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

NordGen

This action plan is 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. This action plan was drafted based on the final report at a workshop in Gardermoen, Norway on February 6, 2015 with the following participants:

- Carl-Johan Junge, Per Kryger & Birgitte Lund – Denmark
- Juha Kantanen, Lassi Kauko & Lauri Ruottinen – Finland
- Bjørn Dahle, Lars Kirkerud, Tor-Erik Rødsdalen & Nina Sæther – Norway
- Ingvar Arvidsson – Sweden
- Peer Berg, Linn Groeneveld & Anne Præbel – NordGen

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# 1. Executive summary

## 1.1 Background

The brown bee, *Apis mellifera mellifera*, is the honeybee subspecies that occurs natively in the Nordic and Baltic region. In the 20th century, other honeybee 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 honeybees 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-Baltic 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 following priority list of recommended actions for the conservation of the brown bee in the Nordic-Baltic region was compiled. The most urgent actions are stated at the top of the list.

## 1.2  Priority list of recommended actions

1. Establish a standardized method for characterization of bee colonies, including morphometric, behavioral, genetic and performance related data.

2. Promote a common repository for the characterization data described above.

3. Establish and promote a network among Nordic and Baltic brown bee breeders as a platform for Nordic collaboration, for example to encourage sharing of knowledge and exchange of breeding material, where appropriate.

4. Recruitment of new brown bee beekeepers through increased promotion of the subspecies by Nordic and Baltic beekeepers' associations.

5. Conduct a scientific study to investigate whether the brown bee is more sensitive to brood diseases than other subspecies and whether there are population-level differences; using hygienic behaviour as an indicator of brood disease resistance.

6. Offer training courses in standardized characterization of bee colonies in each of the Nordic and Baltic countries to ensure lowest possible inter-observer differences in Nordic characterization data.

7. Conduct a scientific study on the genetic diversity within and between Nordic and Baltic brown bee populations; possibly including GxE experiments.

8. Develop a SNPchip tailored to assessing diversity in the Nordic and Baltic brown bee, to facilitate studies on inbreeding and potential of populations for genetic exchange.

9. Mapping of critical management differences between brown bees and other subspecies, including queen production and collection of traditional knowledge.

10. Offer brown-bee-specific training courses for beekeeping instructors, in order to promote brown-bee-specific management skills.

11. Establish regional expertise in artificial insemination of brown bees.

12. Conduct a scientific study to assess the impact of the bottom board structure of the hive on chalkbrood prevalence and spring development.

13. Establish a collection of cryopreserved brown bee semen from the Nordic-Baltic countries as a back-up for *in situ* conservation.

14. Evaluate implications of saving queens from bacterially-infected colonies.
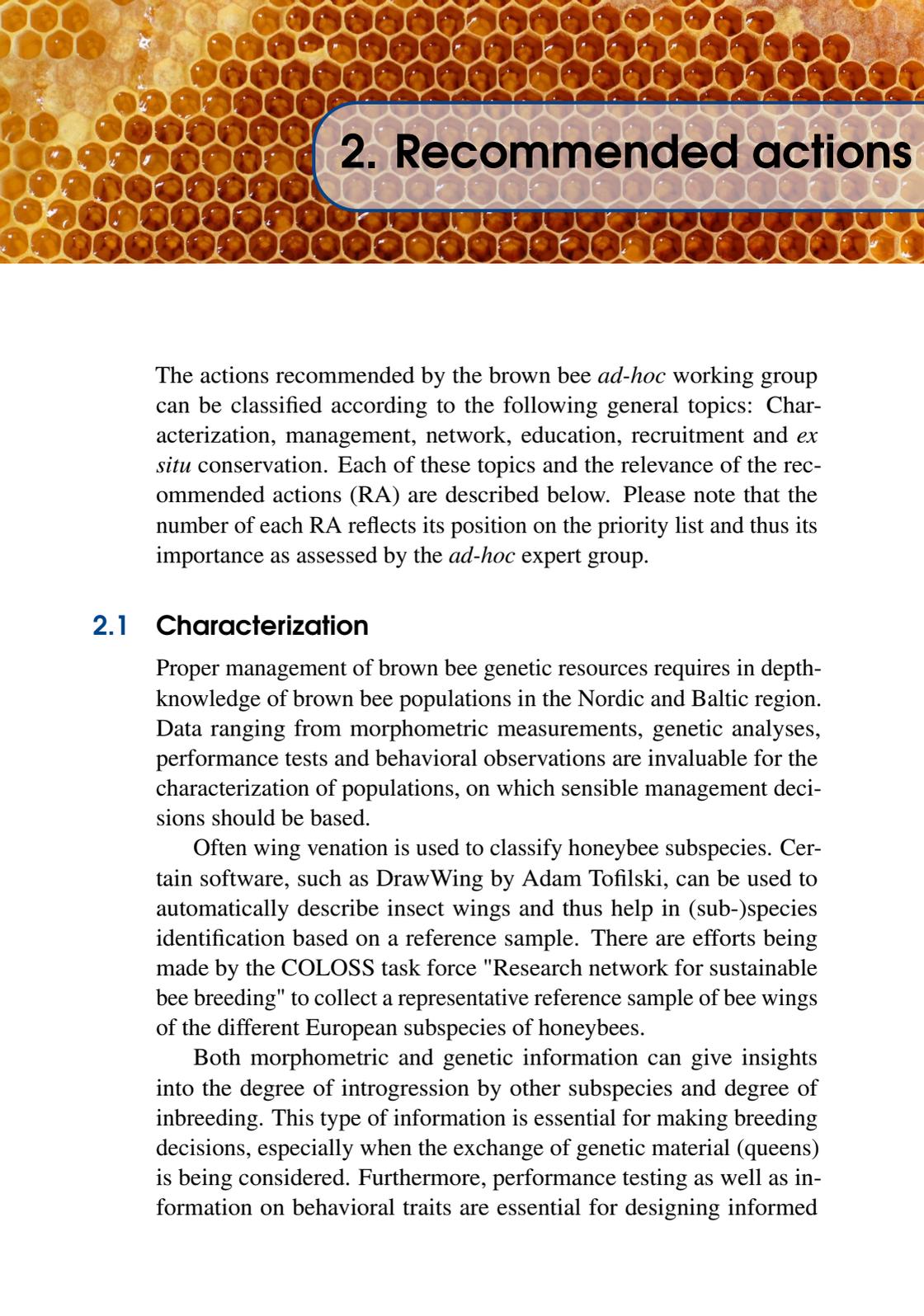
# 2. Recommended actions

The actions recommended by the brown bee *ad-hoc* working group can be classified according to the following general topics: Characterization, management, network, education, recruitment and *ex situ* conservation. 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 Characterization

Proper management of brown bee genetic resources requires in depth-knowledge of brown bee populations in the Nordic and Baltic 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 honeybee 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. There are efforts being made by the COLOSS task force "Research network for sustainable bee breeding" to collect a representative reference sample of bee wings of the different European subspecies of honeybees.

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 (queens) 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.

Thus, the characterization of all Nordic and Baltic brown bee populations should be prioritized, since these data are the basis for all further management and conservation decisions.

**RA1 – 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 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. This ties in with RA3: Establishment of a network. ∎

**RA2 – Database** Promote a common repository for the characterization data described in RA1. Existing repositories, such as one run by the Institute for Bee Research, Hohen Neuendorf, Germany, found under www.beebreed.eu, should be evaluated. This database stores breeding and performance data and can be translated into national languages. ∎

**RA5 – Brood disease study** Conduct a scientific study to investigate whether the brown bee is more sensitive to brood diseases than other subspecies and if there are population-level differences; using hygienic behaviour as an indicator of brood disease resistance. The results of this study could potentially be used to breed for brood-disease resistance, as well as help to counteract the bad reputation of the brown bee. ∎

**RA7 – Genetic diversity study** Conduct a scientific study on the genetic diversity within and between Nordic/Baltic brown bee populations; possibly including GxE experiments. This study could yield important information on the status of different Nordic/Baltic 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. This study could be carried out with currently available and tested microsatellite markers. ∎

**RA8 – SNPchip development** Develop a SNPchip tailored to assessing diversity in the Nordic and Baltic brown bee, to facilitate studies on inbreeding and potential of populations for genetic exchange. This action would develop tools needed for the utilisation of the most advanced breeding techniques. It could be based on the results of other research efforts, such as the smartbees project (http://www.smartbees-fp7.eu/). ∎

## 2.2  Management

Management techniques should take into account the behavioral and physiological differences between the different honeybee subspecies. Currently, most widely-used management techniques are tailored to the needs of Italian (*A. m. ligustica*) and/or Carniolan (*A. m. carnica*) bees. Handling of brown bees with unsuitable management practices may have contributed to the negative reputation that brown bees have in some parts of the beekeeping community. Even though some brown bee beekeepers have devised brown bee-specific management techniques, currently there is no readily available manual outlining the best management practices for brown bees. Identifying and compiling the management practices found to be best suited for brown bees would be of great value both for existing brown bee beekeepers and for recruiting beginners, who could then be more easily convinced to keep the native brown bee instead of one of the introduced subspecies.

**RA9 – Management differences** Mapping of critical management differences between brown bees and other subspecies, including queen production, yearly management cycle and collection of traditional knowledge. This would result in the identification of the critical management differences and suggestions for an improved management of brown bees. This valuable information would then be disseminated through RA10. ∎

**RA12 – Bottom board study** Conduct a scientific study to assess the impact of the bottom board structure of the hive on chalkbrood prevalence and spring development. There is reason to believe that a hive construction with an open bottom board leads to an increased risk for chalkbrood and impaired spring development in brown bees. If this is the case, a change in hive construction would be a measure to counteract chalkbrood prevalence. ∎

## 2.3 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.

**RA3 – Brown bee network** Establish and promote a network among Nordic and Baltic brown bee breeders as a platform for Nordic collaboration, for example to encourage sharing of knowledge and exchange of breeding material, where appropriate. ∎

**RA14 – Saving queens** Evaluate implications of saving queens from bacterially-infected colonies. Possibly establish routines for collection and shipping of queens from possible breeder colonies infected by notifiable diseases in Norway, Sweden and Denmark to Finland where these diseases are not notifiable/handled by destruction of colonies.                                                        ∎

## 2.4   Education

The dissemination of management techniques tailored to brown bees is of utmost 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.

**RA6 – Characterization training** Offer training courses in standardized characterization of bee colonies in each of the Nordic and Baltic 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.       ∎

**RA10 – Training for trainers** Offer brown-bee-specific training courses for beekeeping instructors, in order to promote brown-bee-specific management skills. This ties in with RA9, the mapping of brown-bee-specific management techniques.                          ∎

## 2.5  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-Baltic brown bee beekeepers will greatly support this action.

> **RA4 – Recruitment** Recruitment of new brown bee beekeepers through increased promotion of the subspecies by Nordic and Baltic beekeepers' associations, researchers and brown bee beekeepers. Promotion of the brown bee would include presentations at scientific conferences, beekeeping meetings and publications aimed at the general public. Exchange of experiences and ideas for recruitment of new beekeepers among the Nordic-Baltic countries will help to achieve the best possible return of promotion efforts. ■

## 2.6  *Ex situ* conservation

Complementing *in situ* conservation efforts with *ex situ* measures, particularly cryopreservation, 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.

> **RA11 – 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. ■

**RA13 – Cryopreservation** Establish a collection of cryopre-
served brown bee semen from the Nordic-Baltic countries as a
back-up for *in situ* conservation. Cryopreservation is available
through the Smartbees project through the partner Bieneninstitut
Hohen Neuendorf in Germany.                                        ∎

# A. Appendix

## A.1 State of affairs February 2015

| Recommended action | Responsibility |
| --- | --- |
| **RA1** Standardized characterization | Bjørn Dahle will evaluate smartbees and a COLOSS task force effort and propose a route of action at the first brown bee network meeting. |
| **RA2** Database | Suitability of beebreed.eu will be evaluated by the brown bee network. |
| **RA3** Brown bee network | NordGen organizes a first meeting. Possible synergies: NordBi bi-annual meetings, next one: March 2016; smartbees networking activities, contact: Bjørn Dahle. |
| **RA4** Recruitment of new beekeepers | Brown bee network |
| **RA5** Brood disease study | This will be covered by the smartbees project and thus does not require any action at this moment. |
| **RA6** Characterization training | Lauri Ruottinen will make a preliminary plan and budget and will coordinate with smartbees. |
| **RA7** Genetic diversity study | NordGen will evaluate the ERAnet call and propose a further line of action. |
| **RA8** SNPchip development | This could be based on results from the smartbees project, which are not available yet. |
| **RA9** Management differences | Lauri Ruottinen will make a preliminary plan for collecting the differences. |
| **RA10** Training for trainers | Lauri Ruottinen will make a plan & budget for a course. |
| **RA11** Artificial insemination | Brown bee network |
| **RA12** Bottom board study | Brown bee network |
| **RA13** Cryopreservation | Brown bee network |
| **RA14** Saving queens | Brown bee network |