

# Second Plan of Action for the Conservation of the Nordic Brown Bee



The first version of this action plan was based on the conclusions of an *ad-hoc* working group on the conservation of the Nordic Brown bee, comprised of bee experts from the Nordic countries, instated by the Nordic Genetic Resource Center in 2011. Their final report "Status and Conservation of the Nordic Brown Bee: Final report" was published in November 2014. The first action plan was drafted based on the final report at a workshop in Gardermoen, Norway on February 6, 2015. The second version of the action plan is based on a meeting held in Gardermoen, Norway on February 11, 2019 with the following participants:

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# 1. Executive summary

## 1.1 Background

The brown bee, *Apis mellifera mellifera*, is the honey bee subspecies that occurs natively in the Nordic region. In the 20th century, other honey bee subspecies were introduced to this region by beekeepers. Today, the native brown bee is endangered due to displacement and introgression by these other subspecies. The conservation of genetic diversity is imperative for maintaining future adaptive potential. Bees are not only important farm animals due to their honey production, but also due to their pollination services. Roughly a third of the world's crop production is based on insect-pollinated plant species and honey bees represent an important pollinator.

In 2014, the Nordic Genetic Resource Center published a report on the current status and conservation of the Nordic brown bee. This final report of an international *ad-hoc* working group, consisting of beekeepers, researchers and members of national beekeeping organizations came to the conclusion that cooperation amongst actors and coordination at the national and international level in the conservation of the brown bee is of utmost importance. More specifically, consistent characterization of bee populations in the Nordic region to facilitate exchange of breeding material where necessary and development and promotion of brown bee specific management techniques were identified as important conservation measures. The ultimate goal is to have viable populations of brown bees, with characteristics that beekeepers value, in each of the Nordic countries. A priority list of recommended actions for the conservation of the brown bee in the Nordic region was compiled for the first time in 2015 and updated in this second version in 2019. The most urgent actions are stated at the top of the list.

The main difference between the first and second version of the "Plan of Action for the Conservation of the Nordic Brown Bee" is that there is no longer a recommended action on management *per se* included in the second version. As a result of the first Plan of Action, the Brown bee network identified brown bee specific management techniques and made them available to the general public through a wiki (<https://wiki.nordgen.org/brownbee>). Further dissemination of the management techniques falls under RA17 – Materials for courses.

## **1.2 Priority list of recommended actions**

1. Maintain and promote a network among Nordic brown bee breeders as a platform for Nordic collaboration.
2. Breed brown bees with qualities that are attractive to beekeepers by performance testing and subsequent selective breeding.
3. Recruitment of new brown bee beekeepers through increased promotion of the subspecies by Nordic beekeepers' associations.
4. Facilitate the exchange of pure breeding material in the Nordic countries to counteract both inbreeding and introgression.
5. Encourage the commercial production of brown bee queens.
6. Conduct a scientific study on the genetic diversity within and between Nordic brown bee populations; possibly including GxE experiments and number of sex alleles.
7. Establish a standardized method for characterization of bee colonies, including morphometric, behavioral, genetic and performance related data.
8. Create a leaflet that can be attached to brown bee honey jars, which tells the story of the Nordic brown bee and its conservation.

9. Establish regional expertise in artificial insemination of brown bees.
10. Establish a Nordic or multiple national brown bee centers.
11. Develop a SNPchip tailored to assessing diversity in the Nordic brown bee, to facilitate studies on inbreeding and potential of populations for genetic exchange.
12. Conduct a study documenting brown bee qualities.
13. Promote a common repository for characterization data.
14. Ensure that there is a recurrent Nordic brown bee meeting.
15. Establish a collection of cryopreserved brown bee semen from the Nordic countries as a back-up for *in situ* conservation.
16. Offer training courses in standardized characterization of bee colonies in each of the Nordic countries to ensure lowest possible inter-observer differences in Nordic characterization data.
17. Develop brown bee-specific teaching materials.
18. Evaluate implications of saving queens from bacterially-infected colonies.





## 2. Recommended actions

The actions recommended by the brown bee *ad-hoc* working group can be classified according to the following general topics: network, breeding, recruitment, research, characterization, marketing, *ex situ* conservation, and education. Each of these topics and the relevance of the recommended actions (RA) are described below. Please note that the number of each RA reflects its position on the priority list and thus its importance as assessed by the *ad-hoc* expert group.

### 2.1 Network

Most of the proposed actions for the conservation of the Nordic brown bee rely on cooperation across the range of this subspecies. A joint effort to conserve this valuable genetic resource results in added value for all of the involved. Comparative studies of genetic diversity rely on samples from a wide range of populations, without which they are meaningless. Exchange of breeding material, to improve certain characteristics or mitigate effects of inbreeding, can only be carried out, if detailed knowledge of the involved populations is available in a comparable format. Furthermore, those involved in education and recruitment of new brown bee beekeepers, as well as marketing of brown bee products can learn from the experiences of others.

**RA 1– Brown bee network** Maintain and promote a network among Nordic brown bee breeders as a platform for Nordic collaboration, for example to encourage sharing of knowledge and exchange of breeding material, where appropriate. ■

**RA10 – Nordic or national brown bee center** Establish a Nordic or multiple national brown bee centers, which can serve as hubs for knowledge exchange and promotion of the brown bee. ■

**RA14 – Nordic brown bee conference** Ensure that there is a recurrent Nordic brown bee meeting, where all brown bee enthusiasts can meet and learn from one another. The biannual conference that the Swedish Brown Bee association organizes i Ånge, Sweden could serve this purpose. ■

## 2.2 Breeding

Breeding has been used as a powerful tool for the improvement of livestock for hundreds of years. It has the power to yield desired properties, but always goes hand in hand with the loss of genetic diversity. Therefore, breeding decisions, especially in small populations, have to be carefully weighed. The brown bee has been subjected to less intense breeding and thus selection than some of the other honey bee subspecies. This is on one hand an advantage, as this translates into higher genetic diversity, but is also a disadvantage since certain properties desirable for beekeepers may not be expressed. It is important to pave the way for the exchange of breeding material, to improve certain characteristics or mitigate effects of inbreeding. In order to make informed decisions, detailed knowledge about the involved populations has to be available in a comparable format.

**RA2 – Bee improvement** Breed brown bees with qualities that are attractive to beekeepers by performance testing and subsequent selective breeding. This could include breeding for disease resistance. ■

**RA4 – Exchange of breeding material** Facilitate the exchange of pure breeding material in the Nordic countries to counteract both

inbreeding and introgression. To avoid negative consequences, the breeding material should be characterized genetically and phenotypically before breeding decisions are taken. ■

**RA5 – Commercial queen production** Encourage the commercial production of brown bee queens. In some of the Nordic countries, the available brown bee queens pose the bottleneck in increasing the number of brown bee colonies. There are more beekeepers interested in keeping brown bees than queens available. ■

**RA9 – Artificial Insemination** Establish regional expertise in artificial insemination of brown bees. There are currently not many brown bee breeders in the Nordic region who have mastered and apply this technique. Increasing the number of bee breeders with this expertise would open new possibilities for the exchange of genetic material. ■

**RA18 – Saving queens** Evaluate implications of saving queens from bacterially-infected colonies. Possibly establish routines for saving queens from infected conservation populations to avoid loss of genetic diversity. ■

## 2.3 Recruitment

The successful *in situ* conservation of brown bee relies heavily on increasing the number of beekeepers committed to this subspecies. This can be achieved by strengthening the national brown bee beekeepers' associations and trying to turn around the brown bees bad reputation through education. Having an active network of Nordic brown bee beekeepers will greatly support this action.

**RA3 – Recruitment** Recruitment of new brown bee beekeepers through increased promotion of the subspecies by Nordic beekeepers' associations, researchers and brown bee beekeepers. Promotion of

the brown bee would include presentations at scientific conferences, beekeeping meetings, agricultural fairs and publications aimed at the general public. Exchange of experiences and ideas for recruitment of new beekeepers among the Nordic countries will help to achieve the best possible return of promotion efforts. ■

## 2.4 Research

Our knowledge of brown bee-specific physiology, genetics and behavior is characterized by large knowledge gaps. Many claims about brown bees are made based on anecdotal evidence only. Cooperation with research institutions and universities is needed to close the gaps and to be able to make evidence-based decisions regarding the management of brown bees.

**RA6 – Genetic diversity study** Conduct a scientific study on the genetic diversity within and between Nordic brown bee populations; possibly including experiments to investigate genetic versus environmental impact and their interaction (GxE) and number of sex alleles. This study could yield important information on the status of different Nordic brown bee populations relating to the degree of inbreeding and relatedness among populations, which would be valuable for decisions on the exchange of breeding material. ■

**RA11 – SNPchip development** Develop a SNPchip tailored to assessing diversity in the Nordic brown bee, to facilitate studies on inbreeding and potential of populations for genetic exchange. This is expected to be an outcome of the EU SmartBees project. ■

**RA12 – Brown bee qualities** Conduct a study examining brown bee qualities, ranging from flight activity in cold and wet weather, spring development, temperament, swarming tendency and honey yield to winter food requirements. Certain characteristics have been attributed to brown bees, but hardly any of them are documented

through hard data.

## 2.5 Characterization

Proper management of brown bee genetic resources requires in-depth knowledge of brown bee populations in the Nordic region. Data ranging from morphometric measurements, genetic analyses, performance tests and behavioral observations are invaluable for the characterization of populations, on which sensible management decisions should be based. Often wing venation is used to classify honey bee subspecies. Certain software, such as DrawWing by Adam Tofilski, can be used to automatically describe insect wings and thus help in (sub-)species identification based on a reference sample. Both morphometric and genetic information can give insights into the degree of introgression by other subspecies and degree of inbreeding. This type of information is essential for making breeding decisions, especially when the exchange of genetic material is being considered. Furthermore, performance testing as well as information on behavioral traits are essential for designing informed breeding programs. For example, if a certain population shows elevated swarming behavior, as compared to other brown bee populations, it would be beneficial to weigh the trait of low swarming more highly than others in the breeding scheme.

**RA7 – Standardized characterization** Establish a standardized method for characterization of bee colonies, including morphometric, behavioral, genetic and performance related data. It will be evaluated to which degree software such as DrawWing and genetic markers can aid in characterization efforts. To achieve this aim, beekeepers, researchers and representatives of national beekeeping associations will have to be gathered to find a consensus on the methods and grading system used.

**RA13 – Database** Promote a common repository for the characterization data, including pedigree data and breeding values, de-

scribed in RA7. Existing repositories, such as one run by the Institute for Bee Research, Hohen Neuendorf, Germany, found under [www.beebreed.eu](http://www.beebreed.eu), should be evaluated. This database stores breeding and performance data and can be translated into national languages. ■

## 2.6 Marketing

Marketing brown bee products, as well as the bees themselves, can give added value to the beekeepers, as well as educate the public about the Nordic Brown bee.

**RA8 – Branding – honey leaflet** Create a leaflet that can be attached to brown bee honey jars, which tells the story of the Nordic brown bee and its conservation. This could give brown bee beekeepers added value and would spread knowledge about the brown bee and its plight to consumers. ■

## 2.7 *Ex situ* conservation

Complementing *in situ* conservation efforts with *ex situ* measures, particularly cryopreservation of semen, increases the chances of longterm success. On one hand cryopreservation of reproductive material can be seen as longterm safeguarding of genetic diversity and thus represents a back-up for *in situ* conservation measures. On the other hand, cryopreserved bee semen could also be used for artificial insemination of queens in current day breeding. This could thus be a useful tool for the exchange of genetic material.

**RA15 – Cryopreservation** Establish a collection of cryopreserved brown bee semen from the Nordic countries as a back-up for *in situ* conservation. There might be possibilities to collaborate with the Bieneninstitut Hohen Neuendorf in Germany. ■

## 2.8 Education

The dissemination of management techniques tailored to brown bees is of great importance. Appropriate management will help in improving the performance and survival of brown bee colonies, but almost more importantly will serve to improve the brown bees negative reputation. Moreover, training in standardized characterization methods will improve the quality of data in respect to comparability across populations and country borders.

**RA16 – Characterization training** Offer training courses in standardized characterization of bee colonies in each of the Nordic countries to ensure lowest possible inter-observer differences in characterization data. This would ensure that data collected in the different countries are comparable and would also increase awareness of the importance of characterization for successful breeding schemes in the brown bee beekeeping community. ■

**RA17 – Materials for courses** Develop brown bee-specific teaching materials covering topics such as breeding, performance testing, management differences, marketing of brown bee products and recruitment of new beekeepers. ■





## A. Appendix

### A.1 State of affairs March 2019

Recommended action	Responsibility
<b>RA1</b> Brown bee network	Network has been established; NordGen acts as secretariat
<b>RA2</b> Bee improvement	Beekeepers & national beekeeping associations
<b>RA3</b> Recruitment	Network & national beekeeping associations
<b>RA4</b> Exchange of breeding material	Beekeepers & national beekeeping associations
<b>RA5</b> Commercial queen production	Beekeepers & national beekeeping associations
<b>RA6</b> Genetic diversity study	Ongoing in some national programs
<b>RA7</b> Standardized characterization	Network
<b>RA8</b> Branding – honey leaflet	Network & national beekeeping associations; ongoing project
<b>RA9</b> Artificial Insemination	NordGen is exploring the possibility of hosting a workshop in 2019
<b>RA10</b> Nordic or national brown bee center	Ongoing efforts in Norway to establish <i>Norsk Brunbiesenter</i>
<b>RA11</b> SNPchip development	Expected outcome of SmartBees
<b>RA12</b> Brown bee qualities	Ongoing Interreg project
<b>RA13</b> Database	Suitability of <a href="http://www.beebreed.eu">www.beebreed.eu</a> will be evaluated by the national associations
<b>RA14</b> Nordic brown bee conference	Ånge meeting is positive towards Nordic participation
<b>RA15</b> Cryopreservation	Norway is exploring possibilities in collaboration with the Bieneninstitut Hohen Neuendorf in Germany.
<b>RA16</b> Characterization training	Network
<b>RA17</b> Materials for courses	Network & national beekeeping associations
<b>RA18</b> Saving queens	Network & national beekeeping associations