Australian Government
Department of the Environment

# Changes to plant-pollinator associations caused by bumblebees, Bombus spp.

**Advice to the Minister for Environment and Heritage from the Threatened Species Scientific Committee on a public nomination of a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999***

## 1. Name and description of the threatening process

### Name

'Changes to plant-pollinator associations caused by bumblebees, *Bombus* spp.'

Information and expert opinion varies widely on the inclusiveness of the process as named. The complete genus *Bombus* was nominated, however, the only species that currently occurs in Australia is the Large Earth Bumblebee, *Bombus terrestris*. Information on impacts of other species is based on impacts, or suspected impacts, of *Bombus* species in other countries; and *Bombus terrestris* in Tasmania.

Expert opinion on the process varies widely. For example:

- all bumblebee species are a potential threat;
- other *Bombus* spp. (especially those in New Zealand) could potentially invade Australia;
- the other three *Bombus* spp. in New Zealand are more specialised and would be unlikely to colonise Australia to the same degree as *Bombus terrestris*;
- there is no relevant research on other *Bombus* species;
- there is no mention of species other than *Bombus terrestris*; and
- the impacts of other bumblebee species are irrelevant as they are not present in Australia, and importation is strictly controlled by Australia's importation and quarantine regulations.

The TSSC regards exotic species that are not present within Australia as not suitable for consideration for listing as key threatening processes in Australia, since the potential impact of these species, and thus judgement against the criteria, is wholly speculative. Further, given Australia's strict importation and quarantine regulations, under which applications for import of exotic species must prove minimal environmental impact, listing an exotic species which is not present in Australia as a key threatening process would not further the aims of the EPBC Act in protecting Australian biodiversity.

The TSSC recommends the process be renamed: **'Changes to plant-pollinator associations caused by Large Earth Bumblebees, *Bombus terrestris'***

## Description

The following description is based on that provided in the nomination, with appropriate alterations consistent with the name change described above:

'Changes to plant-pollinator associations caused by Large Earth Bumblebees, *Bombus terrestris*' includes the impacts on native Australian ecosystems as a result of Large Earth Bumblebees:

- displacing native anthophilous (flower-feeding) animals, through competing for food;
- reducing pollination of native plants; and
- pollinating exotic plant species specifically adapted to bumblebees, leading to proliferation of plant weeds.

Large Earth Bumblebees were first reported in Tasmania in 1992, having been introduced illegally or accidentally. There are unconfirmed reports of bumblebee sightings from Victoria and Queensland, but no records from the mainland have been confirmed. Further introductions which could be matters of concern include: the spread of Large Earth Bumblebees from Tasmania to mainland Australia; the importation of more genetic material into Tasmania (including semen); and the importation of additional Large Earth Bumblebees from other countries to Australia.

Large Earth Bumblebees have a natural distribution in temperate zones throughout the northern hemisphere. They are large, primitive eusocial bees, which establish colonies in spring in underground nests. Colonies die at the beginning of autumn, when the queens mate and hibernate until the next spring. Since 1988, Large Earth Bumblebees have been used in many countries to improve pollination in greenhouse crops, particularly tomatoes. This is due to their pollination method which involves vibration of the poricidal anthers of flowers to extract pollen - "buzz pollination". This behaviour is practised by bumblebees and some solitary bees, including some native Australian bees, but not by honeybees.

## 2. How judged by TSSC in relation to the *Environment Protection and Biodiversity Conservation Act 1999* criteria

Section 188(4) of the *Environment Protection and Biodiversity Conservation Act 1999* states:

*A threatening process is eligible to be treated as a key threatening process if:*

1. *it could cause a native species or an ecological community to become eligible for listing in any category, other than conservation dependent; or*

2. *it could cause a listed threatened species or a listed threatened ecological community to become eligible to be listed in another category representing a higher degree of endangerment; or*
3. *it adversely affects 2 or more listed threatened species (other than conservation dependent species) or 2 or more listed threatened ecological communities.*

Information relevant to all three criteria is summarised here, while information specific to each criteria is included under the headings below.

Difficulties in assessing this process arise as it is a relatively recent event and the evidence available does not strongly prove a negative effect, only a possible potential to threaten listed species and broader ecological processes. A number of experts state there is insufficient or no evidence against any of the criteria to justify listing, some believing the evidence presented is circumstantial and conflicting. Others believe that although data is lacking there is a clear potential for impacts and that the nomination is comprehensive and balanced. Further views include that waiting for compelling evidence would mean leaving *Bombus terrestris* unchecked and that listing and abatement should occur as a precautionary measure.

Many experts believe there is potential for impacts through: competition with native animals for nectar and pollen; interference in pollination systems; and potentially activating sleeper weeds. These changes could alter the structure of ecological communities, especially those with specialised plant-pollinator relationships. The transmission of parasites and diseases is mentioned, however, no information is currently available on possible effects on native species. The actual impact of bumblebees depends on factors such as density, distribution, and temporal overlap on which limited or no data is currently available.

Other relevant expert comments on information and the data presented include that:

- there are "a few" plants previously not visited by honeybees which may have been an important exclusive resource for native bees that are now visited by bumblebees;
- bumblebees have particular plant preferences such that any impact would not be the same for all plants. Bumblebees prefer plants which are abundant and with good nectar supply and this varies from year to year;
- aggression in bumblebees is rare;
- pollen and nectar resources are ample for native species, so bumblebees will rarely, if ever, compete;
- there is little evidence of reduced pollination or seed set in plants due to changes in pollinators- even if bumblebees are not as good at pollinating after a single visit, this may be irrelevant in terms of eventual seed set, since individual flowers are likely to receive tens or hundreds of visits;
- other native animals can pierce the flowers (and rob nectar from) *Epacris impressa*; and

- the proportion of successfully pollinated, robbed flowers is not known.

There is insufficient information available to assess the likely impact of the process on weeds, and thus the likely resultant biodiversity impacts. Some experts comment that weeds with long-corolla tubes and or poricidal anthers will most likely benefit (e.g. Foxglove *Digitalis purpurea,* and Silver Leaf Nightshade *Solanum elaeagnifolium)*; and that *Bombus terrestris* is a major pollinator of the introduced Tree Lupin *Lupinous arboreus* and many other weeds including Broom and Gorse, and this is the most serious threat. The only weed species mentioned which currently occurs on the List of Weeds of National Significance is Gorse *Ulex europaeus*. One study in Tasmania found no evidence of a large impact on the weed potential of Tree Lupins, however it recommended the relationship between bumblebees and introduced flora be investigated further. Other experts point out that:

- there is no information on whether the weeds are pollinator-limited;
- it is unclear if seed production would be increased in plants which require buzz-pollination, or even if native buzz-pollinators already do this;
- it is not clear if increased seed production would result in more propagules in the landscape;
- there is no published report specifically linking bumblebees to weed spread, including in the United States where Whitehorse Nettle *S. elaeagnifolium* (included in the nomination as a potential sleeper weed) and *Bombus* spp. occur; and
- no evidence exists that either the number or distribution of weeds has increased in Tasmania since bumblebee establishment.

A number of experts believe honeybees affect pollination systems, and that, as bumblebees are social and operate in similar ways, it can be inferred they could have similar effects. However there is no consensus on the impact of the ubiquitous honeybee.

In November 2002 the NSW Scientific Committee made a Final Determination to list 'Competition from feral honey bees, *Apis mellifera L.*' as a Key Threatening Process under the *Threatened Species Conservation Act 1995*, based on competition for hollows, and competition for floral resources due to the widespread and abundant nature of this species in Australia and the competitive displacement of native fauna. Bumblebees do not however nest in tree hollows, and there are varied opinions as to their ability to spread and proliferate in Australia.

"The introduction and spread of Large Earth Bumblebee *B. terrestris* into Victorian terrestrial environments" was listed as a Potentially Threatening Process in Victoria in September 2000. This listing is based on the assumption that the bumblebee, in the absence of appropriate management, poses or has the potential to pose a significant threat to the survival of two or more taxa. The final recommendation states that bumblebees may compete for resources thus reducing the reproductive output of native fauna. The final recommendation further states that the Regent Honeyeater *Xanthomyza phrygia*, Black-eared Miner *Manorina melanotis*, and Swift

Parrot *Lathamus discolor* are listed as species 'which may be affected by the introduction of the bumblebee to Australia through resource competition'.

Many experts believe bumblebees will reach mainland Australia, whether through deliberate introduction, migration across islands, or as stowaways in agricultural produce. Experts differ in their opinion on the potential of bumblebees to become widespread and established across Australia, and in which habitats. Opinions vary from bumblebees having the potential to become common and widespread, to their being restricted to urban areas in temperate climates. Experts provided the following information and comments on bumblebee abundance and spread:

- as bumblebees do not store food, and require suitable nest sites, their ability to spread is limited;
- sightings of migrating queens do not mean establishment in an area, seasonal population density and individual sightings need to be distinguished from established presence;
- in Tasmania there are large unexplained distribution gaps, the reproductive success of the majority of nests in the bush is extremely low, and very high densities are only seen in suburban gardens;
- the density of bumblebees foraging beside honeybees (and native bees) in southern Tasmanian forests is relatively small;
- bumblebees would most likely not invade arid areas of mainland Australia; and
- higher relative numbers of honeybees and native bees in Australia may hinder bumblebee spread.

A study by Hingston *et al.* (2002) reported observations of Large Earth Bumblebees in all of Tasmania's major vegetation types, suggesting that they may have the capacity to establish colonies in a range of habitats. Evidence suggesting the establishment of colonies in National Parks and remote areas indicates that Bumblebees may not be entirely dependent on introduced garden plants as a food source.

The effects of an exotic pollinator may result in significant changes for ecological processes over time. Subtle differences in environmental conditions may also alter the level of an impact. Therefore robust determination of the impacts of bumblebees at a species or ecosystem level is difficult and extrapolation of experimental results should be used with caution. A number of experts advise 'suitable more rigorous research be initiated to strengthen claims of negative impacts.' A three-year study of environmental impacts by Hergstrom *et al* (2002), conducted on behalf of Horticulture Australia, investigated some of the interactions of bumblebees with flora in Tasmania. The results of this study showed that the impacts of bumblebees on the seed set of native and introduced plants is variable and depends on species, location and season. Further work is required to determine the impacts of bumblebees on ecological communities and species. In addition, a number of overseas studies, while clearly establishing the

invasiveness of the species, also reveal a lack of compelling evidence regarding the impact that Large Earth Bumblebees have on existing ecological processes.

## A. Could the threatening process cause a native species or an ecological community to become eligible for listing as Extinct, Extinct in the Wild, Critically Endangered, Endangered or Vulnerable?

The nomination and expert submissions contain information on potential pathways of impact and potential adverse effects on a range of species, but no information on the potential for any native species to become eligible for listing as a result of the process.

Some experts believe the process is likely to significantly increase extinction risk for many native flower-visiting animals, especially native bee species with narrow foraging profiles, through competition for floral resources; and that by 'adopting a precautionary approach, criteria (a) seems justified, as the process could cause native invertebrate, vertebrate and plant species to become eligible for listing'.

Contrasting expert views include that:

- preliminary surveys of native bees did not indicate abundance declines;
- there are no published studies in Tasmania showing any impact on survival, colony size or fitness of native bees;
- studies of competition are based on short-term observations of very limited replicates;
- changes in the behaviour of native bees in the presence of bumblebees do not necessarily mean competition and/or effects on survival and reproductive ability; and
- native bees have fluid distributions and opportunistic natures, so even if some displacement occurred temporarily, the areas could be recolonized from adjacent suburban gardens.

The study undertaken by Hergstrom *et al* (2002) considered the effect of bumblebees on the seed set of three native plant species (Common Heath, *Epacris impressa*, Bladder Pea, *Gompholobium huegelii* and Blue Gum, *Eucalyptus globulus*) and three weed species (Tree Lupin, *Lupinus arboreus*, Scotch Thistle, *Onopordum acanthium* and Greater Trefoil, *Lotus uliginosus*) in Tasmania. The results demonstrated that there was a significant increase in the seed set of Tree Lupin and Greater Trefoil in the presence of bumblebees, but a decrease in the seed set of Scotch Thistle. The impacts of bumblebees on the native flora species were variable. Seed set was higher for Common Heath in the presence of bumblebees, although it was not tested whether this was a result of bumblebees choosing sites with a greater concentration of flowers per stem. Bumblebees represented only 2% of the total number of potential pollinators at eighteen locations of Blue Gum and for Bladder Peas visitation rates varied dependent on season and locality but were generally at low levels (0-14%). These results demonstrate that the impacts of bumblebees will be dependent on species, season and

locality which makes it difficult to extrapolate the potential effects of bumblebees when localised effects are not yet clear.

Hergstrom *et al.* (2002) also examined the relationship between introduced and native pollinators. The data collected was presented as the number of individual pollinators of a species visiting a site and plant type per hour. Honeybees (*Apis mellifera*) were suggested to be the dominant pollinator, particularly at urban sites on introduced plants. Bumblebees were shown to be more populous than native pollinators on the introduced plants at urban sites that were surveyed, although at remote bush, rural and urban bush locations, native pollinators were significantly more prevalent than bumblebees. However, it is not clear whether these relationships are ecologically significant and how the change in numbers of different pollinators recorded between sites relates to pollination and reproductive success of flora species. The study did not explore the indirect or direct impacts of bumblebees on fauna species or at an ecosystem level. The results of the study do not provide comprehensive evidence to analyse the impact of Bumblebees on native species or ecological communities.

**Conclusion**: Based on the information provided and summarised above, TSSC considers that while potentially invasive, the ecological effects of this process on unlisted native species and ecological communities are not clearly defined or easily predicted, and that there are few quantitative data on actual or potential impacts. The information is considered insufficient to determine whether the threatening process meets this criterion at this time.

## B. Could the threatening process cause a native species or an ecological community to become eligible to be listed in another category representing a higher degree of endangerment?

The nomination lists three endangered species as being adversely affected by the process: Swift Parrot *Lathamus discolor*, Helmeted Honeyeater *Lichenostomus melanops cassidix*, and Regent Honeyeater *Xanthomyza phrygia*. The nomination asserts that Large Earth Bumblebees frequently consume nectar and pollen of the Tasmanian Blue Gum, *Eucalyptus globulus globulus*, and are therefore very likely to compete with Swift Parrots for non-renewable pollen resources, and may compete for renewable nectar resources. The nomination also claims that bumblebees may compete with Helmeted and Regent Honeyeaters for nectar resources. No further information is provided on the potential for these species to be listed in a category representing a higher degree of endangerment (i.e. critically endangered).

Bumblebees could pose a threat to endangered species especially if the competition mechanism is likely to be localised. *Bombus terrestris* densities can be highly variable; and the adoption of a precautionary approach, under criteria (b) may seem justified, as the process could cause listed vertebrate and plant species to become eligible for listing in a higher category. However, feeding on the same floral species at some time is not evidence of a negative impact. It is also worth noting that the Action Plan for Australian Birds 2000 does not include competition from insect nectarivores as a potential or current threat to these three bird species.

The Swift Parrot breeds only in Tasmania, with its breeding range largely restricted to the east coast within the range of the Tasmanian Blue Gum, and its breeding season coinciding with flowering. Nectar of this tree is the main food source during breeding, with breeding success varying from year to year depending on the intensity and extent of flowering. In times of poor Blue Gum flowering the Swamp Gum, *Eucalyptus ovata*, is also used.

The addition of bumblebees as a further competitor (along with introduced honeybees) in heavily reduced and fragmented habitat, may be a threat to Swift Parrots. Visits to Blue Gum and Swamp Gum mean competition is highly likely, and, if bumblebees restrict the already limited number of years where nectar is sufficient for breeding, parrot recruitment could be reduced. Conversely, the Swift Parrot Recovery Plan 2001-2005 does not include competition from insect nectarivores as a potential or current threat to the species. It is unclear the impact that bumblebees are potentially having on the nectar availability from Blue Gums, with sightings of bumblebees in Blue Gums on the east coast still apparently very low. Numbers would need to be consistently high on the east coast concentration of Blue Gums to indicate a potential threat. Hergstrom *et al.* (2002) reported that bumblebees represented only two percent of the total number of potential pollinators observed at eighteen locations surveyed. Whilst this does not determine whether bumblebee impacts are significant in limiting food availability for native species, it does suggest that other factors such as habitat degradation may be a greater threat to the Swift Parrot. Other experts comment that eucalypt flowering is very sporadic; does not usually coincide with bumblebee colony cycles; and that birds already have to compete with other fauna for nectar.

Neither Regent nor Helmeted Honeyeaters occur in Tasmania, however, some experts believe these species would potentially be at risk if bumblebees reached the mainland. As summarised above, there is limited and conflicting information and opinion on the potential for bumblebees to become widespread and established across mainland Australia and to invade many varied habitats.

Nectar is the principal food of Regent Honeyeaters, but sugary exudates from insects are also used, and insects are essential for breeding. The Regent Honeyeater Recovery Plan identifies increased competition from other nectarivores (including honeybees) as a postulated cause of decline, but quotes studies that conclude that aggression between nectarivores is not at a level which would significantly reduce survivorship or breeding success. The diet of Helmeted Honeyeaters consists primarily of invertebrates, lerps and manna. The Recovery Plan for this species indicates that shortage of nectar during winter due to vegetation removal was previously thought to be one reason for decline of this species, but research has since discounted this hypothesis. Resource competition which could change the conservation status of the honeyeaters would depend on bumblebees successfully competing for limited food resources, to the extent that survival and or recruitment in bird populations is reduced. No information is currently available to determine the extent of any possible impact on these honeyeaters due to bumblebees should they become established in mainland Australia.

**Conclusion**: TSSC considers that, based on the information provided and summarised above, the potential for this process to cause the Swift Parrot, Helmeted Honeyeater or Regent

Honeyeater to become eligible for listing in a category representing a higher degree of endangerment, is not sufficiently known, nor easily predicted. The information is considered insufficient to determine whether the threatening process meets this criterion at this time.

## C. Does the threatening process adversely affect 2 or more listed threatened species (other than conservation dependent species) or 2 or more listed threatened ecological communities?

The nomination lists three endangered species as being adversely affected by the process: Swift Parrot, Helmeted Honeyeater, and Regent Honeyeater. Information and expert opinion on the impacts of the threatening process on these species is summarised above.

Although the information and expert opinion is not clear enough to determine whether the process could cause these species to become eligible to be listed in a category representing a higher level of endangerment, there is sufficient information to judge whether the process is currently adversely affecting these species.

Evidence of any effect on the Swift Parrot is extremely limited, with a negative impact inconclusive. As neither Regent nor Helmeted Honeyeaters occur in Tasmania, there are no current effects on these species, only potential impacts based on bumblebees reaching the mainland, establishing themselves in large numbers in the habitats of these species, and successfully competing for food resources and thus reducing survival and/or recruitment rates.

**Conclusion**: Based on the evidence provided and summarised above TSSC considers that:

- although the process may be adversely affecting the listed Swift Parrot, there is, as yet, no evidence of an effect; and
- the process is not currently adversely affecting the Helmeted Honeyeater or the Regent Honeyeater.

The threatening process is not adversely affecting at least 2 listed threatened species and is therefore not eligible under this criterion.

**Conclusion** - The process **does not meet s188(4)(c) of the EPBC Act**. There is **insufficient evidence at this stage to determine whether the process meets s188(4)(a), (b) or (c) of the *EPBC Act***.

# 3. Recommendations

1. TSSC recommends that the name of the threatening process to be considered for listing as a Key Threatening Process be altered to:
   **'Changes to plant-pollinator associations caused by Large Earth Bumblebees, *Bombus terrestris*'**

2. TSSC recommends that 'Changes to plant-pollinator associations caused by Large Earth Bumblebees, *Bombus terrestris*' is not eligible for listing as a Key Threatening Process under the EPBC Act.
3. The Committee regards the introduction of any exotic species as a potential environmental risk, noting that in Tasmania, the bumblebee has become widespread in both modified and natural systems. However, on the data available, insufficient impact has been detected, and therefore the Committee recommends that the threatening process cannot be listed at this time. The Committee urges that extreme caution be shown in considering any proposal to introduce this species to the mainland. In taking this position, it highlights the concern that many native species are dependent on native pollinators, so it could potentially be a threat in the future.

## Publications used to assess the nomination


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