Volume 2, Issue 1: First Half 2014

Bumblebee Conservator

Newsletter of the BumbleBee Specialist Group

In this issue

IUCN SSC Species Survival Commission

IUCN SSC BUMBLEBEE SPECIALIST GROUP

From the Chair

A very happy and productive 2014 to everyone! We start this year having seen enormously encouraging progress in 2013. Our different regions have started from very different positions, in terms of established knowledge of their bee faunas as well as in terms of resources available, but members in all regions are actively moving forward. In Europe and North America, which have been fortunate to have the most specialists over the last century, we are achieving the first species assessments. Mesoamerica and South America are also very close, despite the huge areas to survey and the much less well known species. In Asia, with far more species, many of them poorly known, remarkably rapid progress is being made in sorting out what is present and in building the crucial keys and distribution maps. In some regions there are very few people to tackle the task, sometimes in situations that make progress challenging and slow – their enthusiasm is especially appreciated! At this stage, broad discussion of problems and of the solutions developed from your experience will be especially important. This will direct the best assessments for focusing the future of bumblebee conservation.

From the Editor

Welcome to the second issue of the Bumblebee Conservator, the official newsletter of the Bumblebee Specialist Group. Currently, the plan is to produce and distribute the newsletter twice a year. The first issue of the year will include the Annual BBSG Report along with additional articles. The second issue of the year will focus more on bumblebee research, notes and articles of interest to the membership. With the ongoing process of Bumblebee Red Listing we would like to focus the second issue of 2014 on Red Listing and the efforts by the various regions on their progress, problems, issues and what we need as we continue the process. If you have an article or note in you regarding this issue or you know of any articles that would be beneficial for the discussion please submit them. Thank you in advance.

The Bumblebee Conservator invites contributions of research, reviews on current management and conservation issues, methods or techniques papers, upcoming conferences and workshops, editorials, news and recent publications, etc. We also actively encourage submissions describing the current activities relating to projects and academic institutions in order to help inform the community as to the general state of current research and conservation activities. Please send submissions and comments to the Editor for consideration, preferably via e-mail attachment – to: Ed Spevak, Saint Louis Zoo spevak@stlzoo.org

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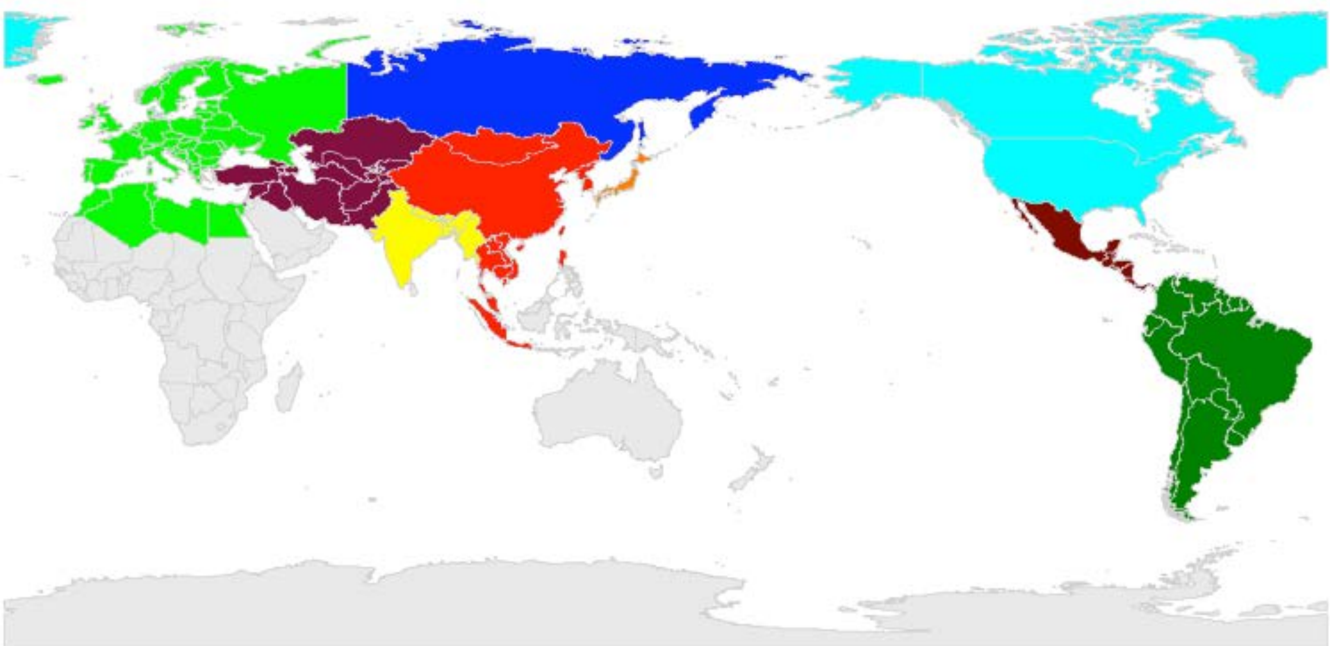

Bumblebee Specialist Group Report 2013

Paul Williams (Chair, UK)

Sarina Jepsen (Red List Authority Coordinator, USA)

BBSG IN 2013

The BBSG exists to foster the conservation of bumblebees (c. 250 species) and their habitats around the world. In this second report of the BBSG's activities, we see the BBSG already producing results in terms of regional Red List assessments of bumblebee species. For another year it is very encouraging to see such strong progress by our 75 volunteer members in many regions.

SIZE OF THE CHALLENGE

We are probably all familiar with the idea that bumblebees tend to be most plentiful, in terms of both numbers of species and of numbers of individuals, in cool habitats in temperate and mountainous regions. The maps (Figures 1 and 2) show variation in species richness and in a measure of species endemism (as relative range-size rarity, reviewed in Williams, 2000) among equal-area grid cells for all bumblebee species world-wide.

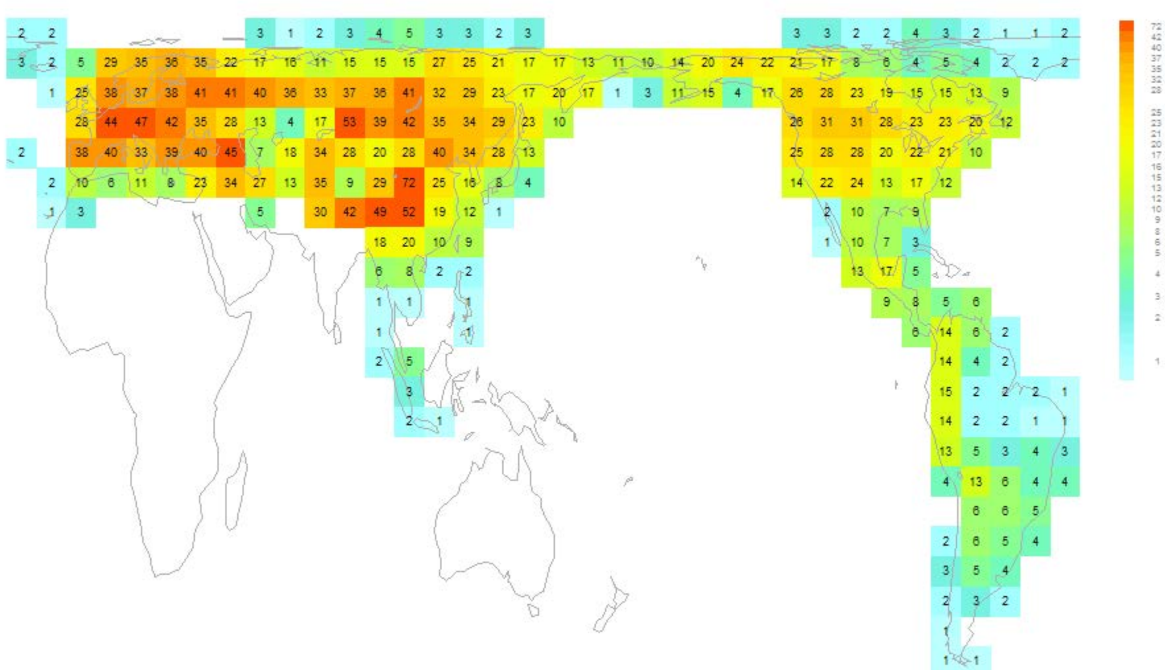

Figure 1: Species richness of bumblebees among equal-area grid cells.

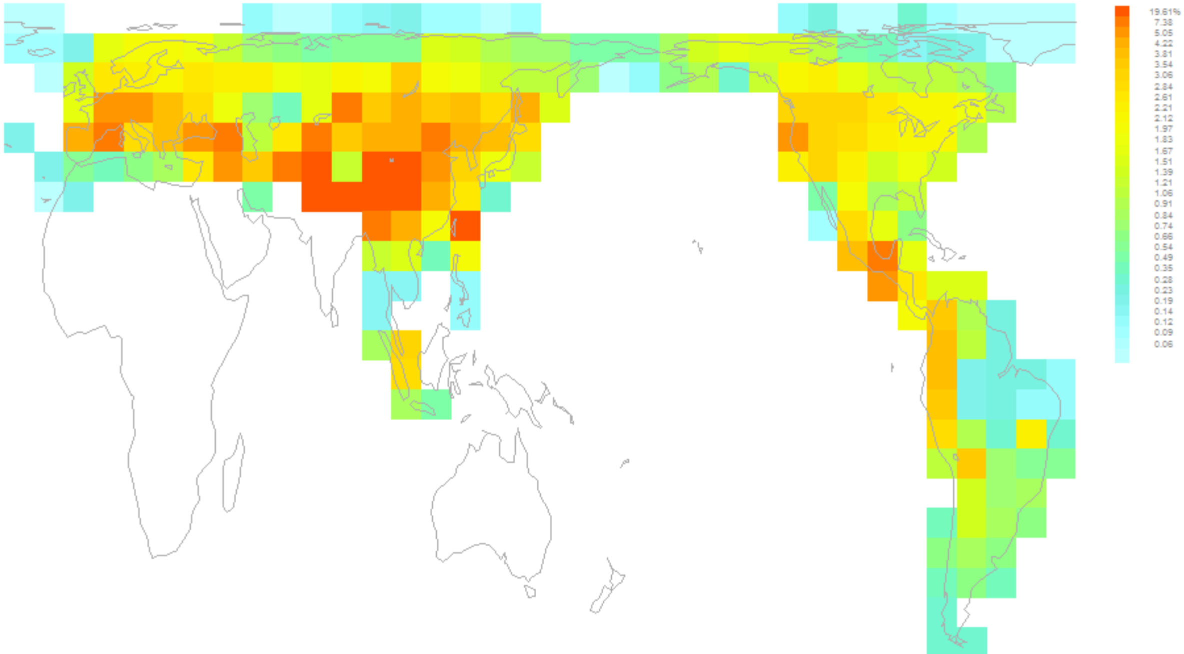

Figure 2: Species endemism (range-size rarity) of bumblebees among equal-area grid cells.

But how does this relate to BBSG regions? The next two maps (Figures 3 and 4) show estimates of the bumblebee species richness and species endemism for the nine BBSG regions:

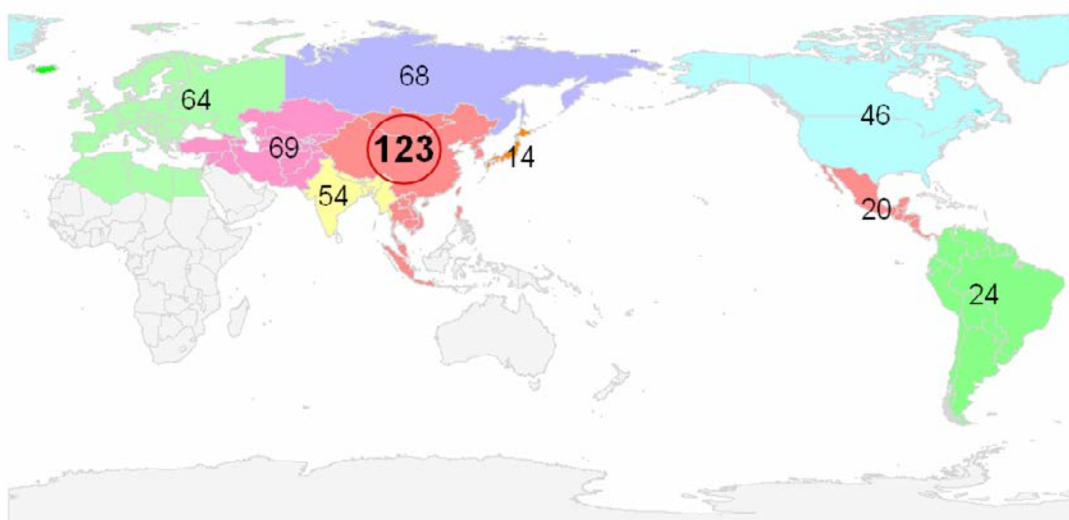

Figure 3: Species richness of bumblebees among BBSG regions.

The species richness map obviously shows the size of the problem of how many species need assessments within each region. But the species endemism map shows for how many species each region is uniquely responsible. The North American region is perhaps fortunate in having relatively few species in total, but contributing many unique species. In contrast, the East Asian Region has very many species in total for the same number of unique species.

The ultimate aim of the BBSG as an IUCN-SSC member is to produce Red List assessments of the Red List status for each bumblebee species on a world-wide basis. So we are keen to encourage discussions among regional groups to share ideas and experience on the assessment methods. We hope to be able to move towards a common view of best practice, so that it is easier to arrive at comparable assessments around the world. We will need to combine these among regions in some cases to produce global assessments of the most widespread species.

REF: Williams PH. 2000. Some properties of rarity scores used in site quality assessment. *British Journal of Entomology and Natural History* 13: 73-86. nhm.ac.uk/research-curation/research/projects/bombus/Williams00_rarity.pdf

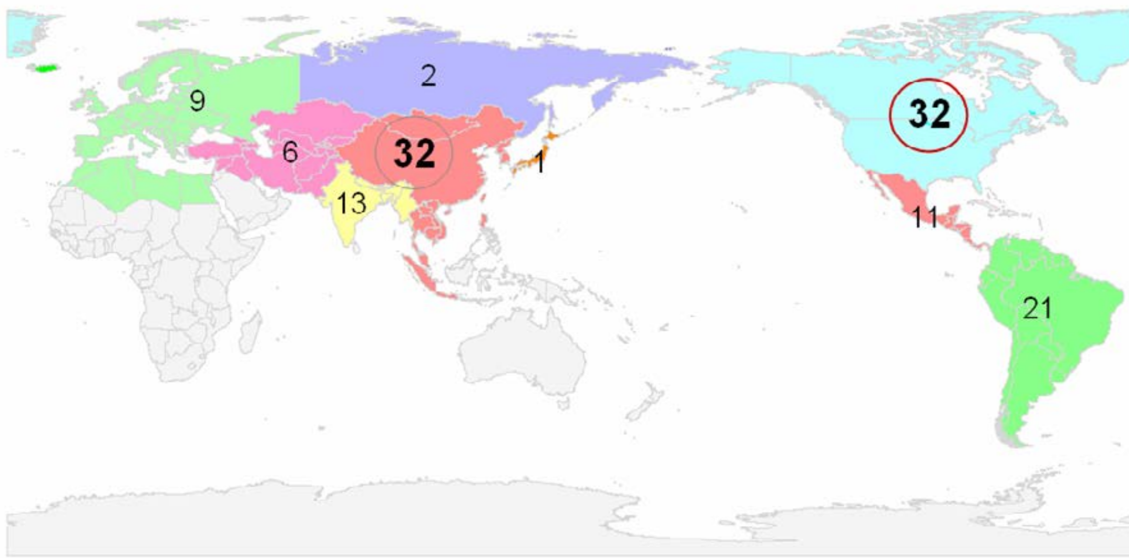

Figure 4: Species endemism of bumblebees among BBSG regions.

EUROPE

Pierre Rasmont / Stuart Roberts / Denis Michez

Thanks to a very wide cooperation that allowed data to be gathered from a large number of contributors, the STEP project team was able to compile 929,361 data for West-Palaearctic bumblebees. All of the maps are shown on the website *Atlas Hymenoptera* (Rasmont & Iserbyt 2010-2012: http://www.zoologie.umh.ac.be/hymenoptera/page.asp?id=169). All maps show data for 3 recording periods: before 1950, from 1950 to 1989, and since 1990. This allows the present status of each species to be visualised easily. From this very large data set, the BBSG - European Region extracted the information to complete assessments for all 68 bumblebee species found in the region covered (891,619 data). All maps are now displayed on the IUCN website. It should be noted that the information displayed in the two atlases is different, complementing one another and providing a base for future refinement of the assessment. The group held a meeting of specialists (Bjorn Cederberg, Denis Michez, Ana Nieto, Vladimir Radchenko, Pierre Rasmont, Stuart Roberts) in Brussels in August 2012 to examine carefully all of the available information and to assess the status of each bumblebee species. One species is listed as Critically Endangered (Figure 5), 7 species are Endangered, 7 species are Vulnerable, 3 species are Near Threatened, 44 species are Least Concern, and 6 species remain Data Deficient. It is noticeable that inside the category Least Concern, 7 species are clearly expanding, 24 species seem more or less stable, while 13 species are conspicuously regressing in one or other parts of the region.

Compared with most other wild bees, the bumblebee data are especially numerous in both time and space. This abundance of data proved invaluable for assessing the conservation status of these insects. However, the group also completed the historical and statistical data with personal visits to locations where some of the rarest species were found most recently. These field data showed that some of the most regressing species could not now be found in most of their sites with recent records. For *Bombus cullumanus* (Figure 5), *B. armeniacus, B. fragrans, B. mocsaryi* and *B. zonatus* we have not found any recent specimens in most of the sites where we observed abundant populations 10-20 years ago. Some other of the most endangered species live in areas that are so restricted that they are at risk of extinction, particularly for *B. brodmannicus, B. inexspectatus* and *B. reinigiellus*.

In summary, of the 68 bumblebees present in the area assessed by the group, 7 species are expanding (10%), 24 are stable (35%), 31 are regressing (46%) and 6 (9%) are Data Deficient (Figure 6 and 7). The situation for European bumblebees is serious.

Figure 5*: B. cullumanus serrisquama*, a species with Critically Endangered status in Europe. The West-European nominal subspecies is now Extinct. Nevertheless, the yellow-banded ssp. *serrisquama* persists in Caucasian region, along the Volga and in few locations in Spain. (Photo Pierre Rasmont.)

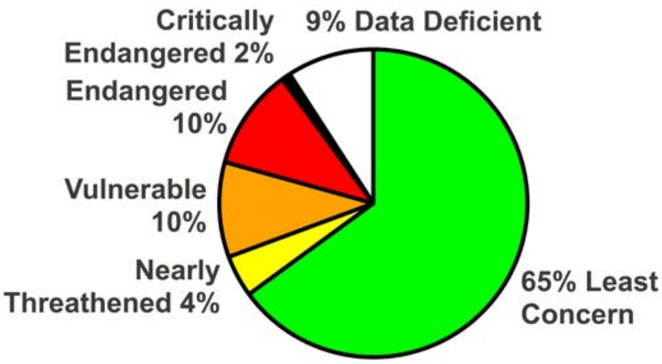

Figure 6: Red List status of European bumblebees. There are 68 bumblebee species in the studied area.

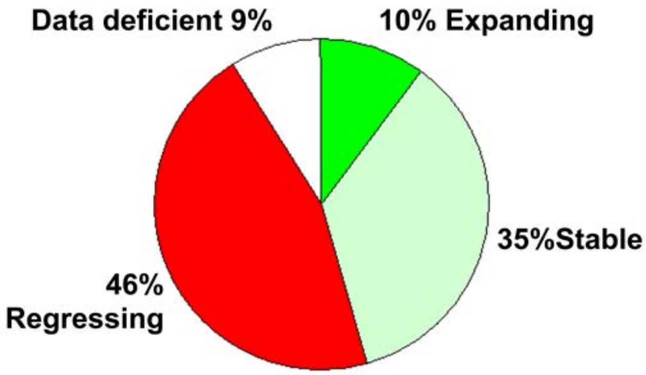

Figure 7: Summary of the regression status of European bumblebees. "Regressing" includes the IUCN categories Critically Endangered, Endangered, Vulnerable, Nearly Threatened, and Least Concern, where the species show conspicuous regression in some part of their distribution. The species with "stable" and with "expanding" status also include species in the IUCN category Least Concern.

NORTH AMERICA

Robbin Thorp / Sheila Colla / Sarina Jepsen

In North America, we are using a database of nearly 300,000 digitized, georeferenced museum specimens from multiple contributors spanning the period 1805-2012 to evaluate the conservation status of the 46 North American *Bombus* species north of Mexico. To do this, we are assessing changes in relative abundance, extent of occurrence, and persistence between a recent time period (2002-2012) and an earlier time period (1805-2001), then qualitatively evaluating the survey effort that has occurred in the recent time period, in order to identify potentially misleading changes in extent of occurrence. Our preliminary findings suggest that nearly one-third of the North American bumblebee fauna is in a moderate to severe level of decline (Vulnerable, Endangered, or Critically Endangered). We have assigned species to threat/ rarity categories using IUCN criteria and will soon send these preliminary results to North American regional members for review. We are also in the process of compiling biological information and knowledge about known and suspected threats to each species to help with future conservation management of declining species. We anticipate submitting a manuscript describing this work to a peer-reviewed journal in early 2014.

Figure 8: *B. terricola*, a species with a draft status of Vulnerable in North America, robbing *Silene vulgaris* flowers near Barrie, Ontario, Canada. (Photo Sheila Colla.)

MESOAMERICA

Remy Vandame

This was another year of intensive field work for the Mesoamerica regional group, with people sampling in Guatemala and all of the north of Mexico. Nearly 8000 bumblebees have been collected from more than 400 sampling sites in the last two years. Their bodies (pin-mounted), legs (DNA), and guts (pathogens) are providing much new information. At first sight, some new species are apparent, and a heterogeneous distribution of pathogens seems to reflect agricultural practices. There is certainly work for many years to come in these samples. Fortunately, collaborations in Mexico, the US, and Switzerland, will all help in making progress rapid. All of the work is made possible by an important grant from Conabio (National Commission on Biodiversity), who are concerned about the likely impacts of species introduced for pollination, species which could become invasive. In 2013, the group has worked hard with the help of Nieves Garcia to draft an initial Red List assessment for the main species in the region.

Looking forward, the group will organize the IX Mesoamerican Congress on Native Bees, to be held in San Cristóbal de Las Casas in 2015. With plenty of new data, this will certainly be an important bumblebee meeting.

Figure 9: Jorge Mérida, Erika Núñez, and Philippe Sagot taking a pause during field work(Photos Jorge Mérida)

Figure 10: *B. ephippiatus* (left) and *B. huntii* at Guadalupe y Calvo, Chihuahua, Mexico (Photos Jorge Mérida)

SOUTH AMERICA

Carolina Morales

2013 was a year full of activities and achievements for the South American Group. In January 2013 we set the goal of completing the Red List assessment of at least one third of the 24 bumblebee species included in our region during this year. The assessments of all the 24 species are in progress, some of them relatively advanced and now almost ready. Thanks to the effort of the whole team of South American specialists, in particular of those volunteer members who committed to lead individual species assessments (Claus Rassmusen, Aline Martins and Carolina Morales, with the assistance of Yamila Sasal), and the invaluable technical support of Nieves Garcia who coordinated this process, the majority of the work is completed. Therefore, we should be able to finalize the assessments soon. For these final steps, Neil Cox recently joined the team and will be working on finalizing the Red List assessments for the South American bumblebees over the next few months. Finally, this year we welcome a new bumble bee specialist, Dr Victor Gonzales-Betancourt, from Colombia.

Figure 11: *B. dahlbomii*, a species with a draft status of Endangered in South America, visiting *Vicia nigricans* flowers at Nahuel Huapi National Park, Rio Negro, Argentina. (Photo Carolina Morales.)

NORTH ASIA

Alexandr Byvaltsev

In 2013, we worked in the following areas:

1. Mapping bumblebee species ranges in Russia. We hope to show the first version of our web-page with these data at the end of 2013.
2. All of us collected bumblebees in the regions where we live. Research to assess the relative abundance of bumblebees in the steppes of Khakassia was carried out for the first time.
3. The second edition of the Red Book of Tomsk Oblast was published. Four species of bumblebees were included – *B. confusus*, *B. modestus*, *B. muscorum* and *B. patagiatus*.
4. Estimations of populations of 65 bumblebee species in eight regions were conducted:
   - European North Russia (excluding Vologda Oblast; Yulia Kolosova);
   - Vologda oblast (Natalya Kolesova);
   - North-West Caucasus (Krasnodar krai, Adygea, Karachay-Cherkessia: Igor Popov);
   - Khanty-Mansiysk Autonomous Okrug – Ugra (Aigul Demidova);
   - Tomsk Oblast (Olga Konusova);
   - forest-steppe and steppe life zones of the West-Siberian Plain: Russia – Kurgan, Omsk and Novosibirsk Oblast, and Altay Territory; Kazakhstan – North Kazakhstan Oblast and the northen part of Kostanai Oblast (Alexandr Byvaltsev);
   - Kuznetsk-Salair Mountain Area (Sergei Luzjanin);
   - steppe zone of Khakassia (Alexandr Byvaltsev).

Three groups of threatened species are identified:

1. *B. amurensis*, *B. fragrans, B. zonatus*, *B. wurflenii* – Vulnerable or Extinct;
2. *B. muscorum, B. semenoviellus* — Vulnerable;
3. *B. modestus* — Near Threatened.

Even though we have no quantitative estimates for the regional habitat of *B. unicus, B. anachoreta* and *B. czerskii*, nonetheless they should be assessed as Vulnerable because of the small area of their habitat (mainly in Primorye) and because of their weak representation in collections in comparison with other species. Assessment of the threats is reflected in the formula - VU E.

WEST ASIA

Murat Aytekin / Alireza Monfared

Surveys of new regions of Iran were carried out in 2013 with the help of a team of MSc students. Most previous collections of bumblebees in Iran have concentrated on the Elborz mountains of the north, although bumblebees are also known to inhabit mountains in the northwest (Sabalan), west (Zagros), and some central areas.

In the northwest of Fars Province, bumblebees were collected from localities in the Saran plains and Sepidan. Three species were recorded: *B.* (*Sibiricobombus*) *niveatus*, *B.* (*Thoracobombus*) *armeniacus,* and *B.* (*Thoracobombus*) *zonatus*, among which the most abundant was *B. armeniacus*. Fars province is a mostly arid region in the south of Iran. In the North West of the province, in the regions of Sepidan, are the mountains of the Zagros range. The higher elevations are covered with snow in winter, providing cool habitats for bumblebees. The study will continue to look for nests in the coming year.

Figure 12: Collecting site at Sepidan, Fars, Iran. (Photo Alireza Monfared.)

In Chaharmahal and Bakhtyari Province, bumblebees were collected from localities including Baba Haidar, Kuhrang, Abshar, Chelgerd, and Cheshmehshaykhalikhan. These bumblebees were identified as: *B. niveatus*, *B. armeniacus, B. zonatus*, *B.* (*Megabombus*) *argillaceus*, *B.* (*Megabombus*) *portchinsky*, *B.* (*Thoracobombus*) *ruderarius*, and *B. zonatus*.

Figure 13: Alireza Monfared collecting bumblebees near Baba Haidar city, Chaharmahal and Bakhtiari, Iran.

In Zanjan province, a survey collected seven bumblebee species from one new locality. The species included: *B. argillaceus*, *B. zonatus* (both yellow- and white-banded patterns), *B. niveatus* (both yellow- and white-banded patterns), *B. armeniacus, B. maxillosus, B. persicus,* and *B. fragrans.*

EAST ASIA

An Jiandong / Paul Williams

Work has continued to focus on the basics of finding out what is present in this, the largest and least well known bumblebee fauna world-wide. Field surveys are extending our reference collections to cover even more remote and rarely visited areas, such as the Kunlun mountain range at the north of the Tibetan plateau (below). Based on these collections, several subgenera of bumblebees are being revised from DNA and morphology to clarify the species present, with a particular focus at present on the subgenera *Mendacibombus* and *Megabombus,* which are especially well represented in China. The results are now feeding into reviews of the broader fauna, which this year include the first guide to the bumblebees of North China (78 species, which is larger than the fauna of any other region), to include keys, photos, and distribution maps. All of this work is being organised with the aim of moving towards Red List assessments for all species.

Figure 14: Collecting in the Kunlun Shan, at the northern edge of the Tibetan plateau. Upper photo: The mountain is Yushu Feng reaching 6170 m. Lower photo: The neighbouring site at 4614 m had 7 species recorded, typical of the Ladakh-Kunlun Shan fauna of the arid interior of the Tibetan plateau. (Photos Paul Williams/Lucy Bailey.)

OTHER ACTIVITIES

In Russia, the second edition of the Red Book of Tomsk Oblast was published, which included four bumblebee species: *B. confusus, B. modestus, B. muscorum* and *B. patagiatus*.

In Canada, *B. affinis* had previously been listed as Endangered (largely based on IUCN criteria) federally and provincially. Three other species are now under assessment: *B. bohemicus, B. occidentalis,* and *B. terricola*.

In the US, a petition for the protection of *B. affinis* under the ESA has been submitted by the Xerces Society.

Last but by no means least, our newsletter (*Bumblebee Conservator*) was introduced in 2013, many thanks to Ed Spevak (Saint Louis Zoo), and our website (iucn.org/bumblebees) has grown.

BBSG IN 2014

We are now well in progress with species assessments in at least some of the regions. Now that these have begun, we need to share experience in how best to apply IUCN Red List criteria to bumblebee data. The BBSG group mailing list (iucn-bumblebee@googlegroups.com) is just one route that can be used for this. We are also trying to raise money to fund an international meeting to help with the exchange of ideas. As ever, let us know what you need and we will try to find a way to help.

Bumblebees in the News

Plight of the Bumblebee

Anthony King (Reprinted from Science News 14 September 2012 http://news.sciencemag.org/2012/09/plight-bumblebee?ref=hp)

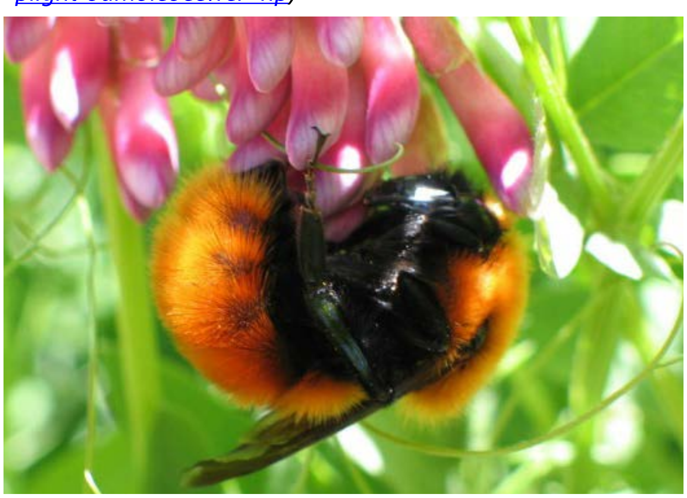

Figure 15: *B. dahlbomii* Photo Carolina Morales

Bad buzz. A deadly parasite, possibly carried by European bees imported for pollination, is infecting Patagonia's native giant bumblebee, *Bombus dahlbomii*.

When Europeans arrived in the Americas, they carried measles, flu, and smallpox to the native peoples. Now history is repeating itself—in the world of bees. The introduction of a European bumblebee to South America—and the parasite that the bee carries—may have decimated populations of that continent's indigenous „giant bumblebee," scientists reported last week in *Biological Invasions*.

The queen bees of the spectacular native „giant bumblebee" of South America, *Bombus dahlbomii*, are the largest bumblebees in the world. *B. dahlbomii* once ranged across thousands of kilometers of Patagonia, the cool, southernmost tip of South America, where it was the only bumblebee species. But the species' burly size has not kept it safe: Populations of the native bee have declined sharply in recent years.

The spotlight of suspicion is now on a recent arrival, the European white-tailed bumblebee (*B. terrestris*), which was introduced into Chile in 1997 to pollinate agricultural crops. The European bee escaped from greenhouses and outdoor pollination sites into the wild; researchers observed it in Patagonia by 2006. At about the same time, the giant bumblebee began to disappear from this area.

The link between those two events, scientists suspect, may be a deadly single celled parasite that hitchhiked to Patagonia along with the European invader. In the new study, scientists identified the parasite, *Apicystis bombi*, in three species of bumblebee—the native bumblebee; *B. terrestris*; and another European bumblebee, *B. ruderatus*—in Patagonia. The parasites wreak havoc on the bees, starting off as a gut infection and spreading to other parts of the body. They cause behavioral effects, increase worker bee death rates, and impede the founding of new colonies.

„There is evidence that this parasite was introduced with *Bombus terrestris* and spilled over to other species here in the region," says Marina Arbetman, lead study author and Ph.D. candidate at the National University of Río Negro in Argentina.

The parasite is certainly a relatively recent arrival: In the study, Arbetman and her team looked at preserved specimens of the native bee as well as *B. ruderatus*, also called the carder bumblebee. The carder bee first arrived in South America in the 1980s, but researchers could not detect the parasite's DNA in the preserved specimens.

The parasite is rare in bees in Europe, found in only 1% to 8% of white-tailed bees. However, it is surprisingly common in the European bumblebees living in Patagonia, the researchers found—almost half of the white-tailed bees in the region were infected, as well as the native giant bumblebees.

„We are not saying that the decline is only due to parasites," says co-author and bee biologist Carolina Morales of Argentina's national research council. For example, competition for food with the European bees could also be responsible for species decline. However, the speed of the native bee decline suggests that the parasite is a major factor, she says—and other native bumblebees north of Patagonia may be at risk from the parasite.

Indeed, „the giant bumblebee appears to have disappeared from 80% of its range," says bee biologist David Goulson of the University of Stirling in the United Kingdom. „I went out there earlier this year and hunted high and low for them, but couldn't find a single one." A clash over food or territory alone wouldn't be likely to decimate the giant bumblebees, he says. „The native bee has a long tongue and tends to feed on deep flowers that *Bombus terrestris* wouldn't feed on, so they really shouldn't be competing. The only sensible explanation that fits is that *terrestris* is carrying some kind of disease, and this one seems to be a pretty good candidate."

Goulson predicts the giant bumblebee species could be extinct within a few years—and adds that there could be wider ecological implications, as a lot of wild plants in the Andes will lose their main pollinator. „It is incredibly frustrating for people like me who are trying to conserve things that some idiot can do so much damage by bringing in an alien bee."

Still, it's not certain that European bees are primarily responsible for bringing this particular parasite to South America—or even that *A. bombi* is the only parasite involved. „There is correlational evidence to suggest that this parasite may have either been brought in or hugely increased in its abundance by the invasive bumblebee, but there is no causal evidence. It's not a smoking gun," says evolutionary biologist Mark Brown of Royal Holloway, University of London. „I don't think they can conclude that the parasite wasn't in native bumblebees in Patagonia prior to *Bombus terrestris* arriving, because the sample size was not large enough to do that." (That small sample size was due to the difficulty in locating surviving native bees, according to the researchers in Argentina.) Furthermore, Brown says, „if this parasite was introduced to native bees by commercial bees then it is highly likely that other parasites would have crossed over at the same time."

Morales, however, says that the study highlights a fearsome cautionary tale. Many companies export bumblebee species, sending them around the world to pollinate crops such as the tomato. The research, she says, paints a picture of what could happen if infected European species entered bumblebee-rich places such as China and Nepal—that is, assuming this parasite is just as detrimental to their bees.

****Correction 10:34 a.m., 17 September**: The first invader species was B. ruderatus, not B. pascuorum.*

Journal Reference:

Arbetman, M. P., I. Meeus, C. L. Morales, M. A. Aizen and G. Smagghe. 2013. Alien parasite hitchhikes to Patagonia on invasive bumble beebumble bee. Biological Invasions. DOI 10.1007/s10530-012-0311-0

Abstract The worldwide trade in bumblebees can lead to the spread of diseases, which in turn has been claimed as a factor in bumblebee decline. Populations of the introduced Bombus terrestris, which invaded NW Patagonia, Argentina, in 2006, harbor the highly pathogenic protozoan Apicystis bombi. We asked whether A. bombi had been co-introduced with B. terrestris, and if so, whether spillover occurred to the two resident bumblebee species in the region: the introduced European Bombus ruderatus and the native Bombus dahlbomii. We searched for A. bombi by means of PCR in samples of B. ruderatus and B. dahlbomii collected before and after the invasion of B. terrestris and in samples of the latter. We found no A. bombi in samples of B. ruderatus and B. dahlbomii collected before

B. terrestris invasion, whereas post invasion, A. bombi was present in all 3 species. The identity of the parasite was established by sequencing the 18S region, which was identical for the three bumblebee species and also matched the European sequence, confirming it to be A. bombi. This is the first report of A. bombi in B. ruderatus and B. dahlbomii. Moreover, our results suggest that Patagonia had been free of A. bombi until this parasite was co-introduced with B. terrestris, and spilled over in situ to these two previously resident species. Finally, our findings provide indirect circumstantial evidence of a potential link between the population collapse and geographic retraction of B. dahlbomii and the introduction of this novel parasite.

Additional Reference:

Morales C.L., Arbetman MP, Cameron SA. Aizen, M.A (2013) Rapid ecological replacement of a native bumble bee by invasive species. Frontiers in Ecology and the Environment, **11**: 529–534. http://dx.doi.org/10.1890/120321"

Abstract: Despite rising global concerns over the potential impacts of non-native bumble bee (*Bombus*) introductions on native species, large-scale and long-term assessments of the consequences of such introductions are lacking. *Bombus ruderatus* and *Bombus terrestris* were sequentially introduced into Chile and later entered Argentina's Patagonian region. A large-scale survey in Patagonia reveals that, in 5 years post-arrival, the highly invasive *B terrestris* has become the most abundant and widespread *Bombus* species, and its southward spread is concurrent with the geographic retraction of the only native species, *Bombus dahlbomii*. Furthermore, a 20-year survey of pollinators of the endemic herb *Alstroemeria aurea* in northern Patagonia indicates that *B ruderatus* and *B terrestris* have replaced *B dahlbomii*, formerly the most abundant pollinator. Although the decline's underlying mechanisms remain unknown, the potential roles of exploitative competition and pathogen co-introduction cannot be ruled out. Given that invasive bumble bees can rapidly extirpate native congeners, further introductions should be discouraged.

Total Buzz Kill: Metals in Flowers May Play Role in Bumblebee Decline

Reprinted from Science *Daily*®

http://www.sciencedaily.com/releases/2013/04/130402152432.htm

Apr. 2, 2013 — Beekeepers and researchers nationally are reporting growing evidence that a powerful new class of pesticides may be killing off bumblebees. Now, research at the University of Pittsburgh points toward another potential cause: metal pollution from aluminum and nickel.

Published in the journal *Environmental Pollution*, the Pitt study finds that bumblebees are at risk of ingesting toxic amounts of metals like aluminum and nickel found in flowers growing in soil that has been contaminated by exhaust from vehicles, industrial machinery, and farming equipment. The Pitt study finds that bumblebees have the ability to taste -- and later ignore -- certain metals such as nickel, but can do so only after they visit a contaminated flower. Therefore, the insects are exposed to toxins before they even sense the presence of metals.

„Although many metals are required by living organisms in small amounts, they can be toxic to both plants and animals when found in moderate to high concentrations," said Tia-Lynn Ashman, principal investigator of the study and professor and associate chair in Pitt's Department of Biological Sciences in the Kenneth P. Dietrich School of Arts and Sciences. „Beyond leading to mortality, these metals can interfere with insect taste perception, agility, and working memory -- all necessary attributes for busy bumblebee workers."

Ashman and George Meindl, coauthor of the study and a PhD candidate in Ashman's lab, studied bumblebee behavior using the *Impatiens capensis*, a North American flower that blooms in summer. Its flowers are large, producing a high volume of sugar-rich nectar each day -- an ideal place for bumblebees to forage. The blooms were collected from the field each morning of the two-week study and were of a similar age, color, and size.

To determine whether nickel and aluminum in the flowers' nectar influenced bumblebee behavior, Ashman and Meindl used two groups of uncontaminated flowers, one group of flowers contaminated by nickel, and another contaminated by aluminum. When a bumblebee visited a flower in an array, the entire visitation was recorded as well as the time spent (in seconds) foraging on each individual flower. This included monitoring whether the bee moved from a contaminated to a noncontaminated flower, whether the bee moved to the same group it had just sampled, or whether the bee left the flower group without visiting other individual blooms. Following each observed visit, all flowers in the array were replaced with new flowers, to ensure accurate results.

„We found that the bees still visited those flowers contaminated by metal, indicating that they can't detect metal from afar," said Ashman. „However, once bumblebees arrive at flowers and sample the nectar, they are able to discriminate against certain metals."

In the study, the bees were able to taste, discriminate against, and leave flowers containing nickel. However, this was not the case for the aluminum-treated flowers, as the bees foraged on the contaminated flowers for time periods equal to those of the noncontaminated flowers.

„It's unclear why the bees didn't sense the aluminum," said Meindl. „However, past studies show that the concentrations of aluminum found throughout blooms tend to be higher than concentrations of nickel. This suggests that the bees may be more tolerant or immune to its presence."

These results also have implications for environmentally friendly efforts to decontaminate soil, in particular a method called phytoremediation -- a promising approach that involves growing metal-accumulating plants on polluted soil to remove such contaminates. Ashman says this approach should be considered with caution because the bees observed in the study foraged on metal-rich flowers. She states that further research is needed to identify plants that are ecologically safe and won't pose threats to local animals that pollinate.

The paper „The effects of aluminum and nickel in nectar on the foraging behavior of bumblebees" first appeared online March 6 in *Environmental Pollution*. Funding was provided by the Carnegie Museum of Natural History's Powdermill Nature Reserve in Rector, Pa., a Botany-In-Action Fellowship from the Phipps Botanical Garden and Conservatory in Pittsburgh, an Ivey McManus Predoctoral Fellowship to Meindl, and a National Science Foundation grant (DEB 1020523) to Ashman. The bees were observed at a nature reserve in Western Pennsylvania during August and September 2012.

Story Source:

The above story is based on materials provided by **University of Pittsburgh**.

Journal Reference:

George A. Meindl, Tia-Lynn Ashman. **The effects of aluminum and nickel in nectar on the foraging behavior of bumblebees**. *Environmental Pollution*, 2013; 177: 78 DOI: 10.1016/j.envpol.2013.02.017

Exposure to pesticides results in smaller worker bees

Royal Holloway, University of London

(reprinted from Royal Holloway, University of London. "Exposure to pesticides results in smaller worker bees." ScienceDaily, 20 January 2014. www.sciencedaily.com//releases/2014/01/140120090643.htm .

January 20, 2014

Exposure to a widely used pesticide causes worker bumblebees to grow less and then hatch out at a smaller size, according to a new study.

Exposure to a widely used pesticide causes worker bumblebees to grow less and then hatch out at a smaller size, according to a new study by Royal Holloway University of London.

The research, published today in the Journal of Applied Ecology, reveals that prolonged exposure to a pyrethroid pesticide, which is used on flowering crops to prevent insect damage, reduces the size of individual bees produced by a colony.

The researchers, Gemma Baron, Dr Nigel Raine and Professor Mark Brown from the School of Biological Sciences at Royal Holloway worked with colonies of bumblebees in their laboratory and exposed half of them to the pesticide.

Figure 16: Prolonged exposure to a pyrethroid pesticide, which is used on flowering crops to prevent insect damage, reduces the size of individual bees produced by a colony. Photo Royal Holloway, University of London.

The scientists tracked how the bee colonies grew over a four month period, recording their size and weighing bees on micro-scales, as well as monitoring the number of queens and male bees produced by the colony.

"We already know that larger bumblebees are more effective at foraging. Our result, revealing that this pesticide causes bees to hatch out at a smaller size, is of concern as the size of workers produced in the field is likely to be a key component of colony success, with smaller bees being less efficient at collecting nectar and pollen from flowers," says researcher Gemma Baron from Royal Holloway.

The study is the first to examine the impact of pyrethroid pesticides across the entire lifecycle of bumblebees. The topical research is at the heart of a national Bee Health Conference running in London.

Professor Mark Brown said: "Bumblebees are essential to our food chain so it's critical we understand how wild bees might be impacted by the chemicals we are putting into the environment. We know we have to protect plants from insect damage but we need to find a balance and ensure we are not harming our bees in the process."

Given the current EU moratorium on the use of three neonicotinoid pesticides, the use of other classes of pesticide, including pyrethroids, is likely to increase.

Dr Nigel Raine, who is an Invited Speaker at this week's bee conference, said: "Our work provides a significant step forward in understanding the detrimental impact of pesticides other than neonicotinoids on wild bees. Further studies using colonies placed in the field are essential to understand the full impacts, and conducting such studies needs to be a priority for scientists and governments."

Story Source:

The above story is based on materials provided by Royal Holloway, University of London. Note: Materials may be edited for content and length.

Journal Reference:

1. Gemma L. Baron, Nigel E. Raine, Mark J. F. Brown. Impact of chronic exposure to a pyrethroid pesticide on bumblebees and interactions with a trypanosome parasite. Journal of Applied Ecology, 2014; DOI: 10.1111/1365-2664.12205

Managed honeybees linked to new diseases in wild bees, UK study shows

February 19, 2014

Source:

Biotechnology and Biological Sciences Research Council

Summary:

Diseases that are common in managed honeybee colonies are now widespread in the UK's wild bumblebees, according to new research. The study suggests that some diseases are being driven into wild bumblebee populations from managed honeybees.

(Reprinted from ScienceDaily: Biotechnology and Biological Sciences Research Council. "Managed honeybees linked to new diseases in wild bees, UK study shows.". ScienceDaily, 19 February 2014. <www.sciencedaily.com/releases/2014/02/140219133335.htm>.)

Figure 17: *B. terrestris* Photo Ed Spevak

Diseases that are common in managed honeybee colonies are now widespread in the UK's wild bumblebees, according to research published in Nature. The study suggests that some diseases are being driven into wild bumblebee populations from managed honeybees.

Dr Matthias Fürst and Professor Mark Brown from Royal Holloway University of London (who worked in collaboration with Dr Dino McMahon and Professor Robert Paxton at Queen's University Belfast, and Professor Juliet Osborne working at Rothamsted Research and the University of Exeter) say the research provides vital information for beekeepers across the world to ensure honeybee management supports wild bee populations.

Dr Fürst, from the School of Biological Sciences at Royal Holloway, said: "Wild and managed bees are in decline at national and global scales. Given their central role in pollinating wildflowers and crops, it is essential that we understand what lies behind these declines. Our results suggest that emerging diseases, spread from managed bees, may be an important cause of wild bee decline."

This research assessed common honeybee diseases to determine if they could pass from honeybees to bumblebees. It showed that deformed wing virus (DWV) and the fungal parasite Nosema ceranae -- both of which have major negative impacts on honeybee health -- can infect worker bumblebees and, in the case of DWV, reduce their lifespan.

Honeybees and bumblebees were then collected from 26 sites across the UK and screened for the presence of the parasites. Both parasites were widespread in bumblebees and honeybees across the UK.

Dr Fürst explained: "One of the novel aspects of our study is that we show that deformed wing virus, which is one of the main causes of honeybee deaths worldwide, is not only broadly present in bumblebees, but is actually replicating inside them. This means that it is acting as a real disease; they are not just carriers."

The researchers also looked at how the diseases spread and studied genetic similarities between DWV in different pollinator populations. Three factors suggest that honeybees are spreading the parasites into wild bumblebees: honeybees have higher background levels of the virus and the fungus than bumblebees; bumblebee infection is predicted by patterns of honeybee infection; and honeybees and bumblebees at the same sites share genetic strains of DWV.

"We have known for a long time that parasites are behind declines in honeybees," said Professor Brown. "What our data show is that these same pathogens are circulating widely across our wild and managed pollinators. Infected honeybees can leave traces of disease, like a fungal spore or virus particle, on the flowers that they visit and these may then infect wild bees."

While recent studies have provided anecdotal reports of the presence of honeybee parasites in other pollinators, this is the first study to determine the epidemiology of these parasites across the landscape. The results suggest an urgent need for management recommendations to reduce the threat of emerging diseases to our wild and managed bees.

Professor Brown added: "National societies and agencies, both in the UK and globally, currently manage so-called honeybee diseases on the basis that they are a threat only to honeybees. While they are doing great work, our research shows that this premise is not true, and that the picture is much more complex. Policies to manage these diseases need to take into account threats to wild pollinators and be designed to reduce the impact of these diseases not just on managed honeybees, but on our wild bumblebees too."

Story Source:

The above story is based on materials provided by Biotechnology and Biological Sciences Research Council. Note: Materials may be edited for content and length.

Journal Reference:

1. M. A. Fürst, D. P. McMahon, J. L. Osborne, R. J. Paxton, M. J. F. Brown. Disease associations between honeybees and bumblebees as a threat to wild pollinators. Nature, 2014; 506 (7488): 364 DOI: 10.1038/nature12977

Bumblebee diversity in India: Current status and future prospects

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Abstract

We review the bumblebee diversity and their spatial foraging distribution in India. Although diversity is sustained, the density of foraging and their spatial distribution along the land gradient is declining with a rapid rate in India. It is evident from the research work conducted since 2007, decline in floral resources, growing urbanization, land use changes, deforestation pests and pathogens and abrupt changes in habitat might be the possible reasons for the loss of their density in western Himalayas. Bumblebee conservation will help sustain natural resources important for ecosystem functioning and sustaining food productivity and food security. The present article reviews current status and challenges for bumble bee fauna in India.

Introduction

Bumblebees enjoy the status of a curiosity for most of the people residing in Indian states except some of the hilly states having higher elevations of Himalayan ranges. This myth has been discarded as some of the scattered populations of bumblebees have also been observed and documented from the plain areas of Jammu in the foothill of Himalayan ranges (Abrol, 1998). This rare and generalist bee has a special interest among the people working in the field of pollination and ecology due to their unique colour pattern, robust build and potential to perform vital pollination services in several crops (Abrol and Shankar, 2013; Free and Butler, 1959; Plowright, 1996).

India is endowed with the great diversity of climates and altitudinal variation which provide a broad range of habitat for bumblebees. The bumblebees of Jammu and Kashmir State are of particular interest as this area presents a narrow corridor of mountains between the large and divergent oriental and palaearctic bumblebee fauna's. Different climatic regions not only differ in their flora but in combination with altitudinal zonation and variation in local exposures contribute toward a particularly broad range of habitats. Bumblebees are the most efficient pollinators of plant species of great economic importance. They can work well in confinement and especially in small enclosures. They have extensively been used for pollination in cages for several crops like *Brassica oleracea, B. napus, Cichorium endivia, Raphanus sativa, Solanum melongena, Lycopersicum esculentum* etc. They have been reported to increase seed yield from 110 kg/ha to 210kg/ha in red clover at differing bumblebee densities. They can work at extremely low temperatures (-3.6 °C) at which no other insect pollinator can fly, exploit flowers with deep corollas and have higher foraging rates.

The bumblebee fauna has been extensively studied throughout the world, however, such information from India needs more attention. The Indian species of *Bombus* has generally been restricted to higher elevations especially Himalayan ranges. These species are so adapted to these specific habitats that many of the species found here are not reported from low altitude areas and vice-versa (Saini et al. 2012). These bees play a very significant role in conserving the fabulous tapestry of high-altitude plant germplasm in the entire Himalayan region.

Bingham (1897) listed 24 species of bumblebees from higher elevations of the country including Kashmir, Himachal through Sikkim and Assam. Mani (1962) reported four species of bumblebees at elevations of over 4000 m at Himalayas. In another study, Abrol (1998) has recorded *B. haemorrhoidalis* from intermediate and plain areas of Jammu region. Subsequent workers added 149 species to this list, but due to a lot of synonymy as put forth by Williams (1998), only 47 species stand valid. Currently, the genus *Bombus* is represented by 48 species covering ten subgenera from India, of which 30 have been reported from the Kashmir Himalaya (Williams 2004, Williams et al., 2008; Saini et al. 2011, 2012a). *Bombus miniatus* Bingham is an Oriental species and is widely distributed in Kashmir, Himachal Pradesh, Uttarakhand and Sikkim with a long seasonal activity period with a preference for some species of Lamiaceae, as well as *Taraxacum officinale* and *Cirsium* spp. (Asteraceae), and *Trifolium* spp. (Fabaceae) (Raina et al., 2013). Saini and Ghattor (2007) provided the list of seven species of bumblebee in Lahaul-Spiti valley of Himachal Pradesh and also illustrated their taxonomic description, synonymy, food plants and distribution pattern. Among the anthophilous insects, bumblebees exhibit special morphological and other adaptations for removing nectar and pollen from the flower species they visit. These adaptations include hairy bodies well adapted for pollen collection, the presence of pollen baskets or corbiculae on the bees' hind legs, mandibles and a long tongue used to remove pollen grains from anthers and to moisten the pollen grains with a regurgitated droplet of nectar (Saini et al. 2012b) The bumblebees of Kashmir Himalaya have been reviewed by (Williams 1991, Saini et al. 2011, 2012a).

Plate 1: Foraging of Bumblebees on various crops **A**. *Bombus haemorrhoidalis* on medicinal plant, holy thistle (*Silybium marianum*) **B**. *B. haemorrhoidalis* on *Crisium falconeri* **C**. *B. tunicatus* on *C. falconeri* **D.** *B. haemorrhoidalis* on *Vitex negundo* **E**. *B. tunicatus* on Lamiaceae plants **F**. B. *haemorrhoidalis* on *Anisomeles indica* **G**. *B. haemorrhoidalis* on *Solanum melongena* **H**. *B. haemorrhoidalis* on *Luffa cylindrica* **I**. *B. haemorrhoidalis* on *Sesamum indicum* **J**. *B. haemorrhoidalis* on *Abelmoschus esculentus* **K**. *B. haemorrhoidalis* on *Plectranthus rugosus* **L**. *B. haemorrhoidalis* on grassland legume weeds

Foraging

Some studies have been conducted on foraging behaviour of bumblebee from India. For instances, foraging behaviour of *B. haemorrhoidalis* has been recorded on *Sesamum indicum* flowers and cucurbits (Abrol and Shankar, 2013; pers comm.). Of all these insects, bumblebees were the most efficient pollinators as they inserted tongues deep in the flower to collect nectar as compared to honeybees which mostly collected nectar from the side of the flowers thereby acting as nectar thieves. Bumblebees initiated activities early in the morning at 0630 hrs and maximum abundance was observed up to 1100 hrs, thereafter the population declined and again activities increased from 1500 hrs onward and continued up to 1800 hrs in the evening. Bumblebees on average spent 6.12±0.23 secs. /flower (n=20) on *Sesamum* and cucurbits. An insufficient number of suitable pollinators can cause the decline in fruit and seed production (Partap, 2001). Sesame (*S. indicum*) blossom structure facilitates cross-pollination, even though the crop is usually viewed as self-pollinating. The rate of cross-pollination lies between 0.5% and 65% depending on insect activity, environmental conditions and availability of other vegetation (Rakesh and Lenin, 2000). Sinu et al. (2011) determined the pollination efficiency on the basis of pollen transfer to the stigma following a single visit of the pollinator to a virgin flower. *B. haemorrhoidalis*, *Apis cerana*, *Megachile lanata*, *Episyrphus balteatus* (hover fly), *Macroglossum stellatarum* (hawk moth), and *Aethopyga siparaja* (crimson sunbird) visited the flowers of *Amomum subulatum*. Of these, *B. haemorrhoidalis*, *M. lanata*, and *Aethopyga siparaja* were effective pollinators. *B. haemorrhoidalis* was an important pollinator across all the plantations. Flower opening pattern influenced the pollination efficiency of visitors. Deka et al. (2011) reported the bumblebee, *B. breviceps* Smith as an effective pollinator of large cardamom (*Amomum subulatum* Roxb.) during the initial flowering period at different altitudes of cultivation in the sub-Himalayan state of Sikkim, India.

Bumble bees are advantageous over the honey bees in polyhouses due to their long working hours, long tongue length, effectiveness in lower numbers and their capacity to forage vigorously at low temperature and low light intensities. Further, they recorded twenty two per cent increase in total monitory returns from bumblebee pollinated cucumber crops grown in polyhouses at cost benefit ratio of 1: 2.02 (Chauhan and Thakur, 2011).

Avdhesh and Alexander (1998) described the relationships between bumblebee species (*Bombus tunicatus, B. funerarius, B. haemorrhoidalis, B. festivus, B. flevescens, B. rufofasciatus, B. trifasciatus, B. simillimus and B. melanurus*) and flowering plants and the distribution of the bees at high altitude during pre-monsoon, monsoon and post-monsoon periods. The most important plant visited by the bumblebees is *Trifolium repens* wherein wing length was found to be positively correlated with proboscis length (Avdhesh and Lall, 1999). Further they studied the morphometric on some bumblebee (*Bombus*) species from Northwest India. Abrol (1996) recorded the bumblebee, *B. haemorrhoidalis* as the important pollinator of sunflower, *Helianthus annuus* in Jammu, India. Saeed et al. (2012) suggested that bumble bees can significantly improve cotton reproductive success and can further be explored for their potential as a yield management strategy of cotton crops.

Abrol (1998) recorded that *Bombus* species are important potential pollinators visiting horticultural and agricultural crops during March-December in Kashmir, India. *Acacia modesta* flowers were recorded as the important source of forage to *B. haemorrhoidalis* (Abrol, 1996). *Bombus asiaticus, B. albopleuralis* and *B. simillimus* were observed to be an important pollinators of solanaceous and leguminous crops in Srinagar, India during the blooming period of several fruit and field crops (Abrol, 1989).

As suggested by many authors (Edwards and Williams, 2004; Goulson et al., 2005; Carvell et al., 2006), maintaining Fabaceae-rich grasslands in areas where populations remain, combined with specific management to support the later emerging species, may be the best immediate conservation actions. Banaszak (1992) recommends that a minimum of 25% of land cover should be semi-natural habitat in order to conserve a region's bee diversity.

Wing-beat frequency

In order to evaluate the flight efficiency of bumblebees, Abrol (1991) studied the wing-beat frequency of *B. asiaticus* and *B. albopleuralis* and showed that while the frequency varies between individuals and species and is a function of body parameters, in general the former has a higher wing-beat frequency. *B. asiaticus* has greater weight and size than *B. albopleuralis*. Experimental results agree with theoretically computed values obtained from mass-flow theory.

Parasites and natural enemies

Bumblebee nests also support a diversity of parasitic and commensal organisms. For these reasons, it can be argued that bumblebees are 'keystone species', upon which the survival of many other organisms depend (Goulson et al. 2008). The chief problem associated with their utilization is the erratic and unpredictable fluctuations in their numbers during different years/seasons. The variations in their numbers largely occur due to reduction in nesting sites and weather conditions which determine food supply. They are further hampered by diseases and parasites; predators such as mice, skunks, badgers and birds, and human-created problems such as pesticides and the destruction of nesting sites. Their usefulness under natural conditions can be increased by the individual grower or the community where their services are desired. They can be „encouraged" in an area by providing nests and nesting areas for them. Their enemies can be controlled and consideration can be given in the use of herbicides and insecticides. Crops can be planted or wild flowers encouraged on which they can forage during the unavailability of resources or dearth periods (Thakur, 2012). Rana et al. (2011) noticed the presence of parasitic larva or pupa in the abdomen of about 20% of queens which were identified as conopid fly. These flies lay eggs on adult bees while foraging in the field. The larva after hatching enters into the abdomen of the queen and starts feeding on their abdominal contents. It pupates and overwinters inside the infested queens. That's why, the development of a conopid fly inside a queen affected the egg laying and caused death. Further observations on dissected queens (90.7%) revealed the presence of spermathecae without any spermatozoa in about 65.3% queens which indicates that in nature some unmated queens overwinter. These studies revealed that hindrance in successful rearing or initiation of colony development/egg laying may be due to parasitization of queen bumble bees by conopid flies or the survival of unmated queens in nature. Chauhan et al (2013) observed the incidence of pests and diseases with the development of bumblebee colonies. The pests were found to be nematodes, conopid flies, mites and moths. Similarly, the colonies were also found to be affected with *Nosema* and bacterial diseases. Bumblebee queens (17.65%) were infected by a large number of juveniles and eggs of the nematode, *Sphareularia spp*. (Sphaerulariidae). Conopid flies were present in the abdomen of 20.58% of queens. Small oval reddish brown mites were located in 11.76% of queens. While the brownish grey coloured moths that feed on the wax and pollen in colonies also caused losses to 8.83% of developing colonies of bumblebees. In 14.7% of queens, numerous *Nosema* spores were found in the mid gut causing infection and finally leading to their death. Rod like bacterial cells belonging to family Streptococcaceae were found in the guts of workers in 17.65% of colonies.

Putatunda and Abrol (2003) recorded several species of mites associated with bumblebees in Jammu and Kashmir. Koch et al (2013) investigated the diversity, host specificity and transmission mode of two of the most common, yet poorly known, gut bacteria of honeybees and bumblebees: *Snodgrassella alvi* (Betaproteobacteria) and *Gilliamella apicola* (Gammaproteobacteria). They analysed 16S rRNA gene sequences of these bacteria from diverse bee host species across most of the honeybee and bumblebee phylogenetic tree from North America, Europe and Asia. These focal bacteria were present in 92% of bumblebee species and all honeybee species but were found to be absent in the two related corbiculate bee tribes, the stingless bees (Meliponini) and orchid bees (Euglossini).

Challenges and future prospects

The recent declines in honey bees and bumblebee species in several countries (Allen et al. 1998; Williams and Osborne 2009; Stokstad 2006; Potts et al. 2010), reduced fruit and seed-set and disruption of plant-pollinator interaction (Steffan- Dewenter and Tscharntke 1999; Waser and Ollerton 2006) has drawn considerable attention to conservation, utilization and exploitation of wild and unmanaged bees in agricultural and wild plant pollination (Biesmeijer et al. 2006; Greenleaf and Kremen 2006; Winfree et al. 2007; Winfree 2010; Colla and Packer 2008). A decline in pollinator populations is one form of global change that actually has credible potential to alter the shape and structure of terrestrial ecosystems. The decline in pollinator populations and diversity presents a serious threat to agricultural production and conservation and maintenance of biodiversity in many parts of the world. One indicator of the decline in natural insect pollinators is decreasing crop yields and quality despite necessary agronomic inputs.

Pollinator decline will have serious socio-economic consequences particularly in India where the economic value of such pollinated crops is $726 million annually (Sidhu 2005). It is evident that the management and conservation of bumblebee species is urgently needed for sustaining natural resources and agricultural production. No such attempt has been made from temperate areas of India to replace their potential for planned pollination services. The species composition, distribution pattern and factors affecting population dynamics and rearing under artificial condition of these bumblebees remains unexplored.

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How environmental variation shapes dispersal in the bumble bee *Bombus bifarius*

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One of the outstanding concerns in bumble bee conservation is the degree to which dispersal is likely to be affected by a world undergoing increasing alteration, including human induced habitat modification and climate change. Directly studying movement in bumble bees is notoriously challenging for obvious reasons. However, the field of population genetics makes inferences possible from studying the DNA of individual bees. Population geneticists look at patterns of relatedness among individuals to determine how isolated populations are, and thus how much migration is occurring. Over the past decade, and formalized by the formation of the IUCN Bumble Bee Working Group Conservation Genetics Committee, researchers have been employing genetics to examine dispersal across diverse landscapes.

Although population genetics studies in bumble bees are still relatively limited, the available data suggest that these insects are good fliers, and dispersal is likely to be extensive in many species. A number of species show fairly limited genetic isolation over large distances, at least when major migration barriers are absent. For example, species in the eastern U.S. show essentially no genetic isolation among population separated by more than 1,000 km, similar to patterns observed for *Bombus terrestris* in mainland Europe. On the other hand, certain features of the landscape appear to act as important migration barriers when they are encountered, including urban areas, bodies of water, and isolation on islands. Recent research has found that species in mountains also buck the trend of weak population isolation. Luckily such observations provide opportunities to understand environmental mechanisms that limit dispersal in bumble bees, as well as run around in the mountains in the summer and escape the Alabama heat.

One montane species that shows a particularly interesting pattern is the North American *B. bifarius*. This species exhibits striking color pattern polymorphism, with bright red-banded forms in the southern Rocky Mountains switching to black-banded morphs further to the west, and some intermediate color forms in between (Figure 18, left). Genetic markers have identified several broad regional groups of populations that roughly correspond with color pattern. In a recent study published in *Conservation Genetics*, Jamie Strange, Jonathan Koch, and I investigated how environmental variability might help explain patterns of *B. bifarius* dispersal and population isolation over a large geographic scale in western North America (Lozier *et al.* 2013 and references therein).

First, we made use of the vast resources in natural history collections by digitizing specimen information for a study led by Sydney Cameron (University of Illinois-Urbana-Champaign). Using thousands of specimen records and publically available spatial climate data, we then mapped the distribution of climatically suitable habitat for *B. bifarius* across its range. We used this map to estimate the "environmental distance" among populations sampled for genetics, where regions of high suitability increase spatial connectivity and regions of low suitability decrease it (Figure 1, left). Our results show that by taking into account spatial climatic variation with this environmental connectivity, we can accurately predict patterns of genetic connectivity among populations of *B. bifarius*. This is exciting because we now can identify the specific climatic conditions that facilitate or impede dispersal in *B. bifarius*, and potentially other species that occur in similar habitats. Our results suggest that annual precipitation is important for *B. bifarius*, and that overly warm and dry low-lying areas act as important dispersal barriers. Since these conditions may become more prevalent under climate change, we expect that high elevation bumble bees will become increasingly isolated in the future, potentially affecting population stability.

We are now not only looking at patterns of dispersal along environmental gradients, but at the forces shaping adaptation to these habitats, with the goal of conserving these species, but also to identify traits useful for informed domestication of native species. With the bumble bee genome on the horizon to aid these efforts, it is certainly an exciting time to be a bumble bee geneticist!

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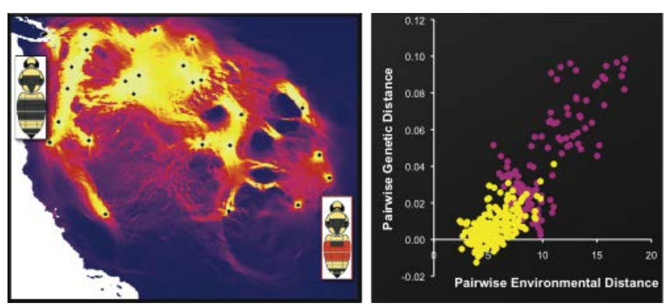

Figure 18: (left) Patterns of connectivity among *B. bifarius* populations sampled for population genetics based on climatic suitability maps (high-to-low connectivity = yellow-to-purple shades); (right) Environmental distance explains genetic distance in *B. bifarius* better than geographic distance alone, suggesting that we can make predictions about dispersal barriers by looking at the environments connecting two populations (colors indicate whether population pairs belong to the same or different regional color pattern group). From Lozier *et al.* 2013.

Grab Your Camera – Bumble Bee Watch is Here!

Figure 19: *Bombus affinis*, photos Ed Spevak

Website is launched to help you identify and protect bumble bees

We wanted to share some exciting news: BumbleBeeWatch.org, a website that allows you to identify and help protect bumble bees in North America is now live! Through BumbleBeeWatch.org you can connect with experts and enthusiasts to help track the status of these essential pollinators.

If any pollinator is iconic, it's the bumble bee. Furry and hardworking, the many species of bumble bees help to deliver bountiful harvests to farmers markets and grocery shelves. Their labor also provides seeds and fruits for songbirds and many mammals, while helping to keep healthy plant populations in our meadows and backyards. In short, they are essential to wildlands, gardens, and farms.

Alarmingly, many recent reports suggest that we may be losing their familiar buzz from our summer landscapes. Habitat loss, insecticide use, disease, and climate change all pose threats to North American bumble bees. More information is needed to determine their conservation status, and that process demands a continent-wide collaborative effort.

We have an amazing community of citizen scientists who have helped us follow a handful of bumble bee species. This new website will generate greater awareness and make it easier for more people to join this community. The more people that we have directly helping with studying and learning about these fascinating insects, the more likely we are to achieve the changes necessary to protect them. Join us at BumbleBeeWatch.org today!

A smartphone or simple digital camera is all that's needed to start exploring BumbleBeeWatch.org:

- Upload photos of bumble bees to start a virtual bumble bee collection
- Use an interactive guide to identify the bumble bees in your photos
- Have your identifications verified by experts
- Help determine the status and conservation needs of bumble bees
- Help locate rare or endangered populations
- Learn about bumble bees, their ecology, and ongoing conservation efforts
- Connect with other citizen scientists engaged in pollinator conservation

Figure 20: *B. affinis*, photos Ed Spevak

Bumble Bee Watch is a partnership between the Xerces Society, Wildlife Preservation Canada, the University of Ottawa, the Montreal Insectarium, the Natural History Museum in London, and BeeSpotter.

For More Information:

- Learn how to contribute your photos
- Learn how to take helpful photos of bumble bees
- Meet the partners
- Read more about bumble bees at risk on Xerces' Project Bumble Bee web page
- Watch the Bumble Bee Watch trailer video on YouTube

Xerces and NRDC ask FWS to take legal steps to protect rusty patched bumble bee

On February 13, 2014, the Xerces Society and NRDC filed a notice of intent to sue the Secretary of the Interior for failure to respond to a petition to list the rusty patched bumble bee (*Bombus affinis*) as an endangered species under the Endangered Species Act (ESA). The rusty patched bumble bee is an important pollinator of cranberries, plums, apples, alfalfa, and numerous other crops and wildflowers. Historically, it was found across the Upper Midwest and Eastern Seaboard, but in recent years it has been lost from 87% of its historic range and its abundance relative to other bumble bees has declined by 95%.

The Xerces Society filed a petition to protect the rusty patched bumble bee under the ESA more than a year ago. Under the ESA, the Secretary of the Interior must make an initial response to a petition within 90 days (a simple statement of whether or not the petition presents sufficient information to support the requested protection), and if the Secretary finds that protection may be warranted, this law further requires her to decide within a year of the petition whether or not the species should be protected. Neither of these deadlines has been met, hence the Xerces Society and NRDC are taking the next step.

Meanwhile, the rusty patched bumble bee continues to face threats. Declines in some North American bumble bees have been associated with increased pathogen levels and reduced genetic diversity, and scientists are currently investigating the hypothesis that exotic pathogens were introduced to wild rusty patched bumble bees from commercial bumble bee colonies. The rusty patched bumble bee may also be threatened by other pathogens, pesticides, habitat loss or fragmentation, climate change, and competition with honey bees for nectar and pollen.

With Endangered Species Act protection, remaining populations of this species could be protected from site specific threats and the bee's habitat could be enhanced. Government agencies would also need to address issues such as the registration of new pesticides that may be harmful to this species and the movement of commercial bumble bees which may transfer disease to wild bumble bees.

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Books

Bumblebee Guides: In-Hand and On-line

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How do we get people to conserve wildlife, especially bumblebees? Lecture them? Show them a documentary? Ask them to give money? We can try all these things but most importantly we need to get them involved. We need to get them out in the field "where the wild things are."

Getting people into the field is but the first step in affecting conservation actions. To affect change people need to know what they are conserving. Field guides have the potential to expand the education of individuals regarding bumblebees as well as other types of bees. It has been argued that education alone is insufficient to instill change, yet is undeniable that the advent of fields guides for various taxa has inspired and encouraged people to explore the natural world (Cheesman and Key 2007), swelled the ranks of concerned individuals (Pearson and Shetterly 2006) and increased conservation advocacy (Brussard and Tull 2007).

Figure 21

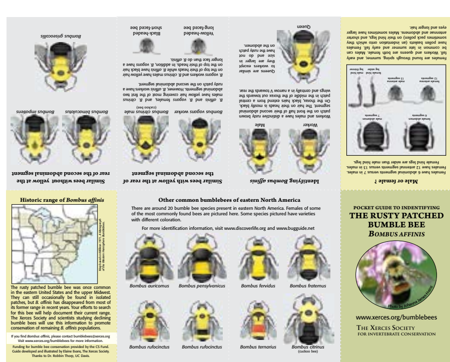

Figure 22

Field guides abound for a variety of taxa from birds and mammals to reptiles and fish. For invertebrates there are numerous general and regional field guides and a number of specific guides focused on butterflies and moths, dragonflies and damselflies and beetles but there are very few guides for bees. However, of the bee guides that are available, luckily most focus on bumblebees and over the last couple decades they have come out in a variety of formats from species specific pocket guides, to regional one or multi-page formats, to books, to apps for your IPhone or IPad. This look at bumblebee guides is not comprehensive but will hopefully give the reader an idea of the diversity of ways to promote bumblebee conservation and education.

The United Kingdom has been at the forefront of bumblebee guides. Why have the English been so taken by bumblebees? It may be due to the longtime love affair that the English have with their gardens (Fearnley-Whittingstall 2003).and the wildlife that inhabit them or perhaps the fact that Darwin was so taken by the "humble-bee" and their importance to pollination (Darwin 1859, 1876). Whatever the reason, the first popular guides to bumblebees have dealt with those of Great Britain and Ireland (e.g., Edwards and Jenner 2005, Pinchen 2006). Buglife with the Field Studies Council also produced a series of laminated guides including the Guide to Bees of Britain (2007) that included the "Big Six" bumblebees (Figure 21). It should be noted that even though these more recent guides have made it easier for the public to identify bumblebees in their own backyard, the British have been writing about humble-bees or bumblebees since the beginning of the 20th century (http://www.nhm.ac.uk/research-curation/research/projects/bombus/books.htm).

Around the same time as the recent popular guides in the U.K., the Xerces Society developed and published their Pocket Guide to Identifying Bumble Bees for the Yellowbanded Bumble Bee (Bombus terricola), the Rusty Patched Bumble Bee (B. affinis) and the Western Bumble Bee (B. occidentalis) (Figure 22). These pocket guides focused on several declining taxa in North America and are available as downloadable pdfs from the Xerces Society (http://www.xerces.org/publications/identification-guides/bumble-bee-pocket-id/). In 2008, the University of Illinois with the Saint Louis Zoo produced the Bumble Bees of Illinois and Missouri (figure 23) as part of the University of Illinois' Beespotter Program. This guide is also available as a downloadable pdf from the Beespotter (http://beespotter.mste.illinois.edu/topics/key/) and the Saint Louis Zoo's website (http://www.stlzoo.org/conservation/wildcare-institute/center-for-native-pollinator-conservation/).

However, what was lacking in the U.S. were more comprehensive guides that people could utilize for larger regions of the country. In 2011 and 2012 the Bumble Bees of the Eastern United States and the Bumble Bees of the Western United States were published respectively covering the approximately 40 species of bumblebees found in the U.S. (Colla et al, 2011; Koch et al. 2012) (Figure 24 and 25). Both of these guides are available for sale or as downloadable pdfs through Pollinator Partnership (www.pollinator.org). These guides are being followed by the upcoming publication of the more comprehensive Bumble Bees of North America: An Identification Guide (Williams et al, 2014) (Figure 26).

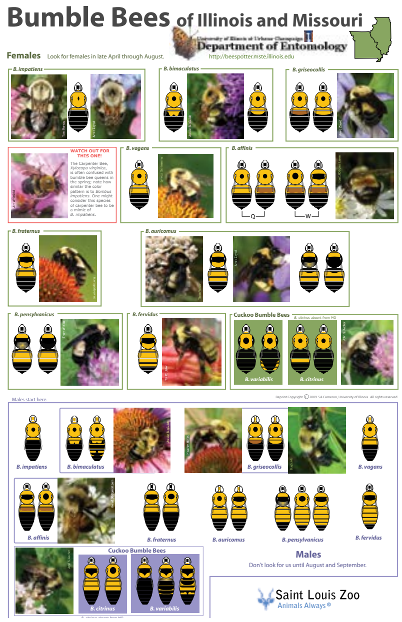

Figure 23

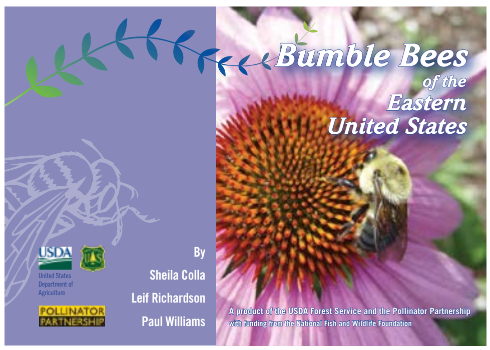

Figure 24

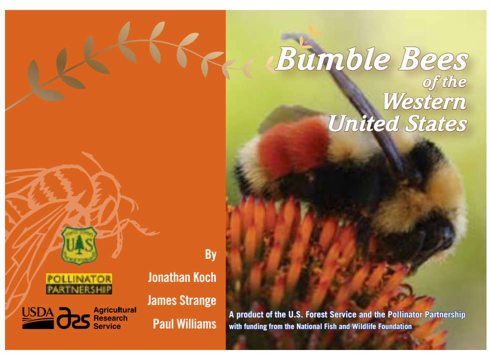

Figure 25

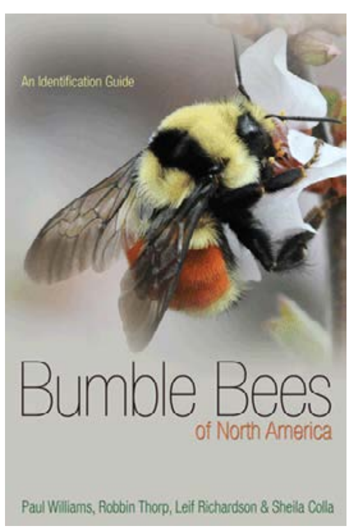

Figure 26

Finally, electronic media, both the internet and apps, have become more prevalent and relevant for bumble bee conservation and research. Shortly after the publication in 1998 of the "Annotated checklist of bumble bees.." (Williams 1998), Paul Williams launched the Bombus: Bumblebees of the World website in part "as a way of updating the information to try to keep it current" (Figure 27): The website (http://www.nhm.ac.uk/research-curation/research/projects/bombus/) is a rich an invaluable resource for all Bombus species and for all Bombus regions worldwide and includes an interactive identification guide. Several Bumblebee Citizen Scientists websites also include identification guides to empower individuals to assist with bumble bee conservation including the Bumblebee Conservation Trust (http://bumblebeeconservation.org/), Beespotter (http://beespotter.mste.illinois.edu/), Bumble Bee Watch (http://bumblebeewatch.org/)(also see article page 20) and the Hanamaru Maruhana Project (http://meme.biology.tohoku.ac.jp/bumblebee/). The most recent electronic bumblebee guide has been published by NatureGuides in partnership with Bumblebee Conservation Trust and Habitat Aid (Figure 28) and is available for IPhones and IPads and covers the 23 bumblebee species found in Britain and Ireland and features identification guides, photos, videos and distribution maps. This program, as well as, hopefully, additional guides and apps to be developed, will get more people thinking about, looking for, and helping bumblebees. Perhaps one day bumblebee watching will be as popular as birding or at least butterfly watching.

Figure 27

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Figure 28

Figure 31 B. ternarius, photo by Ed Spevak