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# Assessing the risk of invasive ants: a simple and flexible scorecard approach

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**Abstract.** Numerous ant species are being transported around globe through international trade, many of which become invasive. To mitigate the potential impacts of invasive ant species, an assessment system is needed which is simple, can be tailored for specific-user and regional requirements, and has the potential to integrate a variety of additional information. Here we present such a system, which has been used in New Zealand to determine which ant species pose the greatest threat to natural ecosystems. However, the scorecard system could be applied widely around the globe for assessing the threat of invasive ant species.

*Keywords:* Risk assessment, invasion, border, impacts, framework.

Invasive ant species (Hymenoptera: Formicidae) are currently receiving considerable attention around the globe, with increasing evidence of economic and agricultural impacts, health effects on humans, displacement of native ant species, and disruption to natural ecosystems (Williams, 1994; Holway et al., 2002). The extent and diversity of exotic ant species transported by global trade is considerable (McGlynn, 1999; Lester, 2005; Suarez et al., 2005; Ward et al., 2006). For example, McGlynn (1999) estimated at least 150 ant species had accidentally arrived at new regions via trade. Suarez et al. (2005) showed that over a 60-year period, 232 species (58 genera) were intercepted at the United States border; and most recently, Ward et al. (2006) found that at least 114 species of ants from 52 genera have been intercepted at the New Zealand border in the last 50 years.

Despite these numbers, and the fact that the impacts of invasive ants are a global issue, few regions have made a comprehensive assessment of the risks posed by invasive ant species and the mechanisms behind their arrival and establishment (but see Deyrup et al., 2000; Harris et al., 2005). To mitigate the establishment of such species (i.e. pre-border) two components are required: (i) preventing their entry, and (ii) responding to border incursions through eradication or control (Commonwealth of Australia, 2006). These two components rely on the risk assessment of specific species and trade pathways. Identification of high risk species and high risk trade pathways assists in decision-making by allowing biosecurity authorities to prioritise and target risks.

However, in many regions, a number of invasive ant species are already established and widely distributed (i.e. post border). For these regions, it is also beneficial to determine which of the invasive ant species present is of greatest threat. Again, such information enables biosecurity and pest management authorities to prioritise pests for management, and may help contain or eradicate species if they spread to new regions. Therefore, risk assessments can also be used to assess the threats of already established and widespread invasive species.

Here, we present a risk assessment scorecard for invasive ant species (Table 1). The scorecard, ranks species in terms of threat and can be used for species that are already established, or those that may arrive in the future. The scorecard represents a framework that is flexible and simple to use, allowing different users to tailor the scorecard to suit specific regional requirements, or to place emphasis on specific questions. The scorecard was designed to assess the risk of invasive ant species in New Zealand (Harris et al., 2005; Ward, 2007a, see Table 2), but given invasive ants are a global issue we believe the scorecard approach has wider application.

The scorecard works by individually assessing each species. Each character in the scorecard is scored (0, 0.5,

**Table 1.** Risk assessment scorecard for evaluating the threats of invasive ant species.

| | Scoring | | |
|---|---|---|---|
| **Category and Characters** | **0** | **0.5** | **1** |
| **Pathways** | | | |
| Association with anthropogenic environments | No | Unknown | Yes |
| Is the species in Australia | No | | Yes |
| Is the species in the Pacific | No | | Yes |
| Is the species in the southern hemisphere | No | | Yes |
| Intercepted at border | No | 1–5 | >5 |
| Have nests or queens been intercepted | No | | Yes |
| Established at sites with direct trade pathways | No | | Yes |
| Commodity compatibility | No | Unknown | Yes |
| Future interceptions | Decrease | Similar | Increase |
| **Difficulty in containment of incursion** | | | |
| Incursions previously detected post border | No | 1 | >1 |
| Incursions previously produced sexual stages | No | Unknown | Yes |
| Small size/cryptic nature | No | | Yes |
| Flighted dispersals | No | Unknown | Yes |
| **Establishment success (urban environment)** | | | |
| Climate suitable, inhabits buildings | Low | Limited | High |
| Climate suitable, able to persist in urban outdoors | Low | Limited | High |
| **Establishment success (native environment)** | | | |
| Climate suitable and native 'open' habitat vulnerable | Low | Limited | High |
| Climate suitable, forest habitat vulnerable | Low | Limited | High |
| **Biological traits inferring invasiveness** | | | |
| Recruits in large numbers and monopolises food | No | ? | Yes |
| Reproductive queens | Monogyne | ? | Polygyne |
| Supercolonies with reduced intraspecific aggression | No | Polydomous | Yes |
| Invasive elsewhere | 0 | 1–2 times | > 2 |
| **Likely pest status to humans** | | | |
| Bites and sprays formic acid | No | Unknown/Limited | Yes |
| Stings | No | Unknown/Limited | Yes |
| Damages structures | No | Unknown/Limited | Yes |
| Workers enter buildings | No | Unknown/Limited | Yes |
| Hygiene pest (disease spreading) | No | Unknown/Limited | Yes |
| Outdoor nuisance | No | Unknown/Limited | Yes |
| Horticultural/agricultural pest | No | Unknown/Limited | Yes |
| **Impact on native environment** | | | |
| Competitive advantage over other ants | Unlikely | Some species | Yes |
| Detrimental impacts on native invertebrates | Unlikely | Likely | Severe |
| Detrimental impacts on vertebrates | Unlikely | Possible | Yes |
| Harms indigenous flora | Unlikely | Possible | Yes |

**Table 2.** An example of the rankings of some introduced ant species established in New Zealand. Rankings are based on a weighed percentage to stress the importance of establishment in natural environments and potential impact towards humans and the native environment. Only the 5 top and bottom ranked species are listed.

| | Risk Assessment Category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Weighting (%) | 10 | 5 | 10 | 5 | 20 | 25 | 25 | | 100 |
| Species | Biological traits | Pathways | Difficulty in Containment | Establishment (urban) | Establishment (natural) | Pest status to humans | Impact native environment | Total Score | Total Ranking |
| *Technomyrmex albipes* | 0.9 | 1.0 | 0.5 | 1.0 | 0.8 | 0.6 | 0.5 | 5.2 | 67.3 |
| *Linepithema humile* | 1.0 | 0.8 | 0.0 | 1.0 | 0.5 | 0.6 | 0.9 | 4.8 | 66.5 |
| *Doleromyrma darwiniana* | 0.5 | 0.5 | 0.5 | 1.0 | 0.8 | 0.6 | 0.5 | 4.4 | 61.0 |
| *Pheidole megacephala* | 1.0 | 1.0 | 0.0 | 0.8 | 0.0 | 0.6 | 0.9 | 4.3 | 56.5 |
| *Ochetellus glaber* | 0.8 | 0.8 | 0.5 | 1.0 | 0.5 | 0.4 | 0.4 | 4.3 | 51.5 |
| | | | | | | | | | |
| *Monomorium sydneyense* | 0.3 | 0.4 | 0.8 | 0.8 | 0.3 | 0.1 | 0.1 | 2.7 | 27.5 |
| *Tetramorium grassii* | 0.0 | 0.6 | 1.0 | 0.5 | 0.5 | 0.0 | 0.0 | 2.6 | 25.5 |
| *Solenopsis* sp. | 0.3 | 0.4 | 0.8 | 0.5 | 0.5 | 0.0 | 0.0 | 2.4 | 25.0 |
| *Cardiocondyla minutior* | 0.0 | 0.4 | 0.8 | 0.8 | 0.3 | 0.1 | 0.0 | 2.4 | 22.5 |
| *Strumigenys xenos* | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 11.0 |

1). Scores for characters are averaged within each category, and the averages are summed to produce an overall score. Species are ranked based on this overall score. This overall ranking can also be tailored by weighting the categories, for example, importance could be placed on pathways, or climate suitability, or impacts, depending on the user's requirements. Regional-specific information can also be incorporated into the scorecard to assist risk assessment. For example, in the 'pathways' category (Table 1) several of the characters are New Zealand specific, and while trade pathways from Australia and the Pacific are important for New Zealand (Lester, 2005; Ward et al., 2006), they are unlikely to be as important for other regions. For example, Suarez et al. (2005) found that the majority of ants intercepted at the USA border originated from the Neotropics. Information on economic losses in horticultural/agricultural systems, or climate models that assess climate suitability for colony development (e.g. Korzukhin et al., 2001) could also be incorporated by developing threshold levels for scoring. Thus, the scorecard can easily be modified to incorporate region-specific information.

Risk assessment systems have been widely used for weeds (invasive plants) at global and regional scales (e.g. Reichard and Hamilton, 1997; Pheloung et al., 1999), but we believe this is the first such system for invasive ants. The scorecard is simple to use, can be able to be tailored to specific-user and regional requirements, and is based on systems previously developed for weeds. We acknowledge that, because this is a new framework, the relationship between the amount of knowledge available and the effect on scoring is unknown. However, we intend the scorecard be filled out by ant specialists working in conjunction with pest management authorities. Also, we do not propose that a low score implies an invasive species is having no impact. Rather, the scorecard was about prioritizing species that are likely to be more problematic than others, and thus resources can be directed towards their management. Furthermore, if there is uncertainty regarding some categories, then this may help direct future study and information gathering. For example, climate modelling has been done for a number of invasive ant species in New Zealand to help clarify their potential distribution for different regions (Ward, 2007b). We suggest that the scorecard system presented here is a useful framework for assessing the risk of invasive ants and that it could be applied widely around the globe. Further research will clarify how knowledge of a species translates into scoring, whether additional characters need to be incorporated into the scorecard (e.g. effectiveness of control), and identify ways to increase the utility and uptake of such a system.

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