Submission on the interim national priority list of exotic environmental pests and diseases

Invasive Species Council

October 2019

Submission details

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About the Invasive Species Council

The Invasive Species Council was formed in 2002 to advocate for stronger laws, policies and programs to keep Australian biodiversity safe from weeds, feral animals, exotic pathogens and other invaders. We are a not-for-profit charitable organisation with over 2500 supporters. Our work is almost entirely funded by donations from supporters and philanthropic organisations.

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Contents

1. Support for interim list

The Invasive Species Council welcomes public consultation on the preparation of the priority list of exotic environmental pests and diseases.

We support the interim list as the first endeavour to identify environmental risk priorities across all species groups. It is a good starting point for future development of a more comprehensive list of environmental biosecurity risks for Australia.

The priority list will be important to drive preventative biosecurity activities such as import controls, border detection, in-country surveillance and contingency planning. Stopping a pest or disease from entering Australia is the most practical and feasible way to stop new invasive species from harming our environment. It is usually far cheaper too.

However, prioritisation should not be restricted to just five to seven species per theme, since these are undoubtedly not the only high-risk species. Within all themes, there is likely to be a considerably larger number of high risk species. As discussed below, a more comprehensive prioritisation process will yield a more useful set of priorities for a variety of biosecurity purposes.

We see value in grouping species under a broad range of themes, as has been done for this first priority list, and we commend the short profiles about each priority species. The survey question about how people may use the list is likely to yield useful information.

On a minor note, we believe that the definition of 'exotic to Australia' (page 7, information paper) should be changed. This use of the term 'exotic' is completely different to its use throughout the world. It is commonly accepted that a species can be exotic in Australia irrespective of whether it is under control or not. Any imported animal or plant species not originally native to Australia is an exotic species to Australia. A different term should be used.

2. Need for a more comprehensive approach

The Australian government's first priority list is a good starting point for future development of a more comprehensive priority list that more thoroughly considers environmental biosecurity risks and includes, as discussed below, a strong focus on high-risk pathways.

A more comprehensive identification of high-risk species and pathways will more accurately reflect the biosecurity challenges involved in Australia meeting its ‘appropriate level of protection’ – a high level of sanitary and phytosanitary protection aimed at managing and reducing biosecurity risks to a very low level, but not to zero.

The rationale for restricting the priorities list to just five to seven priorities per thematic group has not been explained, and we see no need for this numerical restriction. Consistent with Australia’s ALOP, the biosecurity focus should be on species that exceed a certain threshold of risk rather than just the top few. Within a larger list, it would of course be useful to indicate the highest priorities, but based on level of risk rather than an arbitrary number.

Restricting the priority list in this way means that one of the purposes of the priority list, namely to ‘inform more efficient and effective targeting of activities and resources’, will not be met. This process, while useful as a case study exercise or representative sample of a broader suite of high risk species, is not efficient for targeting biosecurity efforts because the likelihood of the identified species arriving cannot be quantified and there could be other species with a higher likelihood of arriving.

In some biosecurity processes, it would be useful to focus on the top few priorities, but in others a more comprehensive list of priorities is useful – for example, for import risk analyses. Australian biosecurity will unnecessarily be hamstrung by focusing on just half a dozen or so top priorities in each theme.

The recently completed Australian priority marine pest list (MPSC 2018) exemplifies the limitations of the priority list in the marine thematic group. The MPSC identified six exotic marine pests of national significance, three of which are not on the priority pest list: *Rhithropanopeus harrisii/*Harris’ mud crab, *Perna perna/*brown mussel and *Perna canaliculus/*New Zealand green-lipped mussel. Additional candidate species reviewed during the priority list process were rejected solely because it was decided it was not feasible to eradicate them should they establish. While this is a relevant factor when considering a response to an outbreak, it is not a good reason to reject them as a biosecurity priority.

The insect prioritisation project undertaken by the Invasive Species Council and Monash University highlights even more the limitations of a small list of priorities.

The draft priority list features just five insect species: Asian gypsy moth, Formosan subterranean termite, red imported fire ant, electric ant and harlequin ladybird. All except the latter are already recognised biosecurity priorities in Australia, so are unlikely to drive additional biosecurity work. By a different process, the Monash/ISC insect project researchers compiled an assessment pool of about 250 insect species for which there was sufficient published evidence of negative environmental impacts overseas to enable priority assessment by an IUCN-developed method, the Environmental Impact Classification of Alien Taxa (EICAT). Of the 100 species so far assessed, about three-quarters have concerning impacts on biodiversity somewhere in the world (see attached report):

- 29% are ‘of substantial concern’ (based on being rated as ‘massive’ or ‘major’ in the EICAT assessment)
- 47% are ‘of concern’ (based on being rated as ‘moderate’ or ‘minor’ in the EICAT assessment)
- 11% are ‘of minimal concern’ (based on being rated as ‘minimal’ in the EICAT assessment)
- 13% are ‘data deficient’.

Although these species haven’t yet been assessed for their specific risks to Australia, these results indicate that there are far more than 5 insect species that Australia should prioritise in biosecurity. There are overlaps with the shortlisted species considered for the national priority list, but many concerning species, including of ‘substantial concern’, are not in the shortlist. It is particularly surprising that there are only two ant species on the shortlist, both already in Australia and subject to eradication. The Monash/ISC project highlighted the extremely high invasive risks of ants and social bees and wasps (social Hymenoptera) (see the attached case study). So dominant are ants as harmful invaders – both here and overseas – that they should be prioritised as a group.

There were some limitations in the phase 1 short-listing process. It relied on a species being ‘recorded as an invasive by two or more national, regional or global lists’. This would exclude some species for which there is evidence of harm. National, regional and global lists may not include all known invasive species that impact on the environment because a) these lists have historically been biased towards invasive species that impact on agriculture, b) there is often a lag between a species invading a new area and it being listed, and c) many developing countries have poorly developed biosecurity systems and weak-to-non-existent lists. Also, a species on one country list could be just as concerning as a species on two or more lists – for example, if it is in the early stages of spread or is attacking species relevant to the Australian environment. A more comprehensive shortlist could be obtained by also searching the scientific literature and not disregarding species listed in one jurisdiction.

Phases 2 and 3, using expert elicitation, relied on expert knowledge of known impacts. This inevitably biases the result towards better-studied species that have caused extensive damage elsewhere. The outcomes also depend on which experts are involved.

Because there has been little prior work to identify priority risks in taxa groups such as insects and fungi, the information from which to select priorities in these groups will be far less comprehensive than those in better studied groups such as vertebrates and plants. These deficiencies of knowledge should be clearly acknowledged when presenting results.

There is need to provide further clarity about what the list represents.

The information paper states that the priority list is ‘a prioritised list of species that have been assessed to be of high risk to Australia for the focus of further action’... ‘to highlight and prepare for the sort of environmental biosecurity risks that Australia faces’.

This wording suggests that the priority list and the longer published lists are a definitive list of high-risk species. This is not the case. It is important to clearly communicate that the list is a subset of known high risk invasive species. It may be better stated as a list of 'some' high risk species or 'exemplar' high risk species.

The priority list is introduced as an 'Interim list' on the public consultation website. The term 'interim' is not explained. It should be clarified whether this applies only while the priority list is in draft form, or because it is intended to expand the list in future.

Recommendations:

- The government acknowledges that this is the first step in developing a comprehensive priority list.
- The government aims to expand the priority lists to include all species exceeding a certain threshold of risk rather than restricting the lists to an arbitrary number of species.
- The government uses existing work on priority species, including the shortlisted species for the national priority list, the MPSC work on marine priorities and the Monash/ISC work on insect priorities, to initially develop a more comprehensive list of biosecurity priorities, using a methodology developed in partnership with an academic expert.
- Clarify in public communications that the current priority list is a subset of high-risk potential invasive species and that the list is interim while a more comprehensive list of priorities is developed.

3. Importance of a pathways focus

For effective biosecurity, it is important to combine a species-focused approach with a strong pathways focus. This is particularly the case for species groups, such as insects and fungi, for which there is a large pool of potential invaders that spread by unintentional pathways and very limited taxa-specific information.

One of the major benefits of systematically identifying high risk species for which there is some information are the insights this can yield about high-risk pathways by which both known and unknown high-risk species are likely to establish in Australia. Due to a lack of studies overseas on invasive species impacting the natural environment, as well as unique aspects of Australian ecology, there are likely to be many more high risk species than can be identified through publications, in addition to many species that haven't yet emerged as invasive. A strong pathways focus increases Australia's capacity to prevent the arrival of a greater proportion of high risk species, both known and unknown. For example, preventing new insects invasive in the natural environment will require a priority prevention focus on 10 unintentional pathways, based on global pathways analysis in the Monash/ISC project.

Although the profiles for each of the prioritised species in the interim priority list includes information about pathways, it does not present any analysis on high-risk pathways. We recommend this analysis is conducted based on available pathways information about all known invasive species with environmental impacts supplemented with Australian-specific information about pathway detections.

Recommendation:

- Identify high-risk pathways by conducting pathways analysis for all invasive species with environmental impacts.

4. Importance of a public database

The prioritisation project has generated important information useful for biosecurity workers, stakeholders and researchers. As such, and being publicly funded, the data generated should be made available in a public database.

This is important also for transparency and credibility. Comprehensive information about the process by which the results were produced should be in the public domain as well as the full list of species assessed, the results of the three project phases – shortlisting, expert screening and priority listing – and the reasons for all decisions. It should include the data from the work reported on in Evans et al (2017).

Transparency will improve confidence in the process and its results and enable the process to be repeated. The data would assist further research, facilitate other applications and enable a focus on other potentially harmful invaders.

Recommendation:

- Make all data, decisions and evidence relied on for decisions leading to the priority list available in a public database.

5. Improving future prioritisation

To achieve effective biosecurity it is, of course, important to apply best practice methods for identifying biosecurity priorities. The aim should be to apply (or develop) methods that are comprehensive, robust, repeatable, updateable and transparent.

Prioritisation for the natural environment should also be ecologically based. One common feature of environmental invasions is the complexity of interactions (often involving multiple species and habitat types), which makes predicting environmental impacts much more difficult than predicting agricultural impacts. It is often straightforward to predict agricultural impacts because the same plants and animals are typically farmed all over the world and there is often only one type of interaction responsible for the impacts.

One of the benefits of EICAT assessment process applied in the Monash/ISC project is that it is based in ecology. The scheme was developed by the IUCN as a transparent and standardised way to prioritise invasive species based on ecological impacts. Invasive species are classified according to the mechanisms by which they cause impacts – for example, competition, predation, hybridisation with native species, disease transmission – and assigned to one of six impact categories, ranging from minimal to massive (and including data deficient), based on the maximum impact documented for the species anywhere in the world. The categories are based on the invasive species' impacts on native species populations (declines or extinctions), and community structure and ecosystem composition (reversible or irreversible changes). Another benefit of applying the IUCN method is that it will facilitate data-sharing worldwide and the development of compatible databases.

There are a number of methods that can be used for prioritisation. Because the robustness of selected priorities depends on the process by which they are determined, it is important to fully consider the options, understanding their strengths and weaknesses, as the basis for selecting a prioritisation method. Working with an experienced academic to design a prioritisation methodology will produce a more robust, scientifically rigorous and systematic approach to prioritisation. Examples of suitable expert bodies in Australia that could do this work include the McGeogh Lab at Monash University and CEBRA at Melbourne University.

Recommendation:

- The agriculture department commission an independent scientific review of potential methods for assessing environmental priorities. Aim to apply best practice prioritisation methods that are comprehensive, robust, repeatable, updateable and transparent.

6. Reference to national significance

The prioritisation process relied on ‘national significance’ criteria. This should be reviewed in light of the narrow definition of national significance. These criteria are too narrow to fully encompass significant harmful environmental consequences of invasive species.

In our submission to the draft NEBRA (National Environmental Biosecurity Response Agreement) review (July 2019), endorsed by 12 other organisations, we argued that the national significance test needs to be broadened as follows:

The precautionary approach should be included and the following elements added:

a) Nationally important species:
   - Species that could become threatened as a result of the pest or disease
   - Species listed under state or territory laws where the species is present only in those states or territories, by the IUCN, or otherwise considered to be threatened

b) Nationally important places:
   - Protected areas such as national parks and marine parks

c) Ecologically valuable places including:
   - Ecological communities listed as threatened under federal, state or territory laws or otherwise known to be threatened
   - Ecological communities that could become threatened as a result of the disease or pest
   - Offshore islands with conservation values
   - Wetlands listed in The Directory of Important Wetlands in Australia

Recommendation:

- A more expansive definition of nationally significance be used, including adoption of the precautionary approach and nationally important species and places and ecologically valuable places.

7. Reference to other response deeds

It is important to recognise that the priority list is relevant to all response agreements not just NEBRA. This is not well explained in the information paper.

The hierarchy of response agreement means that NEBRA is only triggered if other emergency response deeds are not triggers. Some pest and diseases that are on the environmental priority pest list may trigger the plant and animal industry emergency deeds and the soon to be finalised marine and agricultural weed response agreements.

8. References

MPSC 2018, Australian Priority Marine Pest List: process and outcomes, prepared by ABARES, Canberra, May.

Evans, J, Brazenor, A, Hennecke, B & Parsons, S 2017, *Exotic invasive species: identification of species with environmental impacts,* ABARES technical report 17.3, Canberra, August.

9. Attachments

Invasive insects: risks and pathways project information sheet

World's worst insect invaders: social Hymenoptera information sheet

INVASIVE INSECTS

Risks and Pathways Project

Preliminary results and biosecurity implications, June 2019

Australia can't afford to allow in any more colonists of the likes of red fire ants, electric ants, browsing ants, yellow crazy ants, Argentine ants, African big-headed ants, Asian honey bees, large earth bumblebees and German wasps. These invasive insects are costing both the Australian environment and economy dearly.

Given the difficulties and costliness of eradicating or controlling invasive insects, one over-riding priority for Australian biosecurity must be to prevent more harmful species arriving and establishing. To do this, biosecurity authorities need to know which insects overseas represent the greatest invasive risks for Australia and how they are likely to arrive here. They already know which insects are the prevention priorities for agriculture, but there is no such list of insect prevention priorities for the Australian environment.

In 2017, with funding from the Ian Potter Foundation, the Invasive Species Council and the McGeoch Research Group of Monash University embarked on a project to fill that gap. Additional funding came from the Australian Government and the Queensland Government.

Our first objective was to identify high-priority potential insect invaders to Australia that could harm the natural environment, and their likely impacts and pathways of arrival. A second objective was to establish a best-practice process (comprehensive, robust, transparent, repeatable, updateable) for identifying environmental biosecurity priorities (high-risk species and pathways) for all species groups.

The first step was to synthesise the scientific knowledge of invasive insect species causing environmental harm anywhere in the world. Evidence of harm elsewhere is the most reliable way to predict potential invasive species. For each of the invasive insects for which there is sufficient evidence in the scientific literature of their environmental impacts, we described and rated the severity of these impacts based on a scheme developed by the International Union for the Conservation of Nature (IUCN) – the Environmental Impact Classification of Alien Taxa (EICAT)[1,2] – and identified the pathways by which they have spread. This detailed literature review and assessment work was done by a dozen insect and biosecurity risk experts from Monash University and other research institutions. The results will be published as peer-reviewed scientific papers and in an open source information platform that enables updates as more information becomes available.

INVASIVE INSECTS CAUSING ENVIRONMENTAL HARM

Insects are the world's most diverse class of animals and have a profound ecological influence (whether as native or non-native species) including as predators, plant-eaters, pollinators, parasites and disease carriers. Their abundance and diversity as well as small size, rapid reproduction and multiple life stages make them a very important, but very challenging, group of animals for biosecurity.

In contrast to the mountain of studies on the agricultural impacts of invasive insects, there was until recently very little work on their ecological impacts. Of the world's estimated 4 to 6 million insect species – of which only 1 million have been described – we found reports of more than 2800 having some sort of an environmental impact outside their native range (Figure 1). There is evidence of adverse environmental impacts for over 500 species, and sufficient evidence (from multiple sources) for about half of these (247 species) to allocate them to a priority assessment pool. So far, we have assessed about 100 of the priority species for their global impacts (by the EICAT method).

Of these, about three-quarters have had concerning impacts on biodiversity somewhere in the world:

- 29% are 'of substantial concern' (based on being rated as massive or major in the EICAT assessment).
- 47% are 'of concern' (based on being rated as 'moderate' or 'minor' in the EICAT assessment).

The most common mechanisms by which they cause harm to other species are

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Figure 1: The process for refining the global species pool of invasive insect species.

competition, herbivory, predation and transmission of disease.

A very few insect groups dominate the assessment pool of 247 harmful invaders. Of the world's 24 orders of insects, only 10 are represented in this pool and only 6 are represented by more than 1 species (Figure 2). By far the most dominant group are the ants, bees and wasps (order Hymenoptera), accounting for half of the pool species. Most of these invasive hymenopteran species are sociable, living in colonies, and their sociality – often extreme in invasive ants – helps explain their invasion success and the immense harm they cause. The next most common invaders are beetles (order Coleoptera, about one-sixth of the assessment pool) and sap-sucking insects (order Hemiptera, about one-seventh).

PATHWAYS BY WHICH INVASIVE INSECTS TRAVEL

In this age of globalisation, with more than 50,000 merchant ships plying the seas[3] carrying some 10 billion tonnes of goods a year[4,5], there are many ways for insects to travel to new countries. They can be introduced intentionally (for biological control, for example), unintentionally as contaminants of traded goods (such as flowers or timber) or as stowaways on ships or planes, or by natural dispersal from another invaded country.

In this project we recorded all the pathways by which the assessment pool of 247 insects have spread around the world, using a scheme adopted by the Convention on Biological Diversity that encompasses 44 different pathways. Most (85%) of the harmful insect invaders for which there is information about pathways have been introduced unintentionally. This is the opposite of the situation for invasive plants and vertebrate animals, most of which have been spread intentionally[6,8]. However, the pathways for close to half the harmful insect invaders are unknown.

The unintentional spread of invasive insects makes it difficult to predict which species will arrive, so there should be a strong biosecurity focus on identifying the high-risk pathways and minimising those risks[1]. This offers the potential to prevent a large number of new species arriving, including those whose invasion risks are unknown.

Our assessment found that 10 unintentional pathways are commonly used by invasive insects (Figure 3). The top three pathways are contamination of imported plants and nursery material and the timber trade. The ants, wasps and bees (Hymenoptera) and beetles (Coleoptora) use all 12 of the most prevalent pathways, indicating that their flexible travel habits (through their association with a wide range of traded products and ability to endure adverse conditions during travel) are a major reason for their high level of invasiveness.

RECOMMENDATIONS

The assessment work for the project is ongoing, including completing all EICAT assessments and assessing the potential ecological consequences for Australia of certain priority invasive insects. The next steps are to work with Australia's biosecurity agency and other stakeholders to (a) incorporate the results of the project into Australia's biosecurity system, (b) apply the process

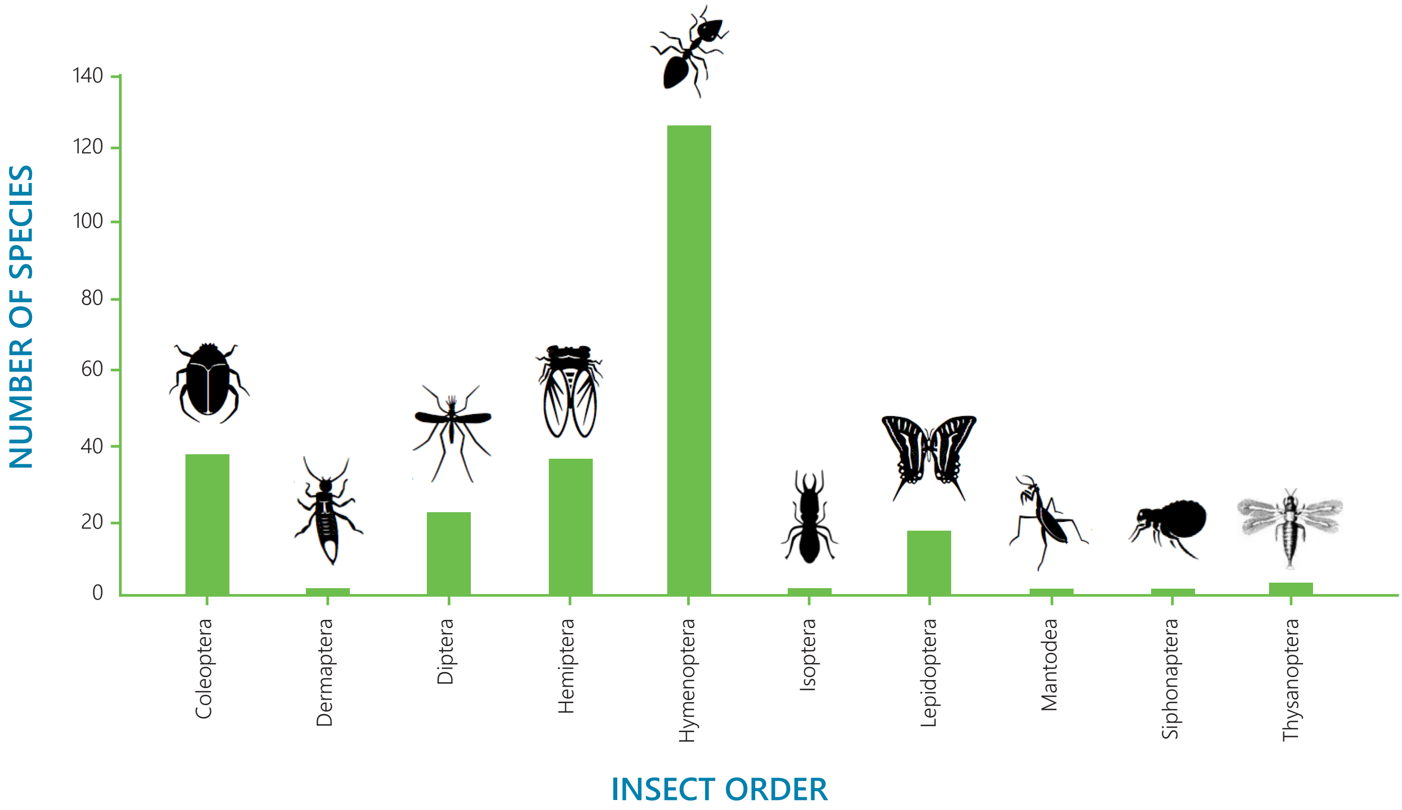

Figure 2: The insect orders with the highest numbers of environmentally harmful invasive insect species worldwide.

to other species groups and (c) establish a sustainable and publicly accessible data platform to maintain and regularly update information on potential invasive risks for the Australian environment. The Invasive Species Council and Monash University are seeking funds to undertake a similar assessment for invasive fungi.

Preventing insect invasions into Australia

Priority species: Invasive insect species of environmental concern not already in Australia should be incorporated into Australia's biosecurity system – including by assessing all 'of concern' insect taxa for their specific risks to the Australian environment, reviewing the adequacy of biosecurity protocols to detect and prevent these species, and developing contingency plans for all high-risk species.

Introduction pathways: Because most insect introductions are unintentional and there are likely to be many more harmful insect invaders than are documented, there should be a strong focus on reducing the risks of insect spread via the 10 most prevalent pathways for unintentional introductions. This includes assessing the Australian-specific environmental risks of these pathways and imposing import conditions to reduce the risks of high-risk pathways.

Social Hymenoptera: Because of the prevalence of social Hymenopteran species, particularly ants, as invaders, their harmful impacts on biodiversity, and their wide and versatile use of introduction pathways, reducing the risks of hymenopteran introductions should be a top priority for biosecurity. The national invasive ant biosecurity plan should be fully implemented and Australia's preparedness to respond to new incursions should be strengthened.

Applying best practice processes for prioritising potential environmental invaders

Other species groups: The methods used in this project to identify high-priority invasive insect species and pathways globally are robust, transparent and repeatable, and provides a comprehensive base of information from which to determine Australian-specific biosecurity priorities. A similar process should be applied to other species groups as the basis for determining priorities for Australian environmental biosecurity.

Sustaining the process with an accessible data platform

Database: A national public exotic and invasive species data platform is needed that:

- provides comprehensive, up-to-date information to support risk assessments;
- is updateable, repeatable and accessible to all, except for restricted data;
- is sustainable, with resources allocated for regularly updating the information and quality control.

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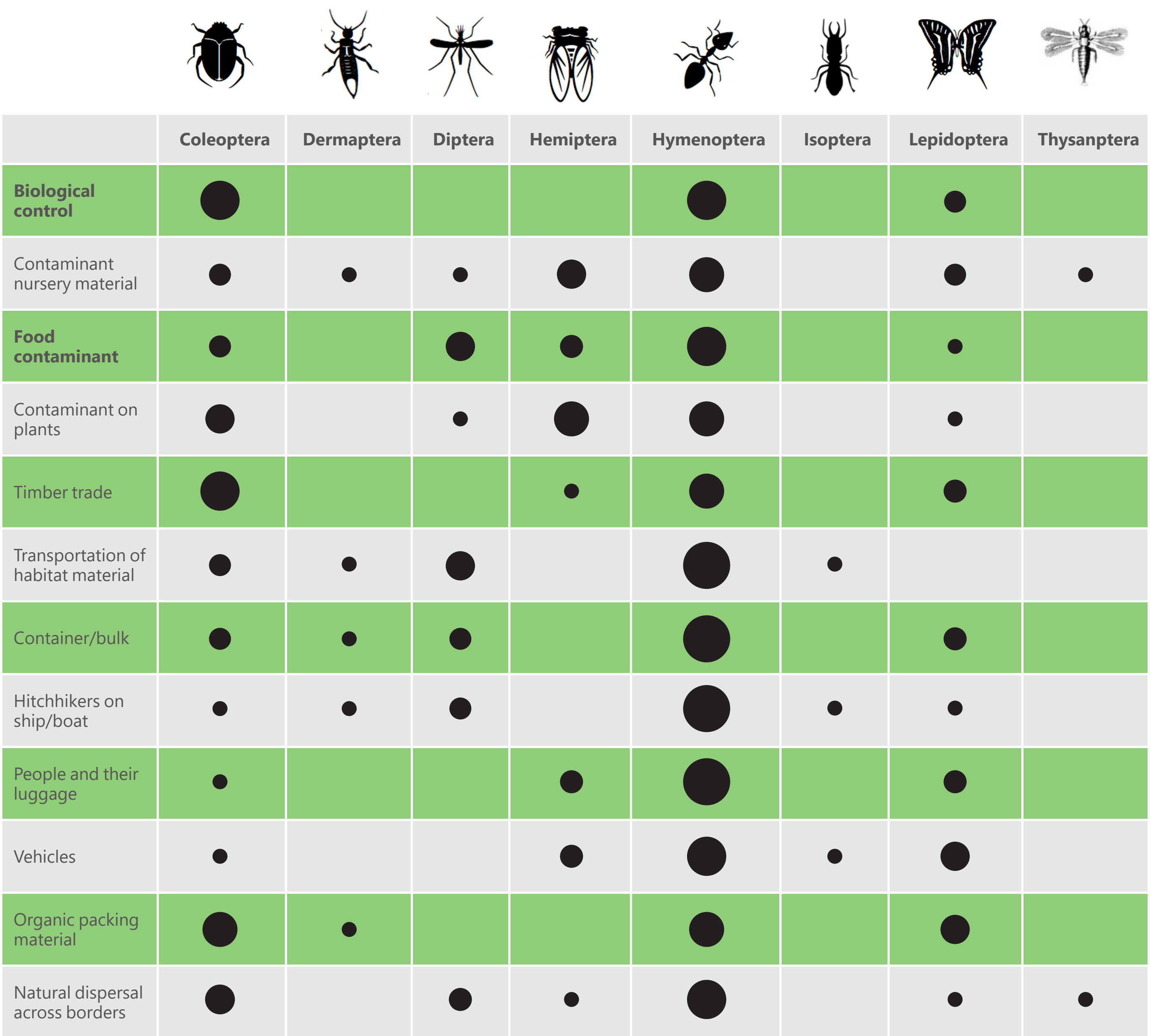

Figure 3: The use of introduction pathways by invasive insect orders. Only the most prevalent pathways and insect orders are shown. Circles and their sizes represent the relative contribution (%) of each insect order to the number of species using a particular pathway. Circle sizes (from smallest to largest) represent 1–10%, 11–20%, and so on up to 60%.

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The recommendations have been developed with the benefit of advice from 20 biosecurity experts from government and research institutes who attended a workshop for this purpose.

Invasive Insects: Risks and Pathways Project

WORLD'S WORST INSECT INVADERS: SOCIAL HYMENOPTERA

UPDATED: JUNE 2019

The Invasive Insects: Risks and Pathways project has found that the world's environmentally harmful invasive insect species are dominated by just one insect order – that of ants, bees and wasps (Hymenoptera)[1]. This order accounts for 16 of the 17 insect invaders known to be causing environmental harm in Australia. Why are ants, bees and wasps so successful and so harmful?

One answer is that they are habitual and versatile world travellers. Of the dozen main pathways by which invasive insects reach new countries, Hymenoptera use them all and frequently so[1].

Another clue is that most invasive Hymenoptera are social, and the most harmful of them – typically ants – tend to live in extremely large societies, which can be more populous than the biggest human megapolises.

Western yellowjackets, invasive in Hawaii, are aggressive hunters.
Photo: TJ Gehling | Flickr CC BY-NC-ND 2.0

DOMINANT INSECT INVADERS

Of the world's 24 insect orders, the Hymenoptera accounts for half the species in the assessment pool of the Invasive Insects: Risks and Pathways project (made up of species for which there is evidence of environmental harm somewhere in the world)[1]. The leading invaders are ants (all social), accounting for more than one in eight species assessed – three times as many as any other insect family. Bees, most of which are social, and parasitoid wasps, which are not, are also common invaders.

Of Australia's 17 insect invaders known to be causing environmental harm, 16 are Hymenoptera (9 ants, 3 wasps, 3 bees) and 1 is a beetle (Table 1)[1]. Three have been recorded in Australia for the first time just this century. As one indicator of the harm caused by social hymenopteran species, Australia is currently spending over $60 million a year on eradication programs for five ant species – seeking national eradication of red imported fire ants, electric ants and browsing ants, and partial eradication of yellow crazy ants (Wet Tropics) and Argentine ants (Norfolk Island).

In their invasive range, European fire ants reach extremely high densities, displacing nearly all other ants.
Photo: Ryszard | Flickr | CC BY-NC 2

The impacts of social hymenopteran species are complex, brought about mainly by predation, competition, and interaction with other exotic species[1]. Yellow crazy ants on Christmas Island demonstrate all these mechanisms. Capable of achieving extremely high population densities (more than 2000 a square metre), they aggressively displace most other animals from their invasive range[2,3]. The ants benefit enormously by 'farming' an invasive scale insect from which they gain honeydew. They have killed tens of millions of red land crabs by spraying their eyes and mouthparts with formic acid. Because the crabs eat leaf litter, seeds and seedlings, their absence has drastically altered the structure and composition of invaded forests, and the forest canopy is suffering dieback due to the outbreaks of invasive scale insects protected by the crazy ants and from sooty mould caused by honeydew[4]. The loss of crabs also enables the spread of another invasive species, the giant African land snail[5].

WHAT WE MUST KEEP OUT OF AUSTRALIA

Of the 27 social hymenopteran species assessed so far in the Invasive Insects: Risks and Pathways project, 24 have been rated as 'of concern' or 'of substantial concern' (15 ants, 5 wasps, 4 bees)[1]. Of these, more than half (7 ants, 3 bees and 3 wasps) are already established in Australia. It is important to stop more introductions of these species – to

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Table 1: Invasive insect species for which there is evidence of environmental harm in Australia

Order	Family	Species	Common name	Date of first detection or mention	First state or territory record
Hymenoptera	Apidae	*Apis mellifera*	European honey bee	1820	Queensland
Hymenoptera	Formicidae	*Solenopsis geminata*	Tropical fire ant	1863	?
Hymenoptera	Formicidae	*Paratrechina longicornis*	Black crazy ant	1886	Queensland
Hymenoptera	Formicidae	*Monomorium floricola*	Floral ant	1910	Queensland
Hymenoptera	Formicidae	*Monomorium destructor*	Singapore ant	1910	Queensland
Hymenoptera	Formicidae	*Pheidole megacephala*	African big-headed ant	1911	Queensland
Coleoptera	Scarabaeidae	*Heteronychus arator*	African black beetle	1920	South Australia
Hymenoptera	Formicidae	*Linepithema humile*	Argentine ant	1939	Victoria
Hymenoptera	Vespidae	*Vespula vulgaris*	Common wasp	1959	Victoria
Hymenoptera	Vespidae	*Vespula germanica*	European wasp	1959	Tasmania
Hymenoptera	Formicidae	*Anoplolepis gracilipes*	Yellow crazy ant	1975	Northern Territory
Hymenoptera	Vespidae	*Polistes chinensis*	Asian paper wasp	1979	New South Wales
Hymenoptera	Megachilinae	*Megachile rotundata*	Leafcutting bee	1987	New South Wales
Hymenoptera	Apidae	*Bombus terrestris*	Large earth bumblebee	1992	Tasmania
Hymenoptera	Formicidae	*Solenopsis invicta*	Red imported fire ant	2001	Queensland
Hymenoptera	Formicidae	*Wasmannia auropunctata*	Electric ant	2006	Queensland
Hymenoptera	Apidae	*Apis cerana*	Asian honey bee	2007	Queensland

prevent re-invasion of those being eradicated and new areas being invaded, and to stop new genetic material from boosting their invasiveness. This leaves at least 11 additional species that are likely to be a high priority to keep out of Australia (subject to Australia-specific risk assessment), including 8 ants, 2 wasps and 1 bee (see Table 2). There are likely to be other priority species once 28 additional Hymenoptera in the assessment pool have been assessed.

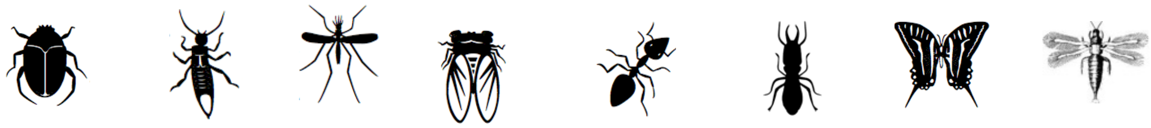
Table 2: The invasive social Hymenoptera not established in Australia that are of concern or substantial concern due to environmental impacts elsewhere in the world

Family	Species	Common name
Apidae	*Apis mellifera scutellata*	East African lowland honey bee
Formicidae	*Myrmica rubra*	European fire ant
Formicidae	*Pachycondyla chinensis*	Asian needle ant
Formicidae	*Paratrechina fulva*	tawny crazy ant
Formicidae	*Solenopsis richteri*	black imported fire ant
Formicidae	*Technomyrmex albipes*	white-footed ant
Formicidae	*Lasius neglectus*	invasive garden ant
Formicidae	*Tapinoma melanocephalum*	ghost ant
Formicidae	*Solenopsis papuana*	Papuan thief ant
Vespidae	*Vespula pensylvanica*	western yellowjacket
Vespidae	*Vespa velutina*	Asian hornet

WHY ANTS ARE SUCH SUCCESSFUL INVADERS

The Hymenoptera is one of, if not the largest of, insect orders, abundant everywhere except in polar regions and ecologically highly influential. A major reason for their success is the nutritious food they provide to their offspring[6]. Parental care in this order has been taken to a new level with the evolution of sociality, which has occurred several times, being the case for some bee and vespid wasp species and for all ants. Social structures enable dozens to millions of individuals to work cooperatively to exploit resources, build nests, care for young, and maintain strong defences.

The most successful invasive Hymenoptera are the ants – which achieve an extreme form of sociality. A typical ant colony has one queen attended by her sterile daughters, who aggressively defend their territory, particularly against members of their own species[7]. But many invasive ants



	Coleoptera	Dermaptera	Diptera	Hemiptera	Hymenoptera	Isoptera	Lepidoptera	Thysanptera
Biological control	●				●		●	
Contaminant nursery material	●	●	●	●	●		●	●
Food contaminant	●		●	●	●		●	
Contaminant on plants	●		●	●	●		●	
Timber trade	●			●	●		●	
Transportation of habitat material	●	●	●		●	●		
Container/bulk	●	●	●		●		●	
Hitchhikers on ship/boat	●	●	●		●	●	●	
People and their luggage	●			●	●		●	
Vehicles	●			●	●	●	●	
Organic packing material	●	●			●		●	
Natural dispersal across borders	●		●	●	●		●	●

Figure 1: The use of introduction pathways by invasive insect orders. Only the most prevalent pathways and insect orders are shown. Circles and their sizes represent the relative contribution (%) of each insect order to the number of species using a particular pathway. Circle sizes (from smallest to largest) represent 1-10%, 11-20%, 21-30%, 31-40%, 41-50%, 51-60%.

form supercolonies, with many queens and many interconnected nests. The individuals from different nests behave amicably rather than aggressively towards each other and can move freely between nests. 'Thus, the cooperation that promotes the success of social insects generally appears to be exaggerated in many invasive ants'[8].

The largest known supercolonies are those of the Argentine ant (Linepithema humile). In its native range, it usually forms colonies with small territories that are aggressively defended against other Argentine ants, and lives among many other native ant species[8]. Sometimes it forms supercolonies spanning hundreds of metres, although these endure for only a few years, probably due to competition with other supercolonies and other ant species[9]. But their supercolonies in invaded areas can cover hundreds of kilometres, and some are more than a century old. One colony along the Mediterranean coast extends more than 6000 km, and one in Australia spans 2800 km[9]. These and several other supercolonies have their origins in just one ancestral supercolony from Argentina, and represent 'the most populous known animal society'[10].

Normally, low genetic diversity is thought to be harmful but, for ants, by reducing their aggression towards their own kind, it frees up a lot of extra energy for colony growth, foraging, defence and competing with other species[7, 8]. Extremely high ant densities can be achieved, allowing domination over other species. Over 1 million Argentine ant queens and 4.4 cubic metres of workers and brood were captured from one 8-hectare orchard in the United States (cited in 10).

Ants also have flexible diets (as omnivores), easy-to-fulfil nesting requirements, and an association with humans that allows them to travel around the world in traded products and as stowaways on ships. The Invasive Insects Risks and Pathways project found they travel frequently on all 10 of the most prevalent unintentional pathways for insect introductions (see Figure 1).

Asian needle ant. Photo: © Matt Bertone

IMPLICATIONS FOR BIOSECURITY

The prevalence and harmfulness of the invasive hymenopteran species, particularly ants, means they should be a top biosecurity priority in Australia. As tiny, tough and versatile travellers, they are also very challenging for biosecurity. We must strive to prevent new introductions, including of the species already here, eradicate those we can, and protect Australian biodiversity from their impacts.

Recommendation 1

Fully implement Australia's invasive ant biosecurity plan[11]. This plan was adopted in mid 2019 by all national, state and territory governments but has no targeted funding for implementation. One particularly important action, essential for coordination and motivation, is to establish a 'permanent national body to coordinate national actions on invasive ants.' This is consistent with the seriousness of both existing and potential threats to the Australian environment, as well as human amenity and the economy.

Recommendation 2

Develop a biosecurity plan (or plans) for other social Hymenoptera. With the potential for invasive bees and wasps to disrupt pollination communities, and the predatory efficiency of invasive wasps, they can have profound ecological impacts.

Recommendation 3

As a high biosecurity priority, reduce the risks of unintentional introduction pathways for the Hymenoptera. Given their flexible travel habits – with ants in particular common on all 10 of the most prevalent unintentional pathways worldwide for invasive insects – the only feasible way to prevent new invasive hymenopteran species is to reduce the frequency by which they travel with traded products and as stowaways on ships and planes. This requires assessing the risks of each of these pathways, imposing import conditions to reduce the risks and improving inspection and diagnostic protocols.

Recommendation 4

As a high biosecurity priority, improve Australia's preparedness to respond to incursions of social Hymenoptera. This requires developing effective surveillance programs and being ready to efficiently eradicate new incursions. Hymenopteran surveillance in Australia can be boosted by supporting citizen science programs.

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ABOUT THIS PROJECT

The Invasive Insects: Risks and Pathways Project is a partnership between Monash University and the Invasive Species Council. To find out more visit invasives.org.au/risks-and-pathways.