

An Assessment of Risk Pathways for the spread of Argentine Ants (*Linepithema humile*) and Rainbow Skinks (*Lampropholis delicata*) by Commercial Businesses in the eastern Rodney District, New Zealand to the Islands of the Hauraki Gulf.



A report for Auckland Council Biosecurity-Environmental Sciences Division  
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*Note that this is a preliminary report and final reports will be available by the end of 2015.*

## **1.0 Introduction:**

### **1.1. The Hauraki Gulf and Invasive Species:**

The Hauraki Gulf Marine Park encompasses an area of over one million hectares and includes a group of islands, some of which are classified as 'pest-free' (Department of Conservation, DOC, n.d.). Due to historical, ecological, cultural and economic value of these islands, significant effort is being made to protect these islands from the impacts of invasive species (DOC, n.d.). The negative effects of invasive species on native species and ecosystems may include ecosystem alteration, interspecific competition, predation, and disease transmission (Peace, 2004). Invasive species are a threat to current conservation of the Hauraki Gulf Islands and are spread both intentionally and unintentionally by human mediated dispersal (Humble, 2009). Two species in particular that are of increasing risk to the islands are the Argentine ants (*Linepithema humile*) and rainbow (or Plague) skink (*Lampropholis delicata*).

Rainbow skinks were found in Auckland in the 1960's and are believed to have arrived accidentally from Australia via cargo and freight (Peace, 2004). They have since spread and are now found from Northland to Waikato, and other isolated populations in the North Island (Figure 1; DOC, 2011). In Hawaii the rainbow skinks appear to have displaced the native moth skink (*Lygosoma noctua noctua*) through increase of range and competition (Hunsaker & Breese, 1967 recorded as *Lecolopisina metallicum*; Baker, 1979). It is assumed that a similar impact of *L. delicata* may occur with New Zealand's native lizards via competition for food and habitat. This threat is potentially increased by the rainbow skink's ability to reproduce almost five times as fast as most of our native skinks and therefore, they are able to create and establish larger populations at a much faster rate with an expected displacement of native skinks (Peace, 2004).

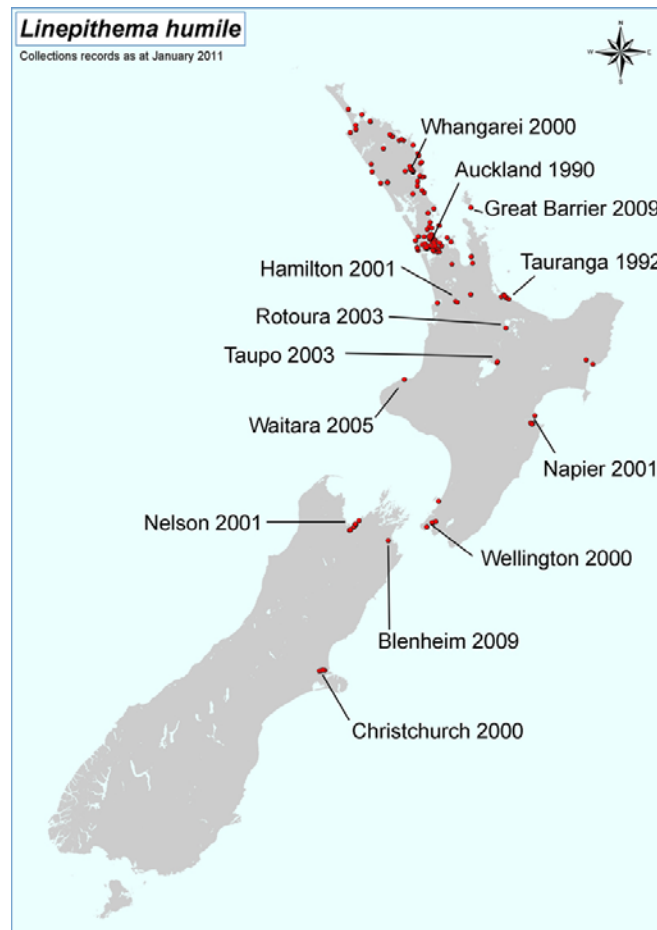


**Figure 1.** New Zealand range of the invasive rainbow skink (*Lampropholis delicata*)

(Department of Conservation, 2011)

The Argentine ant is a global invasive species that is spread via human mediated dispersal (Harris, 2002). The ant was first discovered in New Zealand at the Mount Smart stadium, Auckland after the opening ceremony of the Commonwealth Games in 1990 (Ward & Toft, 2011). The ants are now widespread throughout Auckland and range from Northland to as far south as Canterbury (Harris, 2002; Ward 2011) (Figure 2). Temperature appears to be the principal controlling factor on further range expansion of this species, however, is predicted that with global warming and ecological adaptation, these ants will continue to increase their habitat range into areas currently not invaded (Walters & Mackay, 2003). *L. humile* is a highly destructive ant species that has significant impacts including loss of productivity in the horticultural and honey production industries, the risk of disease transmission, attacking and sometimes killing hatchlings of both commercial and native bird species, destruction of native invertebrate

communities and cascade effects of ecosystem function (Landcare Research, 2015). In North Carolina a experiment was conducted on the competitiveness of the Argentine ant on seven other ant species, and demonstrated that all seven species were displaced by *L. humile* (Holway, 1999). Eradication of Argentine ants is in progress at two locations on Kawau Island in the Hauraki Gulf, both at significant financial and manpower costs to achieve the eradication goal (J. Cook, pers.comms November, 2014).



**Figure 2.** New Zealand range of the invasive Argentine ant (*Linepithema humile*) (Ward, 2011)

## **1.2 Vector Pathways**

The Hauraki Gulf islands are isolated from the mainland North Island and, therefore, the most likely conduit of Argentine ants or rainbow skink to the islands is via human mediated dispersal (Ward, et al. 2005). As the public (both residents, contractors and visitors) travel to these islands they risk transporting these two species as stowaways in/on their luggage, supplies, and boats. An additional risk pathway is via commercial businesses that are transporting high risk products such as soil, wood and construction supplies to the Hauraki Gulf islands. These products are ideal habitats for *L. humile* and *L. delicata* (Morgan, 2014; Ward et al. 2005).

## **1.3 Commercial businesses as vectors of spread**

Richard Toft and Alice McNatty of the Hawke's Bay Regional Council, have previously categorised businesses in relation to a risk scoring system (low, moderate, high and very high risk) for the potential risk of spread of Argentine ants (Richard Toft & Alice McNatty, unpublished data). The findings of this business risk category system were adopted by Shanti Morgan (2014) to assess the risk of businesses in the eastern Rodney district of potential transport of Argentine ants to the islands of the Hauraki Gulf. Morgan also applied this methodology to the assessment of the risk of spread of rainbow skinks by these businesses. Morgan's study focused on high and very high business risk categories. As such it was not able to adequately assess the survey tool as a mechanism for identifying the risk across the spectrum of businesses. This study will build on the study by Morgan (2014) to include businesses in low and moderate risk categories.

The protection of the Islands of the Hauraki Gulf Marine Park from further invasion by all invasive species, but particularly *L. delicata* and *L. humile*, is vital for the maintenance of these islands as sanctuaries for New Zealand native species. The identification of sources of spread of these invasive species and the pathways of dispersal to the islands will significantly aid in the future management of island biosecurity.

## **2.0 Aims:**

The aims of this project are stated below:

- To establish the presence or absence of rainbow (plague) skinks and Argentine ants within selected businesses within the eastern Rodney District.
- To conduct a survey in the eastern Rodney District businesses to determine potential low, moderate, high and very high risk vector sites for the spread of rainbow (plague) skinks and Argentine ants to the Hauraki Gulf Islands.
- To test the effectiveness of the survey tool as a predictor of high/very high risk businesses as conduits for the spread of Argentine ants and rainbow skinks.
- To raise awareness of the Treasure Islands Campaign by encouraging social behaviour change around invasive species and the impacts they have on the Hauraki Gulf Islands to all risk category businesses in the Rodney District.



## **3.0 Methodology**

### **3.1 Business selection**

Using a random number generator, 85 businesses were selected in the eastern Rodney district and surveyed to assess the likelihood of the business acting as a conduit of Argentine ants or rainbow skinks to the islands of the Hauraki Gulf Marine Park. The survey utilised pre-determined low, moderate, high and very high categories of businesses as per the property risk scoring system developed by Richard Toft and Alice McNatty (Morgan, 2014) in the following 5 locations: Silverdale, Whangaparaoa, Matakana, Sandspit and Warkworth.

The following were selected from each business risk category in each of the five locations (Table 1):

- Low and moderate risk category businesses: TWO businesses per business type (Table 1) were selected per business category (low and moderate) in each of the 5 locations in the eastern Rodney district (Total: 60 businesses)
- High and very high risk category businesses: ONE business was selected per business type (Table 1) in each of the 5 locations, as per risk categories stated by Morgan (2014), (Total: 25 businesses). These were repeat visits of businesses surveyed in 2014 by Morgan (2014).
- In locations where the business type was not present, (e.g. in Matakana there was only one petrol station present, however two are needed to complete the total businesses per category) another medium risk category business—was selected, to ensure a large enough data set was collected.
- If a business did not wish to be surveyed, another business was randomly selected to replace the original site.

The original aim was to survey a total of 85 businesses, i.e. 12 low and moderate and 5 high/very high risk business types per 5 sites. However not all sites had a large enough range of the business categories to allow this degree of selection, e.g. the presence of only one petrol station in Matakana. Sandspit was the site with the least businesses surveyed due to the presence of only 3 businesses. To compensate for this and for the purpose of the survey, the Sandspit location was extended to include businesses in the region of Matakana and Sandspit. Businesses were then randomly selected from this enlarged area. The total number of 65 businesses surveyed included 24 Low, 20 Moderate and 21 High/Very High risk category.

**Table 1:** Business categories pre-determined as low, moderate and high/very high risk for the transport of Argentine ants and rainbow skinks to the islands of the Hauraki Gulf Marine Park (Number in brackets indicates the total number of businesses surveyed in each of the 5 locations).

Category of Risk	Low (6)	Moderate (6)	High-Very High (5)
<b>Business type</b>	Indoor retail (2)	Utilities (2)	Plant Nurseries (1)
	Food outlet (2)	Vehicle related (2)	Construction/contracting (1)
	Services (2)	Petrol station (2)	Building suppliers (1)
			Transport (1)
			Boat related (1)

### **3.2 Implementation**

At each business conversations were initiated with the appropriate staff member to enable completion of the risk survey. The interviewer introduced and promoted the values of the Hauraki Gulf via the Treasure Island campaign. Information resources were provided to explain the protection of the Hauraki Gulf Islands.

Hand searches were conducted at each business—for Argentine ants and rainbow skinks, which included searching the outside areas (no indoor searching) by walking around the property and selecting areas of good habitat for both species. Searches were about 10-15 minutes long and if a rainbow (plague) skink or Argentine ants were found, the search was stopped and their presence was recorded.

If ants were found and identification of Argentine ants was in doubt, presence of *L. humile* was confirmed by collection of samples, 2-4 ants per sample, for professional microscopic identification.

### **3.3 The Survey**

The survey has a total of ten questions, each question with a scale of five (one question with four) answers (Table 2, Appendix 1). These answers correspond with a mark (usually 1-5) which is used for completing a property risk score (PRS). The PRS determines the risk category of the business, thus proving or disproving the accuracy of the survey as a tool for risk management. All surveys were completed immediately on completion of visit and data was entered into an excel spreadsheet. Data included the time, weather and any additional notes in regards to the visit.

Questions included:

1. Is ant control undertaken on the site?
2. Where are your products being stored before leaving the site?
3. On average, how long do goods stay on the site before leaving?
4. How tidy are the property grounds?
5. How much good ant/skink habitat is on the site?
6. Where do you transport goods/materials to?
7. What packaging materials leave this site?
8. What products/items leave the property?
9. How abundant are the Argentine ants on the property?
10. How abundant are the rainbow skinks on the property?

### **3.4 Assessment of risk score**

The calculation of risk score will be as follows:

The code beside each question, either (S) or (C) represents whether the question refers to the risk of the site (S) or the risk of the commodity (C).

To obtain a final Property Risk Score (PRS):

- The scores for Questions 3,5,10 & 11 are added to give the S(Total)
- The scores for Questions 4,6,7 & 9 are added to give the C(Total)
- The scores from the Presence absence of species (Questions 1 & 2) are added to give the A(Total)

The following equation will then be executed:

$$\text{PRS} = (\text{S(Total)} \times \text{C (Total)} \times \text{A (Total)} \times 100) / (\text{S(max)} \times \text{C (max)} \times \text{A (max)})$$

Where:

- PRS = overall property risk score
- S = site risk score
- C = commodity risk score
- A = Argentine ant population score
- S (max) = maximum possible site risk score
- C (max) = maximum possible commodity risk score
- A (max) = maximum possible Argentine ant population score

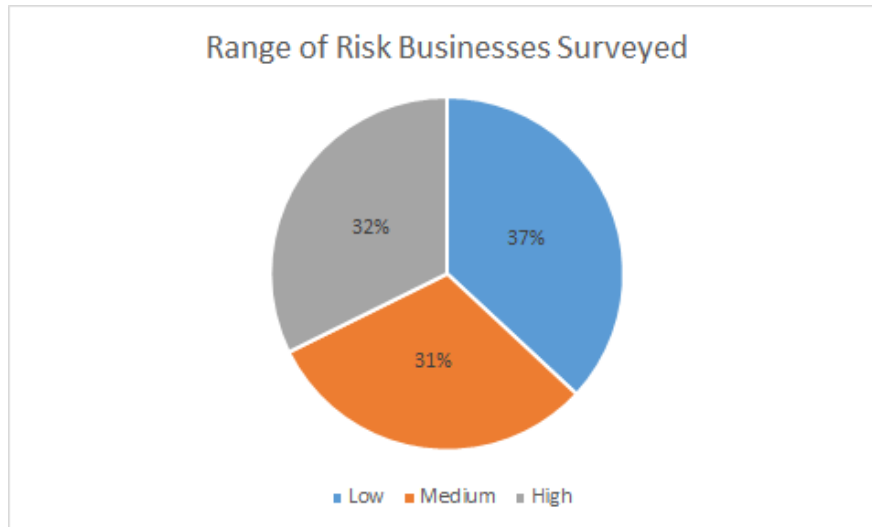
This will be repeated for rainbow skinks.

This calculation will provide an overall risk score for each property (100 = maximum risk possible), and the tool will then allocate an Absolute Risk Category (ARC) to properties.

Data and the analysis of this data will be available in the final reports at the end of 2015.

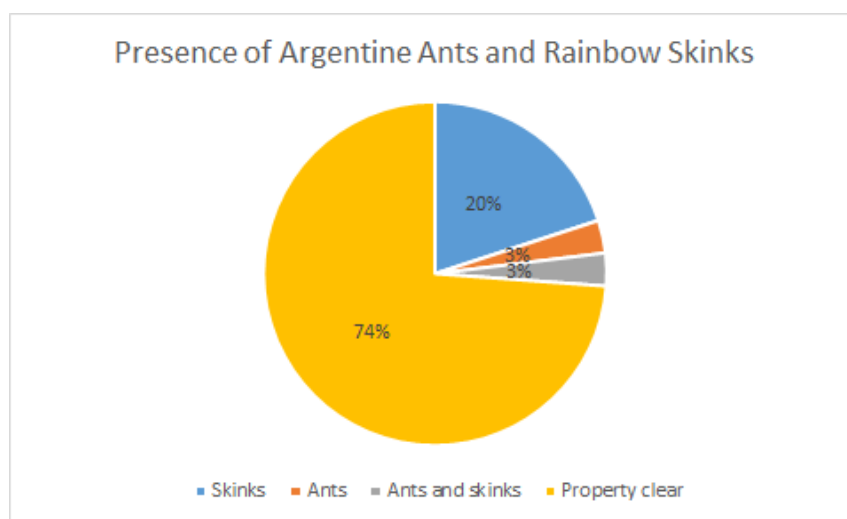
## 4.0 Results

Of the 65 businesses that were surveyed, 37% were categorised as a low risk category business, 31% were moderate risk and 32% were high risk (High and very high risk businesses as of Morgan, 2014) (Figure 3).



**Figure 3:** Percentage of businesses surveyed in each of the business categories.

As a percentage of all properties surveyed, 74% of all businesses were found to have neither Argentine ants or rainbow skinks present, 23% had presence of rainbow skinks, 6% had Argentine ants and 3% had both Argentine ants and rainbow skinks (Figure 4).



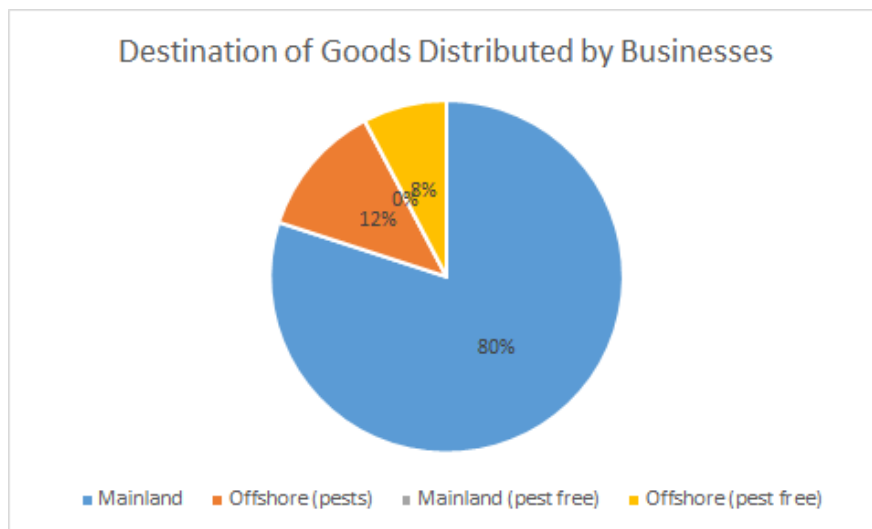
**Figure 4:** Percentage of businesses that had presence of Argentine ants and rainbow skinks.

A total of two incidences of presence of Argentine ants were detected; one at a moderate risk category business and one at a high risk category business (Table 3). Rainbow skinks were detected at a total of 14 businesses with detections at high, moderate and low risk businesses; nine, four and one respectively (Table 3). Two of the high risk category businesses surveyed had presence of both Argentine ants and rainbow skinks.

**Table 3:** Presence of Argentine ants and rainbow skinks at each risk category (low, moderate, and high to very high)

Business Risk Category (BRC)	Presence		
	Argentine ants	Rainbow skinks	Both
Low	0	1	0
Moderate	1	4	0
High	1	9	2

Of the 65 businesses surveyed, 80% of these transported goods within the mainland, 12% transported to goods to the islands in the Hauraki Gulf that are not pest free, 8% transported to pest-free islands and 0% to pest free areas on the mainland (Figure 5).



**Figure 5:** Destination of the goods distributed by businesses surveyed.

Businesses that were recorded as having a presence of Argentine ants were found not to transport goods to either pest-free or non-pest-free islands (Table 4). Of the businesses that had presence of both Argentine ants and rainbow skinks, one business transported goods to a non-pest-free island but none transported goods to a pest-free island (Table 4). However, one moderate and three high risk businesses with presence of rainbow skinks transported goods to non-pest-free islands while one moderate and two high risk businesses transported goods to pest-free islands (Table 4).

**Table 4:** Destination of products in relation to the presence of Argentine ants, rainbow skinks or both (P = presence, M = Mainland distribution only, ONPF = Offshore islands non-pest free, OPF = Offshore pest free).

BRC	Argentine ants				Rainbow skinks				Both			
	P	M	ON PF	OPF	P	M	ON PF	OPF	P	M	ON PF	OPF
Low	<b>0</b>	0	0	0	<b>1</b>	1	0	0	<b>0</b>	0	0	0
Moderate	<b>1</b>	1	0	0	<b>4</b>	2	1	1	<b>0</b>	0	0	0
High	<b>1</b>	1	0	0	<b>9</b>	4	3	2	<b>2</b>	1	1	0

## **5.0 Discussion**

### **5.1 Survey findings**

The results indicate that businesses in the eastern Rodney district are likely vector pathways of both the Argentine ant and rainbow skink to the islands of the Hauraki Gulf. Where there is presence of either species, the high risk category businesses are the most likely to transport goods to the Hauraki Gulf (Tables 3 & 4). This study supports previous findings of Morgan (2014). Although only 26% of businesses had a presence of Argentine ants and/or rainbow skinks, it is important to note that nearly half (12%) of these ship goods to the Hauraki Gulf Islands.

Presence of rainbow skinks was found to be more widely distributed than the Argentine ants. Skinks were found at all five locations surveyed, while ants were only found in three locations; Warkworth, Silverdale and Whangaparaoa. No Argentine ants were found at any property in the low business risk categories.

When the data from this year's study is compared with that of last year (Morgan 2014), it is clear that the presence of Argentine ants in high and very high risk business categories has increased from 2% to 5% of properties surveyed, while rainbow skink presence has increased from 30% to 43% and presence of both has increased from 5% to 10 % of properties surveyed (Table 5). This increase on presence of both of these invasive species in one year is extremely worrying, especially as it will ultimately result in a higher risk of transport of these species to the islands of the Hauraki Gulf.

Although hand searches were performed in a thorough manner, there is always the risk that the target species is undetected. Factors which may contribute to this include the limited time frame of the physical search at each business and the inexperience of those involved. Detection skills increased over time with increased recognition of suitable habitats and location where skinks were likely to be basking in the sun (Peace, 2004). The Argentine ants are known to be present deeper in the soil profile at times of high temperature and low soil moisture (late January to mid-February) (J. Cook, pers.comms January, 2015). This may have resulted in under detection of the presence of this species. Lack of skill of the operators in the identification of Argentine ants may have been a factor. However, samples were taken for professional microscopic identification if any doubt existed as to the species present. Control of ants during the summer months in businesses may have affected detection rates but this is unlikely with rainbow skinks due to the lack of current effective control measures.



**Table 5:** Percentage of Argentine ants and rainbow skinks in different business risk category for this study compared with Morgan (2014).

<b>Study</b>	<b>Low Risk category</b>	<b>Moderate risk category</b>	<b>High/Very High risk category</b>
<b>Argentine ants</b>			
Morgan (2014)	-	-	2
Current study	0	5	5
<b>Rainbow skinks</b>			
Morgan (2014)	-	-	30
Current study	4	20	43
<b>Both species</b>			
Morgan (2014)	-	-	5
Current study	0	0	10

Of the businesses with presence of either or both of these invasive species (18; 28%), 56% (10/18) transported goods to the mainland or sold products directly from their property, 28% (5/18) transported to non-pest free islands and only 17% (3/18) transported to pest-free islands (Table 4). All businesses transporting goods to pest-free islands had a presence of rainbow skinks but not Argentine ants. This suggests that the pest-free islands may be currently more susceptible to the transport of rainbow skinks rather than that of Argentine ants. However, with the increase in incidence of both species in the eastern Rodney district, it is inevitable that the risk of transport of either or both species will increase. It is important to note that even if a business does not transport goods directly to the islands, their customers may purchase high risk products, such as plants, from these businesses and indirectly transport these to one of the islands. This highlights a potential non-recognised transport vector pathway for these species to the islands.

## **5.2 Assessment of survey**

The survey allowed for businesses in different risk categories (low, moderate and high) to be included. Using the same survey questions across all risk levels allowed for ease of comparison of businesses and accurate results, helping to rule out bias between business risk levels. The final report at the end of 2015 aims to provide more clarity to the effectiveness of the survey tool as comparisons between this and last year's results will be analysed.

The effective communication of information and questions for the completion of surveys is often difficult. In this study, the interpretation of the wording of the survey proved to be confusing for some businesses. When analysing the data with that of Morgan (2014), discrepancies were found in the answers given by the same businesses surveyed in both years in relation to the transport of goods to the islands. On further investigation it was confirmed that the businesses in question did transport goods to the Hauraki Gulf islands. This confusion appeared to arise from the term "ship" in the question "Do you ship any products to the Hauraki Gulf Islands?". Confusion arose as businesses did not proactively ship to the islands but knew that their products were shipped to islands by their customers. This highlighted the need for extreme care and clarity of communication when conducting surveys.

Many of the businesses surveyed were interested in the information provided, both in form of discussion and the brochures, about the Argentine ant and rainbow skink. There was confusion, however, in the identification of the species. It was evident that there is a lack of knowledge on the identification of rainbow skinks, as presence of skinks was affirmed by comments such as "we have skinks but we have those brown native ones." This confusion may be caused by the name "rainbow skink" in relation to the pictures on the brochures, which may be misleading by showing a reflective, metallic-like skink. These skinks are not easy to identify to the untrained eye and it is suggested that live specimens of rainbow skinks would be extremely helpful in the education of the general public and businesses on the identification of this invasive species.

## **6.0 Conclusion**

Argentine ants and rainbow skinks are probably being transported to the Hauraki Gulf Islands, particularly by “high risk” businesses or customers of these businesses in the Eastern Rodney district. Results from the survey showed that rainbow skinks are more widespread than Argentine ants but both species are likely to be transported by commercial businesses to the Hauraki Gulf islands. The survey allowed for businesses in different risk categories (low, moderate and high) to be included in this study. There was a recurring trend that many of the businesses surveyed showed no knowledge or a lack of concern of these two species and the impacts on our native species and ecosystems. It is important that future management of these species is taken seriously as there is opportunity to keep both of the species from reaching the Hauraki Gulf islands. Education of the public and businesses is required in order to achieve this goal.

## **7.0 Recommendations**

The following are a list of recommendations from this study.

- Businesses in the high risk category should be educated about both species; including how to identify them, where the skinks are likely to be on their property, and control. Ongoing monitoring in the form of a survey of the high risk businesses should continue to collect data on the presence (and abundance) of these species.
- Pest free warrants should be made compulsory for vessels that regularly transport goods to and from the islands of the Hauraki Gulf. This should be extended to businesses that regularly ship their goods to the islands to show compliance and improve biosecurity strategies for the control of invasive species.
- Stricter rules on the control of moving high risk products to the Hauraki Gulf islands (e.g. soil, plants, building materials). Approved inspection or treatment before transportation. These checks should be made compulsory at the main ports of transport (e.g. Sandspit).
- Rainbow skink control method to be developed and used throughout businesses with known rainbow skink presence and to eradicate from the Hauraki Gulf Marine Park.
- Using ‘plague skink’ as the common name instead of rainbow skink. This should include more accurate pictures of the rainbow skink within marketing to help the public with confusion over the rainbow skink and native skinks.

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## Appendix 1: Survey

1 Is ant control undertaken on the site? (S)		
a	Yes, professional pest controllers undertake treatments for ants at regular intervals	1
b	Yes, professional pest controllers are contracted to undertake treatment of ants when we notice ants on site	2
c	Yes, when ants are a problem we sometimes lay bait ourselves over most of the property	3
d	Yes, we sometimes lay a few baits around the building or use fly spray on ant trails	4
e	No, the ants don't worry us; or we don't have ants	5

2 Where are your products being stored before leaving the site? (S)		
a	No goods distributed from site (e.g. lawyers, accountants offices)	0
b	Entirely inside a shop or closed warehouse	1
c	Some product stored outside, but on a sealed surface and >5 m from nearest ant habitat (e.g. bare earth, garden, lawn, organic waste area, open cracks)	3
d	Stored outside on gravel or sealed surface <5m from nearest ant habitat	4
e	Stored on or immediately adjacent to bare earth, weedy, or overgrown areas	5

3 On average, how long do goods stay on the site before leaving (i.e. dwell time) (s)		
a	No goods distributed or office documents only.	0
b	Same day turn-around	1
c	1 – 3 days	3
d	4 – 7 days	4
e	>7 days	5

4 How tidy are the property grounds? (S)		
a	Clean and tidy, no overgrown/neglected areas, no rubbish piles, and neighboring properties also tidy.	0.5
b	Clean and tidy, no overgrown/neglected areas, no rubbish piles, but neighboring properties noticeably less tidy.	1
c	Generally tidy, but boundaries overgrown or some light weedy areas present, and/or some rubbish lying about edges.	1.5
d	Generally untidy, with weedy areas around yard and noticeable rubbish around buildings and boundaries.	2
e	Very untidy, plenty of discarded packaging, rubbish and/or old machinery, and overgrown areas.	2.5

5 How much good ant/skink habitat is on the site? (S)		
a	Almost entirely sealed with concrete/bitumen, no gardens or lawn	0.5
b	Mostly sealed with concrete/bitumen, but some small garden areas present (<5%)	1
c	Substantially sealed, but gardens/ lawn/unsealed ground covering 5–20%	1.5
d	Unsealed ground/ gardens/ lawn occupy >20%, but <50% of property	2
e	Unsealed earth/gardens/or lawn occupy 50% or more of property	2.5

6 Where do you transport good/materials to? (S)		
a	mainland	2
b	Offshore (pests)	4
c	Mainland (pest free)	6
d	Offshore (pest free)	8

7 What packaging materials leave this site? (C)		
a	No packaging, Office envelopes, or plastic shopping bags only	0
b	Factory sealed commercial cartons	2
c	Unsealed cartons or plastic crates	3
d	Wooden boxes/crates	4
e	Pallets or shipping containers	5

8 What products/items leave the property? (See Guide, assessed for Question 4a) (C)		
a	Negligible risk	2
b	Low risk	4
c	Medium risk	6
d	High risk	8
e	Very high risk	10

(S) Site characteristic; (C) commodity characteristic

8a products/items Risk guide		
a	Negligible risk	Metal sheets, glass
b	Low risk	Plastic pipes, drain tubing
c	Medium risk	Pavers, treated wood, tractors, trucks
d	High risk	Aggregates, stones, camping equipment, boats
e	Very high risk	Soil, <u>ponga</u> trunks, plants, untreated wood

<b>9 How abundant are Argentine ants on the property?</b>		
a	None seen on property after 5 person-mins searching, and none on adjacent properties either.	1
b	None seen on property after 5 person-mins searching, but present on neighboring properties (determine later).	2
c	No obvious activity, on property after 5 person-mins searching, but presence noted from business owner	3
d	No or small areas of minor activity seen, and/or more than 3 nests found by searching up to 5 person minutes	4
e	Activity/trails easily seen around property without searching for nests	5

<b>10 How abundant are Rainbow skinks on the property?</b>		
a	None seen on property after 5 person-mins searching, and none on adjacent properties either.	1
b	None seen on property after 5 person-mins searching, but present on neighboring properties (determine later).	2
c	No obvious activity on property after 5 person-mins searching, but presence noted from business owner/representative	3
d	One Skink found by searching up to 5 person minutes	4
e	Two or more Skinks easily seen around property by searching up to 5 person minutes	5