Invasive Ant Risk Assessment

Paratrechina longicornis

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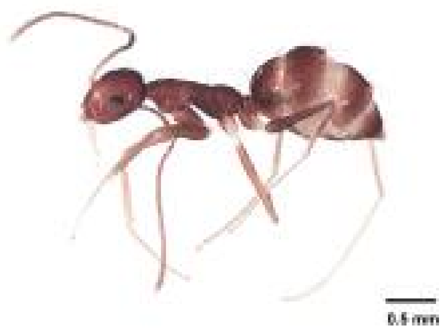
(A) PEST INFORMATION

A1. Classification

Family:	Formicidae
Subfamily:	Formicinae
Tribe:	Lasiini
Genus:	*Paratrechina*
Species:	*longicornis*



Richard Toft , Landcare Research

A2. Common names

Crazy ant (Smith 1965), long-horned ant, hairy ant (Naumann 1993), higenaga-ameiro-ari (www36), slender crazy ant (Deyrup et al. 2000).

A3. Original name

Formica longicornis Latreille

A4. Synonyms or changes in combination or taxonomy

Paratrechina currens Motschoulsky, *Formica gracilescens* Nylander, *Formica vagans* Jerdon, *Prenolepis longicornis* (Latreille)

Current subspecies: nominal plus *Paratrechina longicornis* var. *hagemanni* Forel

A5. General description (worker)

Identification

Size: monomorphic workers about 2.3–3 mm long.

Colour: head, thorax, petiole, and gaster are dark brown to blackish; the body often has faint bluish iridescence.

Surface sculpture: head and body mostly with inconspicuous sculpture; appearing smooth and shining.

Whole body has longish setae. Appears quite hairy. Hairs are light in colour grey to whitish.

General description: antennae and legs extraordinarily long. Antenna slender, 12-segmented, without a club; scape at least 1.5 times as long as head including closed mandibles. Eyes large, maximum diameter 0.3 times head length; elliptical, strongly convex; placed close to the posterior border of the head. Head elongate; mandibles narrow, each with 5 teeth. Clypeus without longitudinal carinae. Alitrunk slender, dorsum almost straight from anterior portion of pronotum to propodeal dorsum. Metanotal groove slightly incised. Propodeum without spines, posterodorsal border rounded; propodeal spiracles distinct. One node (petiole) present, wedge-shaped, with a broad base, and inclined forward. Dorsal surface of head, alitrunk and gaster with long, coarse, suberect to erect greyish or whitish setae. Propodeum without erect hairs. Hind femora and tibiae bearing suberect hairs with length almost equal to the width of the femora. Stinger lacking; acidopore present.

Sources: www39

Formal description: Creighton (1950)

This species is morphologically distinctive and is one of the few *Paratrechina* species not consistently misidentified in collections.

The crazy ant is extremely easy to identify from its rapid and erratic movements (wwwnew49). Identification can be confirmed with the aid of a hand lens through which the extremely long antennal scape, long legs, and erect setae are obvious.

Fig. 1: Images of Paratrechina longicornis; a) group of workers , b) dorsal view of worker showing long antennae (Source: S.D. Porter, USA-ARS).

A6. Behavioural and biological characteristics

A6.1 Feeding and foraging

Paratrechina longicornis foragers are opportunists (Andersen 1992). Workers are very fast moving, darting about in a jerky, haphazard fashion as if lacking a sense of direction (Smith 1965). They commonly form wide but thinly populous trails up to 0.5 m wide over walls and floors (Collingwood et al. 1997). Meier (1994) stated "trails form moving toward the nest only", but this is not the case as they have been observed to forage to and from nests in thin (1–2 cm) trails (P. Lester, pers. comm.). They can forage long distances, up to 25 m from the nest (Jaffe 1993). They are very quick to discover food (Lee 2002) but are often displaced when dominant ants discover and then recruit to food (Banks & Williams 1989). In tropical locations they forage continuously (Meier 1994).

Workers are omnivorous. They feed on live and dead insects, honeydew, fruits, and many household foods (Smith 1965). Honeydew is obtained by tending plant lice, mealy bugs and scales (Smith 1965; Rawat & Modi 1969; Farnsworth 1993). Crazy ants are especially fond of sweet food (Smith 1965). Foragers will also collect seeds (Smith 1965). Large prey items, e.g., lizards, are carried by a highly concerted group action (Trager 1984). They appear to show a strong preference for protein during summer, when they will refuse honey or sugar baits (Trager 1984). They can forage in the intertidal zone, where they "surf" if caught by a wave (Jaffe 1993). *P. longicornis* was also recorded on decaying rabbit carcasses in India, feeding on moist areas around the eyes, nose, mouth, and anal region during the early stage of decay and on dead flies, dead larvae, skin of carrion, etc., during later decay stages (Bharti & Singh 2003).

A6.2 Colony characteristics

Paratrechina longicornis has polygyne colonies (Passera 1994), with nests containing up to 2000 workers and 40 queens (Mallis (1982, cited in Thompson 1990). Reproductives are produced throughout the year in warm climates but are more restricted (~5 months) in cooler climates, e.g., Gainsville, Florida (Trager 1984). Workers are probably sterile (Passera 1994). Colonies occur in temporary nests (Andersen 2000), are highly mobile and will move if disturbed (Trager 1984). Crazy ants nest in diverse locations from dry to moist environments (www47). They tolerate nesting sites with relatively low humidity, such as gaps in walls, thatching and dry litter (Trager 1984). Outdoors, nests are primarily on the ground, often in wood, trash, and in mulch, but occasionally they occur aboreally in tree holes and leaf axils (Trager 1984; Way et al. 1989). Indoors, nests are often in wall spaces and under stored items (Smith 1965; www47). Colonies and individuals from the same location appear to tolerate each other, but they behave aggressively towards individuals from distant sites (Lim et al. 2003). Queens do not appear to be responsible for this lack of intra-specific aggression; rather colony odours obtained through their diet influence their behaviour (Lim et al. 2003).

Colonies nesting in sand at densities of over 1 nest/m^2 have been recorded in India (Jaffe 1993). At high tide, nests were underwater and probably protected from flooding by air trapped in their galleries.

A7. Pest significance and description of range of impacts

A7.1 Natural environment

Paratrechina longicornis appears to be a disturbance specialist and is seemingly absent from undisturbed natural habitat. Where it does occur in semi-natural vegetation it is often a minor component of the community (e.g., Andersen & Reichel 1994; Clouse 1999; Santana-Reis & Santos 2001). Holway et al. (2002a) in their review of invasive ants did not consider *P. longicornis* significant. Mostly, it is not a competitive dominant (Levins et al. 1973; Torres 1984; Banks & Williams 1989; Morrison 1996). On Nukunonu Island, Tokelau, in forested areas without the dominant invasive ant *Anoplolepis gracilipe, P. longicornis* was the second most frequently caught ant in pitfall traps (Lester & Tavite 2004) and repelled other ants from baits (P. Lester, pers. comm.). This was a highly modified environment with few ant competitors. It was not sampled where *A. gracilipes* was present in forested areas, and was rare in urban areas that were dominated numerically by *A. gracilipes* (Lester & Tavite 2004).

MacArthur and Wilson (1967) reported that on the Dry Tortugas, *P. longicornis* was "an overwhelmingly abundant ant and has taken over nest sites that are normally occupied by other species in the rest of southern Florida: tree-boles, usually occupied by species of *Camponotus* and *Crematogaster*, which are absent from the Dry Tortugas; and open soil, normally occupied by crater nests of *Dorymyrmex* and *Forelius*, which genera are also absent from the Dry Tortugas". The Dry Tortugas are the outermost of the Florida Keys, and are important ecologically as feeding and nesting grounds for turtles and frigate birds (Wetterer & O'Hara 2002). The islands are far from pristine and have many non-indigenous plants and animals. They are also highly disturbed, being periodically reshaped by hurricanes, which alter the size and even the number of keys.

Wetterer and O'Hara (2002) reported *P. longicornis* to be common on four of the five islands in Florida Keys they surveyed. On Garden Key, *Solenopsis geminata* was the dominant ant on the ground, while *P. longicornis* was the most common ant in trees. On Loggerhead Key and Bush Key, *Pheidole megacephala* and *P. longicornis* were the most common ants. Although *P. longicornis* was common, Wetterer and O'Hara (2002) did not mention it, instead raising concern about the impacts of *S. geminata* and *Ph. megacephala*.

The presence of *P. longicornis* at baits found first by another species was recorded during sequential checking of sugar water dishes and was used as a measure of species replacement by Clark et al. (1982) in the Galapagos. *P. longicornis* replaced other ant species (including the little fire ant, *Wasmannia auropunctata*) at sugar-water baits in 68% of observations, indicating some potential competition for resources, but it did not stay as long at baits as *W. auropunctata.*

Apparently, *P. longicornis* has limited ability to displace other ants. In Sao Paulo, Brazil, banana plantations where *P. longicornis* was present had fewer other ant species than those without *P. longicornis* (Fowler et al. 1994); however, this may have been caused not by the ability of *P. longicornis* to eliminate other ants, but because different management practices in some orchards eliminated competing species and allowed *P. longicornis* to establish. Only one study conclusively documented detrimental impacts on other ants and other invertebrates, other than at bait; this was in a highly artificial glass house environment –"Biosphere 2" (Wetterer et al. 1999). There, ants were sampled before and after the arrival of *P. longicornis*; the composition of the ant community changed markedly and those species remaining after *P. longicornis* became abundant were uncommon. *Linepithema humile* and *Solenopsis xyloni* both disappeared from the glass house environment and the only abundant invertebrates thriving in Biosphere 2 besides *P. longicornis* were homopterans and species with effective defences against ants (well-armoured isopods and millipedes) or tiny subterranean species not vulnerable to ant predation (mites, cryptic ants, and springtails).

This species was also an abundant opportunist in disturbed habitat (mine site restoration trial plots) in Australia, but it was absent from bare ground dominated by *Iridomyrmex* and undisturbed vegetation (Andersen 1993).

Paratrechina longicornis interferes with seed dispersal of myrmecochorous plants by reducing dispersal distances and leaving seeds exposed on the soil surface (Ness & Bronstein 2004). No seeds were brought to the nest by this species during observations in Puerto Rico (Torres 1984).

In some locations *P. longicornis* is restricted to human settlements, e.g., northern Australia (Andersen 2000), or is a relatively minor component of degraded habits or human-modified systems, e.g., the Canary Islands (Espadaler & Bernal 2003), Sri Lanka (Way et al. 1989) and the Philippines (Way et al. 1998).

A7.2 Horticulture

Foragers are associated with honeydew-producing hemipterans (Smith 1965; Rawat & Modi 1969; Farnsworth 1993). Trails of foraging *P. longicornis* on plants in Biosphere 2 invariably led to homopterans (Wetterer et al. 1999). High densities of ants on plants were always found tending high densities of homopterans, such as the scale insects that heavily encrusted the trunks, branches, and leaves of many *Piper* trees, and mealybugs that covered the branches of many mangrove trees. Ants returning to their nests from these sources were bloated with liquid. Surveys of ants on *Thalia geniculata* L. leaves (common name alligator flag; a plant in the Marantaceae or arrowroot Family) demonstrated a strong positive association between ants and scale insects. On Tokelau, *P. longicornis* is also associated with extra-floral nectaries of *Morinda citrifolia* and breadfruit trees, food sources which might assist them in reaching extreme abundances in some areas (K. Abbott, pers. obser.). They have also been observed tending black citrus aphid *Toxoptera citricida*, (Homoptera: Aphididae) (Michaud & Browning 1999). However, they may not have an important role in protecting homoptera from natural enemies: Dejean et al. (2000) found that the presence of *P. longicornis* did not increase populations of a maize pest in Cameroon, as did other ants present (including *Pheidole megacephala*).

An additional role of *P. longicornis* in a horticultural environment may be as a predator of pest species. They are occasionally present in soybean fields in Florida where they prey on pest insects (Whitcomb et al. 1972). They prey on late instar larvae of a citrus pest in the Caribbean (Jaffe et al. 1990) and other citrus pests in California (deBach et al. 1951). They are abundant in disturbed rice fields in the Philippines (Way et al. 1998). They were often sampled at baits not foraged on by the dominant ants (*S. geminata* and *P. fervens*) (Way et al. 1998). They were abundant in some coconut palms in Sri Lanka, where they removed some eggs of a coconut pest, but were less effective than *M. floricola* (Way et al 1989). They may also be a significant predator of fly larvae and fleas (Pimentel 1955; Smith 1965). It is unclear if they have a role in population regulation of some pest and beneficial insects as Way et al. (1998) discussed in relation to *S. geminata*.

Paratrechina longicornis workers also gather small seeds from seedbeds of crops like lettuce and tobacco (Smith 1965).

They do not appear to damage polythene irrigation tubing (Chang & Ota 1976).

A7.3 Human impacts

The crazy ant is primarily a pest in urban areas where it can become abundant indoors (wwwnew49; Lee 2002). It has been found on the top floors of large apartment buildings in New York, in hotels and flats in Boston and in hotel kitchens in San Francisco, California (wwwnew47). Its presence indoors, as well as its erratic behaviour and dark colour, make it very conspicuous. Workers are omnivorous in an urban setting, feeding on live and dead insects, seeds in seedbeds, fruits, plant and insect exudates, and many household foods. Consequently, they have potential negative and beneficial effects, but these have not been quantified independently of other pest ant species.

Modular housing units in North Lauderdale (Florida) were inundated by the ant to the point that students were described as being 'constantly in a state of turmoil' (wwwnew47). Students' lunches had to be kept in closed plastic bags placed on tables with each table leg sitting in a pan of water as a barrier. Elsewhere, a soda fountain business discontinued operation because of foraging by this ant (Smith 1965). No reports were found of crazy ants damaging wiring or any other structures within buildings.

In a study carried out by pest controllers in Florida, *P. longicornis* was primarily seen as a nuisance both inside and outside of domestic dwellings. They were generally not considered to infest food or wood items (Klotz et al. 1995).

In monsoonal Australia, *P. longicornis* is associated with human settlements, where it is one of the most common of the tramp species (Andersen 2000). In Penang, Malaysia, *P. longicornis* was one of the more common ants sampled in buildings and was the first species to arrive in newly disturbed habitats or new buildings (Lee 2002). In Florida, it was most abundant in southern areas where it was described as a minor nuisance at outdoor-eating areas; it frequently entered buildings (Deyrup et al. 2000). In temperate North America (West Lafayette, Latitude 40.43) *P. longicornis* was only a minor component of the urban-building ant fauna, with *Tetramorium caespitum, Prenolepis imparis,* and *Tapinoma sessile* being numerically dominant (Scharf et al. 2004).

This ant may transmit diseases. It was the second most common species in three Brazilian hospitals, and at least 20% of foragers carried pathogenic bacteria (Fowler et al. 1993).

A8. Global distribution

A8.1 Native range

Paratrechina longicornis probably originated in Africa (Wilson & Taylor 1967; Holway et al. 2002a) or Asia (Smith 1965, Wilson & Taylor 1967), but it is so widespread that it is difficult to determine its origin from ecological and historical records.

A8.2 Introduced range

It is one of the most common tramp ants in the tropics and subtropics, and is probably one of the most widely distributed of all the tramp ants (Fig. 2). It has also established in temperate regions where it is found in greenhouses and heated buildings. Some of the notable gaps in its distribution (e.g., southern China; Indonesia) may reflect the lack of published ant checklists from these regions rather than the absence of the species.

A8.3 History of spread

Paratrechina longicornis is a common tramp species that is frequently intercepted and has been spread with trade for well over a century. It has been present in many countries outside its native range for a long time (over 100 years). In some locations it may reinvade frequently rather than establishing permanently; Trager (1984) suggests this is the case in California.

A.9 Habitat range

The crazy ant is highly adaptable, and can live in very dry as well as moist habitats. It is usually associated with disturbance, including disturbed natural environments like beaches (Jaffe 1993), the Dry Tortugas (Wetterer and O'Hara 2002), geothermal areas (Wetterer 1998), urban environments (Lee 2002; Andersen 2000; wwwnew47), farms (Collingwood et al. 1997), and even ships (Weber 1940). However, it is also present in some native vegetation in the tropics, e.g., conservation areas on offshore islands of Samoa (K. Abbott, pers. obser.). In cold climates, crazy ants nest in centrally heated apartments and other similar buildings such as glasshouses and airport terminals (e.g., Freitag et al. 2000; Naumann 1994).

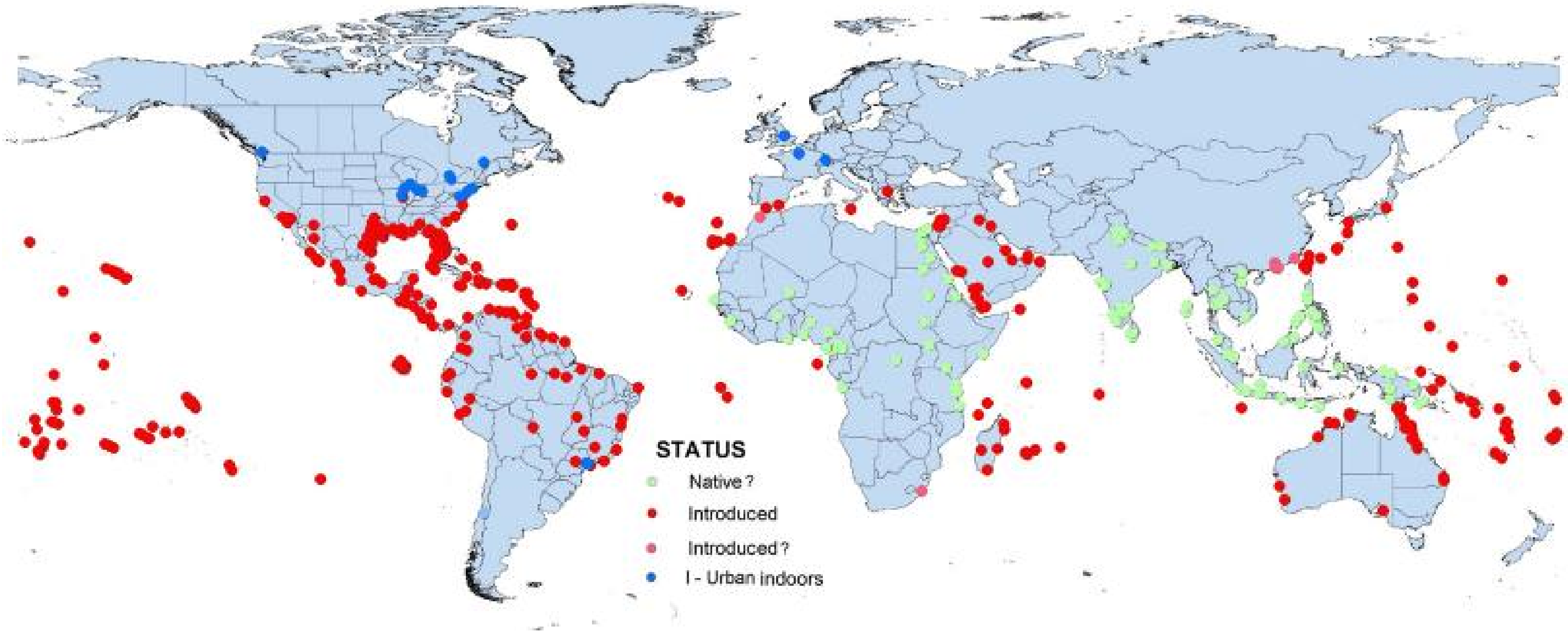


Fig. 2: Global distribution of Paratrechina longicornis*. It is unclear whether Africa or Asia represents the original native range. Data are from the Landcare Research Invasive Ant Database (January 2005). The blue urban records are those where the ant was reported to be restricted to buildings.*

(B) LIKELIHOOD OF ENTRY

B1. Identification of potential pathways

Crazy ants have been reported to be transported extensively by humans (Passera 1994) and associated with nearly all pathways taken by humans. They are commonly reported associated with potted plants (e.g., Clark 1941; Miller 1994).

There are several potential pathways by which *P. longicornis* could enter New Zealand. Between 1997 and the end of 2002, it was intercepted at the New Zealand border 16 times; since then, a directive to identify all ants intercepted at New Zealand ports has resulted in 47 further interceptions at the border (MAF records).

Paratrechina longicornis has been observed entering New Zealand on goods from a wide range of countries and commodities (Table 1 & 2). Most (> 80%) interceptions have been from sea freight and about 60% have been at Auckland sea or air ports with the remaining interceptions scattered widely around New Zealand. In recent years, post-border interceptions have occurred regularly at the Port of Auckland and elsewhere. In April 2002, samples taken from wharves at the Port of Auckland confirmed an incursion (Anon. 2004). Ants were subsequently found at a transitional facility in Mangere, South Auckland. In March 2003, three nests were found near the Mount Maunganui wharf of Port Tauranga. In 2004 a single worker was found at Sulphur Point (Port Tauranga) and a nest was observed and treated in Wellington. All these areas are being treated and/or monitored to ensure eradication.

Most interceptions are of workers, but clearly queens are also being transported alive as colonies have been found post-border. Stopping this species arriving will be very difficult given its extensive distribution, close association with humans and ease of movement. Sea containers (full and empty) and timber appear to represent the main commodity pathways, but the high frequency with which this ant is found on ships means any vessel in any New Zealand ports is a potential risk. A pest risk analysis has been conducted specifically for the timber pathway after several interceptions on Jellico wharf in Auckland; these were associated with timber from the Pacific (Ormsby 2003).

In Australia, *P. longicornis* has been intercepted frequently from many commodities and origins (Tables 3 & 4). Further analysis of the container data indicates the diverse range of goods with which they are associated with (Table 5).

Fifteen interceptions from Hawaii in plants and fresh produce (data from January 1995 to May 2004; Source: Hawaii Department of Agriculture) list California and Georgia (USA) as origins not recorded in the Australia and New Zealand data.

Some crazy ant interceptions at the New Zealand, Hawaiian and Australian borders are reported to have originated from countries not listed in the Landcare Research Invasive Ant Database as part of this ant's distribution. These include Brunei, the Cocos (Keeling) Islands, Germany, Iran, Ireland, Italy, Malawi, Nauru, New Zealand (five interceptions in Australia), and Norfolk Island. If some of these origins are correct (and not errors or ants picked up in transit), this would further increase the risk pathways to New Zealand. Crazy ants are often intercepted on ships and clearly there is scope for contamination of freight in transit.

B2. Association with the pathway

Paratrechina longicornis is well established across the Pacific region and throughout much of the world's tropical areas. Much trade arrives in New Zealand from areas of the Pacific region where this ant is present. It is commonly associated with urban areas and buildings. Interceptions showing its association with a wide range of commodities suggest it is usually a stowaway; this makes it difficult to target high risk commodities for particular scrutiny. In addition, the wide range of countries in which it is established and from whence it has been intercepted makes targeting specific pathways for this ant species particularly difficult.

B3. Summary of pathways

A summary of freight coming to New Zealand from localities within 100 km of known sites of *P. longicornis* infestation is presented in Fig. 3 (also see Appendix 1). During 2001-2003, total volumes of freight from localities near this ant were high, representing about 32.2% of total air freight and 34.9% of sea freight (44.2% of sea freight where the country of origin was reported). At many of the more temperate locations the densities of *P. longicornis* will likely be low and the distribution restricted; this reduces the risk of spread to New Zealand.

Table 1: Commodities from which *P. longicornis* has been intercepted at the New Zealand border.

Freight type	1997-2002	2003-Mar 2004
Fresh produce	7	7
Miscellaneous	1	3
Personal effects	2	
Timber	1	9[b]
Containers	1	23[c]
Cut flowers	3	
On ship		2
Incursion [a]	1	5

[a] found near border but outside freight and association not known.

[b] 4 interceptions from consignments on the same day on wharf in Auckland.

[c] 3 empty.

Table 2: Country of origin for New Zealand border interceptions of *P. longicornis*.

Country	1997-2002	2003-Mar 2004
Australia	2	1
Fiji	5	9
Indonesia		2
Malaysia	1	
PNG	1	12
Singapore	1	4
Solomon Islands		5
Thailand	1	2
Tonga	4	3
Vanuatu		1
Vietnam	1	
Wallis & Futuna Islands	3	

Table 3: Country of origin for Australian border interceptions of *P. longicornis*. Data from January 1986 to 30 June 2003 (Source: Department of Agriculture, Fisheries and Forestry, Canberra).

Country	No.
Australia	4
Brunei	1
China	3
Christmas Is.	8
Cocos (Keeling) Islands	1
East Timor	10
Fiji	15
France	2
Germany, Fed. Repub.	1
Guam	2
India	2
Indonesia	32
Iran	1
Ireland	1
Italy	5
Japan	2
Malawi	1
Malaysia	16
Mauritius	1
Nauru	1
New Caledonia	1
New Zealand	5
Norfolk Is.	1
Pacific Region	9
Papua New Guinea	82
Philippines	2

Country	No.
Samoa (American)	2
Ship	18
Singapore	38
Solomon Islands	4
Spain	1
Sri Lanka	1
Syria	1
Thailand	9
Tonga	3
United Arab Emirates	1
Unknown	9
USA	1
Vanuatu	2
Vietnam	4

Table 4: Freight types associated with Australian border interceptions of *P. longicornis*. Data from January 1986 to 30 June 2003 (Source: Department of Agriculture, Fisheries and Forestry, Canberra).

Freight type	No.
Air baggage	27
Container (full)	90
Container (empty)	73
Cut flowers	17
Fresh produce	18
Incursion	2
Machinery/vehicles	10
Miscellaneous	10
Plants	3
Post	3
Ship	16
Timber	15
Wood products	20

Table 5: Details of commodities listed from full containers intercepted at the Australian border containing *P. longicornis*. Data from January 1986 to 30 June 2003 (Source: Department of Agriculture, Fisheries and Forestry, Canberra).

Commodity	No
Packing	26
External on shipping container	23
Shipping container—unknown	16
Stock food/dried foods	9
Machinery/vehicle	5
Metal	3
Wooden furniture	2
Stone carvings	1
Glass	1
Cookers	1
Rubber	1
Slate	1
Gas cylinders	1

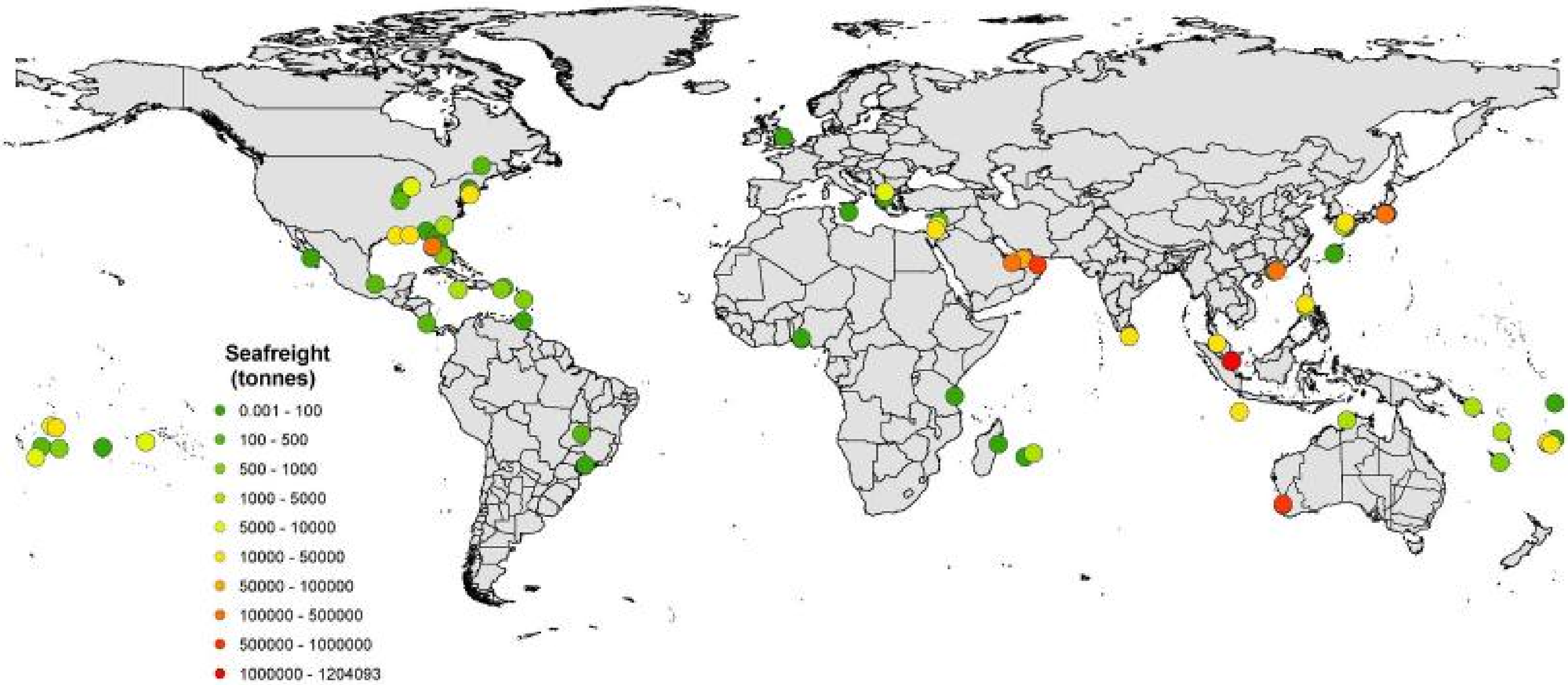


Fig. 3a: *Summary of sea freight coming to New Zealand from localities within 100 km of known sites of* P. longicornis*. Values represent the total freight (tonnes) during 2001, 2002 and 2003 (source: Statistics New Zealand). Details of locations are given in Appendix 1.*

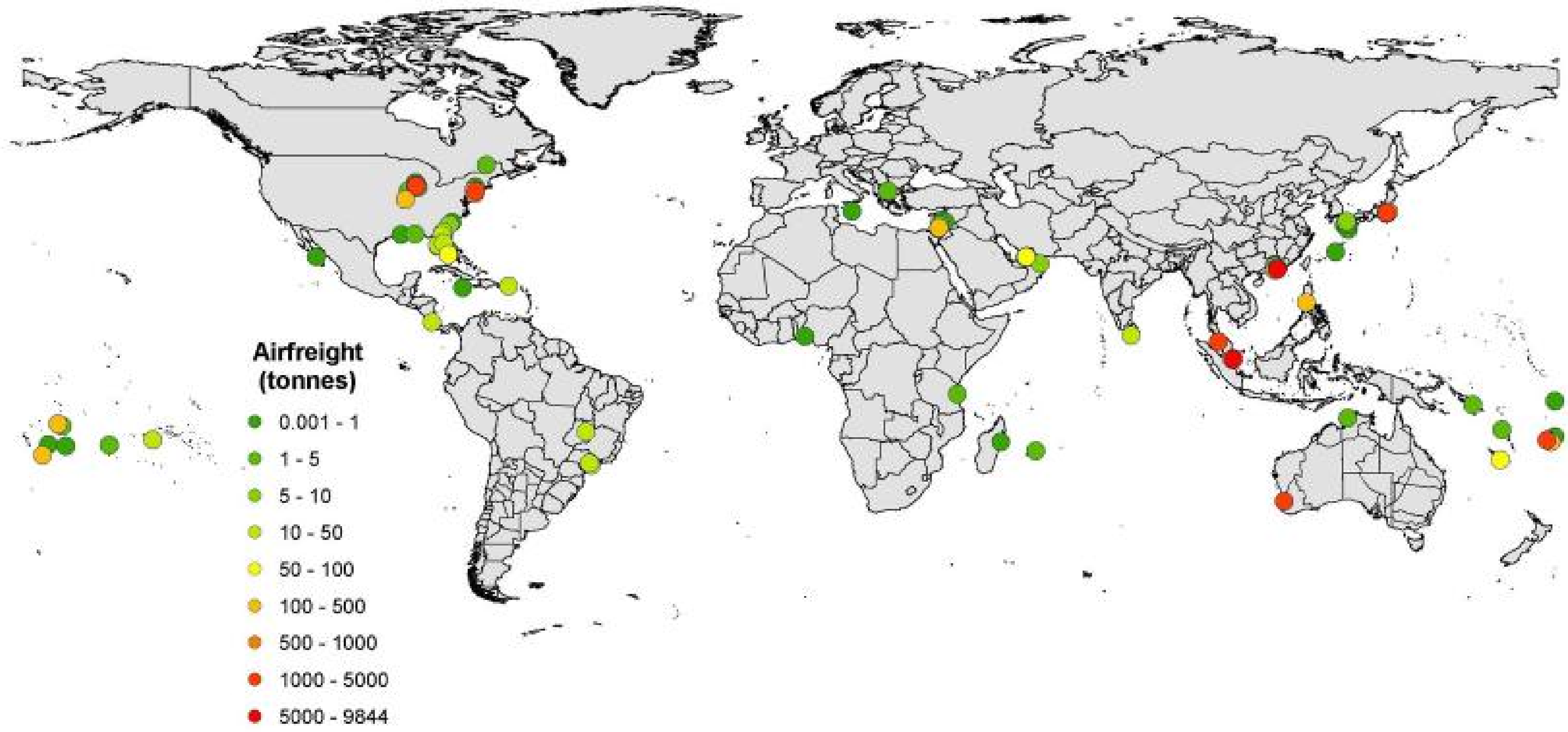


Fig. 3b: *Summary of air freight coming to New Zealand from localities within 100 km of known sites of* P. longicornis. *Values represent the total freight (tonnes) during 2001, 2002 and 2003 (source: Statistics New Zealand). Details of locations are given in Appendix 1.*

(C) LIKELIHOOD OF ESTABLISHMENT

C1. Climatic suitability of regions within New Zealand for the establishment of the ant species

The aim of this section is to compare the similarity of the New Zealand climate to the locations where the ant is native or introduced using the risk assessment tool BIOSECURE (see Appendix 2 for more detail). The predictions are compared with those for two species already established in New Zealand (*Ph. megacephala* and *L. humile*) (Appendix 3). In addition, a summary climate risk map for New Zealand is presented; this combines climate layers that most closely approximate those generated by the risk assessment tool Climex.

C1.1 Climate limitations to ants

Given the depauperate ant fauna of New Zealand (only 11 native species), and the success of many invasive ants throughout the world in locations with diverse ant faunas (e.g., Human & Gordon 1996), competition with New Zealand native ant species is unlikely to be a major factor restricting the establishment of invasive ants in New Zealand, although competition may be important in native forest where native ant abundance and diversity is higher (R. Harris, pers. obs.). For some species, the presence of other non-native ants in human modified environments may limit their distribution (e.g., *Solenopsis invicta* has severely restricted the distribution of *S. richteri* and *L. humile* within the USA (Hung & Vinson 1978; Porter et al. 1988)) or reduce their chances of establishment. However, in most cases the main factors influencing establishment in New Zealand, should queens or colonies arrive here, are likely to be climatic.

A significant relationship between maximum (and mean) daily temperature and foraging activity for both dominant and subordinate ants species indicated temperature rather than interspecific competition primarily determined the temporal activity of ant communities in open Mediterranean habitats (Cerda et al. 1998). Subordinates were active over a wider range of temperatures (Cerda et al. 1998). In California *L. humile* foraging activity was restricted by temperature attaining maximum abundance at bait at 34°C, and bait was abandoned at 41.6°C (Holway et al. 2002b).

Temperature generally controls ant colony metabolism and activity, and extremes of temperature can kill adults or whole colonies (Korzukhin et al. 2001). Oviposition rates may be slow and may not occur at cooler temperatures (e.g., *L. humile* does not lay eggs below a daily mean air temperature of 18.3°C (Newell & Barber (1913) quoted in Vega & Rust 2001)). At the local scale, queens may select warmer sites to nest (Chen et al. 2002).

Environments with high rainfall reduce foraging time and may reduce the probability of establishment (Cole et al. 1992; Vega & Rust 2001). High rainfall also contributes to low soil temperatures. In high rainfall areas, it may not necessarily be rainfall per se that limits distribution but the permeability of the soil and the availability of relatively dry areas for nests (Chen et al. 2002). Conversely, in arid climates, a lack of water probably restricts ant distribution, for example *L. humile* (Ward 1987; Van Schagen et al. 1993; Kennedy 1998), although the species survives in some arid locations due to anthropogenic influences or the presence of standing water (e.g., United Arab Emirates (Collingwood et al. 1997) and Arizona (Suarez et al. 2001)).

New Zealand has a cool temperate climate and most non-native ant species established here have restricted northern distributions, with most of the lower South Island containing only native species (see distribution maps in New Zealand information sheets (wwwnew83)). Few adventive species currently established in New Zealand have been collected outside urban areas in the cooler lower North Island and upper South Island (R. Harris, unpubl. data); for some this could reflect a lack of sampling, but the pattern generally reflects climatic limitations. In urban areas, temperatures are elevated compared with non-urban sites due to the warming effects of buildings and large areas of concrete, the "Urban Heat Island" effect (Changnon 1999). In addition, thermo-regulated habitats within urban areas (e.g., buildings) allow ants to avoid outdoor temperature extremes by foraging indoors when temperatures are too hot or cold (Gordon et al. 2001).

C1.2 Specific information on P. longicornis

No specific information on temperature tolerances was found for *P. longicornis*. Lee (2002) reported this ant to be most active in urban Malaysia at night (average air temperature of 25ºC with activity gradually ceasing late in the afternoon when temperatures peaked (averaging around 33ºC).

The risk to New Zealand might usefully be assessed from the crazy ant's distribution in Hawaii, where it is restricted to the dry lowlands (< 900 m) (Reimer 1994). This suggests that New Zealand is too cold. Ant species that occur in Hawaii's colder mountainous areas (900–1800 m, Reimer 1994) include *Pheidole megacephala* (which has a very restricted northern distribution in New Zealand (Appendix 3)) and *Linepithema humile*. *Linepithema humile* also extends into the dry subalpine communities in Hawaii (1800–2700 m (Reimer 1994)), and its New Zealand distribution extends into the South Island (Appendix 3).

C1.3 BIOSECURE analysis

152 locality records were used for the assessment of *P. longicornis*, mostly from the introduced range (Fig. 4).

The native plus introduced ranges show some overlap with all of New Zealand for mean annual temperature (MAT) and mean temperature of the coldest month (MINT), because of records from heated buildings in very cold climates, e.g., Quebec (Francoeur 1977) (Fig. 5; Table 6 & 7). Precipitation (PREC) is within the native and introduced ranges except in some south-western and alpine areas (Fig. 5a).

The native and introduced (non-urban range) shows no overlap for MAT (Fig 5b). Minimum temperatures are unlikely to restrict establishment over most of lowland New Zealand. Precipitation is within the native and introduced ranges except in some south-western and alpine areas, but these regions are probably too cold for establishment outside permanently heated buildings. None of the other climate parameters are highly discriminating for lowland New Zealand.

Climate summary

The general climate summary for the international range of *P. longicornis* indicates low similarity to New Zealand, particularly compared to *L. humile* (Fig. 6). Climate summary graphs are less useful than individual climate layers as contrasts in the risk between species and regions of New Zealand are less evident.

Climate match conclusions

Available data indicate that New Zealand has low climatic similarity with non-urban sites where *P. longicornis* is established. There is no overlap for MAT, and MINT is either at the lower end of international data or does not overlap. The lack of sufficiently high temperatures over the summer period for foraging and colony development is likely to severely limit the likelihood of this species' establishing permanent populations in non-urban habitats in New Zealand.

Paratrechina longicornis could survive in most urban areas in New Zealand, as it will inhabit heated buildings when outside temperatures are too cold. In summer it is likely to forage outdoors, and in warm microhabitats within urban areas colonies may persist outdoors throughout the year.

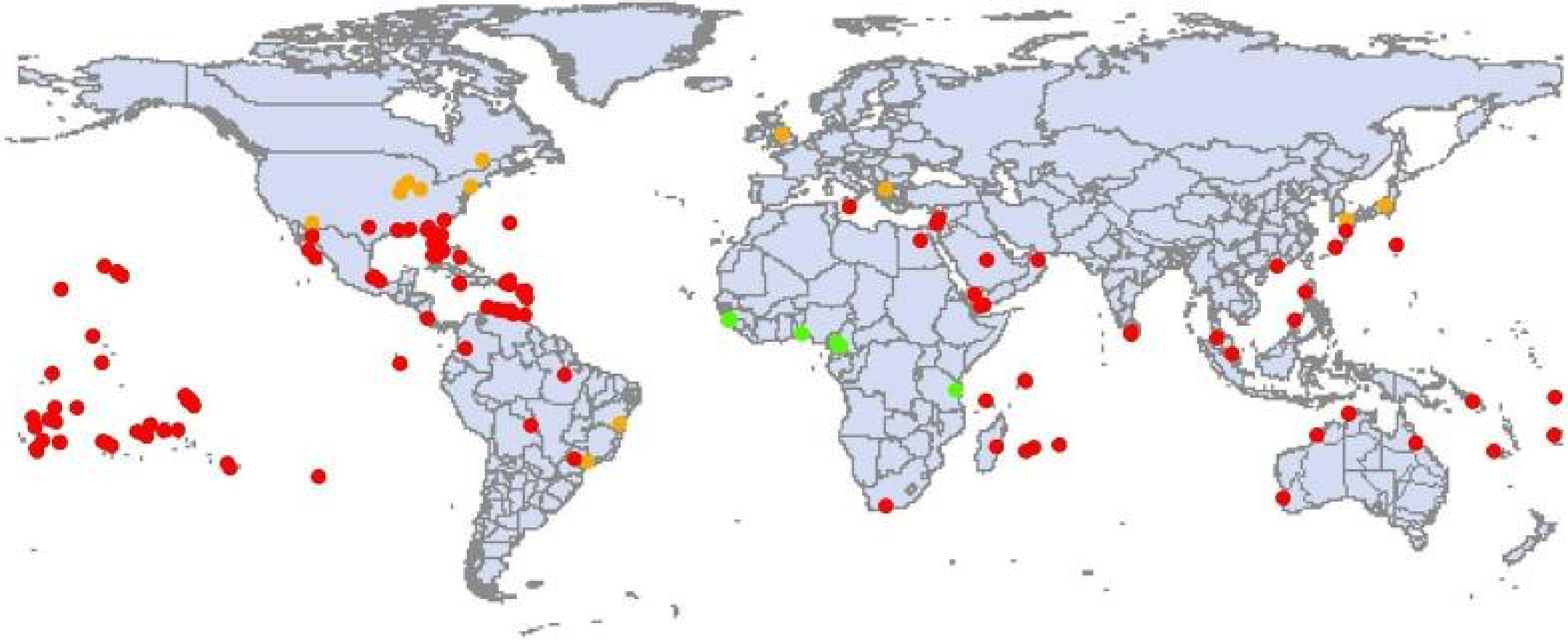


Fig. 4: *Native (green), introduced non-urban (red), and introduced urban (orange) distribution records used in BIOSECURE analysis of* P. longicornis.

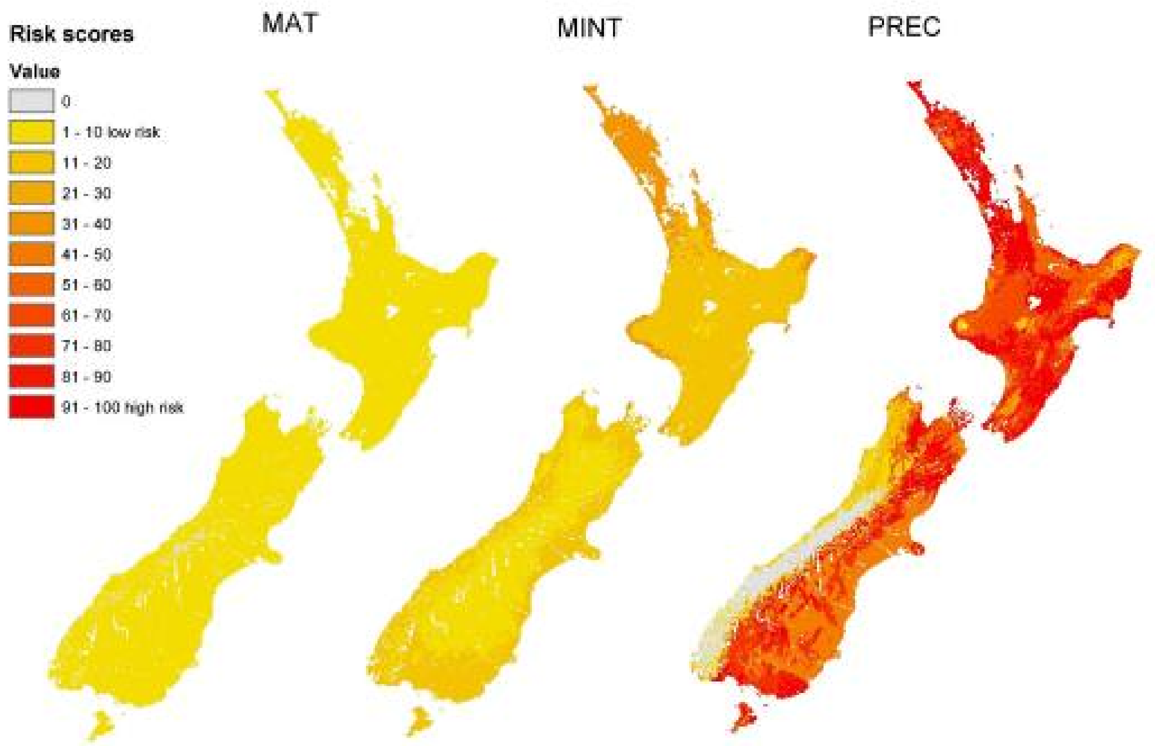
Table 6: Comparison of climate parameters for native and introduced range and native and introduced non-urban range of *P. longicornis.*

	n	Mean	Minimum	Maximum
Mean Annual Temperature (°C)				
Native Range	7.0	24.5	23.2	26.2
Introduced Range	145.0	23.2	4.3	29.3
Introduced Non-urban Range	130.0	24.3	17.5	29.3
Minimum Temperature (°C)				
Native Range	7.0	19.7	17.7	23.1
Introduced Range	145.0	15.3	-17.0	26.3
Introduced Non-urban Range	130.0	17.1	3.0	26.3
Mean Annual Precipitation (mm)				
Native Range	7.0	1851.0	1125.0	3156.0
Introduced Range	145.0	1456.0	9.0	3793.0
Introduced Non-urban Range	130.0	1497.0	9.0	3793.0
Mean Annual Solar Radiation				
Native Range	7.0	14.3	11.5	17.5
Introduced Range	145.0	16.1	9.2	22.9
Introduced Non-urban Range	130.0	16.3	12.1	22.9
Vapour Pressure (millibars)				
Native Range	7.0	23.1	18.0	27.0
Introduced Range	145.0	21.9	5.0	31.0
Introduced Non-urban Range	130.0	23.1	5.0	31.0
Seasonality of Temperature (°C)				
Native Range	7.0	10.7	6.0	14.4
Introduced Range	145.0	9.4	0.6	31.5
Introduced Non-urban Range	130.0	8.2	0.6	23.8
Seasonality of Precipitation (mm)				
Native Range	7.0	369.7	199.0	854.0
Introduced Range	145.0	151.0	3.0	632.0
Introduced Non-urban Range	130.0	157.8	3.0	632.0
Seasonality of Vapour Pressure (millibars)				
Native Range	7.0	8.7	4.0	16.0
Introduced Range	145	8.2	1.0	20.0
Introduced Non-urban Range	130.0	7.8	1.0	19.0

Table 7: Range of climate parameters from (Table A2.1) New Zealand (N = 196 GRIDS at 0.5 degree resolution). Data exclude distant island groups (Chatham, Bounty, Antipodes, Campbell, Auckland, and Kermadec Islands).

Parameter	Min	Max	Mean
MAT	-0.5	16.6	10.9
MINT	-8.3	7.8	3.0
PREC	356.0	5182.0	1765.0
MAS	11.2	14.3	13.0
VP	4.0	15.0	9.7
MATS	6.4	10.6	8.8
PRECS	23.0	175.0	60.5
VPS	4.0	8.0	5.9

a)



b)

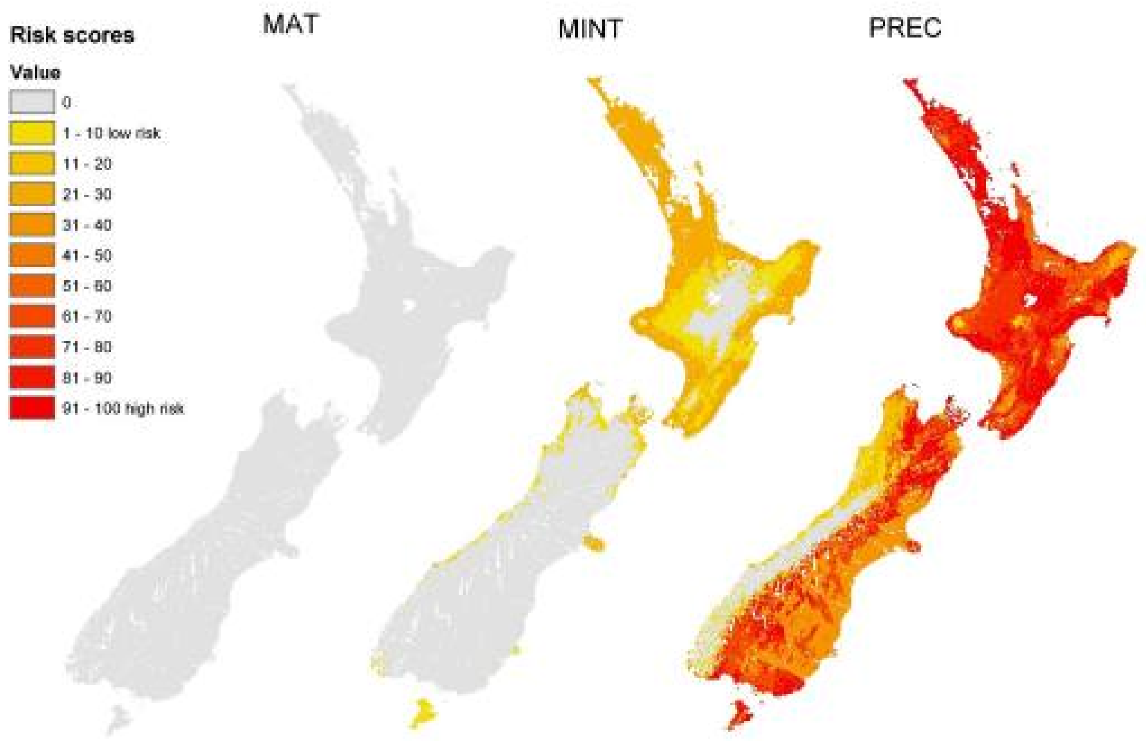


Fig. 5: *Similarity of a) native and introduced ranges and b) native and introduced non-urban ranges of* P. longicornis *to New Zealand for MAT, MINT, and PREC.*

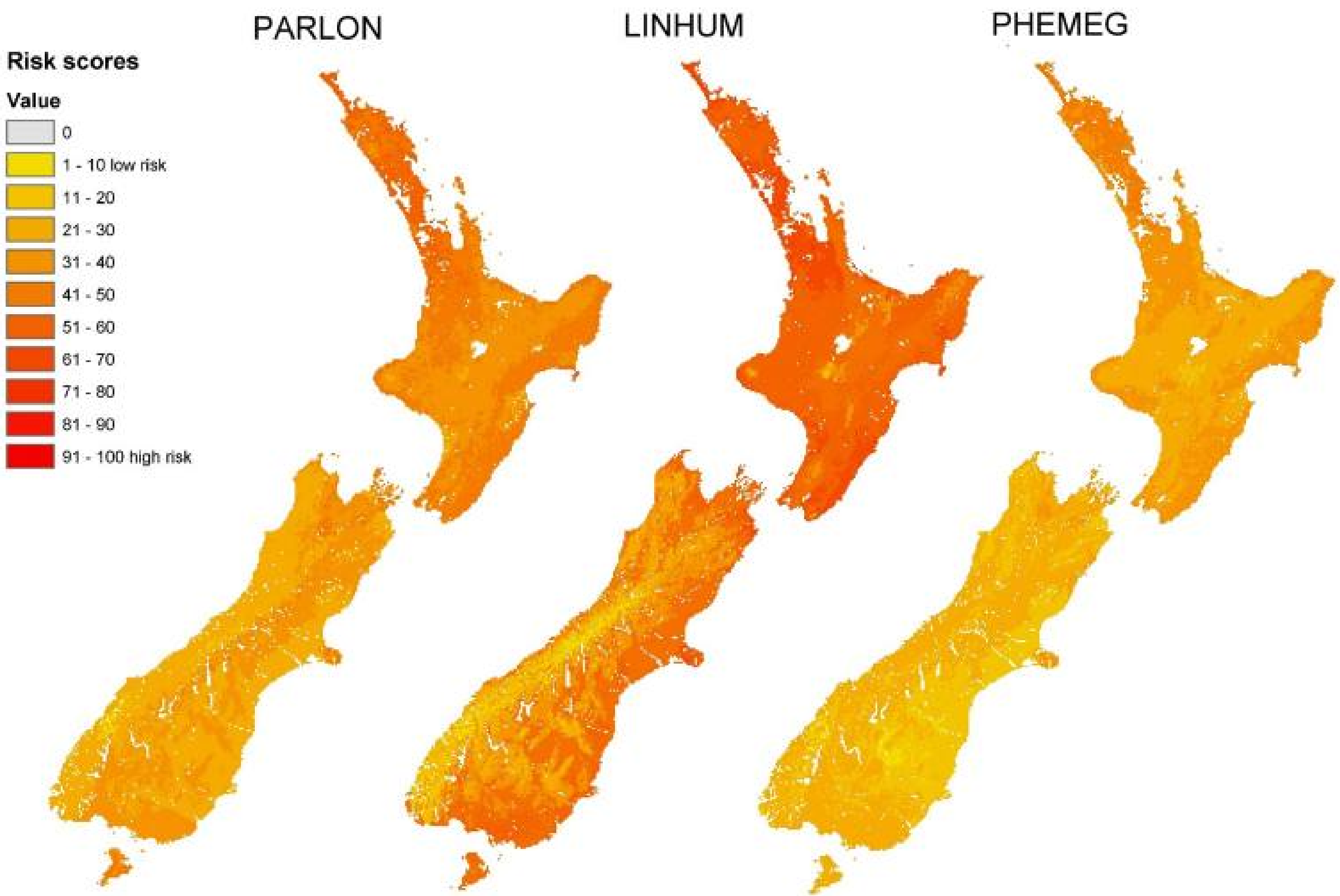


Fig. 6: *Comparison of climate similarity of New Zealand and the international ranges of* P. longicornis, L. humile *and* Ph. megacephala *based on the mean of the similarity scores of five climate layers (MAT, MINT, PREC, VP, and PRECS). This presentation approximates that produced by the risk assessment tool, Climex. The presentations represent native + introduced ranges.*

C2. Potential to establish in protected environments

As described above, *P. longicornis* is highly adaptable. It is closely associated with disturbed environments and will readily establish nest sites in greenhouses, buildings and urban environments and could survive in such habitats in temperate locations.

C3. Documented evidence of potential for adaptation of the pest

Trager (1984) suggested that the tolerance of *P. longicornis* for nesting sites with relatively low humidity, including crannies in walls, board and trash piles, palm thatching and dry litter contributes to its success.

C4. Reproductive strategy of the pest

In the tropics, *P. longicornis* produces sexual brood at any time of the year. However, in Gainesville, Florida (approximately 30 degrees latitude), alate production is apparently limited to the warm, rainy months of the year (Trager 1984). Nuptial flights are thought not to occur (Trager 1984). On warm humid evenings, large numbers of males gather outside nest entrances. Periodically, winged queens emerge and the wings are removed while still callow. Mating was not observed, but Trager (1984) suggested that it occurred in these groupings around the nest entrance. Trager (1994) did not observe males to fly.

Paratrechina longicornis is polygynous (Passera 1994) and probably polydomous. Colonies and individuals from the same location appear to tolerate each other, but they behave aggressively towards individuals from distant sites (Lim et al. 2003). Queens do not appear to cause this; instead, colony odors obtained through their diet appear responsible for the lack of intra-specific aggression (Lim et al. 2003).

C5. Number of individuals needed to found a population in a new location

To our knowledge, no research has been conducted on this aspect of *P. longicornis* ecology. However, an inseminated queen may have the capacity to start a new colony in isolation, but the likely mode of dispersal of this species is whole colonies being transported within freight. Workers alone are incapable of founding a new nest.

C6. Likely competition from existing species for ecological niche

This ant appears to be frequently displaced by more dominant species at baits, but in many other situations can survive and flourish. Rarely, it can become the numerically dominant ant. In Biosphere 2, an artificial biome constructed in Arizona, *P. longicornis* became the dominant ant species within approximately 2 years of first detection (Wetterer et al. 1999). It displaced a suite of local native species that were deliberately introduced before the self introduction of *P. longicornis*. In Canada in a tropical glasshouse *P. longicornis* was in low abundance compared to *Wasmannia auropunctata* (Naumann 1994).

Foraging workers of *P. longicornis* have been shown to discover baits before other ant species, and recruit in high numbers rapidly; however, they are usually replaced within an hour by more aggressive species that recruit additional foragers (Banks & Williams 1989; Lester & Tavite 2004). Wojcik (1994) monitored ant populations with bait traps on transects for 21 years in Gainesville, FL, and found that *Solenopsis invicta* gradually increased from 0 to 43.3%. The presence of *P. longicornis* was positively correlated with *S. invicta* populations, so it appears to be able to coexist with *S. invicta* in Florida as it does in Brazil (Banks & Williams 1989). It was negatively associated with the presence of *Pheidole megacephala* in and around buildings in Brazil (Delabie et al.1995). Successful reduction of *Monomorium* spp. (*M. pharaonis, M. destructor,* and *M. floricola*) from buildings in Malaysia resulted in an increase in *P. longicornis* (and *Tapinoma melanocephalum*) activity, indicating that the *Monomorium* spp. were dominant (Lee 2002). In Sri Lanka, *P. longicornis* was not present on coconut palms that had *Oecophylla*, as this species behaved aggressively towards *P. longicornis* (Way et al. 1989), and on

Floreana Island in the Galapagos, *P. longicornis* was absent from samples at a village site where the abundance of *M. destructor* had increased (Von-Aesch & Cherix 2003). Fowler et al. (1994) found *P. longicornis* and *T. melanocephalum* in 49 of 80 banana plantations surveyed in Sao Paulo, Brazil, but none had both species and both were absent from nearby tea and cocoa crops and native vegetation. On Santa Cruz Island in the Galapagos, *P. longicornis* was only sampled along a transect where *Wasmannia auropunctata* was absent (Clark et al. 1982). Pimentel (1955) reported that *P. longicornis* avoided areas where *S. geminata* and *T. melanocephalum* were present, but would attack and drag away single *S. geminata* workers that tried to steal its food.

Paratrechina longicornis is likely to show considerable overlap in nesting sites with *Linepithema humile* (Argentine ant). Where *L. humile* is established, establishment of *P. longicornis* may be inhibited and if the two did coexist, *P. longicornis* would likely be in relatively low abundance. Similarly, *Doleromyrma darwiniana*, which is also becoming more widespread around urban areas of New Zealand, could potentially compete with *P. longicornis* and reduce its chances of establishment. *Pheidole megacephala* has a very restricted New Zealand distribution so is unlikely to exert competitive pressure on *P. longicornis*. Where *M. pharaonis* is established in heated buildings (this does not appear to be widespread in New Zealand), it may limit *P. longicornis*. Coexistence is likely with other non-native ant species currently established in New Zealand, and native ant species are typically not abundant in disturbed habitats and so are unlikely to inhibit the establishment of *P. longicornis*.

C7. Presence of natural enemies

No reports of natural enemies of *P. longicornis* were found, and establishment in New Zealand is only likely to be hindered by other ant species. It is not attacked by phorid flies that attack *Solenopsis* in South America (Porter et al. 1995).

C8. Cultural practices and control measures applied in New Zealand that may affect the ant's ability to establish

Practices at the point of incursion (e.g., seaports and airports) are likely to affect the ability of *P. longicornis* to establish at those sites. Presently, there are no routine treatments of port areas that would decrease the chances of survival for *P. longicornis*, except for ongoing incursion responses.

Current (2002–2005) surveillance specifically for ants in and around ports is sufficiently thorough to detect large incursions, particularly in summer in northern areas where foragers are highly mobile and are attracted to surveillance baits. In addition, treatment of other invasive ant species in and around ports is likely to reduce the chances of survival of new propagules.

In more southerly sites establishment may be more closely associated with heated buildings and ant surveillance would only detect an incursion if there is foraging outdoors, which would likely occur to some degree in summer.

The importation procedures recommended by Ormsby (2003) for imported timber from the Pacific would reduce establishment probabilities from that pathway, but it is likely to be only one of many potential pathways for *P. longicornis*. Also, Ormsby (2003) only considered management of the timber and not the risks associated with populations in vessels carrying the timber. Interception histories in New Zealand and Australia would suggest ships are relatively commonly infested with *P. longicornis* (see B1. Identification of potential pathways).

(D) LIKELIHOOD OF SPREAD AFTER ESTABLISHMENT

D1. Dispersal mechanisms

Two methods of dispersal have together aided the spread of *P. longicornis* at local, regional, national and international scales—budding and human-mediated dispersal. The latter is probably more significant. *P. longicornis* is a 'tramp' ant (Holldobler & Wilson 1990; Passera 1994), renowned for transportation via human commerce and trade and commonly associated with a wide range of freight (see Association with Pathway section above).

Natural dispersal is primarily by budding. Neither queens nor males appear to fly (Trager 1984). It is a rapid coloniser, often being the first species to arrive in a newly disturbed area (Lee 2002).

D2. Factors that facilitate dispersal

Colonies are characterised by extreme agility—a readiness to move when only slightly disturbed and an ability to swiftly discover new sites and organise emigrations—and often occupy local sites that sometimes remain habitable for only a few weeks or days (Holldobler & Wilson 1990). Trager (1984) reports a large swarm of *P. longicornis* emigrating after being flooded out of its nest by a sprinkler. Their occurrence in disturbed habitats increases the likelihood of their being spread more widely by events such as flooding. A close association with human habitats facilitates dispersal as a consequence of the movement of plants, rubbish and other commodities.

D3. Potential rate of spread in its habitat range(s)

With an absence of winged dispersal, potential rates of spread in new habitats will be limited if human-mediated dispersal is eliminated. No information on rates of spread of *P. longicornis* was found. Their biology (budding, highly mobile colonies) suggests rates of spread will be similar to *Linepithema humile*. Expansion of *L. humile* through budding typically occurs over a relatively small scale, with estimates ranging from near zero in areas of climatic extremes up to 800 m/yr in recently invaded, highly favourable habitats (Holway 1998; Way et al. 1997; Suarez et al. 2001). In New Zealand, the rate of spread of *P. longicornis* could be more limited than that of *L. humile* because of the patchy availability of suitably warm habitats.

D4. Presence of natural enemies

Other ant species (particularly *Linepithema humile* and *Doleromyrma darwiniana*) are likely to be the primary factor limiting spread of *P. longicornis*. Both *L. humile* and *D. darwiniana* may be abundant at sites where they are established in New Zealand, and few other ants appear able to coexist with them (Ward & Harris in prep.; R. Toft, pers. comm.).

(E) THE ENVIRONMENTAL, HUMAN HEALTH AND ECONOMIC CONSEQUENCES OF INTRODUCTION

E1. Direct effects

E1.1 Potential for predation on, or competition with New Zealand's indigenous fauna

Available data suggest that *P. longicornis* is generally not an ecologically dominant species, but is highly opportunistic, with its success centring on its ability to find food rapidly before other ant species. It is omnivorous and will take whatever food is available. It does best in highly disturbed or artificial environments where other species are less suited; in such locations it can become the numerically dominant ant (MacArthur & Wilson 1967; Jaffe 1993; Wetterer et al.1999), displacing other ants and affecting other invertebrates (Wetterer et al. 1999). Highly disturbed native habitats in New Zealand would include coastal dunes, intertidal areas, geothermal areas, and perhaps coastal scrub. The potential for establishment in those habitats is considered low because of climatic limitations. If *P. longicornis* was to establish in native habitat it would probably do so in the far north of New Zealand and on northern offshore islands, all of which have a milder, subtropical climate. If the total ant biomass at a site increased as a result of the establishment of *P. longicornis* (not a certainty considering the limited climate suitability) there would likely be detrimental impacts on the native fauna, particularly the invertebrate community, with many species declining and localised extinctions being possible, placing invertebrate species with severely restricted distributions at risk. No native ants would be at risk of extinction because they are widely distributed and are present in forests that would serve as refuges. Disturbed native habitats are also those where *L. humile* is most likely to establish (Harris et al. 2002b) and it is likely that *L. humile* would displace *P. longicornis* in New Zealand's climate.

Any dispersal into northern native habitats will take many years because of the dispersal mechanisms of this ant. Localities with low visitation rates, especially by boat or vehicle, may never have colonies transported into the area and natural dispersal rates by budding would be limited by the availability of suitable habitat.

Urban areas generally have low native biodiversity values so the consequences of establishment would be minimal.

E1.2 Human health-related impacts

Paratrechina longicornis does not sting or bite (Thompson 1990), and no reports were found of them spraying formic acid onto humans (unlike *A. gracilipes*). However, they could potentially vector pathogens in hospitals (Fowler et al. 1993) and commercial food outlets.

E1.3 Social impacts

In tropical areas, the frenetic behaviour of *P. longicornis* is often considered irritating, and may deter people from sitting in areas where they are abundant. In New Zealand, its presence within heated buildings such as hospitals and hotels would cause similar reactions and probably prompt pest control. Areas where abundant populations occur outdoors would probably be limited but where present they could be a nuisance.

E1.4 Agricultural/horticultural losses

Paratrechina longicornis may be associated with honeydew-producing insects in large numbers (Wetterer et al. 1999). It is likely to reach large densities and be a pest only in glasshouse environments.

A limited economic impact assessment in New Zealand estimates potential treatment expenditure by affected sectors to be relatively small (up to $18 274 (Anon. 2004)).

E1.5 Effect(s) on existing production practices

There are likely to be no direct impacts on production practices from the establishment of this ant. However, if establishment occurs, the nursery trade may be a primary vector for the crazy ant's spread around the country. If measures to stop spread were implemented within an area of incursion, freight companies and nurseries would be affected. Also people moving rubbish etc.

E1.6 Control measures

This section is largely based on the review of baiting by Stanley 2004.

Crazy ants are difficult to control, with commercially available baits showing limited effectiveness (Hedges 1996a; Hedges 1996b; Mampe 1997; Summerlin et al. 1998; Lee 2002; wwwnew51). The ant often nests some distance from its foraging area; nests can be in cracks in concrete often making them difficult to locate and control.

Bait matrix (attractant + carrier): Experiments using food attractants found 80% of *P. longicornis* preferred honey over peanut butter (Lee 2002). Lee and Kooi (2004) report that baiting is seldom effective, particularly with paste and granular formulations, against *P. longicornis* in Singapore and Malaysia; however, they recommend sugar-based, liquid or gel formulations for control of *P. longicornis* (Lee 2002). Tuna (in oil) baits used in Biosphere 2 (in which *P. longicornis* was the dominant ant) were consistently more attractive to *P. longicornis* than the pecan cookie baits (carbohydrate) put out at the same time (Wetterer et al. 1999; J. Wetterer, pers. comm.). Few *P. longicornis* were attracted to oil baits in Hawaii (Cornelius et al. 1996), and in New Zealand, foragers preferred sweet baits over protein baits during *P. longicornis* incursions (T. Ashcroft, pers. comm.).

P. longicornis is attracted to sugar but does not have strong preferences for different sugars, unlike *Pheidole megacephala* (Cornelius et al. 1996). Sugar-based baits (1-cm cotton dental roll soaked in 20% sucrose-water) consistently attracted *Paratrechina* spp. in a field trial in Arkansas (Zakharov & Thompson 1998). Peanut butter baits have been used in Hawaii to collect *P. vaga* and *P. bourbonica* (Gruner 2000). Sugar-based baits have controlled *P. longicornis* "pretty well" for homeowners in the San Antonio area, especially in the cooler winter months (wwwnew51).

Toxicants and commercial baits: Hedges (1996b) reported *P. longicornis* would not feed for sufficient time on commercial baits to ensure effective control. Lee et al. (2003) found some evidence that Protect-B® (0.5% methoprene) baits and Combat Ant Killer® bait stations (1% hydramethylnon) are not effective against *P. longicornis*.

Observations during incursions in New Zealand showed that *P. longicornis* recruits well to Xstinguish™ (T. Ashcroft, pers. comm.). However, no formal testing of the attractiveness or the efficacy of this bait against *P. longicornis* has been undertaken. Exterm-An-Ant® (8% Boric acid + 5.6% sodium borate) has also been used against *P. longicornis* in New Zealand and although attractive to foragers (V. van Dyk, pers. comm.) its ability to kill queens within the nest is unknown. Trials to compare the attractiveness of Xstinguish™, and Exterm-An-Ant® with other potential options for management of *P. longicornis* are being conducted in Queensland for MAF (M. Stanley, pers. comm.). *Paratrechina* spp. present in New Zealand (2 undescribed Australian species) do forage on Xstinguish™ (Harris et al. 2002a). Bait attractiveness trials on Palmyra Atoll showed *P. bourbonica* preferred sugar water, with Xstinguish™ next preferred (Krushelnycky & Lester 2003). *P. bourbonica* ignored Maxforce® granules (silkworm pupae matrix) and was not observed carrying away Amdro® granules (soybean oil on corn grit) (Krushelnycky & Lester 2003). Protein baits (fish meal; minced meat and eggs) are used in baits to control *P. fulva* in Colombia (Zenner-Polania 1990; Anon. 1996).

Arkansas field trials on the non-target effects of *Solenopsis invicta* control using Logic® (fenoxycarb) and Amdro® (hydramethylnon) found that *Paratrechina* ants were one of the few genera not to decrease in Amdro®-treated plots, and their abundance more than doubled in the Logic®-treated plots (Zakharov & Thompson 1998). The authors concluded that *Paratrechina* is therefore not susceptible to Logic® or Amdro®. However, this study is difficult to interpret because observations of ants foraging on baits were not carried out and changes in abundance could have been a result of changes in the abundance of competitors.

E2. Indirect effects

E2.1 Effects on domestic and export markets

No effects on domestic or export markets have been recorded. However, if *P. longicornis* became established in New Zealand and transported to another country where they were absent, it could affect import health standards applied to New Zealand exports. However, with the very wide distribution of this ant most major international ports, particularly in tropical and subtropical zones, are likely to already have this ant established.

E2.2 Environmental and other undesired effects of control measures

There have been no documented cases of adverse non-target effects arising directly from the use of toxic baits to control *P. longicornis*. However, any bait used will likely be toxic to other invertebrates that eat it. Should Xstinguish™ baits be used for *P. longicornis*, extreme care will be needed near water as fipronil is highly toxic to fish and aquatic invertebrates (wwwnew81). There is no documented evidence of resistance of any ant to pesticides.

(F) LIKELIHOOD AND CONSEQUENCES ANALYSIS

F1. Estimate of the likelihood

F1.1 Entry

Paratrechina longicornis currently has a *high* risk of entry.

This assessment is based on:

- *P. longicornis* having been frequently intercepted at the New Zealand border (16 times between 1997 and 2002, and 47 times between 2003 and March 2004 during a period of full reporting of interceptions).
- this species having the potential to stowaway in a wide range of freight as it commonly nests in disturbed habitat and in close association with goods that are often transported.
- dispersal being by budding. Colonies being polygyne and highly mobile if disturbed.
- all these characteristics promote the chances of queens with workers being transported.The species being widespread globally relative to other tramp ant species.
- its distribution includes much of the Pacific – a high risk pathway for ants entering New Zealand.

Data deficiencies

- not all ants intercepted at the New Zealand border are reported or identified and it is likely that current interception records underestimate entry of this species (as evident by the dramatic increase in interception reports in 2003). It is also not always clear from interception data if castes other than workers were intercepted.

F1.2 Establishment

Paratrechina longicornis currently has a *high* risk of establishment.

This assessment is based on:

- there being suitable habitat for nesting close to sites of arrival or devanning (container unloading).
- the ant having the capacity to establish nests in warm microclimates in urban areas in the northern part of the North Island and in close association with heated buildings elsewhere in New Zealand.
- the discovery of several persistent incursions of this species at Auckland and Mt Maunganui in 2003–2004, indicating the ability to establish beachhead populations.
- the ant having a history of establishment within urban areas in countries with temperate climates, although in some cases, e.g., California, establishment is not thought to be permanent and there have been several reintroductions.
- the low likelihood that the ant will encounter natural enemies, but a higher likelihood of competition from other adventive ants.
- the presence of numerous pathways from New Zealand's Pacific trading partners for budded colonies to arrive in New Zealand in a fit reproductive state.
- surveillance targeted at other invasive ants (particularly *Solenopsis invicta*) is likely to detect this species, because they will find baits rapidly but will probably be displaced by other species (such as *L. humile*, and *S. invicta*).

Data deficiencies

- there is very little experimental data on climate tolerances of *P. longicornis.* The climate assessment is based principally on consideration of climate from known sites of establishment of *P. longicornis*. Given the numerous interceptions, the frequency of recent incursions, and widespread distribution of this ant it is surprising that it is not already established. This may suggest that New Zealand conditions are not ideal. There is a lack of experimental data on survivorship and reproductive potential of *P. longicornis* at lower temperatures that mirror those of temperate climates.
- there is need for a better data on the global distribution and associated localised environmental parameters of this ant. In particular follow-up on populations reported from temperate localities; are they still present, if so in habitats are they found, and what environmental conditions are they exposed to?
- the ability of *P. longicornis* to establish at sites dominated by *Linepithema humile* is considered unlikely but is not experimentally proven.
- there is no contingency plan for successful eradication of a large incursion of this species.

F1.3 Spread

Paratrechina longicornis has a *medium* risk of spread from a site of establishment.

This assessment is based on:

- areas of New Zealand considered climatically suitable for the ant to colonise are available, although likely to be limited to urban areas.
- suitable habitat occurs in New Zealand. In temperate climates suitable habitat will primarily be urban, but some disturbed native habitat (costal dunes, intertidal areas, geothermal areas and perhaps coastal scrub), predominantly in the far north, could be colonised if climate predictions underestimate distribution.
- the assumption that conditions enable colonies to grow large enough for budding to occur and that human-mediated dispersal would aid spread between urban centres.
- colony development being relatively slow. Sub-optimal temperatures in New Zealand will probably restrict foraging and colony development and extend the time taken for newly established colonies to reach sufficient size to produce reproductives and undergo budding.

Data deficiencies

- based on climate comparisons with the non-urban global distribution, northern New Zealand's climate is considered too cold for *P. longicornis* outside urban areas, but there is a lack of experimental data on developmental rates in relation to temperature to back up this assumption.
- there is a lack of experimental data on the colony status (size and abiotic cues) that promotes budding in polygyne species.

F1.4. Consequences

The consequences of the presence of *P. longicornis* in New Zealand are considered *low*.

This assessment is based on:

- there being no medical consequences of establishment as the ant does not sting or spray formic acid.
- the ant being only a minor nuisance pest both indoors and around domestic dwellings in limited locations, and

probably an occasional pest in commercial premises through product contamination. Occasionally, in ideal conditions it may become a greater nuisance. Some pest control would probably be initiated where the ant was abundant but it is unclear if levels of control currently undertaken for other pests would increase significantly.

- economic consequences being considered minor compared to those of *L. humile*, together with the probable overlap in suitable habitat for the two species in urban areas.
- the low likelihood of environmental consequences even if the ant does establish in native habitats. In optimal climates this species is not ecologically dominant. Detrimental impacts have only been demonstrated in artificial (glasshouse) environments.

Data deficiencies

- there are no impact studies specifically focussing on this species in natural environments.
- although predicted to establish, the extent of its likely distribution and its population densities in urban areas are unknown. There are no quantitative studies of its abundance and/or distribution in temperate cities, but also no reports of its being abundant or a significant pest in such environments.

F2. Summary table

Ant species: ***Paratrechina longicornis***

Category			**Overall risk**
Likelihood of entry	High	Frequent interception.	Medium - high
		Many potential pathways.	
Likelihood of establishment	High	Urban habitats suitable.	
		Recent history of incursions.	
Likelihood of spread	Medium	Human assisted.	
		Predominantly urban areas.	
Consequence	Low	Restricted distribution.	
		Minor impacts.	

A detailed assessment of the Kermadec Islands is beyond the scope of this assessment.

(G) References

(NB: a copy of all web page references is held by Landcare Research (M. Stanley) should links change)

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(J) Appendices

Appendix 1: Freight summary

Table a. Summary of sea freight coming to New Zealand from localities within 100 km of known sites with *P. longicornis.* Values represent the total freight (tonnes) during 2001, 2002 and 2003 (source: Statistics New Zealand). Total freight is broken into different commodity types. NB: New Zealand received some freight from all locations listed, but if total freight is below 500 kg it is listed as 0 tonnes. Details of the freight types that comprise each category are given (c) as are the categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database (d).

Country	Port of export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
American Samoa	Pago Pago	18772	929	3	21	5	0	0	0	17796	0	0	17
Australia	Adelaide, SA	331071	39124	412	137503	123093	2031	106	5368	11616	895	9576	1349
Australia	Brisbane, QL	1241885	55439	5267	382987	440174	7092	489	112104	128971	18011	61131	30221
Australia	Cairns, QL	117546	0	0	0	68684	0	0	0	0	0	0	48862
Australia	Darwin, NT	1035	134	9	463	142	3	0	1	109	0	16	158
Australia	Fremantle, WA	989264	7243	338	873646	13793	2055	563	54063	25388	2	8948	3226
Australia	Geraldton, WA	66215	0	0	0	66215	0	0	0	0	0	0	0
Australia	Kwinana, WA	492392	0	0	492392	0	0	0	0	0	0	0	0
Australia	Perth, WA	3980	592	31	248	225	77	1	511	429	0	1760	106
Australia	Port Adelaide, SA	175	35	0	0	20	0	0	0	72	26	16	6
Australia	Port Stanvac, SA	312369	0	0	311863	0	0	0	0	506	0	0	0
Australia	Port Stanvac, SA	312369	0	0	311863	0	0	0	0	506	0	0	0
Bahrain	Bahrain	4688	0	1	0	15	0	0	0	4672	0	0	0
Barbados	Bridgetown	306	2	0	0	298	0	0	2	0	0	0	3
Brazil	Belem, PA	756	0	0	0	0	14	0	0	0	172	570	0
Brazil	Brasilia, DF	167	59	0	0	0	0	0	20	88	0	0	0
Brazil	Campinas, SP	20	3	0	0	17	0	0	0	0	0	0	0
Brazil	Rio de Janeiro, RJ	4494	327	3	13	1910	5	0	433	1200	17	108	478
Brazil	Salvador, BA	633	1	1	0	388	0	0	3	113	0	0	128
Brazil	Santarem, PA	57	1	0	0	31	0	0	0	0	0	26	0
Brazil	Santos, SP	27326	2875	40	33	16008	4	60	1927	1742	78	1541	3018
Brazil	Viracopos Apt/Sao Paulo, SP	16	0	0	0	0	0	0	0	0	0	0	16
Brunei Darussalam	Bandar Seri Begawan	133354	0	0	133334	0	0	0	0	20	0	0	0
Brunei Darussalam	Muara	21	21	0	0	0	0	0	0	0	0	0	0
Canada	Chemainus, BC	2548	0	0	0	0	0	0	0	0	0	2548	0
Canada	Crofton, BC	934	0	0	0	0	0	0	0	0	0	934	0
Canada	New Westminster, BC	26959	1948	42	122	2957	39	20	137	2082	74	19402	133
Canada	Oakville, ON	42	0	0	0	35	0	0	6	1	0	0	0

Country	Port of export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
Canada	Quebec Apt, QC	56	4	0	0	0	9	0	13	30	0	0	0
Canada	Quebec, QC	198	40	5	63	6	0	0	0	68	0	13	2
Canada	Toronto Apt, ON	2088	355	6	62	985	28	0	5	603	0	4	40
Canada	Toronto, ON	18010	1710	21	485	2332	186	0	304	1390	10950	73	559
Canada	Vancouver Apt, BC	38307	541	93	8001	28164	64	0	176	402	24	732	110
Canada	Vancouver, BC	1401880	4736	558	1302629	73541	420	2	1599	8462	3738	5659	537
Canada	Victoria Apt, BC	9	9	0	0	0	0	0	0	0	0	0	0
Canada	Victoria, BC	0	0	0	0	0	0	0	0	0	0	0	0
China	Chiwan	2957	202	65	1851	189	155	5	31	281	71	40	67
China	Guangzhou (Canton)	68269	1634	549	56342	1526	1013	121	2916	2129	94	399	1545
China	Huangpu	38933	2482	1098	15217	4050	2892	146	4452	3498	201	1850	3047
China	Quanzhou	2102	228	64	468	244	13	11	336	279	112	205	142
China	Shekou	2012	87	30	106	170	149	5	889	314	35	104	124
China	Shenzhen	3347	288	53	105	108	392	51	1913	254	0	55	127
China	Xiamen	43808	1826	3612	6814	1378	3500	1531	5986	11934	363	342	6521
China	Yantian	13267	3561	167	95	103	3887	183	1961	1922	6	321	1062
China (Hong Kong)	Hong Kong SAR	455059	64385	33371	154811	27265	32065	5596	27075	60995	3831	9946	35718
China (Hong Kong)	Kowloon	188	10	20	0	0	42	30	1	36	0	37	14
China (Macau)	Macau	26	6	12	0	0	0	1	0	1	0	1	4
Christmas Island	Christmas Island	31500	0	0	31500	0	0	0	0	0	0	0	0
Colombia	Barranquilla	294	0	0	0	102	0	0	0	0	0	0	192
Colombia	Buenaventura	1922	0	0	0	1800	3	0	55	64	0	0	0
Colombia	Cartagena	847	77	56	21	128	0	0	47	24	491	3	0
Cook Islands	Aitutaki	93	67	0	0	0	0	0	0	2	22	0	1
Costa Rica	San Jose	120	0	0	0	52	0	0	0	0	69	0	0
Dominica	Portsmouth	976	913	0	0	25	4	0	0	31	0	1	0
Dominican Republic	Santo Domingo	74	0	0	0	0	0	0	22	52	0	0	0
Ecuador	Guayaquil	166503	0	6	0	2515	0	0	1	0	163973	7	1
Egypt	Cairo (El Qahira)	222	0	222	0	0	0	0	0	0	0	0	0
Egypt	Damietta	27720	89	71	22108	1258	68	0	844	715	2337	95	134
Egypt	Port Said	556	8	3	0	535	0	0	0	7	3	0	0
El Salvador	San Salvador	18	0	0	0	0	0	0	0	16	2	0	0
Fiji	Lautoka	13455	574	219	0	7892	160	4	1	817	1570	1296	921
Fiji	Nadi	839	4	2	0	16	0	0	0	14	774	0	28
Fiji	Savusavu	66	1	0	0	0	0	0	0	0	0	65	0
Fiji	Suva	40544	940	464	83	8512	290	3	82	2211	18069	9328	562
France	Melun	0	0	0	0	0	0	0	0	0	0	0	0
France	Paris	1874	617	22	52	270	15	1	136	446	3	125	186
France	Paris-Charles De Gaulle Apt	346	74	4	2	19	33	0	171	24	0	1	17
French Polynesia	Papeete	5364	321	1	6	4530	9	0	0	463	11	1	21
Ghana	Tema	119	0	1	0	51	10	0	0	0	0	57	1
Gibraltar	Gibraltar	33	0	0	0	0	0	0	0	33	0	0	0
Greece	Thessaloniki	7250	1	35	5656	1131	0	0	102	60	55	0	210
Greece	Volos	35	0	35	0	0	0	0	0	0	0	0	0

Country	Port of export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
Guyana	Georgetown	2598	0	0	21	0	0	0	0	2004	0	573	0
India	Banddar	98	0	12	0	37	2	0	11	25	0	0	11
India	Bangalore	1599	7	16	104	802	38	0	256	181	58	62	75
India	Bombay (Mumbai)	31975	890	3753	6603	5258	744	191	4196	5475	1469	401	2994
India	Calcutta	13477	28	2441	423	118	2	75	522	9724	35	1	107
India	Cochin	4549	100	806	689	1636	7	0	163	218	656	205	69
India	Delhi	4704	303	699	352	520	248	95	704	1148	81	61	494
India	Haldia	4588	67	117	843	0	0	0	47	3497	0	2	13
India	Ranchi	27	1	5	21	0	0	0	0	0	0	0	0
Indonesia	Bandung, Java	1	0	1	0	0	0	0	0	0	0	0	1
Indonesia	Benoa, Bali	2	0	0	0	0	0	0	0	0	0	2	0
Indonesia	Denpasar, Bali	34971	0	0	34660	55	13	0	4	12	0	225	1
Indonesia	Jakarta, Java	627407	7678	6649	482350	25252	2467	74	21925	45631	26	28056	7300
Indonesia	Semarang, Java	36975	80	921	30220	1	3453	4	796	72	5	1411	12
Israel	Ashdod	32747	269	35	31300	333	13	0	0	369	0	1	426
Israel	Haifa	9932	506	1547	1542	504	310	1	14	4315	5	27	1162
Israel	Tel Aviv	311	17	154	65	0	11	0	1	63	0	0	0
Jamaica	Kingston	2084	0	6	0	2016	0	0	0	0	23	38	0
Japan	Chiba, Chiba	30452	1882	0	28570	0	0	0	0	0	0	0	0
Japan	Fukuoka, Fukuoka	524	516	0	0	4	0	0	1	2	1	0	0
Japan	Funabashi, Chiba	65477	65466	0	0	0	1	0	1	9	0	0	0
Japan	Hakata, Fukuoka	16258	8240	9	38	32	0	0	0	7913	21	1	5
Japan	Haneda Apt/Tokyo	44	17	0	0	19	0	0	0	8	0	0	0
Japan	Ikejima, Nagasaki	32	17	0	0	0	0	0	0	0	0	15	0
Japan	Kumamoto, Kumamoto	35	35	0	0	0	0	0	0	0	0	0	0
Japan	Miike, Fukuoka	71	44	0	0	0	0	0	0	26	0	0	0
Japan	Nagasaki, Nagasaki	1147	1142	4	0	0	0	0	0	0	0	0	1
Japan	Naha, Okinawa	53	44	1	0	0	0	0	0	8	0	0	0
Japan	Okinawa, Okinawa	31	26	0	0	0	0	0	0	5	0	0	0
Japan	Tokyo, Tokyo	106422	21527	233	46367	3553	373	3	394	29479	71	1513	2909
Japan	Yatsushiro, Kumamoto	8	6	0	0	0	0	0	0	2	0	0	0
Japan	Yokohama, Kanagawa	410100	256656	358	7301	9200	196	5	762	100878	173	18235	16335
Jordan	Amman	1	0	0	0	0	0	0	0	1	0	0	0
Kenya	Nairobi Apt	38	4	1	0	0	6	0	0	1	0	0	26
Lebanon	Beirut	177	22	0	0	144	0	0	0	2	3	2	4
Malaysia	Bagan Luar (Butterworth)	299	0	0	0	279	0	0	0	0	0	0	20
Malaysia	Pasir Gudang, Johor	120238	2267	180	177	92311	3555	5	10597	7282	5	2952	908
Malaysia	Penang (Georgetown)	30233	1752	748	258	7349	2379	1	623	10781	3	4846	1493
Malaysia	Prai	15	0	0	0	0	0	0	0	2	0	13	0
Malaysia	Sipitang, Sabah	7	0	7	0	0	0	0	0	0	0	0	0
Malaysia	Tanjong Pelepas	270508	16335	5042	105266	26303	5137	420	37261	38394	3643	24398	8308
Malta	Malta (Valetta)	29	2	0	0	0	0	0	0	0	8	0	18
Mauritius	Port Louis	1257	67	12	0	788	7	0	0	361	0	2	19
Mexico	Mazatlan, SIN	15	0	0	0	0	9	0	6	0	0	0	0

Country	Port of export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
Mexico	Tampico, TAM	202	14	0	21	32	2	0	26	108	0	0	0
Mexico	Veracruz, VER	498	296	14	82	19	0	0	2	86	0	0	0
Morocco	Casablanca	930083	0	1	930050	26	3	0	3	0	0	0	0
Nepal	Kathmandu	4	0	2	0	0	0	1	0	0	0	0	0
New Caledonia	Noumea	812	262	1	12	31	0	1	0	58	411	3	35
Nicaragua	Managua	39	0	0	0	39	0	0	0	0	0	0	0
Nigeria	Apapa	20	0	0	0	0	0	0	0	0	0	20	0
Nigeria	Lagos	23	0	0	0	0	0	0	0	0	23	0	0
Niue	Niue Island	606	9	0	0	42	5	0	0	5	544	0	0
Northern Mariana Islands	Saipan	0	0	0	0	0	0	0	0	0	0	0	0
Oman	Min-al-Fahal	862459	0	0	862459	0	0	0	0	0	0	0	0
Oman	Muscat	351	2	0	0	312	0	0	0	38	0	0	0
Oman	Port Qaboos	180	0	0	0	174	0	0	0	6	0	0	0
Panama	Balboa	167	4	3	0	19	0	0	0	45	45	8	42
Panama	Colon	544	37	0	0	0	0	0	0	12	494	0	0
Panama	Cristobal	162	117	0	0	0	0	0	0	22	23	0	1
Panama	Panama City	147	8	9	0	93	0	19	0	6	0	2	9
Panama	Puerto Armuelles	233	0	0	0	23	0	0	0	0	210	0	0
Papua New Guinea	Kimbe	7382	0	0	0	6897	0	0	0	0	0	485	0
Papua New Guinea	Madang	5396	72	0	0	1486	0	0	0	0	0	3829	9
Papua New Guinea	Manus Island Apt	78	16	0	53	0	0	0	8	0	0	0	0
Papua New Guinea	Port Moresby	7025	248	0	10	1208	1	0	0	79	0	5467	11
Papua New Guinea	Rabaul	1093	0	0	0	933	0	0	0	0	0	158	2
Peru	Callao	5904	2	15	585	4459	4	0	36	1	103	691	9
Peru	Lima	28195	0	2	28046	144	0	2	0	0	0	0	0
Philippines	Cagayan de Oro, Mindanao	138	0	0	0	0	0	0	0	0	138	0	0
Philippines	Cebu	1675	0	34	0	938	263	10	369	3	5	20	32
Philippines	Manila	25224	924	1401	719	9993	666	37	295	6839	2947	451	951
Phillipines	Zamboanga, Mindanao	816	0	0	0	816	0	0	0	0	0	0	0
Portugal	Porto Santo	1	0	1	0	0	0	0	0	0	0	0	0
Puerto Rico	Ponce	703	0	0	0	699	0	0	0	0	0	0	5
Puerto Rico	San Juan	167	0	0	0	159	0	0	0	0	0	0	8
Reunion	St Denis de La Reunion	90	37	0	0	21	0	0	0	32	0	0	0
Samoa	Apia	6594	411	14	1	3275	1	0	0	666	2166	38	23
Saudi Arabia	Damman	45126	102	1063	28140	82	0	0	20	15628	17	0	74
Saudi Arabia	Dhahran	26483	0	0	26419	0	0	0	0	64	0	0	0
Saudi Arabia	Jeddah	557670	56	2517	537416	1366	0	0	9228	7067	0	0	19
Saudi Arabia	Ras Tanura	539060	0	0	539060	0	0	0	0	0	0	0	0
Singapore	Jurong	46	44	0	0	0	1	0	0	1	0	0	0
Singapore	Singapore	1204093	60294	16705	641019	76567	9858	583	47443	257167	7200	44352	42903
Singapore	Singapore Container Terminal	95555	8284	4242	10745	11364	1671	70	7422	37763	1991	6455	5547
Solomon Islands	Honiara, Guadalcanal Island	3205	83	1	63	471	0	0	0	0	312	2225	49
Solomon Islands	Noro, New Georgia	226	0	0	0	127	0	0	0	0	0	1	98

Country	Port of export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
South Africa	Durban	59503	3535	1071	7339	8560	241	4	1567	12990	234	13539	10423
Sri Lanka	Colombo	11891	38	1241	218	5417	18	0	1266	2149	717	479	348
Switzerland	Zurich	409	220	12	3	0	4	0	10	127	0	1	33
Syria	Damascus (Damas)	24	0	0	23	0	0	0	0	0	0	0	0
Taiwan	Kaohsiung	143597	3742	1284	71543	1982	3691	33	2467	52419	105	1946	4385
Taiwan	Keelung (Chilung)	117117	12861	17064	11309	3466	4087	130	2815	57590	32	801	6959
Taiwan	Suao	0	0	0	0	0	0	0	0	0	0	0	0
Taiwan	Taipei	23820	1867	499	10496	211	435	34	595	8960	1	92	630
Taiwan	Taitung	108	10	0	0	12	15	0	0	67	3	0	0
Tanzania	Dar es Salaam	4	0	0	0	2	0	0	0	0	0	2	1
Tanzania	Tanga	32	2	30	0	0	0	0	0	0	0	0	0
Thailand	Bangkok	463060	36771	5583	88891	101865	4602	304	88983	105922	3191	16557	10391
Thailand	Koh Sichang	97	0	0	0	0	0	0	0	97	0	0	0
Thailand	Sriracha	34663	714	10	12532	3619	1	0	747	14404	21	82	2534
Tonga	Neiafu	0	0	0	0	0	0	0	0	0	0	0	0
Tonga	Tongatapu-Nuku'alofa	5782	558	0	12	174	13	0	3	516	4335	159	12
Tonga	Vava'u	369	18	0	0	5	0	0	0	11	333	1	1
Trinidad and Tobago	Port of Spain	71	23	0	40	8	0	0	0	0	0	0	0
Tuvalu	Funafuti	44	35	0	0	1	0	0	0	7	0	0	0
UK	Beckingham	17	0	0	0	17	0	0	0	0	0	0	0
United Arab Emirates	Dubai	95457	61	4	1054	981	20	0	91870	1392	6	5	65
United Arab Emirates	Jebel Ali	99733	45	10	90472	1148	4	0	5593	2391	36	0	33
United Arab Emirates	Jebel Dhanna	415091	0	0	415091	0	0	0	0	0	0	0	0
USA	Albany, GA	1	0	0	0	0	0	0	0	0	0	0	0
USA	Annapolis, MD	1	1	0	0	0	0	0	0	0	0	0	0
USA	Baltimore, MD	9964	7345	487	397	342	16	0	122	466	0	374	415
USA	Baton Rouge, LA	17703	0	0	0	17703	0	0	0	0	0	0	0
USA	Bellingham, WA	62	59	0	0	0	0	0	0	0	0	0	3
USA	Benicia, CA	20	0	0	0	0	0	0	19	0	0	0	0
USA	Brownsville, TX	4	0	0	0	0	0	0	0	4	0	0	0
USA	Burbank Apt, CA	44	28	0	0	3	0	0	0	1	0	10	2
USA	Charleston, SC	3172	210	184	1870	436	69	0	19	161	0	118	104
USA	Chester, NY	5	5	0	0	0	0	0	0	0	0	0	0
USA	Chicago Apt, IL	1258	344	1	73	156	24	0	1	337	69	65	189
USA	Chicago, IL	9277	2397	93	202	1012	229	2	229	2385	12	536	2179
USA	Corpus Christi, TX	15	0	0	15	0	0	0	0	0	0	0	0
USA	Dallas-Fort Worth Reg, TX	105	8	19	0	4	0	0	21	31	0	4	19
USA	Dulles Intl Apt/Washington	111	0	1	0	0	0	0	0	110	0	0	0
USA	Fort Lauderdale, FL	43	28	0	0	15	0	0	0	0	0	0	0
USA	Freeport, TX	3517	0	0	0	0	0	0	0	3517	0	0	0
USA	Galveston, TX	15	15	0	0	0	0	0	0	0	0	0	0
USA	Gramercy, LA	4667	0	0	0	4667	0	0	0	0	0	0	0
USA	Honolulu, HI	335	43	3	0	16	19	0	0	219	0	0	35
USA	Houston, TX	152881	3481	83	11146	1526	166	257	1722	123544	92	4376	6486

Country	Port of export	Total freight	Appliances	Fibres	Bulk	Foodstuffs	Furniture	Furs	Glass	Metals	Produce	Wood	Other
USA	Jacksonville, FL	41	3	0	3	0	0	0	0	3	0	10	23
USA	Jersey City, NJ	37	3	0	0	0	0	0	34	0	0	0	0
USA	John F Kennedy Apt/New York	681	214	20	0	274	9	0	8	74	0	66	16
USA	La Guardia Apt/New York	0	0	0	0	0	0	0	0	0	0	0	0
USA	Long Beach, CA	125753	8771	945	65911	25023	795	131	1654	10317	3028	1997	7180
USA	Los Angeles, CA	386498	47014	3118	88274	79498	3102	246	4544	67318	39961	12227	41195
USA	Miami, FL	596	197	13	1	4	24	0	6	109	10	23	209
USA	Mobile, AL	18061	0	0	18040	0	0	0	0	0	0	0	21
USA	New Orleans Intl Apt, LA	456	1	0	0	26	0	0	0	301	0	120	7
USA	New Orleans, LA	68718	185	6	38821	28801	1	0	94	661	0	72	77
USA	New York, NY	37835	3703	462	1295	10845	558	20	1439	7338	1083	5545	5548
USA	Newark, NJ	517	65	31	4	5	2	0	0	257	0	36	116
USA	Norfolk, VA	96532	2186	473	69480	11647	62	1	1622	2812	3830	1908	2512
USA	Norfolk-Newport News, VA	2806	152	10	92	559	6	0	508	362	0	988	128
USA	Oakland, CA	46899	869	23	3597	27540	436	1	199	1038	10627	1551	1019
USA	Orlando, FL	80	4	0	9	0	2	0	0	29	0	0	36
USA	Pearl Harbour, HI	2	2	0	0	0	0	0	0	0	0	0	0
USA	Peoria, IL	11	11	0	0	0	0	0	0	0	0	0	0
USA	Philadelphia, PA	34312	825	355	5544	15255	110	14	1726	4631	848	3766	1237
USA	Port Everglades, FL	2	2	0	0	0	0	0	0	0	0	0	0
USA	San Antonio, TX	103	2	0	0	0	0	0	0	0	44	57	0
USA	San Francisco, CA	2731	276	3	330	611	148	1	92	266	577	61	364
USA	San Jose, CA	27	0	12	0	0	0	0	0	14	0	0	0
USA	San Mateo, CA	25	0	0	25	0	0	0	0	0	0	0	0
USA	San Pedro, CA	617	11	102	0	0	1	0	0	272	0	21	208
USA	St Louis, MO	271	31	0	23	0	1	0	2	77	0	19	119
USA	St Petersburg, FL	51	0	0	0	0	0	0	0	51	0	0	0
USA	Tampa, FL	272758	23	0	272714	0	0	0	0	20	0	0	1
USA	Texas City, TX	2134	9	0	1	0	13	0	0	2098	0	0	13
USA	Wilmington, DE	96	55	18	0	0	0	0	0	0	0	23	0
Vanuatu	Espiritu Santo	4884	26	0	0	4676	3	150	0	0	29	0	0
Vanuatu	Port Vila	2158	188	0	0	1474	0	396	12	22	57	4	4
Viet Nam	Haiphong	979	53	52	90	0	165	2	183	147	0	8	279
Viet Nam	Hanoi	426	10	44	0	94	8	0	40	35	177	12	5
Viet Nam	Ho Chi Minh City	43845	520	1236	1	6645	10398	408	14925	4031	1290	1184	3207

Table b. Summary of air freight coming to New Zealand from localities within 100 km of known sites with *P. longicornis*. Values represent the total freight (tonnes) during 2001, 2002 and 2003 (source: Statistics New Zealand). Total freight is broken into different commodity types. NB: New Zealand received some freight from all locations listed, but if total freight is below 500 kg it is listed as 0 tonnes. Details of the freight types that comprise each category are given (c) as are the categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database (d).

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Funiture	Fur	Footware	Foodstuffs	Fibres	Other
American Samoa	Pago Pago	2	1	0	0	0	0	0	0	0	0	0	0
Angola	Cabinda	0	0	0	0	0	0	0	0	0	0	0	0
Antigua and Barbuda	Antigua	0	0	0	0	0	0	0	0	0	0	0	0
Australia	Adelaide, SA	2783	914	7	4	276	24	33	11	61	161	868	423
Australia	Brisbane, QL	25096	1931	16252	222	1315	90	487	157	139	2484	609	1409
Australia	Cairns, QL	77	5	2	0	1	0	1	0	0	63	0	4
Australia	Cooktown, QL	0	0	0	0	0	0	0	0	0	0	0	0
Australia	Darwin, NT	5	4	0	0	0	0	0	0	0	0	0	1
Australia	Fremantle, WA	3	2	0	1	1	0	0	0	0	0	0	0
Australia	Perth, WA	1294	365	50	149	221	19	21	41	2	58	172	198
Australia	Port Adelaide, SA	5	0	4	0	0	0	0	0	0	0	0	0
Bahrain	Bahrain	8	0	0	0	7	0	0	0	0	0	0	0
Belize	Belize City	0	0	0	0	0	0	0	0	0	0	0	0
Bermuda	Hamilton	0	0	0	0	0	0	0	0	0	0	0	0
Brazil	Brasilia, DF	27	0	0	0	0	0	0	0	0	26	0	0
Brazil	Campinas, SP	8	0	0	0	0	0	0	0	5	0	3	0
Brazil	Guarulhos Apt/Sao Paolo, SP	20	7	0	0	0	0	0	0	1	4	2	6
Brazil	Rio de Janeiro, RJ	6	0	0	0	1	1	0	0	1	0	1	1
Brazil	Salvador, BA	0	0	0	0	0	0	0	0	0	0	0	0
Brazil	Santos, SP	2	0	0	0	0	0	0	0	2	0	0	0
Brazil	Viracopos Apt/Sao Paulo, SP	29	3	0	0	7	1	0	0	3	0	13	1
Brunei Darussalam	Bandar Seri Begawan	5	1	0	0	1	1	0	0	0	0	0	2
Canada	Hamilton Apt, ON	1	1	0	0	0	0	0	0	0	0	0	0
Canada	Nanaimo Apt, BC	0	0	0	0	0	0	0	0	0	0	0	0
Canada	Oakville, ON	1	1	0	0	0	0	0	0	0	0	0	0
Canada	Quebec Apt, QC	1	0	0	0	0	0	0	0	0	0	0	0
Canada	Quebec, QC	4	3	0	0	0	0	0	0	0	1	0	0
Canada	Toronto Apt, ON	352	114	0	89	65	5	3	0	0	9	4	62
Canada	Toronto, ON	300	100	0	50	55	9	4	1	0	2	6	72
Canada	Vancouver Apt, BC	241	140	3	10	25	3	6	1	0	9	6	38
Canada	Vancouver, BC	108	52	10	0	9	5	2	0	0	14	5	12
Canada	Victoria Apt, BC	0	0	0	0	0	0	0	0	0	0	0	0
Canada	Victoria, BC	0	0	0	0	0	0	0	0	0	0	0	0
China	Guangzhou (Canton)	279	29	0	0	18	4	15	3	5	4	186	16

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Funiture	Fur	Footware	Foodstuffs	Fibres	Other
China	Huangpu	1	0	0	0	0	0	0	0	0	0	0	1
China	Quanzhou	6	1	0	0	0	0	0	0	0	0	5	0
China	Shekou	1	0	0	0	0	0	0	0	0	0	0	0
China	Shenzhen	8	2	0	0	1	0	1	0	0	0	2	2
China	Xiamen	110	19	1	0	8	2	6	13	6	10	41	4
China	Yantian	0	0	0	0	0	0	0	0	0	0	0	0
China (Hong Kong)	Hong Kong SAR	7514	2458	2	53	615	51	434	203	237	87	2301	1073
China (Hong Kong)	Kowloon	2	0	0	0	0	0	0	0	0	0	1	0
China (Macau)	Macau	6	2	0	0	4	0	0	0	0	0	0	0
Colombia	Medellin	1	0	0	0	0	0	0	0	0	0	0	1
Cook Islands	Aitutaki	4	1	2	0	0	0	0	0	0	0	0	1
Costa Rica	San Jose	33	0	33	0	0	0	0	0	0	0	0	0
Dominican Republic	Santo Domingo	0	0	0	0	0	0	0	0	0	0	0	0
Ecuador	Guayaquil	0	0	0	0	0	0	0	0	0	0	0	0
Egypt	Cairo (El Qahira)	4	0	0	0	0	1	0	0	0	1	1	0
El Salvador	Acajutla	0	0	0	0	0	0	0	0	0	0	0	0
El Salvador	San Salvador	0	0	0	0	0	0	0	0	0	0	0	0
Fiji	Lautoka	37	0	24	0	1	0	0	0	2	7	2	0
Fiji	Nadi	4316	31	2733	6	5	0	3	3	301	661	550	23
Fiji	Savusavu	1	0	0	0	0	0	0	0	0	0	1	0
Fiji	Suva	127	5	4	0	0	0	0	0	64	17	29	7
France	Paris	539	174	0	34	53	9	13	8	4	12	22	210
France	Paris-Charles De Gaulle Apt	1059	441	0	31	112	37	34	9	6	30	76	283
France	Paris-Orly Apt	129	11	0	0	2	1	1	1	0	0	2	112
French Polynesia	Bora Bora	0	0	0	0	0	0	0	0	0	0	0	0
French Polynesia	Papeete	17	6	0	0	3	0	0	0	0	3	1	4
French Polynesia	Raiatea	0	0	0	0	0	0	0	0	0	0	0	0
Ghana	Accra	0	0	0	0	0	0	0	0	0	0	0	0
Gibraltar	Gibraltar	1	0	0	0	0	0	0	0	0	0	0	1
Greece	Thessaloniki	1	0	0	0	0	0	0	0	0	0	0	0
Guatemala	Guatemala City	6	0	1	0	0	0	4	0	0	0	1	0
Haiti	Port-au-Prince	0	0	0	0	0	0	0	0	0	0	0	0
India	Banddar	0	0	0	0	0	0	0	0	0	0	0	0
India	Bangalore	150	43	61	0	2	6	0	0	0	5	22	10
India	Bombay (Mumbai)	509	55	21	86	40	9	12	6	16	13	225	25
India	Calcutta	170	11	0	0	7	0	0	104	0	1	43	3
India	Cochin	9	0	0	0	0	0	0	0	0	1	5	2
India	Delhi	589	24	0	78	38	3	43	24	84	9	251	35
Indonesia	Bandung, Java	4	0	0	0	0	0	0	0	0	0	3	1
Indonesia	Benoa, Bali	2	0	0	0	0	0	0	0	0	0	1	1
Indonesia	Denpasar, Bali	286	50	1	5	30	13	7	16	13	3	87	60
Indonesia	Jakarta, Java	312	46	4	6	55	1	6	6	13	13	131	31
Indonesia	Jakarta-Soekarno-Hatta Airpo	0	0	0	0	0	0	0	0	0	0	0	0
Indonesia	Semarang, Java	0	0	0	0	0	0	0	0	0	0	0	0

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Funiture	Fur	Footware	Foodstuffs	Fibres	Other
Israel	Ashdod	0	0	0	0	0	0	0	0	0	0	0	0
Israel	Haifa	5	4	0	0	0	0	0	0	0	0	0	0
Israel	Tel Aviv	160	88	1	0	23	0	0	0	0	7	9	30
Jamaica	Kingston	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Chiba, Chiba	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Fukuoka, Fukuoka	9	5	0	0	2	0	0	0	0	0	0	2
Japan	Funabashi, Chiba	2	2	0	0	0	0	0	0	0	0	0	0
Japan	Hakata, Fukuoka	6	6	0	0	0	0	0	0	0	0	0	0
Japan	Haneda Apt/Tokyo	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Ikejima, Nagasaki	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Kawasaki, Kanagawa	12	11	0	0	0	0	0	0	0	0	0	0
Japan	Kumamoto, Kumamoto	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Nagasaki, Nagasaki	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Okinawa, Okinawa	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Tokyo, Tokyo	1912	1061	0	7	284	50	37	21	1	24	24	403
Japan	Yatsushiro, Kumamoto	0	0	0	0	0	0	0	0	0	0	0	0
Japan	Yokohama, Kanagawa	31	28	0	0	1	0	0	0	0	0	0	1
Jordan	Amman	0	0	0	0	0	0	0	0	0	0	0	0
Kenya	Nairobi Apt	17	0	16	0	0	0	0	0	0	1	1	0
Kiribati	Tarawa	0	0	0	0	0	0	0	0	0	0	0	0
Lebanon	Beirut	0	0	0	0	0	0	0	0	0	0	0	0
Malaysia	Malacca	12	0	0	0	12	0	0	0	0	0	0	0
Malaysia	Pasir Gudang, Johor	16	0	0	0	16	0	0	0	0	0	0	0
Malaysia	Penang (Georgetown)	1675	1569	0	1	24	0	5	20	0	20	7	27
Malaysia	Tanjong Pelepas	22	4	0	0	4	1	0	1	0	3	4	4
Malta	Malta (Valetta)	1	0	0	0	0	0	0	0	0	0	0	0
Mauritius	Port Louis	4	0	1	0	0	0	0	0	0	0	0	3
Mexcio	Hermosillo, SON	0	0	0	0	0	0	0	0	0	0	0	0
Mexico	Mazatlan, SIN	0	0	0	0	0	0	0	0	0	0	0	0
Mexico	San Carlos, BCS	0	0	0	0	0	0	0	0	0	0	0	0
Morocco	Casablanca	1	0	0	0	0	0	0	0	0	0	0	0
Morocco	Tangier	0	0	0	0	0	0	0	0	0	0	0	0
Nepal	Kathmandu	30	1	0	0	0	0	1	2	0	0	15	11
New Caledonia	Noumea	88	23	58	0	1	0	1	0	0	2	0	4
Nicaragua	Managua	1	0	0	0	0	0	0	0	0	0	0	0
Nigeria	Lagos	1	0	0	0	0	0	0	0	0	0	0	0
Niue	Niue Island	0	0	0	0	0	0	0	0	0	0	0	0
Northern Mariana Islands	Saipan	0	0	0	0	0	0	0	0	0	0	0	0
Oman	Muscat	7	0	0	0	6	0	0	0	0	0	0	0
Panama	Colon	1	0	0	0	0	0	0	0	1	0	0	0
Panama	Panama City	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	Kimbe	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	Madang	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	Port Moresby	7	2	0	0	0	0	0	0	0	4	0	0

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Funiture	Fur	Footware	Foodstuffs	Fibres	Other
Peru	Callao	0	0	0	0	0	0	0	0	0	0	0	0
Peru	Lima	60	0	0	0	0	0	0	45	0	0	15	0
Philippines	Cebu	13	0	0	0	4	0	0	0	0	1	0	7
Philippines	Manila	232	156	4	2	33	1	8	3	0	2	7	15
Portugal	Porto Santo	7	0	0	0	0	0	0	0	3	0	1	2
Puerto Rico	San Juan	50	2	0	18	1	0	0	0	2	5	0	21
Samoa	Apia	265	8	179	1	1	0	0	0	0	70	3	4
Saudi Arabia	Damman	1	0	0	0	0	0	0	0	0	0	0	1
Saudi Arabia	Jeddah	58	17	0	0	42	0	0	0	0	0	0	0
Singapore	Singapore	9844	5382	168	114	1000	105	125	71	66	278	544	1994
Singapore	Singapore Container Terminal	11	5	0	0	2	0	0	0	0	0	0	3
Solomon Islands	Honiara, Guadalcanal Island	2	0	0	0	0	0	0	0	0	1	0	0
Somalia	Mogadishu	0	0	0	0	0	0	0	0	0	0	0	0
South Africa	Durban	85	20	0	2	22	1	6	1	0	3	12	18
Sri Lanka	Colombo	34	3	0	0	1	0	2	0	0	11	14	3
Sudan	Khartoum	1	0	0	0	0	0	0	0	0	0	0	0
Switzerland	Zurich	934	339	0	35	103	20	11	29	4	21	49	323
Syria	Damascus (Damas)	1	0	0	0	0	0	0	0	0	0	1	0
Taiwan	Kaohsiung	98	14	2	0	47	0	2	1	0	8	18	7
Taiwan	Keelung (Chilung)	119	52	0	2	20	2	6	0	0	0	27	10
Taiwan	Suao	0	0	0	0	0	0	0	0	0	0	0	0
Taiwan	Taipei	2811	1856	3	23	347	20	60	11	2	7	278	205
Taiwan	Taitung	0	0	0	0	0	0	0	0	0	0	0	0
Tanzania	Dar es Salaam	1	1	0	0	0	0	0	0	0	0	0	0
Thailand	Bangkok	1602	415	36	32	285	23	34	38	25	55	404	254
Tonga	Neiafu	0	0	0	0	0	0	0	0	0	0	0	0
Tonga	Tongatapu-Nuku'alofa	149	3	23	0	0	0	0	0	0	119	0	4
Tonga	Vava'u	0	0	0	0	0	0	0	0	0	0	0	0
Tuvalu	Funafuti	0	0	0	0	0	0	0	0	0	0	0	0
United Arab Emirates	Dubai	57	12	0	0	7	1	2	0	1	13	3	17
United Arab Emirates	Jebel Ali	0	0	0	0	0	0	0	0	0	0	0	0
United Arab Emirates	Sharjah	1	0	0	0	0	0	0	0	0	0	0	0
USA	Baltimore, MD	6	4	0	0	0	0	0	0	0	0	0	2
USA	Baton Rouge, LA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Beaumont, TX	8	0	0	0	8	0	0	0	0	0	0	0
USA	Bellingham, WA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Brownsville, TX	9	8	0	0	0	0	0	0	0	0	0	1
USA	Burbank Apt, CA	1	0	0	0	0	0	0	0	0	0	0	0
USA	Charleston, SC	6	4	0	0	0	0	0	0	0	0	0	1
USA	Chicago Apt, IL	1057	503	1	16	189	15	17	4	2	30	17	262
USA	Chicago, IL	1519	636	1	45	245	12	31	5	1	137	29	377
USA	Corpus Christi, TX	0	0	0	0	0	0	0	0	0	0	0	0
USA	Dallas-Fort Worth Reg, TX	415	221	0	17	80	2	9	1	1	3	15	67
USA	Dulles Intl Apt/Washington	20	11	0	0	4	0	0	0	0	0	0	5

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Funiture	Fur	Footware	Foodstuffs	Fibres	Other
USA	Flushing Apt/New York	0	0	0	0	0	0	0	0	0	0	0	0
USA	Fort Lauderdale, FL	18	11	0	0	2	0	1	0	0	0	0	3
USA	Fort Myers, FL	0	0	0	0	0	0	0	0	0	0	0	0
USA	Freeport, TX	0	0	0	0	0	0	0	0	0	0	0	0
USA	Galveston, TX	0	0	0	0	0	0	0	0	0	0	0	0
USA	Georgetown, SC	0	0	0	0	0	0	0	0	0	0	0	0
USA	Hampton-Newport News-Williams	0	0	0	0	0	0	0	0	0	0	0	0
USA	Honolulu, HI	386	185	4	3	26	4	12	4	0	14	16	118
USA	Houston, TX	152	68	0	1	55	0	3	0	0	0	4	21
USA	Jacksonville, FL	11	1	0	0	0	0	0	0	0	0	0	10
USA	Jersey City, NJ	1	0	0	0	0	0	0	0	0	0	0	1
USA	John F Kennedy Apt/New York	1440	400	1	21	261	10	22	3	7	33	81	601
USA	Kahului, HI	0	0	0	0	0	0	0	0	0	0	0	0
USA	Kings Bay, GA	0	0	0	0	0	0	0	0	0	0	0	0
USA	La Guardia Apt/New York	4	0	0	0	0	0	1	0	0	0	1	2
USA	Laredo, TX	15	14	0	0	0	0	0	0	0	0	0	0
USA	Long Beach, CA	12	4	0	0	6	0	0	0	0	0	0	2
USA	Los Angeles, CA	9298	3840	629	79	1470	108	317	54	27	340	378	2055
USA	Lynden, WA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Miami, FL	63	27	2	0	4	0	3	0	1	1	2	23
USA	Mobile, AL	2	2	0	0	0	0	0	0	0	0	0	0
USA	New Orleans Intl Apt, LA	18	8	0	0	4	0	0	0	0	0	1	6
USA	New Orleans, LA	4	1	0	0	1	0	0	0	0	0	0	2
USA	New York, NY	624	295	0	7	71	5	9	1	1	15	22	198
USA	Newark, NJ	117	37	0	8	25	1	1	0	1	2	13	31
USA	Norfolk, VA	21	15	0	2	2	0	0	0	0	0	0	1
USA	Norfolk-Newport News, VA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Oakland, CA	2	0	0	0	0	0	0	0	0	2	0	0
USA	Orlando, FL	44	7	25	1	7	0	1	0	0	0	0	3
USA	Palm Beach, FL	0	0	0	0	0	0	0	0	0	0	0	0
USA	Peoria, IL	2	2	0	0	0	0	0	0	0	0	0	0
USA	Philadelphia, PA	174	49	0	15	39	3	15	0	0	1	10	40
USA	San Antonio, TX	9	8	0	0	0	1	0	0	0	0	0	0
USA	San Francisco, CA	758	494	39	9	41	3	15	3	1	21	7	125
USA	San Jose, CA	5	2	0	0	0	2	0	0	0	0	0	0
USA	San Pedro, CA	0	0	0	0	0	0	0	0	0	0	0	0
USA	Selby, CA	1	1	0	0	0	0	0	0	0	0	0	0
USA	St Louis, MO	124	48	0	0	14	1	6	0	0	16	0	39
USA	St Petersburg, FL	0	0	0	0	0	0	0	0	0	0	0	0
USA	Tampa, FL	33	22	0	0	2	0	1	0	0	0	0	8
USA	Texas City, TX	1	1	0	0	0	0	0	0	0	0	0	0
USA	West Palm Beach, FL	1	0	0	0	0	0	0	0	0	0	0	0
USA	Wilmington, DE	1	0	0	0	0	0	0	0	0	0	0	0
USA	Wilmington, NC	1	1	0	0	0	0	0	0	0	0	0	0

Country	Port of export	Total freight	Appliances	Produce	Pharmaceuticals	Metals	Glass	Funiture	Fur	Footware	Foodstuffs	Fibres	Other
USA	Yonkers, NY	0	0	0	0	0	0	0	0	0	0	0	0
US Virgin Islands	Frederiksted, St Croix	1	0	0	0	0	0	0	0	0	0	0	0
US Virgin Islands	St Croix Island Apt	0	0	0	0	0	0	0	0	0	0	0	0
Vanuatu	Espiritu Santo	4	0	2	0	0	0	0	0	0	1	0	0
Vanuatu	Port Vila	6	2	0	0	0	0	0	0	0	3	0	1
Viet Nam	Haiphong	0	0	0	0	0	0	0	0	0	0	0	0
Viet Nam	Hanoi	4	0	0	0	0	0	0	1	1	0	2	0
Viet Nam	Ho Chi Minh City	95	7	10	0	5	0	5	9	25	0	31	4

Table c. Details of the freight types that comprise each category and the categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database (source: Statistics New Zealand). Description of categories provided in Table d.

Mode of transport	Type of freight	HS2 Chapters
Sea freight	Appliances and machinery	84–89
	Fibres etc	50–63
	Bulk freight	25, 27, 28, 31
	Foodstuffs	2–4, 9–23
	Furniture/toys etc	94, 95
	Furs and skins	41–43
	Glass, ceramics etc	68–70
	Metals, plastics, organic chemicals etc	72–81, 26, 29, 32, 39, 40
	Produce	6–8
	Wood based products	44–48
	Other	All remaining chapters
Air freight	Appliances and machinery	84–89
	Produce	6–8
	Pharmaceutical products	30
	Metals, plastics, organic chemicals etc	72–81, 26, 29, 32, 39, 40, 83
	Glass, ceramics etc	68–70
	Furniture/toys etc	94, 95
	Fur and skins	41–43
	Footwear	64
	Foodstuffs	2–4, 9–23
	Fibres etc	50–63
	Other	All remaining chapters

Table d. Description of categories (HS2 Chapters) used to classify incoming freight in the Statistics New Zealand database.

Categories	Description
01	Animals; live
02	Meat and edible meat offal
03	Fish and crustaceans, molluscs and other aquatic invertebrates
04	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included
05	Animal originated products; not elsewhere specified or included
06	Trees and other plants, live; bulbs, roots and the like; cut flowers and ornamental foliage
07	Vegetables and certain roots and tubers; edible
08	Fruit and nuts, edible; peel of citrus fruit or melons
09	Coffee, tea, mate and spices
10	Cereals
11	Products of the milling industry; malt, starches, inulin, wheat gluten
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit, industrial or medicinal plants; straw and fodder
13	Lac; gums, resins and other vegetable saps and extracts
14	Vegetable plaiting materials; vegetable products not elsewhere specified or included
15	Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes
16	Meat, fish or crustaceans, molluscs or other aquatic invertebrates; preparations thereof
17	Sugars and sugar confectionery
18	Cocoa and cocoa preparations
19	Preparations of cereals, flour, starch or milk; pastrycooks' products
20	Preparations of vegetables, fruit, nuts or other parts of plants
21	Miscellaneous edible preparations
22	Beverages, spirits and vinegar
23	Food industries, residues and wastes thereof; prepared animal fodder
24	Tobacco and manufactured tobacco substitutes
25	Salt; sulphur; earths, stone; plastering materials, lime and cement
26	Ores, slag and ash
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes
28	Inorganic chemicals; organic and inorganic compounds of precious metals; of rare earth

Categories	Description
	metals, of radio-active elements and of isotopes
29	Organic chemicals
30	Pharmaceutical products
31	Fertilizers
32	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints, varnishes; putty, other mastics; inks
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations
34	Soap, organic surface-active agents; washing, lubricating, polishing or scouring preparations; artificial or prepared waxes, candles and similar articles, modelling pastes, dental waxes and dental preparations with a basis of plaster
35	Albuminoidal substances; modified starches; glues; enzymes
36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations
37	Photographic or cinematographic goods
38	Chemical products n.e.s.
39	Plastics and articles thereof
40	Rubber and articles thereof
41	Raw hides and skins (other than furskins) and leather
42	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)
43	Furskins and artificial fur; manufactures thereof
44	Wood and articles of wood; wood charcoal
45	Cork and articles of cork
46	Manufactures of straw, esparto or other plaiting materials; basketware and wickerwork
47	Pulp of wood or other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard
48	Paper and paperboard; articles of paper pulp, of paper or paperboard
49	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans
50	Silk
51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric
52	Cotton
53	Vegetable textile fibres; paper yarn and woven fabrics of paper yarn
54	Man-made filaments
55	Man-made staple fibres
56	Wadding, felt and non-wovens, special yarns; twine, cordage, ropes and cables and articles thereof

Categories	Description
57	Carpets and other textile floor coverings
58	Fabrics; special woven fabrics, tufted textile fabrics, lace, tapestries, trimmings, embroidery
59	Textile fabrics; impregnated, coated, covered or laminated; textile articles of a kind suitable for industrial use
60	Fabrics; knitted or crocheted
61	Apparel and clothing accessories; knitted or crocheted
62	Apparel and clothing accessories; not knitted or crocheted
63	Textiles, made up articles; sets; worn clothing and worn textile articles; rags
64	Footwear; gaiters and the like; parts of such articles
65	Headgear and parts thereof
66	Umbrellas, sun umbrellas, walking-sticks, seat sticks, whips, riding crops; and parts thereof
67	Feathers and down, prepared; and articles made of feather or of down; artificial flowers; articles of human hair
68	Stone, plaster, cement, asbestos, mica or similar materials; articles thereof
69	Ceramic products
70	Glass and glassware
71	Natural, cultured pearls; precious, semi-precious stones; precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin
72	Iron and steel
73	Iron or steel articles
74	Copper and articles thereof
75	Nickel and articles thereof
76	Aluminium and articles thereof
78	Lead and articles thereof
79	Zinc and articles thereof
80	Tin; articles thereof
81	Metals; n.e.s., cermets and articles thereof
82	Tools, implements, cutlery, spoons and forks, of base metal; parts thereof, of base metal
83	Metal; miscellaneous products of base metal
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles
86	Railway, tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds

Categories	Description
87	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof
88	Aircraft, spacecraft and parts thereof
89	Ships, boats and floating structures
90	Optical, photographic, cinematographic, measuring, checking, medical or surgical instruments and apparatus; parts and accessories
91	Clocks and watches and parts thereof
92	Musical instruments; parts and accessories of such articles
93	Arms and ammunition; parts and accessories thereof
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.s.; illuminated signs, illuminated name-plates and the like; prefabricated buildings
95	Toys, games and sports requisites; parts and accessories thereof
96	Miscellaneous manufactured articles
97	Works of art; collectors' pieces and antiques
98	New Zealand miscellaneous provisions

Appendix 2: Details of BIOSECURE methodology

BIOSECURE is a computer-based decision tool for management of biosecurity risks to New Zealand's indigenous ecosystems. The model runs over Landcare Research's intranet using specifically designed software with links to databases and GIS software.

Methods

Input data

Records of species occurrence are obtained from the scientific literature, ant collections records available on the web, and from communication with various researchers. Records for an exact locality or relatively defined area are predominantly used. For the mainland USA some data on county records are included (e.g., Callcott & Collins 1996) with the county seat used as the data point, and for many islands presence/absence information is all that was available. Data points are separated into those of introduced and native range. Within the introduced range, records closely associated with urban areas are identified and a separate analysis conducted excluding these data in order to separate risks associated with urban areas and heated buildings from other habitats. These data sets are submitted to BIOSECURE.

Climate summary

For each location, climate data was obtained for eight parameters (Table A2.1) from global climate surfaces based on half-degree grid square resolution. Summary data for each parameter (N, mean, minimum, maximum) are presented for native and introduced range separately.

Table A2.1: Global climate surfaces used in BIOSECURE.

Abbreviation	Climate Parameters
MAT	Annual mean of the monthly mean temperature (°C)
MINT	Mean temperature of the coldest month (°C)
MATS	Seasonality of temperature - absolute difference in mean temperature between the warmest and coldest months (°C)
PREC	Mean annual precipitation (mm)
PRECS	Seasonality of precipitation - absolute difference in mean precipitation between the wettest and driest months (mm)
VP	Annual mean of the monthly mean vapour pressure (kPa)
VPS	Seasonality of vapour pressure - absolute differences in mean vapour pressure between the most humid and the least humid months (kPa)
MAS	Annual mean of monthly mean solar radiation ($MJ/m^2/day$)

Climate similarity scores

For each climate parameter a frequency distribution of the data points is produced. The frequency distribution is then divided into 10 equal bins between the minimum and maximum values. Two additional bins of the same size are added, one above and one below the outermost values. Each bin gets a score between 1 (the additional two bins) and 100 based on the rescaled frequency of occurrence of the data within each bin (Fig. A2.1). Then all global grids are allocated a similarity (or risk) score between 0 (the climate parameters value for that grid square is outside the values in the bins) and 100.

The climate similarity scores for New Zealand are projected onto a 25 m resolution climate surface that forms part of the LENZ environmental domains (Leathwick et al. 2003).

Outlier data in each climate layer are checked. Data points are removed and the analysis re-run only if they are identified as entry errors, or the collection site was not well defined. In addition, if the outlying data point falls on the margin between two grids it is automatically allocated to a grid in the processing. If this automatic allocation results in an outlier (e.g., the grid is predominantly mountainous and has extreme temperature values) then the data are altered to move the point into the neighbouring grid.

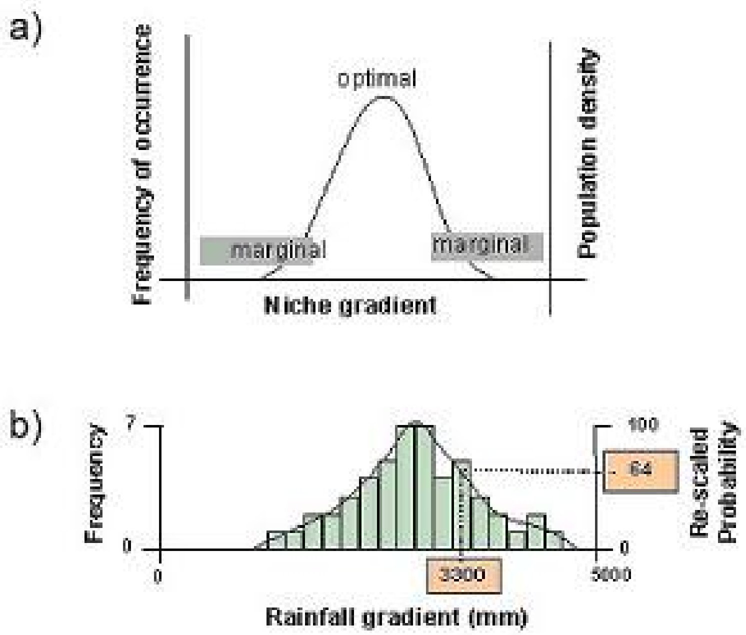

Fig. A2.1: Stylised representation of the conversion of input data points to similarity scores. (a) The input data are assumed to represent the niche of the species for a particular parameter. (b) The frequency distribution is divided into a series of bins across the range of the data, allowing any point on the globe to be compared with this distribution and given a similarity score from 0 (outside the range of the data) to 100 (bin with highest frequency of data = optimal climate) (figure modified from a presentation of G. Barker).

Individual climate layers are assessed for distinctiveness between the international data and New Zealand, and presented in the results if they show a high degree of discrimination (large areas of New Zealand with no similarity or in the marginal zone relative to the international data. MAT, MINT and PREC are routinely presented to allow comparison between species).

An overall summary risk map is also presented; this represents the mean of the similarity scores of five climate layers (MAT, MINT, PREC, VP, PRECS). This presentation approximates the summary map produced by the risk assessment tool Climex.

Appendix 3: Summary of current known distribution and BIOSECURE analysis for two ant species already established in New Zealand.

Linepithema humile is widely distributed in northern New Zealand while *Pheidole megacephala* is restricted to Auckland despite being established since the 1940s (Fig. A3.1).

Prediction of New Zealand range for Linepithema humile *(Argentine ant)*

Native range data for this species overlap with northern New Zealand for MAT. MINT shows similarity for a greater area, but still within northern New Zealand. MAS shows low similarity with New Zealand. The other parameters show some discrimination within New Zealand. The introduced range greatly extends the areas of similarity of New Zealand, as the ant has become widely distributed globally, particularly in areas of anthropogenic disturbance. Large areas of the North Island and the northern South Island show overlap for MAT (Fig. A3.2), and all other parameters show greater overlap. For many areas where temperature parameters show high similarity there is marginal similarity for rainfall (at the high end), which may restrict its distribution (Fig. A3.2).

For MAT the climate in the native + introduced non-urban sites still shows considerable overlap with New Zealand (Fig. A3.3). However, this may be overstated as 3 cold outliers, from native habitat in Chile (Snelling 1975), contribute to the overlap of MAT across southern New Zealand, and these records may be a different species, as the taxonomy of *Linepithema* in South America is in need of revision (A. Wild, pers. comm.).

Predictions of New Zealand range for Pheidole megacephala *(big-headed ant)*

Native range data suggest most of New Zealand is too cold for *Ph. megacephala*, with overlap for MAT only for the far north of the North Island. This overlap results from a single record from grassland by a highway in Pietermaritzburg, South Africa (Samways et al. 1997). The native + introduced range suggests potential range overlap with Northern NZ for MAT (Fig. A3.4) which results principally from urban records, from Sana'a in Yemen (Collingwood & Agosti 1996), and from an imprecise record from "central Spain" (Collingwood 1978). Most of the North Island and coastal South Island is within the range of data for MINT. Precipitation is too high in south-western and alpine areas, and these areas are also too cold (Fig. A3.4). Other climate parameters are highly suitable across much of New Zealand.

For the native + introduced (non-urban range), MAT overlap is minimal (Fig. A3.5), and caused only by the single point from Pietermaritzburg, South Africa. Overlap of MINT is reduced but there is still overlap for large areas of northern New Zealand. Results for the other climate parameters are the same as for the analysis of native + introduced range.

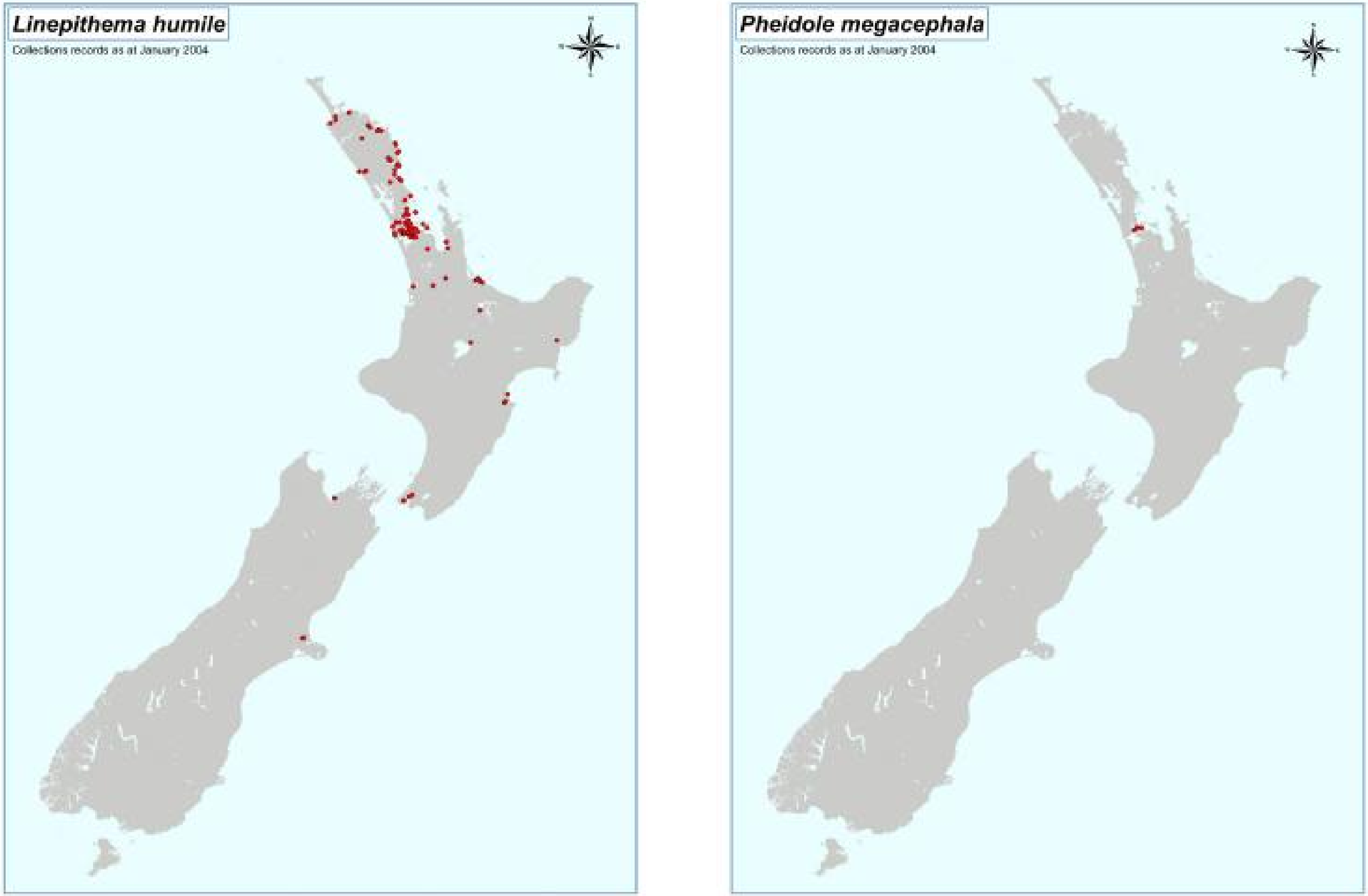

Fig. A3.1: *New Zealand sites where* L. humile *and* Ph. megacephala *are known to be established.*

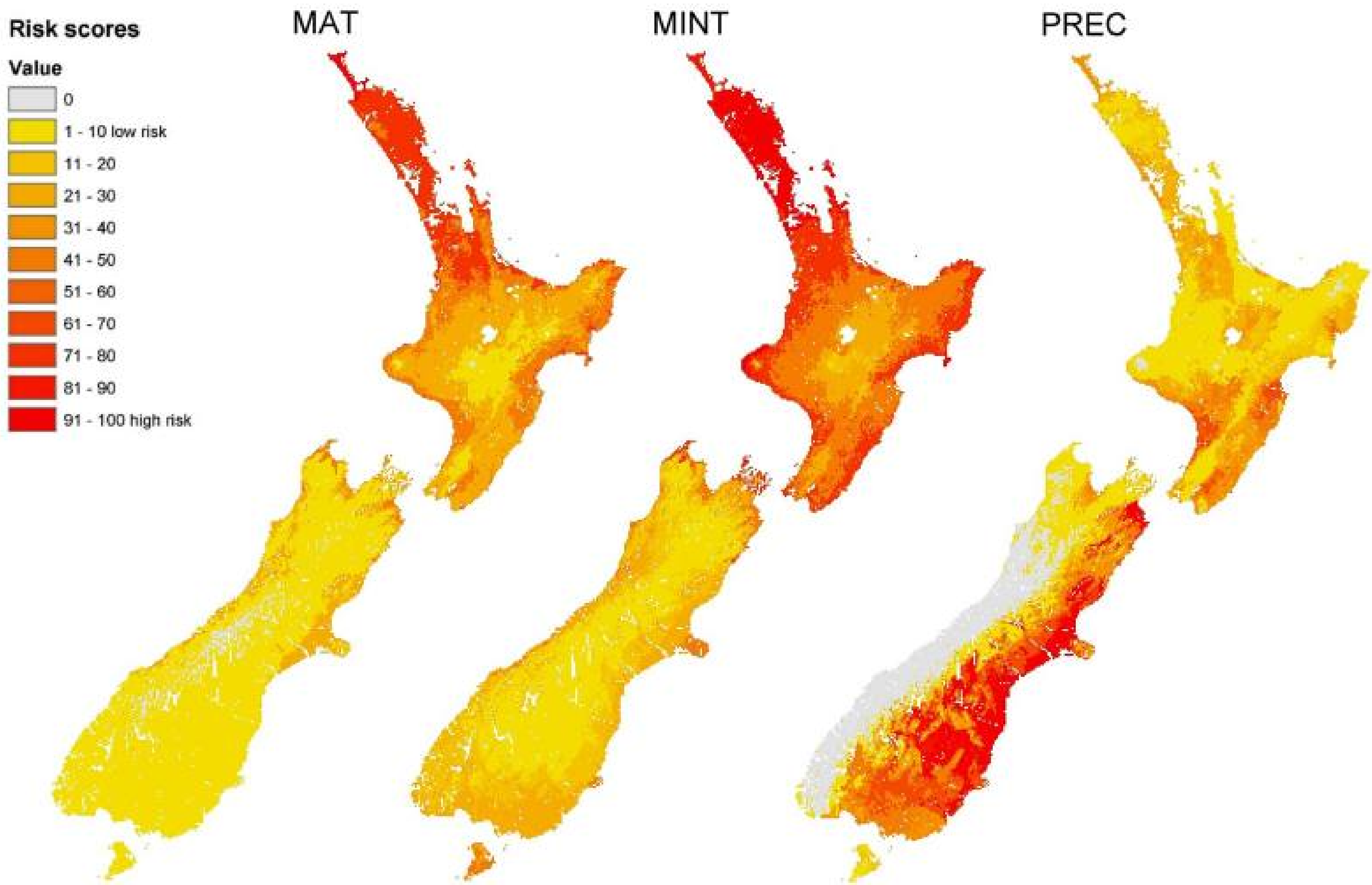

Fig. A3.2: *Similarity of native + introduced ranges of* L. humile *to New Zealand for MAT, MINT and PREC.*

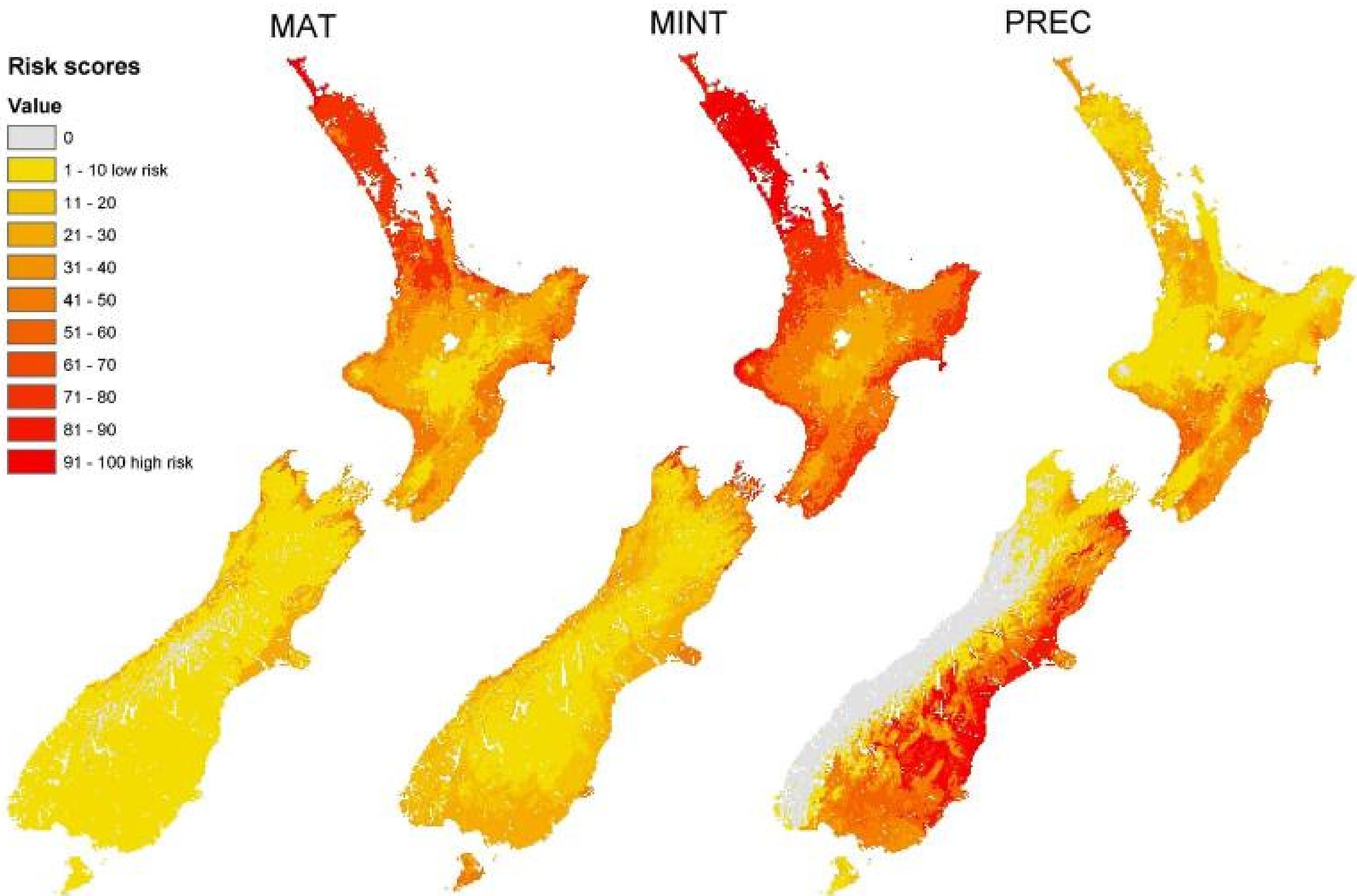

Fig. A3.3: *Similarity of native + non-urban introduced ranges of* L. humile *to New Zealand for MAT, MINT and PREC.*

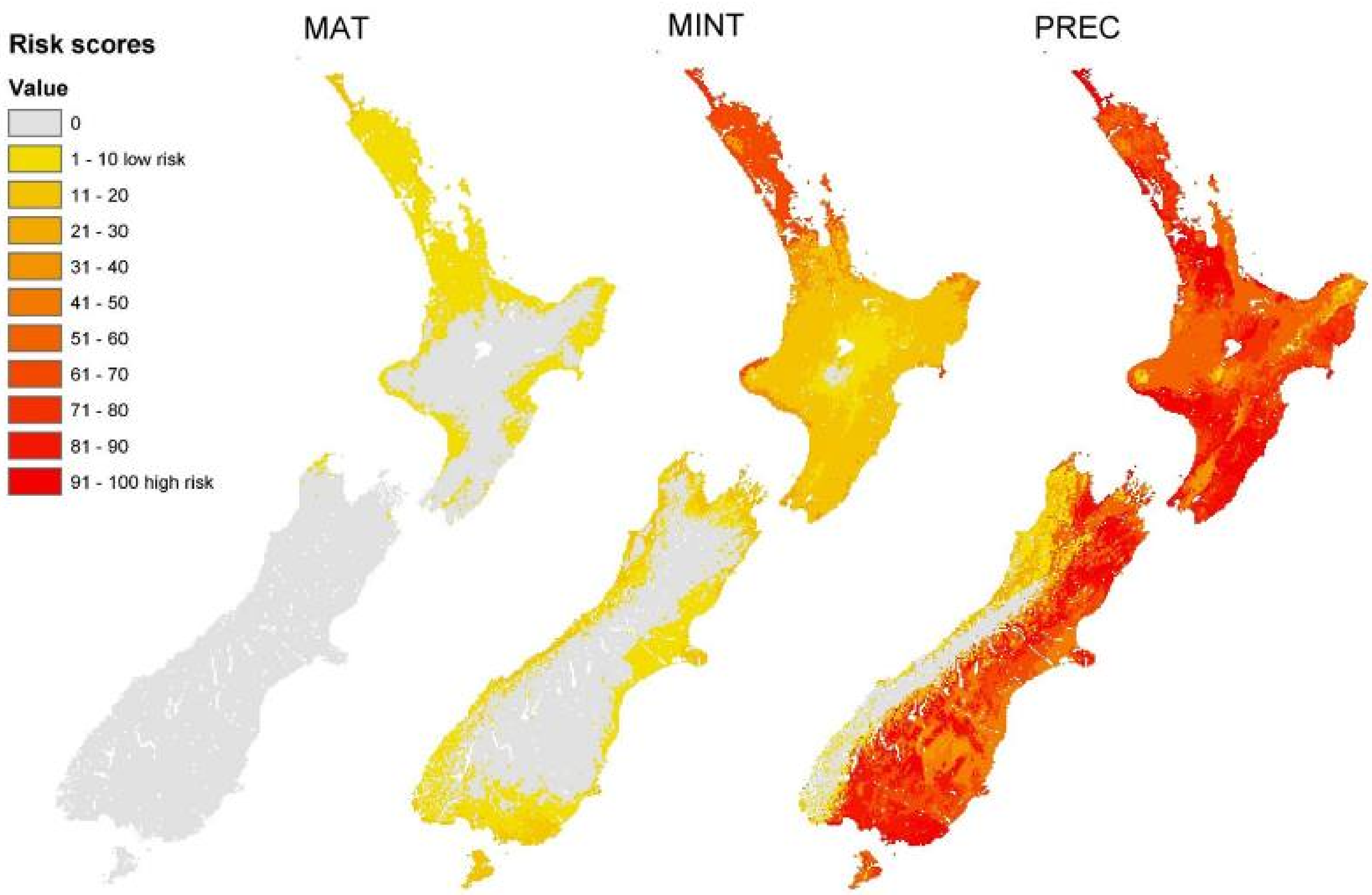

Fig. A3.4: Similarity of native + introduced ranges of Ph. megacephala *to New Zealand for MAT, MINT and PREC.*

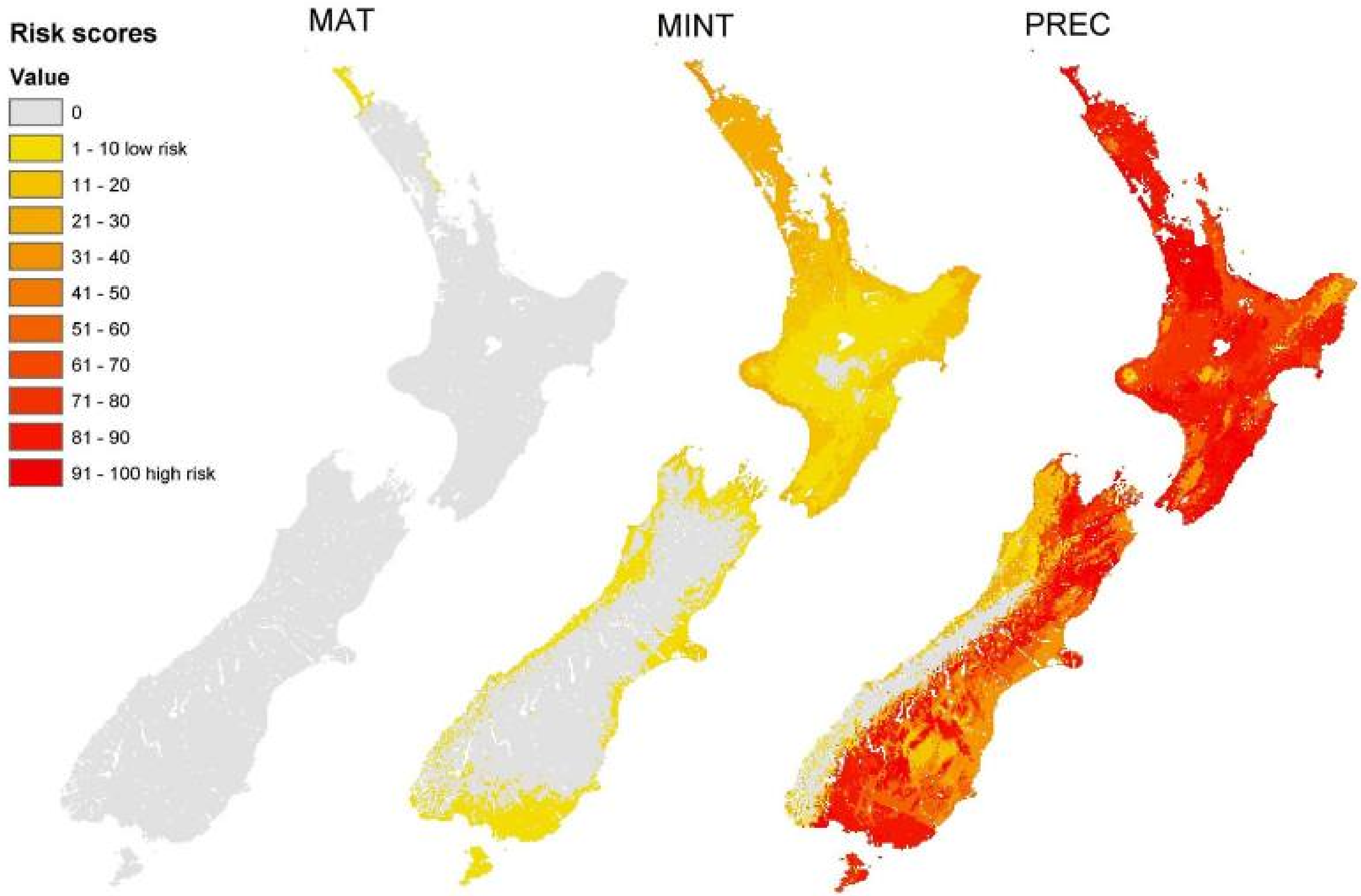

Fig. A3.5: *Similarity of native + non-urban introduced ranges of* Ph. megacephala *to New Zealand for MAT, MINT and PREC.*