Submission to the Senate Standing Committees on Environment and Communications

An inquiry into the risks and opportunities associated with the use of the bumblebee population in Tasmania for commercial pollination purposes.

Submission from the Tasmanian Institute of Agriculture & University of Tasmania (School of Land & Food)

The Tasmanian Institute of Agriculture in conjunction with the University of Tasmania, School of Land & Food welcomes the opportunity to respond to the inquiry into 'The risks and opportunities associated with the use of the bumblebee population in Tasmania for commercial pollination purposes'. TIA supports an open dialogue and can provide further details as needed.

ABOUT THE TASMANIAN INSTITUTE OF AGRICULTURE

The Tasmanian Institute of Agriculture (TIA) is Tasmania's joint State Government/University agricultural research agency. This unique partnership has brought together the human and physical resources of the Tasmanian Government with the scientific research and teaching capacity of the University of Tasmania to create a centre of excellence in agricultural research, development, extension, education and training.

TIA's horticultural researchers maintain intimate industry collaboration through industry participatory research for knowledge exchanges that contribute to co-learning, industry development and/or informed policy. The group specialises in embedded research, both foundational and applied, which provides industry 'ground truthing' at the earliest juncture in the research process and enables identification of multiple intervention points in achieving well-defined outcomes.

Please note that the opinions expressed in this submission reflect broad consultation with staff from TIA and School of Land and Food and do not necessarily represent the institutional position of either the University of Tasmania or the Tasmanian Government.

SUBMISSION PREPARED BY

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EXECUTIVE SUMMARY

- The European bumblebee (*Bombus terrestris)* has spread throughout all of Tasmania since its first sighting in Hobart in 1992.
- Given the existing invasive bumblebee population is already widespread, commercial bumblebee production is unlikely to create unintended ecological impacts, affect biodiversity or create changes in the conservation status of species or ecological communities.
- The commercial stock for bumblebee production should be exclusively sourced from the existing invasive population in Tasmania.
- Bumblebees should not be introduced to mainland Australia.
- The level of adoption of bumblebee pollination services in Tasmania is most obvious for enclosed cropping systems. Commercial bumblebee hives are also marketed overseas to work outdoors alongside honey bees thereby ensuring adequate crop pollination, especially during cold, inclement weather periods; that is, under conditions that honey bees seldom forage.
- It is conceivable that a small to medium scale bumblebee hive production industry could be developed for the state but the economics of this remains unclear.
- The current legislation is a major impediment to anyone wanting to conduct any research on bumblebees that necessitates setting up a bumblebee colony. This needs to be rectified.
- The lucrative returns for beekeepers for honey, and especially leatherwood honey, together with the current relative size, scale and timing of the Tasmanian agricultural sector creates significant supply issues for managed honey bee pollination services in Tasmania. Given forecast growth in the Tasmanian agricultural sector commercial bumblebees may help alleviate some of these supply issues.
- All native Tasmanian bee species are solitary and therefore cannot provide the intensive pollination services required in commercial settings.

(a) existing distribution and population density of exotic bumblebees

- Since the first sighting in Hobart in 1992 of the European bumblebee (*Bombus terrestris*) it has spread throughout Tasmania from sea level to mountain tops, and offshore islands such as Cape Barron and Maatsuyker Island. It is estimated to have spread at least 20km per year in its dispersive phase and had spread throughout Tasmania within at most 14 years.
- Bumblebees have been observed foraging in Tasmania at native flowers in natural habitats as diverse as saltmarshes and alpine heathlands. Similarly, garden flowers of temperate European origin are very common in domestic gardens and are well visited by bumblebees (e.g. lavender).
- The Tasmanian population's gene pool is less than half of the allelic richness and levels of heterozygosity that endemic populations of *Bombus terrestris audax* (the subspecies it came from via New Zealand) have in the United Kingdom. It established from possibly as few as two invasive mated founder queens.
- Population density varies around Tasmania but is not well studied. Anecdotally, populations are highest in or near human settlements, but locally high populations have been observed in rural environments such as the Midlands between Hobart and Launceston.

(b) productivity and economic benefits of the commercial use of bumblebees for agricultural producers

- In most other parts of the world, bumblebees are harnessed for their capacity to efficiently pollinate certain crops, especially in glasshouses. To this end, producers overseas use several species of bumblebee (including *B. terrestris*) to bolster crop yields. Buzz pollination services performed by bumblebees are known to increase both yield and fruit quality (size, weight and shape) in plants such as blueberries, tomatoes, capsicum, eggplant and kiwi fruit that have evolved to require this form of

pollination. Buzz pollination is carried out by only certain bee species and is where bees rapidly contract their flight muscles, producing strong vibrations that forcibly expel pollen from the flower's anthers. Increases in agricultural productivity derived from bumblebee pollination services in glasshouses are well documented. Investigations of the magnitude of these yield increases when compared to honey bee (*Apis mellifera*) pollination have demonstrated significant increased returns to growers; tomato (19%); capsicum (6%); eggplant (25%); cucumber (22%); raspberry (8%) and strawberry (13%) to name but a few.

- Despite glasshouse and protected horticulture production in Tasmania being relatively small in scale compared to mainland Australia, significant increases in crop yield and farm profits are expected with the use of bumblebees in Tasmanian enclosed cropping systems. Further, there is considerable scope to increase protected horticulture and glasshouse production particularly in Tasmania as evidenced by the recent major expansion in berry fruit under protected cropping. The impact that increases in pollination productivity and glasshouse expansion will have on the State's economy in real terms is still unclear.
- The impact bumblebee pollination has on field crops including apples and cherries is currently less quantified. Commercially, sourced bumblebee hives are used overseas in various fruit crops in conjunction with European honey bee hives. It is believed that bumblebee hives promote adequate crop pollination during cold, inclement weather periods; that is, under conditions that honey bees seldom forage. However, further research would need to be conducted to assess the economic viability of this practice.

(c) potential environmental impacts associated with the commercial use of bumblebees

- The commercial use of bumblebees is most obvious for contained glasshouse environments. Scope for use of bumblebees may also exist for enclosed tent pollination of hybrid seed crops and under netted pollination environments (such as bird netting in orchards) where honey bee hive health declines and apiarists lose significant opportunity for honey production. More widespread use in open cropping environments is dependent on comparative costs and benefits of bumblebee and/or honey bee hives for growers and the willingness of honey bee apiarists to service the pollination sector in Tasmania over currently more profitable honey flows, especially leatherwood. Overseas, biocontrol companies such as Koppert and BioBest do market bumblebee hives for use in open cropping pollination where they are recommended to be used in conjunction with honey bees to supplement potential pollination deficits.
- There is evidence of commercial bumblebee hive populations in Europe escaping into the environment, intermixing with the endemic gene pool of the same species of bumblebee and vectoring pathogens to endemic bumblebees. It is suggested that escapes are most likely to be of gynes (males) that are mating with endemic queens. In the case of the proposal for Tasmania, there are no endemic bumblebees other than the existing invasive population. The invasive population has only one documented parasite or pathogen, a host specific mite. As the commercial stock would be sourced from the existing invasive population there would be no impact on the invasive gene pool.
- Overseas, *Bombus terrestris* has proven to be a highly invasive species with unregulated commercial pollination escapes invading Japan and parts of South America, including Chile and Argentina.

(i) impact of the conservation status of a species or ecological community

- As outlined immediately above with the existing invasive population already widespread, commercial bumblebee production is unlikely to add any additional impact on the conservation status of other species or ecological communities.
- More generally the invasion of the bumblebee in Tasmania has had limited empirical studies undertaken on this question. In some flowers such as native heath (*Epacris impressa*) bumblebees have been observed as nectar robbers, stealing nectar from flowers but not successfully causing pollination in the process. Similarly, some reduction of available nectar due to bumblebee consumption in local areas is also hypothesised in regions where nectar is in short supply but this has not been quantified.

(ii) impact on biodiversity

- As outlined above with the existing invasive population is already widespread and commercial bumblebee production is unlikely to add little, if any additional impact on biodiversity.
- More generally, there is limited information on this question in relation to the impact of the existing invasive bumblebee population in Tasmania. Concerns have centred on declines in local biodiversity due to competition for food and living space with native species.

(iii) unintended ecological impacts,

- As outlined above with the existing invasive population is already widespread and commercial bumblebee production is unlikely to add any additional impact to unintended ecological impacts.
- More generally studies in this area have focussed on enhancement of fecundity of certain weeds that are more effectively pollinated by buzz pollination which is undertaken by bumblebees. For instance foxglove (*Digitalis purpurea*) will dispense greater numbers of fertile seed as a result of pollination by bumblebees with which it is likely to have co-evolved in the northern hemisphere. Longer foraging distances by bumblebees than native pollinators may also alter gene flow in communities, though this remains untested.

(iv) contribute to a wider distribution of bumblebees

- Given the already widespread distribution of bumblebees in Tasmania, the commercial use of bumblebees in Tasmania will not result a wider distribution of bumblebees in the state.
- The commercial stock should only be sourced from the existing invasive population in Tasmania.
- In terms of colonisation of any new area, it is the queens (one per commercial hive) that would be most relevant. Queens, however, do not forage but remain in the hive and as an added precaution hives can be fitted with a queen gate or similar device to prevent the queens leaving the hive. At the end of a hive's life, new sexuals (queens and gynes) are produced. Precautions such as the fitting of queen gates (where it is possible that small queens and gynes may still escape) and destruction of hives before new queen production can be undertaken to minimise queen dispersal. Furthermore in glasshouses, ventilation points may be netted to prevent escape from the glasshouse. For sexuals produced in a commercial hive the timing of escape is relevant as they must be in synchrony with the invasive bee population's sexuals which are only produced in autumn.
- Recommendations for hive use in Tasmania could mandate fitting of queen gates and managing of commercial hives to prevent production of sexuals to minimise escapes.

(d) implications for Australia's biosecurity regime of any approval to use bumblebees in Tasmania for commercial purposes

- Bumblebees should not be introduced to mainland Australia. Overwintering mated queens are the stage most likely to be invasive and are of most concern for biosecurity. However, commercial use of bumblebees in Tasmania is unlikely to add significantly to this risk.
- Currently there is a risk that overwintering mated queens from existing invasive populations around farms, towns and ports might stow away on exported products or machinery. Pre-export quarantine officers in Tasmania need to be alert to this possibility in their inspection protocols. This is regardless of whether or not bumblebees are used commercially.
- Despite attempts from researchers at the University of Tasmania to get known floral volatile lures attractive to bumblebees to be deployed around the port of Melbourne, responsibility for doing so did not come under the brief of any state or federal biosecurity agency and the suggestion was not followed through by any agency. We strongly feel that lures should be deployed as a first point of monitoring and control of any possible mainland bumblebee incursion from Tasmania.

(e) potential economic outcomes

- It is anticipated that due to the increased production levels initiated by the enhanced pollination services outlined above, that increased employment in these industries may be required for crop harvesting and subsequent cold chain logistics.
- Aside from the significant economic benefits to the Tasmanian horticultural sector, there remains the possibility of a small to medium scale bumblebee hive production industry to be developed within the state. This could be undertaken by either the State's beekeeping industry, whose extensive knowledge of crop pollination would seem best suited to this role, or by other commercial parties.
- The seed bumblebee stock of any commercial hives should be sourced only from extant Tasmanian populations. It is envisaged that production of hives would positively impact on the state's economy due to increased employment. This industry could be partnered with an existing overseas bumblebee provider who has extensive knowledge of rearing and bumblebee housing or developed independently.
- Commercial bumblebee colonies can be more broadly managed in the same manner as commercial European honey bee (*A. mellifera)* hives, with hives easily moved between cropping systems. Moreover, as bumblebee colonies shrink to dormant queens over winter, there is less cost involved in maintaining colonies over the unproductive period of the year.

(f) effectiveness of alternative pollination options

European honey bee (*Apis mellifera*)

- Honey bees do not forage (and therefore pollinate) in cold (< 15° C), inclement weather or during rain events. This can create problems with the pollination of several field crops, including apples, berries and cherries, if such conditions are experienced during their pollination window. On numerous occasions this issue has limited crop yields and farm profits in Tasmania. Access to commercially sourced, full strength bumblebee hives during the pollination window would increase the likelihood of adequate pollination in field crops being achieved during such weather conditions.
- Honey bee management in glasshouse settings is regarded as difficult due to the aggressive nature of the European honey bee, potential human health issues caused by bee sting allergies and the restricted diets available within glasshouse settings that have deleterious effects on honey bee health. These negative effects on bee health are largely deemed unsatisfactory by most beekeepers, who rely on maintaining and/or increasing hive strength to maximise honey and honey bee production later in the season.
- *Apis mellifera* cannot buzz pollinate and therefore provide the pollination success observed with facultative buzz pollinators such as *Bombus terrestris*.

Other bee species

- All native Tasmanian bee species are solitary and therefore cannot provide the intensive pollination services required in commercial settings. Research has been conducted in South Australia into the efficacy of native blue-banded bees (species of the genus *Amegilla*) as pollinators of glasshouse crops. Although these are efficient buzz-pollinators of a variety of flowers they are absent from Tasmania. Therefore, the use of this species is not an option to Tasmanian growers.

Non-bee methods of pollination

- Alternative pollination options other than other bee species at present include the use of commercially available electric pollination wands and hand pollination of each flower on the plant. Both methods are labour intensive and costly, but are arguably viable in small or specialised operations such as plant breeding.

- Several studies have demonstrated that greater pollination rates and higher quality fruit are achieved with wand pollination compared to honey bees. Pollination wands work by vibrating/sonicating flowers in a fashion similar to bee induced buzz pollination. Despite the success of these wands, greater yields and better fruit quality are still achieved by bumblebees. Furthermore, the labour cost of having to physically vibrate each flowering stem within the crop is significantly higher when compared to the cost of a bumblebee hive/s which may provide daily pollination services for up to 8 weeks.
- Hand pollination is currently in use in some countries, such as India and China, where low wages enable this activity to be cost effective. However, due to high wages in Australia this practice is not cost effective on a commercial scale unless being used for plant breeding.

(g) other related matters

- The current federal legislation Section 303GN of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) states that it is an offence for someone to have in their possession a specimen that was not lawfully imported. As the bumblebees were not lawfully imported, their possession and use would be an offence and individuals are liable to jail and significant monetary fines.
- The legislation is a major impediment to anyone wanting to conduct research on bumblebees that necessitates setting up a bumblebee colony. This research includes environmental research requiring manipulation of bumblebee numbers, pollination research to quantify their impact, and economic research to ascertain the viability of the limited gene pool for commercial rearing and associated rearing costs. Furthermore, bumblebees are ideal models for a joint CSIRO -University of Tasmania project currently underway developing tracking sensors for mounting on flying insects because of their larger size and social behaviour where they return to a hive regularly. None of this work can be undertaken under the current legislation.
- The lucrative returns for beekeepers for honey, and especially leatherwood honey, together with the current relative size, scale and timing of the Tasmanian agricultural sector requiring managed pollination services makes it a somewhat precarious industry. Where honey bee hives are deployed under protected environments (e.g. orchard bird netting), hive health declines; and when coupled with the use of agrochemicals on farm sites, providing pollination services is seen by Tasmanian beekeepers as high risk. This conflict and lack of a developed pollination services industry in Tasmania may see the loss of financially important crops in the Tasmanian economy such as hybrid vegetable seeds to mainland Australia where pollination services are on a scale to be more lucrative. Bumblebees, where honey production is not an issue, may provide a valuable service and return for pollinator providers to ameliorate this issue in Tasmania. The University of Tasmania currently has a research proposal under consideration by the Rural Industries Research and Development Council (RIRDC) in 2016 for funding to measure and improve honey bee hive health under netting using bee mounted sensors.
- If *Varroa* mite invades Australia then the significant pollination services of feral honey bee populations will be lost, costs of managed honey bee populations will rise and a pollinator deficit is probable in the agricultural industry. Bumblebees, along with some native bees, may be able to act as insurance pollinators in Tasmania as they are not impacted by *Varroa* mite.
- Tasmania has a rapidly expanding agricultural sector (eg cherries, vegetable seeds, etc) heavily dependent on pollination. Servicing this sector will be of paramount importance to this expansion.

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