term conservation and seed distribution. For example, if the seeds are collected from few individuals, the diversity collected is most likely not representative of the whole population and regeneration can result in inbreeding depression. In addition, if very few seeds are collected, they cannot be made available to users before either regeneration or re-collection has been carried out.

After evaluation of the seeds and documentation, it is estimated that about 90 accessions will be conserved long-term at NordGen, and 8 accessions will be conserved short-term. For a few of these accessions, the evaluation was based only on documentation, and therefore the final number might change somewhat. All these accessions will be made available to users. They include accessions from all the Nordic countries (Demark, Iceland, Norway, Sweden, and Finland, including Åland) and consist of wild relatives to vegetables (e.g. *Daucus carota* subsp. *carota, Lactuca serriola*) forages (e.g. *Festuca arundinacea, Phleum alpinum, Poa alpina, Trifolium arvense, Trifolium medium*) berries (e.g. *Vaccinium vitis-idaea*), cereals (e.g. *Leymus arenarius*) and spices (e.g. *Carum carvi*).

Figure 15. There are several challenges connected to seed collection, for example weather conditions and a demanding landscape. Collecting seeds of sea kale, *Crambe maritima*, on a windy day on Öland, Sweden, 2023 (left). Collecting seeds of *Phleum alpinum* and *Poa alpina* in Öxi, Iceland (right). Photos by Tor Mjaaland and Hjörtur Thorbjörnsson.

6.4 Budget

In the project budget, DKK 114,000 was assigned to seed collection in each country (including Åland), and it was mainly used for salary and travel costs. Different areas had different challenges (Figure 15), such as need for planning, demand and cost for travel, accessibility, access to experts and so on. This resulted in quite different outcomes in the different areas, and the division between salary and travel costs also varied. On average, the cost per collected seed sample was DKK 4,302. As described in the chapter above, not all seed samples lived up to the minimum requirements for long-term conservation and distribution. If the estimation of average cost only includes the accessions that live up to the criteria at NordGen for long-term or short-term conservation, and are therefore made available to users, the cost would be DKK 6,980 per accession.

The budget for seed processing and conservation included activities such as threshing/seed cleaning, taxonomic evaluation, germination testing, drying, and packing for long-term storage in three locations. The average cost per processed sample was DKK 4,619. This mainly includes salaries and to a small degree costs for materials.

7. Communication and outreach

7.1 Aims and goals

Communication has been an important part of this project and has the long-term aim to strengthen CWR conservation and sustainable use. The approach has been to communicate not only the outputs of the project, but also basic knowledge about CWR and the importance of their conservation. This has been achieved by using a range of approaches targeting four main stakeholder groups: the nature conservation community, the scientific community, the interested general public, and policy makers.

7.2 Travelling exhibition

A travelling exhibition on CWR has been produced in five different versions, one for each of the five main Nordic languages. Each set includes ten outdoor posters in the local language(s) and in English, and an accompanying folder. The exhibitions have circulated in the Nordic countries from 2021 to 2024.

The exhibitions have been displayed in the following locations: Denmark: The Green Museum (Det Grønne Museum). Finland: Kumpula Botanic Gardens, Helsinki (2021, 2024); Elonkierto Agriculture Exhibition Park (now Countryside and Domestic Animal Park Elonkierto), Jokioinen (2021); University of Oulu Botanical Gardens (2022); The Rural Centre in Åland (Ålands Landsbygdscentrum) (2022) and Nuuksio National Park (2023). Iceland: Reykjavik Botanic Garden (2021, 2022, 2023); The Skagafjörður Heritage Museum (2022); Akureyri Botanic Garden (2022); Ásbyrgi, Vatnajökull National Park (2022); The Nordic House in Reykjavik (2022, 2023). Norway: Botanical Garden, Natural History Museum, University of Oslo (2021); Bergen Botanical Garden, Milde, University of Bergen (2021); The Museum Garden, University of Bergen (2022); Ringve Botanical Garden, NTNU University Museum, Trondheim (2023); Natural History Museum and Botanical Garden, Kristiansand, University of Agder (2024, Figure 16). In Kristiansand there was a quiz walk with CWR questions, both for children and adults: Natursti – Naturmuseum og botanisk hage. Sweden: Station Linné, Öland (2021); Fredriksdal's open-air museum, Helsingborg (2021); Gothenburg botanical garden (2021); Tyresta National Park (2022); Jamtli open-air museum (2022); Naturum at High Coast World Heritage Site (2022); the Alnarp Park (2024).

Figure 16. In Norway, the exhibition has been on display in five different botanical gardens between 2021 and 2024. The photo above is from the Natural History Museum and Botanical Garden, University of Agder, in Kristiansand, where the horticulturist has made displays of CWR plant species near each poster. The posters are still in good condition, and they will remain on display until next year. Photo: Malene Østreng Nygård.

7.3 Webpage and media

Plant portraits

The tradition of publishing plant portraits was initiated during previous Nordic CWR projects and since they were popular, it was decided to continue with this communication approach. Each year during the project time period, a few plant portraits have been published on the CWR project webpage. In total, there have been 14 plant portraits published on the following species: spring vetch, (*Vicia lathyroides* L.), alpine timothy (*Phleum alpinum* L.), cock's-foot (*Dactylis glomerata* L.), wild radish (*Raphanus raphanistrum* L.*)*, alpine meadow-grass (*Poa alpina* L.), European dewberry (*Rubus caesius* L.), bilberry/European blueberry (*Vaccinium myrtillus L.*), field mint/wild mint (*Mentha arvensis* L.), welsh onion (*Allium fistulosum* L.), white clover (*Trifolium repens* L.), blackthorn (*Prunus spinosa* L.), mountain clover (*Trifolium montanum* L.), bog bilberry (*Vaccinium uliginosum* L.) and supina bluegrass *(Poa supina* Schrad.*)*. Among NordGen's project webpages, some of these portraits belong to the most visited pages.

Information films

As part of the project, four short information films have been produced and made available at the CWR project webpage and shared in NordGen's social media channels. The overall purpose of the films is to inform a broad target group about CWR and briefly explain some of the project's tasks.

The first film, "The Nordic Project on Crop Wild Relatives 2021–2024", serves as an introduction to the project focusing on why it is important to conserve CWR and use these valuable assets in research and plant breeding, and not least why Nordic cooperation is significant for success. As the title suggests, the second film, "CWR Inventories and Seed Collection", revolves around inventories and seed collections with examples from Norway (Færder National Park), Finland (Hanko peninsula), Sweden (Abisko National Park and Kristianstads Vattenrike Biosphere Reserve) and Iceland (Vatnajökull National Park and Reykjavík/Geldinganes).

In the third film "Climate Change Affects CWR", the work on climate change modelling is explained. The film describes the impact of climate change under the climate change scenarios SSP 245 and SSP 585, and how global warming will affect CWR populations in the Nordic countries. The fourth and last film "Genetic Diversity Analysis" focuses on the project's use of DNA technology to conduct genetic diversity analyses using plant samples collected in all the Nordic countries. In the film, some preliminary results are presented as well as some visions for the future.

Webpage news items and media coverage

During the years, seven news articles about the project have been published on NordGen's website. These news items cover activities such as project workshops, the updated CWR priority list, plant inventories and a seed deposit in the Svalbard Global Seed Vault. The CWR project has also been mentioned in press releases and debate articles written by NordGen. Below, you will find a selection of articles and features related to CWR and the project published by Nordic media during the project period.

- Sveriges Radio, Vetenskapsradion, 10 October 2023
- Sveriges Radio, Vetenskapsradion, 9 October 2023
- Landsbygdens Folk, 13 April 2022
- Landbrugsavisen, 5 April 2022
- Maaseudun Tulevaisuus, 5 April 2022
- Lantbrukets affärstidning ATL, 5 April 2022
- Nationen, 4 April 2022
- Forskning.no, 7 February 2022
- Nationen, 6 February 2022
- Forskning & Framsteg, 2 September 2021
- Titan, UiO.no, 16 April 2021
- Bondebladet, 29 April 2021
- Bændablaðið 17 September 2021
- Landbruks- og matdepartementet, 2 November 2021

7.4 Stakeholder workshops

Within the framework of the project, two stakeholder workshops have been arranged. The main goal of these were to strengthen and expand the Nordic CWR cooperation network, spread information about the activities within the ongoing CWR projects, knowledge exchange and discussions on national and regional conservation approaches, with the long-term aim to stimulate and improve Nordic conservation efforts on CWR. Stakeholders were invited from the *in situ* and *ex situ* conservation communities, the scientific community as well as policy makers.

The first workshop was held at the Natural History Museum in Oslo in November 2021. Forty participants, including people from all the Nordic countries, took part in the workshop, 25 of whom took part in person and the rest online. The workshop included information on activities in the projects, lectures given by international experts, group discussions and a mini future workshop (Figure 17). The outputs from the latter were summarised in an internal report, focusing on suggestions for future actions to strengthen Nordic CWR conservation (Appendix B).

The second workshop was held in the Meeting Centre of the Ministry of Agriculture and Forestry in Helsinki, in November 2023. Forty participants took part on site (the maximum possible with the funding acquired), including stakeholders from all the Nordic countries and international experts, as well as stakeholders from the Baltic countries in order to strengthen the Nordic-Baltic cooperation on this topic. The main sessions were on *in situ* conservation of CWR, use of CWR, outputs from the project, and European and international cooperation, followed by a discussion workshop on conservation of, and access to, CWR in the Nordic region and beyond. An internal report was written on the outcome of the latter and circulated to the workshop participants (Appendix C). The results from both the mini future workshop in Oslo and the group discussions in Helsinki fed into the recommendations presented in Chapter 9.

Figure 17. Active discussions at the Mini future workshop included in the Stakeholder workshop in Oslo 2021. All participants were invited to propose topics for discussion and six central themes were identified: processes at the policy level, developing protected area criteria, data management, network development, communication, and access, use and benefit-sharing. Photo: Jonatan Jacobson.

7.5 Webinars

During the autumn/winter of 2024, a series of lunch webinars was arranged. It included six separate seminars on topics central to the project. The goals were both to share the results from the project and to communicate other information of significance for CWR conservation and use. Speakers included people with a wide range of roles and expertise, such as protected area managers, plant breeders, researchers, representatives from national authorities, and *ex situ* conservation experts. They consisted of partners within the project network as well as other invited speakers.

In contrast to previous in-person workshops, the aim of the webinars was not only to reach Nordic stakeholders, but also a broader audience. Direct invitations were sent out to Nordic stakeholders according to a list developed within the project, as well as to Baltic stakeholders, European experts, and people in a number of groups relevant for this topic, e.g. the ECPGR CWR working group, The IUCN CWR specialist group, NetworkNature Nordic hub, and botanic gardens. In addition, the seminars were advertised on social media. Participation in the meetings varied from 72 to 92 (average 83) and in total 230 individual people from nearly 40 countries were reached with this communication effort.

An overview of the webinars and recordings of them can be found on the Nordic CWR webpage.

7.6 Publications and oral presentations

Publications

One of the approaches used to communicate the results from this project has been different kinds of open access publications. The exception has been a few student reports where open access publication was not possible. During the lifetime of the project (2021–2024), the publications include three datasets, seven inventory reports, one scientific newsletter, six student reports, and one popular science publication. In addition, there are two scientific manuscripts that have been submitted to peer reviewed journals, and additional data has been accumulated for further publications after the end of the project.

Below, we have collected the references of the different kinds of publications that are direct outputs from the project:

- Aronsson M (2022) Crop Wild Relatives – An Inventory in the Biosphere Reserve Kristianstad Vattenrike 2021. Figshare. Book. https://doi.org/10.6084/m9.figshare.21089752.v1 (Inventory report)
- Aronsson M (2023) Crop wild relatives – An Inventory in the Abisko-Torneträsk Area 2022. Figshare. Book. https://doi.org/10.6084/m9.figshare.24849915.v1 (Inventory report)
- Austad I, Hauge L, Svalheim E, Bjureke K, Rosef L & Aamlid T (2023) Norske blomsterenger – Forbilder, frøblandinger, etableringe og skjøtsel. Fagbokforlaget. Page 30-31 about this project. (Popular science)
- de Haro Reyes B, Palmé A, Fizgerald H, Göransson M, Pedersen O, Þorbjörnsson H, Madsen B, Treier UA, Normand S, Hagenblad J (submitted manuscript) An east - west distribution of genetic diversity in Nordic populations of caraway (*Carum carvi* L.) and its conservation priority consequences. (Scientific publication)

- Eriksson D (2023) Optimization of PCR protocol for microsatellite primers in *Fragaria vesca*. (Student project)
- Fahlgren S (2022) Optimisation of PCR Protocol for Microsatellites in *Vaccinium myrtillus*: A first step in evaluating genetic diversity for future conservation. Available from: https://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-185691 (Student project)
- Fitzgerald H and Kiviharju E (2023) Sukulaiset avuksi. Geenivarat p 15. Available from: https://www.luke.fi/fi/documents/geenivarat-2023-tiedelehti (Popular science)
- Fitzgerald H, Aronsson M, Borgen Nilsen L, Bjureke K, Byhring Jordal K, Dons Henriksen J, Göransson M, Henriksen J, Palmé A, Weibull J (2024b) Nordic Wild Food Plant Inventory. Figshare. Dataset. https://doi.org/10.6084/m9.figshare.27925893.v1 (Dataset)
- Fitzgerald H, Palmé A, Aronsson M, Asdal Å, Bjureke K, Endresen D, Hyvärinen M, Kiviharju E, Lund B, Nilsen L B, Göransson M, Thorbjornsson H, Weibull J, Wind P, Rasmussen M, Borgen Nilsen L, Helpdesk G, Palmé A, Bakken V (2023). Nordic crop wild relative priority list. Version 1.15. Nordic Genetic Resource Centre (NORDGEN). Checklist dataset https://doi.org/10.15468/4t4bm5. Accessed via GBIF.org 23/06/2024. (Dataset)
- Fitzgerald H, Palmé A, Aronsson M, Asdal Å, Bjureke K, Endresen D, Göransson M, Hyvärinen M, Kiviharju E, Lund B, Borgen Nilsen L, Rasmussen M, Thorbjornsson H, Weibull J, Wind P (updated 2021) The Nordic Priority Crop Wild Relative Dataset, version 3. Figshare. https://doi.org/10.6084/m9.figshare.5688130.v3 (Dataset)
- Fitzgerald H, Aronsson M, Göransson M and Palmé A (submitted manuscript) Climate change modelling predict dramatic changes in species distribution of Nordic crop wild relatives. (Scientific publication)
- Fitzgerald H, Levo M, Hyvärinen M, Häggblom M (2024) Crop Wild Relatives – Inventories in Nåtö Nature Reserve, Åland Islands, 2023. Figshare. Dataset. https://doi.org/10.6084/m9.figshare.25866787.v1 (Inventory report)
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Oral presentations

Results from the project and information about CWR have been presented in different conferences and meetings during the time frame of the project. For example, at international and Nordic conferences such as the 7th Global Botanic Gardens Congress in Melbourne 2022, the Nordic Conference on climate change adaptation in Reykjavik 2023, the Nordic nature-based solutions conference in Malmö 2024, as well as smaller/local meetings such as at the Swedish reference group for cultivated diversity, NordGen’s working groups, NordGen’s board, and Lund's botanical association.

8. Spin-offs from the project

8.1 Identifying management needs of CWR-species in Færder National Park

In 2022, the Norwegian Genetic Resources Centre received funding from the Norwegian Agricultural Agency (Landbruksdirektoratet) for a project to further assess CWR-species at two of the islands in Færder National Park, including threats and current management needs. This was a direct follow-up of the Nordic project and the extensive inventory of CWR-species conducted in Færder NP. The field work was conducted in 2022 and 2023, and a detailed report was presented to the National Park management and local authority in mid-2024 (Figure 18). The results of the project confirmed the rich diversity of CWR-species in Færder NP and provided a detailed mapping of populations of selected species on two islands in the park. It evaluated the current management practices that have been implemented in the area so far and found that most of them also favour populations of CWR-species. The project identified the need to expand the current management practices, both within existing areas to new areas where selected CWR-species are under threat. It was recommended to develop a comprehensive management plan for the area, which considers conservation of vegetation types and species diversity, including rare species, red-listed species and CWR species. The findings have been published in a report (Pedersen and Nilsen 2024, in Norwegian).


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Identifisering av skjøtselsbehov for kulturplantenes ville slektninger på Mellom og Østre Bolæren i Færder nasjonalpark

NIBIO RAPPORT | VOL. 10| NR. 96 | 2024

Oddvar Pedersen og Linn Borgen Nilsen
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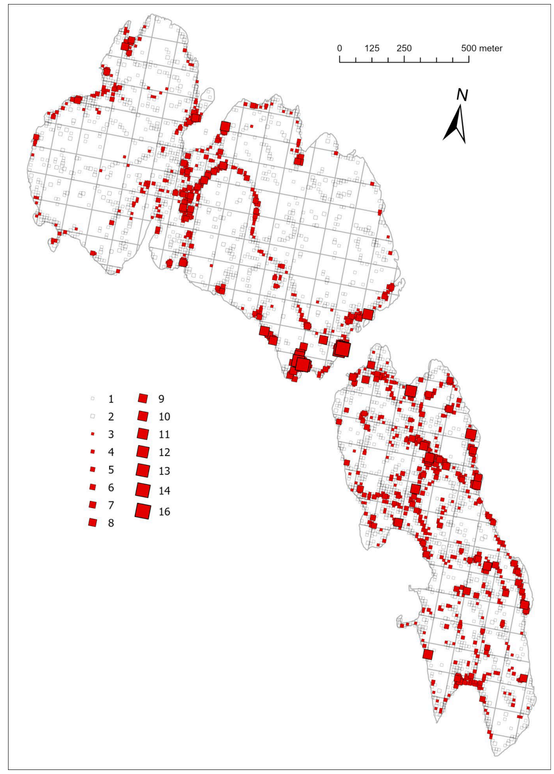

Figure 18. Published report from the spin-off project in Færder NP (left) and map and CWR-taxa on the island of Bolærne in 10x10m squares (right).

8.2 CWR pilot project in Reykjavík

In 2021, Reykjavík Botanic Garden received funding for a CWR pilot project making inventories and management recommendations for CWR populations in green and coastal areas of Reykjavík municipality. The project was one of eight pilot projects in the program for Nature-based solutions funded by the Nordic Council of Ministers. The project was based on an idea that sprung from the Nordic CWR project where inventories were performed in protected areas in nature. In the pilot study, inventories were performed in close vicinity to the city of Reykjavík, with the aim of studying habitats with CWR species in a more urban environment.

8.3 National CWR project in Finland

A national project, "CWR conservation strategy for Finland" 2017–2020, was funded by the Ministry of Agriculture and Forestry, and participants included Luke, the Finnish Museum of Natural History Luomus, and Metsähallitus Parks and Wildlife Finland. The aim was to plan a national implementation of CWR conservation in Finland. An informal network was established to form a discussion forum and to guide the national CWR conservation planning. The Finnish CWR priority list (Fitzgerald 2013) was updated (Fitzgerald & Kiviharju 2018), CWR *in situ* hotspots were identified by complementarity analysis and an inventory of CWR in semi-natural habitats of Nuuksio National Park was carried out. Based on these analyses, potential genetic reserve areas were suggested.

The results showed that a majority of the priority CWR are found in protected areas, and the current management measures are generally profitable for several CWR species. However, not all CWR occur in protected areas, and their conservation requires further planning as well as active management and monitoring of all priority species. Potential costs of CWR conservation were roughly estimated for the future implementation purpose of project recommendations. The main findings of the Finnish CWR project were published in 2023 (Fitzgerald et al. 2023), and detailed information can also be found in the project report (Fitzgerald et al. 2020, in Finnish).

9. Recommendations and conclusions

9.1 Background

The report *Nordic Crop Wild Relative conservation* (Palmé et al. 2019) summarised the findings and experiences of two consecutive projects. As a result of these, a policy brief was developed in preparation of an anticipated joint Nordic declaration aimed at being endorsed as a joint Nordic commitment to implement and fulfil Target 2.5 of the UN Sustainable Development Goals (SDGs). This declaration was never realised. Meanwhile, since 2019, other processes with relevance for the conservation and use of CWR have been implemented. During 2019–2023 the joint Nordic project *Access and Rights to Genetic Resources – A Nordic Approach (II)* was carried out under the auspices of NordGen. Given the international developments over the last two decades within the genetic resources arena, the project aimed at reviewing and possibly updating the Nordic approach in relation to access and use of genetic resources within the region. The outcome of the project – encompassing all relevant domains of genetic resources, including CWR – also yielded specific policy recommendations pertaining to the conservation and use of CWR.

In this report we present an updated and extended set of recommendations (Table 2) – including on policy – to be addressed by decision-making bodies at either the national or the joint Nordic level, as appropriate. For the sake of ease, the recommendations are thematically organised.

9.2 Recommendations

Table 2. Overview of recommendations.

		Recommendations to assure long-tern conservation and access to taxa of particular importance for food security
1	On initial actions	**Complete the development of national strategies for *in situ* conservation of CWR**. The work done at the Nordic level can be used as a framework or as supporting information. National strategies should be complementary to Nordic, European and global strategies. Development of conservation measures should preferentially be based on FAO Voluntary Guidelines (FAO 2017).
2	On involvement	**Carry out cross-sectoral reviews** regarding considerations and measures related to CWR conservation and use in national policy and in local management plans. **Promote policy measures beneficial** for CWR conservation and use, **and remove those found to be detrimental** for the same purpose.
3	On *in situ* conservation	**Identify areas or sites that can serve as climate refugia** for severely affected CWR. **Continue to inventory areas** of particular interest for *in situ* conservation. **Prioritise conserving natural ecosystems and restoring ecological processes** that are important for maintaining the habitats of prioritised species, to allow for genetic diversity to develop over time as a consequence of natural dynamics and ecological interactions. Prioritise and target conservation and protection activities based on **conserving an as wide as possible intraspecific genetic diversity**, incl. focusing on populations characterised by a high level of within-population diversity and, for outcrossing species, low levels of inbreeding. Establish **long-term monitoring** of prioritised CWR taxa conserved *in situ*, preferably both on the population and genetic levels.
4	On *ex situ* conservation	**Collect seed for *ex situ* conservation on a case-by-case basis, prioritising** species with predicted range reductions, to preserve genetic diversity from their entire current distribution.
5	On complementarity	**Evaluate the complementarity of proposed sites for *in situ* conservation** on a Nordic level, aiming at optimising conservation of CWR diversity.
6	On joint measures	**Develop species-specific conservation recommendations at the joint Nordic level** for those prioritised CWR predicted to be severely affected by climate change. **Expand the collection of high-quality occurrence observations** from underrepresented areas and make these publicly available. **Establish Nordic cooperation regarding monitoring** of key Nordic priority CWR species at both population and genetic levels. **Establish joint Nordic monitoring of species** predicted to expand drastically (potential invasiveness).

7	On need for research	**Deepen the understanding of other threats** to CWR, incl. human induced pressures such as habitat fragmentation, over-exploitation and biotic/abiotic factors related to climate change. **Continue to widen the knowledge base** on CWR in the Nordic region through mapping, inventorying, and analysis of genetic diversity. **Develop scientifically based management recommendations** for selected CWR *in situ* conservation sites, targeting locally occurring prioritised populations.
8	On networking	**Establish and maintain a joint Nordic network dedicated to CWR** involving a broad range of stakeholders engaged in genetic resources conservation and use, incl. relevant authorities, conservation managers, botanic gardens, NordGen and plant breeders. **Reach out to local authorities and national park managers** with information about CWR aiming at establishing collaborative projects and activities.
9	On ABS	**Secure facilitated access** to CWR genetic resources conserved *ex situ* in accordance with agreed international benefit-sharing instruments. Given that different national approaches exist, **clarify the legal status** of access to wild genetic resources conserved *in situ*. **Consider registering *in situ* conserved populations** and providing access to them, including their passport information **Continue to collaborate at the Nordic level** regarding exchanging experiences about access and rights to wild genetic resources e.g., through relevant joint Nordic projects.
10	On documentation	**Facilitate access** to **documentation and associated Digital Sequence Information (DSI)** of wild genetic resources for food and agriculture conserved *ex situ* by NordGen, in accordance with agreed international benefit-sharing instruments. **Provide EURISCO with appropriate and updated documentation** of Nordic CWR.
11	On communication and public awareness	**Provide joint awareness raising** for Nordic providers and users of genetic resources of international developments with particular focus on CWR, including access and benefit sharing obligations and objectives. **Increase the public awareness** on CWR conservation and use through collaboration with botanic gardens, conservation areas and relevant museums.
12	On long-term goals	**Consider a cross-sectoral review** of funding mechanisms to genetic resources conservation. Based on such a review, **consider securing dedicated financing** to CWR conservation and use.

9.3 Conclusions

To conclude, this project has improved the conservation and access to Nordic CWR, as well as the knowledge on their diversity, status, distribution, and the expected impact of climate change. This has strengthened the scientific basis for current and future conservation efforts and stimulated national activities. In addition, the Nordic cooperation in this area has been strengthened and communication has reached a wide range of stakeholders, including the nature conservation community, policy makers, the scientific community, and the interested general public. As concluding remarks, we would like to mention the following:

- As shown earlier by the EU-project Farmers' Pride (2017-2020), **conservation of CWR is a cross-sectoral issue** that requires input from several sectors of society, including a multi-stakeholder approach. Wild plant genetic diversity does not restrict itself to one sector alone – e.g. agriculture or nature conservation – as has been repeatedly noted by FAO in its Global Plans of Action. Sectors need to collaborate to optimise conservation efforts, bringing in their respective responsibilities and expertise. Additionally, input from the user communities such as researchers and plant breeders are essential to guide and optimise conservation activities with the aim of safeguarding genetic diversity and its access.
- Getting proper conservation policies and measures in place takes time and the series of Nordic multi-year projects since 2015 has been extremely beneficial in that respect. The insight and purposefulness demonstrated by the Nordic Council of Ministers is therefore highly commendable. **Cooperation among Nordic countries has improved greatly and expedited actions** at the national level. The Nordic CWR community has undergone a constructive development within a range of thematic areas including national gap analysis, seed collection for *ex situ* conservation, genetic diversity analysis, modelling the effects of climate change, and public awareness raising. Continuing the Nordic cooperation would be very beneficial for future development in this area.
- Strengthening the national recognition of CWR diversity as an important aim of conservation in protected areas has contributed to bringing yet another motive to the work of conservation managers. However, raising awareness alone is not sufficient. For the future, it is necessary to aim at **formally including CWR conservation and monitoring in the management plans** of an increasing number of protected areas. This may not be an option for already established protected areas, but countries should consider incorporating this as a requirement when establishing a new one, as appropriate. In the process of deciding upon the conditions for approval, the presence of CWR and their genetic diversity should be important aspects.

- The conclusion from a previous project summary of 2019 (Palmé et al. 2019) is still valid, i.e. **countries need to increase efficiency and coordinate work better**, primarily at the national level. Much has improved over the years that have passed since, but while cross-sectoral collaboration in particular is now at a higher level than before, it is still dependent upon a few individuals and therefore vulnerable. The recommendations given above – particularly under point 8 – aim at trying to avoid such risks.
- The Kunming-Montreal Global Biodiversity Framework, adopted by COP-15 in December 2022, contains one distinct long-term goal and one action-oriented global target that relate to CWR:
    - For 2050: *Goal A – Human induced extinction of known threatened species is halted, and, by 2050, extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels.*
    - For 2030: *Target 4 – Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimise human-wildlife conflict for coexistence.*

To fulfil these requirements, all **Nordic countries therefore need to commit to, and assure, that both long-term conservation and sustainable use for the future** is given full attention and the necessary resources.

10. Glossary

Some concepts and abbreviations used in the report are defined below:

- *Crop Wild Relative (CWR)*: "A wild plant taxon that has an indirect use derived from its relatively close genetic relationship to a crop; this relationship is defined in terms of the CWR belonging to gene pools 1 or 2, or taxon groups 1 to 4 of the crop. CWR include crop progenitors and can broadly be described as any taxon in the same genus (or closely related genera) as a crop" (ECPGR Concept for *in situ* conservation of crop wild relatives in Europe, Maxted et al. 2015).
- *Ex situ conservation*: "[...] means the conservation of components of biological diversity outside their natural habitats". Convention on Biological Diversity, Article 2 (1992).
- Genetic resources: "[...] means genetic material of actual or potential value." Convention on Biological Diversity, Article 2 (1992) ("Genetic material" means any material of plant, animal, microbial or other origin containing functional units of heredity.).
- *In situ conservation*: "[...] the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties." Convention on Biological Diversity, Article 2 (1992).
- *Wild Food Plant (WFP)*: Non-cultivated populations of wild plants species that grow spontaneously in their natural habitat and are used as human food.

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Appendix A. An extract from NordGen's QA assurance system

At NordGen, these minimum standards are applied to all incoming orthodox seeds collected from wild plant populations.

Minimum standards for acquisition of orthodox seeds collected from wild plant populations

1. **The material should be acquired legally** and with the appropriate permissions when this is needed. Observe that collections of species on the red list and any species in nature conservation areas will need special permissions for sampling.
2. **Sampling should be conducted in such a way that the health and survival of the natural population is not endangered**. As a guideline, do not sample more than 20% of the seeds in the natural population. If possible, leave some seeds on all sampled individuals. This is done both to assure enough seeds to produce the next generation and to maintain genetic diversity and adaptive potential in the natural population. Avoid digging up plants unless special circumstances dictate otherwise. The only exception to this standard is when the population is going to be destroyed.
3. **To assure good quality of seeds entering the gene bank**, sampling should be conducted as close to seed maturity as possible and the seeds should be kept in appropriate postharvest conditions. When the seeds have been collected, they should be placed in a container that allows the seeds to dry. Keep in temperatures below 30 °C and relative humidity below 85% whenever possible. The seeds should be placed in a drying environment as soon as possible after collection, generally within 5 days (see E). Accessions with low germination percentage may not be accepted.
4. **The seed sample should be from a minimum number of plants** to assure that a representative sample is collected and to avoid inbreeding depression in the gene bank population. Preferably the same amount of seeds should be sampled from all plants. The following guidelines should be followed:

- Cross-pollinating species: preferably sample from 100 individuals or more, but at least from 30 genetic individuals per population, (multiple samples from clones or related individuals should be avoided and sample distance should therefore exceed the most common dispersal distance of the species).
- Self-pollinating species: at least 10 individuals should be sampled per subpopulation and, if applicable, separate samples from other subpopulations within the metapopulation in the region (preferably several subpopulations). See appendix 3 for further details and examples.

5. **The preferred seed amount is 25,000 per accession** and the minimum amount is 750 for cross-pollinated species and 250 for self-pollinated species.
6. To make sure that the **appropriate documentation is available for all accessions**, each sample should be clearly labelled, and a **collection form** should be filled in for each accession. As much information as possible should be recorded about each accession and the minimum amount of information is specified in NordGen´s collection form. The data can be provided in a predefined electronic format. Photographs should be taken at the sampling location.

If the minimum standards are not reached, NordGen will not accept the samples for long-term conservation except in rare special cases.

Appendix B. Report from the workshop in Oslo 2021

Report from a "mini future workshop" 3 November 2021

Compiled by Jens Weibull (process leader)
Swedish Board of Agriculture

A. Background

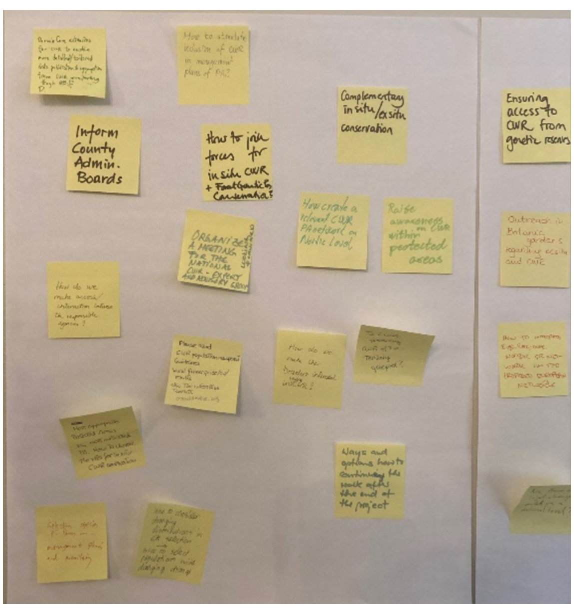
The first Nordic stakeholder workshop on crop wild relative conservation and use placed particular focus on the following theme: Genetic reserve establishment – legal and policy implications. Following a broad palette of presentations and discussion sessions the participants were tasked with developing a work and time plan for the inter-sessional period leading up to the second workshop in 2023. This was done by means of a highly abridged "mini future workshop", a well-known concept used for identifying and making concrete measures to be taken, including deliverables, responsibilities and deadlines.

B. Process

The over-arching theme for the workshop was *Nordic work in focus until 2023*. Due to shortage of time, the "mini future workshop" did not contain all the regular elements of a standard future workshop.[9] Notwithstanding, within the short time given to them, the participants were indeed able to identify a range of concrete activities that most probable will be possible to implement as planned.

Following a brief introduction by Jens Weibull on the theme and the elements of the future workshop, the participants were invited to propose topics for discussion. The topics were then written on Post-it notes and posted on flip charts (photo example below). While the participants were let go for a coffee break, Anna Palmé and Jens Weibull worked on categorising the topics. A total of six resulting themes were identified and proposed, including:

1. Processes at the policy level
2. Developing protected area (PA) criteria
3. Data management
4. Network development
5. Access, use, and benefit-sharing
6. Communication



Ideas flow quickly once the work begins...

While some ambiguities were noticed among the Post-it notes, the themes were approved by the participants. In the following, the topics are listed:

9. https://participedia.net/method/4796

1. Processes at the policy level

- How do we make access/interaction between the responsible agencies?
- Are there any legal changes needed on a national level?
- Looking forward: organize a meeting for the national CWR expert and advisory group
- How to make best out of the European strategy on genetic resources (GenRes Bridge) → Advantages and … [not readable]
- How do we get the ministries to give us instructions to work on CWR?

2. Developing protected area (PA) criteria

- How can we support PA that are interested in CWR to include it in their management/communication?
- Selecting species – and focus on – management and monitoring
- How to stimulate inclusion of CWR in management plans of PAs?
- Most appropriate protected areas vs. most motivated PA: how to choose the sites for *in situ* CWR conservation
- How to consider changing distributions in site selection → how to select populations with changing climate

3. Data management

- Ensure assign ROR[10] IDs for all genebanks conserving CWR (all WIEWS institutions)
- Register all genebank collections (with CWR) GRSciColl (Global Registry of Scientific Collections)
- Harmonize genebank (seedbank) collections with the EU ESFRI[11] DiSSCo (Distributed System of Scientific Collections) infrastructure for sampled CWR
- Utilize the MIDS (minimum information on digital specimens) for sampling of CWR populations
- Register CWR population sites with monitoring in DEIMS (*Dynamic Ecological Information Management System)*
- *Darwin Core extension for CWR to enable more detailed/tailored data publication and aggregation from CWR monitoring through GBIF*
- *Utilise the MIXS Darwin Core extension for genetic monitoring of genetic reserves (through GBIF & Elixir)*
- *Assign PIDs/PUIDs such as DOIs for CWR conservation populations*

10. Research Organization Registry
11. *European Strategy Forum on Research Infrastructures*

4. Network development

- How create a relevant CWR PA network on Nordic level?
- How should an optimal permanent Nordic CWR network look?
- Ways and options how to continue the work after the end of the project
- How to join forces for *in situ* CWR + Forest Genetic Resources conservation?
- How to integrate sub-regional Nordic GR network in the proposed European network?

5. Access, use, and benefit-sharing

- Ensuring access to CWR from genetic reserves
- Complementary *in situ*/*ex situ* conservation
- How bridge gap between users and conservation
- Pilot mini-project to engage plant breeders in characterization of material conserved *in situ*
- How do we make the breeders interested in using CWR?

6. Communication

- Inform county administration boards
- Raise awareness on CWR within protected areas
- Outreach in botanic gardens regarding *ex situ* and CWR
- Communicating the achievements of the Nordic project to the larger European region
- Recognition of the (unintentional) work done for CWR and finding synergies

C. Thematic group work

1. Processes at the policy level

Group members: Björn-Axel Beier, Elina Kiviharju, Birgitte Lund, Snorri Sigurðsson.

Actions: preparation of national CWR strategies – either initiating, continuing or finalising the work.

When: as appropriate and depending on available resources (staff, funding); **IMPORTANT** – concrete time plans remains to be developed incl. *an initial step for each of the proposed actions* (e.g. persons to contact, dividing responsibilities, etc.)

Who: To be determined

2. Developing protected area (PA) criteria

Nota bene! Theme planned to be discussed in connection with theme 4, but was not dealt with due to time constraints.

Group members: Mora Aronsson, Kjersti Bakkebø Fjellstad, Heli Fitzgerald, Anna Palmé, Oddvar Pedersen

Actions: None formulated

When: Not applicable

Who: Not applicable

3. Data management

Group members: Dag Endresen, José Iriondo, Imke Thormann

Actions:

1. Register all stakeholders in ROR (and add ROR institution identifiers to institutions in FAO/WIEWS and EURISCO)
2. Register *ex situ* collections into GRSciColl (linked to holding gene banks with ROR IDs)
3. Register important *in situ* monitoring sites into DEIMS (which is the LTER - Long-Term Ecological Research network registry of sites)
4. Explore assigning DOI option for all CWR monitoring populations
5. Explore DOI endpoints for CWR populations in EURISCO or through ITPGRFA ("The Treaty") GLIS (Global Information System)
6. Explore gene banks participating in DiSSCo (ESFRI → ERIC) and implementing the MIDS (minimum information for digital specimens) standard
7. Apply the GBIF Integrated Data Publishing Toolkit by integrating the Treaty CWR descriptors into a TDWG Darwin Core extension, and utilising MIxS for genetic monitoring *or, alternatively,*
8. Using BioCASe, build an ABCD CWR extension and/or utilise GGBN for genetic monitoring.

When: IMPORTANT – concrete time plans remain to be developed incl. *an initial step for each of the proposed action* (e.g. persons to contact, dividing responsibilities, etc.)

Who: To be determined

4. Network development

Group members: Mora Aronsson, Kjersti Bakkebø Fjellstad, Heli Fitzgerald, Anna Palmé, Oddvar Pedersen

Actions:

1. Develop a permanent Nordic network or Working Group on CWR that is coordinated by NordGen (*in situ* and *ex situ* stakeholders)
   When: 2022?
   Who: Anna/NordGen (in collaboration with forest GR group)
2. Develop an inspirational website with Nordic focus for examples on strategies, publications, and management plans
   When: 2022-2024
   Who: Anna, with input from CWR network
3. Investigate the possibility of cooperation on the national level with forest genetic resources stakeholders (Goal: to talk with one voice to the decision makers)
   When: by 2023
   Who: National representatives of the network
4. A policy paper describing the vision of the Nordic CWR network
   When: 2024
   Who: CWR project network
5. Targeted communication with relevant national environmental stakeholders (biosphere areas, world heritage sites, county boards/governors) (**NOTE**: action aimed for thematic group 2)
   When: 2023
   Who: National representatives active within the Nordic CWR network

Note: **IMPORTANT** – *an initial step for each of the proposed action* needs to be determined (e.g. persons to contact, dividing responsibilities, etc.)

5. Access, use, and benefit-sharing

Group members: Linn Borgen Nilsen, Magnus Göransson, Shelagh Kell

Actions:

1. Develop an information pamphlet about access, use and benefit sharing for CWR, targeting local governments and national park managers.
2. Arrange a workshop with protected area managers to inform them specifically of ABS and value of the resources; discuss needs, interests, synergies, and increase the dialogue.
3. Elaborate a concept of a project aiming at conducting predictive characterisation of traits of particular importance in the Nordic region.
4. Consider other species that may be more attractive to the breeders' community.
5. Analyse the local jurisdiction related to access and use of CWR that are protected through national parks. This includes exploring to what extent national gene banks or NordGen can play a role in collecting seeds and granting access to users, through managing SMTA.

When: IMPORTANT – concrete time plans remain to be developed incl. *an initial step for each of the proposed action* (e.g. persons to contact, dividing responsibilities, etc.)

Who: To be determined

6. Communication

Group members: Kristina Bjureke, Linn Gjellesvik Andresen, Marko Hyvärinen, Jonatan Jacobsson, Hjörtur Þorbjörnsson

Actions:

1. A media package, incl. information folder, pictures free and available, Nordic examples, and an "elevator pitch" (a video)
2. Increased outreach around CWR in protected areas/national parks, incl. communication on guided tours and more knowledge within sites
3. A public outreach package incl. a "CWR trail" and posters aimed at exhibition halls, national parks and botanical gardens
4. Better information aimed at public spaces of counties/municipalities, such as e.g. sand beaches, on how to protect CWR and other plant species

When: IMPORTANT – concrete time plans remain to be developed incl. *an initial step for each of the proposed action* (e.g. persons to contact, dividing responsibilities, etc.)

Who: To be determined

D. Conclusions

A future workshop is normally conducted during a full day or as a lunch-to-lunch activity. From that perspective, a two and a half hour participatory event may seem a futile exercise with little hope of yielding concrete results. The motive behind the mini workshop was, however, to make use of the extensive information that had been presented to the participants during the preceding sessions. Additionally, the preparatory discussion topics also provided a basis for reflections prior to the future workshop. And, finally, participatory activities are generally recognised to be both inspirational and cross-fertilising.

Indeed, despite the limited time allotted to the group discussions, a wealth of actions was proposed, as reported above. One of the identified themes – *Developing criteria* – was however not elaborated further due to time constraints.

The fact that only a handful of the proposed actions were assigned with (relatively) detailed information regarding timing and responsibilities can also be explained by scarcity of time. An extended session would most certainly have allowed the groups to go into more details of the actions, with a resulting higher level of concretion. It is now up to the members of the groups, during the inter-sessional period, to prioritise among their actions, and carve out the very first "hands on" steps of what they consider being the most essential. This could include any of the following:

- assigning individual responsibilities
- identifying target persons with whom to contact
- drawing up a concept note for a project
- drafting a text for policy makers
- deciding upon a date for a follow-up meeting
- etc.

E. Recommendations

Based on the conclusions above, the following recommendations are given.

1. The project management (*i.e.* at NordGen) to request – before 31 December – each thematic group to (a) jointly elaborate and define concrete steps to take and (b) assign responsibilities of at least one, and maximum three, of the proposed actions.
2. Each thematic group to submit their proposal(s) – for discussion in the project coordination group – to the project management before 1 April 2022.
3. Each thematic group to report the project management on state-of-the-art before 1 October 2022 (occasion 1).
4. Each thematic group to report the project management on state-of-the-art before 1 April 2023 (occasion 2).
5. Final reporting of inter-sessional work at second stakeholder workshop in 2023.

F. Evaluation

As a follow-up of the "mini future workshop", two simple questions were sent out to the participants including an invitation to provide personal comments. Given that the time allotted to the future workshop was very limited, the questions were the following:

1. Was it, nevertheless, worthwhile? Yes/No
2. Should we consider a similar exercise – though longer – at the next stakeholder meeting? Yes/No

Of the 25 persons that were asked to provide feedback, nine responded. All of these expressed their appreciation of the activity despite the very tight time frame, and recommended arranging a similar activity at the next stakeholder workshop.[12] Among the comments sent in, the following were noted:

"– The mini future workshop was very much worthwhile for me, even if I am not part of the project."

"– I think it was a good physical exercise, to activate in groups and thinking aloud. Maybe the conclusions could have been firmer – as I don't recall now exactly the outcome of the last discussions. Would be good to have more time."

"– I found the exercise to be very good for two reasons: 1, it gets people involved in a dynamic and collaborative way (and is also fun); 2, although I haven't yet seen the report, it seemed to be very productive, even carried out in a short space of time. In addition, I would say that the spontaneity aspect is very good as it makes people focus their ideas."

"– Aiming at bringing forward broad ideas for a work plan, activities and priorities, I think smaller and focussed groups worked very well." (free translation)

"– The mini-workshop was a fresh and interactive take, which assured that all voices of the (physically present) participants were heard and gave good input towards future endeavours!"

"– I quite like such activities and found the discussions we had during the "mini future workshop" very useful. More time would perhaps have allowed me to get more out of the other groups' discussions as well."

"– [...] it does not necessarily need to be all that much longer to be productive."

12. To be held in 2023.

Appendix C. Report from the workshop in Helsinki 2023

The Nordic stakeholder workshop
Long-term Conservation and Access to Nordic Crop Wild Relatives
23-24 October 2023, Helsinki, Finland

Compiled by Jens Weibull, Swedish Board of Agriculture
and Anna Palmé, NordGen

Background

The Nordic stakeholder workshop *Long-term Conservation and Access to Nordic Crop Wild Relatives* was the second to be held within the joint Nordic project*: Conservation and sustainable use of genetic resources in the Nordic region*, which is a part of the Nordic Council of Ministers' Nature-based solutions programme 2021–2024. The first workshop, held in Oslo 3 November 2021, aimed at identifying themes to focus upon, and activities to be carried out, during the two years to follow. This time focus was mainly placed upon aspects of *in situ* conservation and access to genetic material in protected areas. Prior to the workshop a set of questions were sent out to the participants aiming at having informed group discussions that would assist in developing future Nordic policies with relevance for crop wild relatives. The questions were the following:

1. **Conservation** of crop wild relatives (CWR) in their natural environments
    a. Discuss aspects of long-term robustness of different protected area (PA) categories[13]. Are all PAs equally suitable for CWR conservation? If not, what would the preferable model look like?
    b. MAWP (Most Appropriate Wild Population)[14] is an adopted concept to help prioritising. Discuss whether we should apply the concept in our region and, if yes, how would we proceed?
2. **Access** to these genetic resources
   The availability of genetic resources – in our case a CWR – very likely depends upon the category of PA where the taxon grows. Could you envisage the development of a simplified procedure that would facilitate access? Discuss pros and cons.
3. What **future** Nordic and Baltic **cooperation** activities do you envision could strengthen conservation and access of CWR in the Nordic-Baltic region?


Participants were divided into four groups and left to delve into the questions for over an hour and a half. Reporting was made group-wise. In addition to the group reports, an individual input was provided by Maija Häggblom, The Government of Åland.

13. National park, nature reserve, nature conservation area, biosphere reserve (Unesco), World Heritage site (Unesco), ...
14. ECPGR Concept for in situ conservation of crop wild relatives in Europe.

Results

The following report aims at merging and summarising the groups' responses on the various questions.

Question 1.a – Discuss aspects of long-term robustness of different protected area (PA) categories. Are all PAs equally suitable for CWR conservation? If not, what would the preferable model look like?

There was no preference for any particular type of protected area (PA), as long as they are publicly owned and managed. While in fact all PAs were deemed suitable for CWR conservation, Natura2000 areas and biosphere reserves were identified as being desirable and flexible, respectively. In some regions, however, only a singly type of PA exists. It was also pointed out that privately owned land can play a role and that synergies between PA networks and private landowners should be explored.

The importance of carrying out regular inventories and monitoring was noted. CWRs need to be specifically mentioned in management plans, especially considering grasslands, as many of the taxa require minimum levels of management. This is particularly true since climate change is such a strong driver, and species will – and must – be able to migrate.

While both funding and knowledge of PA managers about CWRs are two essential aspects, it should also be kept in mind that different CWRs have different requirements and, therefore, different types of habitat and maintenance/use are needed.

Finally, long-term conservation of CWRs will require the engagement of both the research and the conservation communities. Communication will be essential to foster understanding of the need to safeguard these resources, and to raise awareness. In this regard, selected species could serve as flagships.

Question 1.b – MAWP (Most Appropriate Wild Population) is an adopted concept to help prioritising. Discuss whether we should apply the concept in our region and, if yes, how would we proceed?

Today we know too little about the genetic diversity of our wild populations and we would need to increase our knowledge about the geographic structure of this diversity, aiming at identifying genetically unique populations. In this respect, the concept Most Appropriate Wild Population – MAWP – makes sense and could help us prioritize. However, being difficult to communicate to less informed groups (policy makers, the general audience) the term needs both a strict definition and to be used with a clear conservation target.

There are a number of aspects to take into account, including whether to identify MAWPs at the national or regional scale, to select CWR taxa based on established priority lists as well as considering that populations will continue to alter their genetic makeup and structure as well as location as a result of, e.g., on-going climate change.

The concept was seen as a valuable tool that could be used when planning conservations practices in PAs, but it was recommended to be used having the breeders' needs in mind. A suggestion was also made to test the concept on a 'trial first' basis, not least to learn more and get hands-on experience of how to implement it. Based on the results of such a trial – which would probably be one of the first of its kind in Europe – further decisions could be taken concerning its use.

Question 2 – Access to these genetic resources. The availability of genetic resources – in our case a CWR – very likely depends upon the category of PA where the taxon grows. Could you envisage the development of a simplified procedure that would facilitate access? Discuss pros and cons

A preferable option, according to several groups, would be that access to wild genetic resources was facilitated through a gene bank. A Nordic approach could, in such a setup, either entail NordGen or national gene banks as the entry point for requests of CWR material (seeds), or both. This includes seeds of threatened species where a competent authority, possibly including a designated focal point, also needs to be involved. Access to living plants was not discussed in detail by any of the groups but might involve a domestic collection (gene bank) in collaboration with a designated authority. The principles of access to genetic material requires adhering to agreed regulatory frameworks and agreements meaning that material transfer agreements (MTA) will be needed. This, in turn, will require the assistance of competent persons to handle future requests. It should be noted that access legislation differs slightly between the Nordic countries; therefore, any future system aimed at handling access application will need to show some flexibility.

Outstanding issues that were not resolved during the discussions include access for commercial purposes and the question of whom would bear the costs for collecting the material.

Question 3 – What future Nordic and Baltic cooperation activities do you envision could strengthen conservation and access of CWR in the Nordic-Baltic region?

It became very clear that the participants of the workshop wanted the joint Nordic collaboration to continue, and preferably also being widened to include colleagues from the Baltic countries. Common goals and challenges should be identified and be expressed in a future joint application for funding. Tentative donors such as the Nordic Council of Ministers, EU LIFE and Horizon Europe were mentioned.

The following is a list of topics that could lead up to a new joint application:

1. Analysis of genetic diversity, incl. hotspot uniqueness, genetic and niche differentiation, geographic scales, and species-specific conservation
2. Long-term monitoring of populations over time incl. extinction risks
3. More focussed *in situ* inventories, assessments of potential overlaps with existing PAs, and development of standards
4. More collaboration on *ex situ* collection and conservation of CWRs, incl. the development of standards and protocols
5. Communication, using a wide palette of tools and approaches
6. Development of a Nordic-Baltic *in situ* inventory/database
7. Knowledge exchange and training

Annex 1. A compilation of all comments provided by the groups in their presentations.

Question 1.a: Discuss aspects of long-term robustness of different protected area (PA) categories[15]. Are all PAs equally suitable for CWR conservation? If not, what would the preferable model look like?

- Promote and extend nature reserves owned by the state
- Protection should not only be rooted locally only, but preferably nationally.
- To cover all the priority CWR species we need different types of habitat and different types of maintenance/use.
- Need to be specifically mentioned in a management plan, especially grasslands.
- Explore synergies between network of PAs and private landowners
- Almost all group 2 members are not working with Pas
- Different CWRs have different requirements
- Presence of different PAs categories is important
- Some CWRs for example need minimum level of management
- Natura2000 is the best category (CWR should be included in the management plan – a list of CWR present in the area)
- Identifying flagship species that shape the environment
- Forest genetic reserves
- There is only one kind of PA in Åland – putting specially the list of CWRs
- Plant inventories and regular monitoring
- National forest inventory in Finland since 1920s – these types of information are important
- this depends on the country, need to be flexible
- e.g. in Spain Biosphere reserve network has been easiest to work with
- All sites are suitable if PAs are aware of CWR and have sufficient funding to carry out conservation work
- Best sites could be ones that are not dependent on national funding
- Need to establish links between CWR research and conservation communities – get the message out there
- Need to think how CWR community can support the PA managers?
- Answer: It depends, legislation differ and regulations – what is possible or not depending on the country.

15. National park, nature reserve, nature conservation area, biosphere reserve (UNESCO), World Heritage site (UNESCO), ...

- All types protected areas could be suitable
- The climate change is an important driver together with landscape management
- A need of a chain of PAs to take care of future changes – to have the possible to move CWR to more suitable PAs
- Genetic "reserves" do not need to be Pas, but how to preserve long-term?
- Biosphere reserve is a possibility that can be flexible enough for CWR "protection"
- In Åland, there is, at least so far, only one kind of protected areas, the nature reserves. Then it is the conservations decision that gives the forms of conservation and possible methods for management. I suppose, it is quite of a suitable approach to achieve sufficiently adapted protection and management, together with updated management plans.
- In many cases in general, even "strict protection" can allow some kind of management. It is mostly a question about what else than CWR is to be protected in the area. If there are some goals for the protecting of the PA that do not work well together with managing and protecting the CWR you wanted to protect there, then the PA is not so good as an area for conservation of CWR. But even this can differ between different CWRs.

Question 1.b: MAWP (Most Appropriate Wild Population[16]) is an adopted concept to help prioritising. Discuss whether we should apply the concept in our region and, if yes, how would we proceed?

- Application of MAWP can help us to prioritize but is demanding in terms of knowledge.
- Concept can be difficult to communicate (many acronyms already) and need to be used with a clear conservation target.
- Can be useful to conserve particularly interesting populations, e.g. locally adapted across a geographical gradient.
- Could be a nice complemental conservation practice to CWR management in PAs.
- Need to take into consideration that populations can move, they can change (less genetic diversity).
- Genetic information on the background population is lacking in most genetic reserves
- The need of conserving genetically peculiar populations

16. ECPGR Concept for in situ conservation of crop wild relatives in Europe.

- The need to work on geographic structuring in genetic diversity and identifying genetically unique populations (for prioritization)
- Obtaining such data throughout the distribution area
- Population level information is important
- May not be fit to range restricted species? Incorporating such population, if not yet considered.
- There is a need to identify populations, MAWP is something we could aim for, need to be pragmatic
- Should MAWPs be selected nationally or regionally? (complementary populations within a country or region)
- If using the MAWP criteria, should exclude invasive or potentially invasive taxa (of those established over 10 generations)
- Answer: Local adaption important when improve populations and when need of species for improve pollination
- Need a lot information and education of political and agency people
- Priority list important both national and Nordic, European....
- What is LAWP? Least AWP
- A strict definition needed to make MAWP relevant
- Evaluated/priority according to breeders need
- Genetic diversity very important in defining and prioritising MAWP
- I guess it could be a good tool in the toolbox. Unless, more monitoring needs to be done before approaching full benefits of it.
- I guess we should learn more about the concept to begin, maybe do some tests with the concept. Then we need to discuss the scale of areas for prioritising: land, certain kinds of areas, Nordic contest...

Question 2: The availability of genetic resources – in our case a CWR – very likely depends upon the category of PA where the taxon grows. Could you envisage the development of a simplified procedure that would facilitate access? Discuss pros and cons.

- Person/centre acts as a coordinator and conduct the administrative work (clearance, SMTA, etc.) on behalf of the PA.
- Access is facilitated through an *ex situ* collection.
- If material is not available in a gene bank it can be requested through an appointed person at national level.
- Regional gene banks are responsible to make collections with research permits and make the data available publicly
- Tracing and managing data sharing – material transfer agreements
- (The use of SMTA)

- SMTA requires reporting to FAO as well
- Making sure that regulated access to these resources is possible
- How about access for commercial purposes?
- It should be ok – since that is the main purpose of conserving them
- But they should share data and benefit
- Access to both in-situ and ex-situ data
- Availability could be arranged through gene banks/seed banks
- Botanic gardens play a role in seed collecting
- Should the users fund the collecting trips if seeds are not already available?
- Answer: In most PAs is easy to get permission for seed collection, but differ some between the Nordic countries
- The need of monitoring – how to include in existing monitoring schemes?
- Each country should have responsibility for their work (collection)
- Citizen Science could be useful if it has a relevant backbone
- In this question I do only consider Åland, because of the own legislation for the autonomous area. In the nature Conservation Act there is the possibility for exception for research that could be used for access to genetic resources. It only demands an application for a permit in that case to get access. In the permit there can/would be terms for using the resources.
- Pros: The progress is quite easy, and the cost is not high (so far? That can change). In case of research, it is not hard to motivate if small amounts and no negative impact for the species, area.
- Cons: can create too much pressure/interest in long-term. Demands special competence of them working with permits and management methods

Question 3: What future Nordic and Baltic cooperation activities do you envision could strengthen conservation and access of CWR in the Nordic-Baltic region?

- Build on already established activities/networks
- Identify common goals in the various countries
- Examples could be:
    - Species-specific conservation
    - Development of a Nordic-Baltic *in situ* inventory
    - Seed collection (for back-up storage)
    - Communication activities, including exhibition, workshops, interest from media etc.
    - Development of tools, protocols and standards (e.g. of inventorying, network-establishment).

- Genetic work throughout the whole distribution area
- Coupling genetic and niche differentiation throughout the distribution area
- Identifying diversity and uniqueness hotspots both under current and future climates
- Assessing whether these hotspots overlap with the already existing PAs
- Cooperation on ex-situ conservation – collaborating on gene banks
- The need of monitoring over long-term – by permeant institutes
- One line of cooperation is communication
- The need of discussing future protection plan
- Especially with focus on vulnerable species and populations (reintroduction, assisted migration, an attempt to bring them back)
- Communication activities
- Sharing knowledge
- Training
- CWR protocols in gene banks
- Genetic diversity analysis
- *In situ* – sharing experience and knowledge

Joint Projects:

- Capacity building call (H2020)
- Nordic Council of Ministers funding
- A cooperation project like this is important for exchanging
- Nordic-Baltic cooperation could easily get financing than pure Nordic cooperation
- Life-project could be a real possibility

Cooperation activities for:

- Continuity in interaction, possibility to share information about species and where they are located, genetic similarities/differences between the different countries in this region.
- A nearer look on if there were some locations with stronger populations of the same species (I mean identical even in question of genotype) that had disappeared/has a risk to disappear in some area of the region, that would be possible to use for experiments for bringing back some species.
- Join discussion on management plans and needs for CWR conservation in the whole region.

Annex 2. Agenda and participant list

23 OCTOBER

Welcome and introduction (Chair: Hjörtur Þorbjörnsson, Reykjavík Botanic Garden)		
13:30	Opening of the workshop & welcome addresses	Kirsi Heinonen, Ministry of Agriculture and Forestry Elina Kiviharju, Natural Resources institute Finland (Luke)
13:40	Crop Wild Relatives (CWR) and why we need to conserve them	Anna Palmé, NordGen
***In situ* conservation** (Chair: Hjörtur Þorbjörnsson, Reykjavík Botanic Garden)		
13:50	Finnish conservation areas and their management	Kaija Eisto, Metsähallitus, Parks & Wildlife Finland
14:05	*In situ* conservation in Nåtö Nature Reserve	Maija Häggblom, the Provincial Government of Åland
14:20	Experiences from establishing genetic reserves in Spain	Ada Stella Molina Pertíñez, Rey Juan Carlos University
14:35	Management recommendations for CWR in Faerder National Park	Linn Borgen Nilsen, Norwegian Genetic Resource Centre, NIBIO
14:50	Discussion and Q&A	Chair, all
15:00	*Coffee break*	
Use of CWR (Chair: Birgitte Lund, Danish Agricultural Agency)		
15:20	Use of Nordic CWR in plant breeding of field crops.	Merja Veteläinen, Boreal Plant Breeding
15:35	Use of CWR in berry/fruit breeding	Saila Karhu, Natural Resources institute Finland (Luke)
15:50	Caraway project	Marjo Keskitalo, Natural Resources institute Finland (Luke)
16:05	Discussion and Q&A	Chair, all

The Nordic Crop Wild Relative project (Chair: Birgitte Lund, Danish Agricultural Agency)		
16:15	Project introduction	Anna Palmé, NordGen
16:25	Effect of climate change on Nordic crop wild relatives	Heli Fitzgerald, Finnish Museum of Natural History, LUOMUS, University of Helsinki
16:40	Inventory of CWR in protected areas in the Nordic countries – lessons learned	Mora Aronsson, Swedish Species Information Centre, SLU
16:55	Genetic diversity within Nordic CWR	Bernardo de Haro Reyes, Linköping University and NordGen
17:10	Discussion and Q&A	Chair, all
17:25 – 17:30	Closing the meeting	Chair and Anna Palmé

24 OCTOBER

European and international cooperation on CWR (Chair: Anna Palmé)		
9:00	The PRO GRACE project	Joana Brehm, University of Birmingham
9:15	A new European project on CWR: COUSIN	Sylvain Aubry, Federal Office for Agriculture, Switzerland
9:30	Utilizing Digital Twins for Crop Wild Relatives: Advancing Food Security and Conservation Efforts	Desalegn Chala, Natural History Museum, University of Oslo
9:45	Discussion and Q&A	Chair, all
Discussion workshop on conservation of, and access to, crop wild relatives in the Nordic region and beyond.		
10:00	Introduction to the discussions	Jens Weibull, Swedish Board of Agriculture
10:10	Group discussions with *Coffee break*	All
12:00	Reporting from the groups and discussions	Jens Weibull, all
12:50 - 13:00	Closing words	Elina Kiviharju and Anna Palmé

PARTICIPANT LIST

Full name	Organisation
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About this publication

Nordic Crop Wild Relative (CWR) Conservation for a More Resilient Agriculture

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TemaNord 2025:515

ISBN 978-92-893-8151-2 (PDF)
ISBN 978-92-893-8152-9 (ONLINE)
http://dx.doi.org/10.6027/temanord2025-515

Cover photo: Inventory and seed collection i Abisko National Park, 2022. Photo by Mora Aronsson.
Published: 13/2/2025

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