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# A survey of environmental and pest management attitudes on inhabited Hauraki Gulf islands

Joanne P. Aley and James C. Russell



Department of  
Conservation  
*Te Papa Atawhai*

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Cover: Waiheke Island. *Photo: James Russell.*

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# A survey of environmental and pest management attitudes on inhabited Hauraki Gulf islands

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## Abstract

The progression of pest eradication to inhabited islands is now possible due to the knowledge gained from successful eradications on uninhabited islands. However, the success of this is likely to be influenced by the attitudes of landowners. The consistency of island inhabitants' attitudes towards pest management, both within and among islands, is currently unknown. Therefore, we assessed the environmental and pest management attitudes of the communities of four inhabited islands in the Hauraki Gulf of New Zealand (Rakino Island, Kawau Island, Great Barrier Island (Aotea Island) and Waiheke Island) and compared the results with an adjacent mainland community to better understand this social influence. The results suggested that respondents from all four island communities had more overarching support for pest management and conservation in general than those from the mainland, reflecting greater levels of environmental concern. While it might be expected that strong positive environmental attitudes would translate into strong positive pest management attitudes, this was not always the case, with greater levels of uncertainty being associated with attitudes towards pest management. In particular, values associated with the environment and place attachment were related to environmental attitudes but were unrelated to pest management attitudes. The results do suggest, however, that pest eradication may have had long-term positive effects on the attitudes of inhabited island communities, with the residents of the only island from which rats have been eradicated (Rakino) having consistently more positive attitudes towards pest control. The findings of this study will help identify areas for future engagement and ways in which barriers to achieving pest eradication can be overcome.

Keywords: attitudes, environment, pest management, eradication, inhabited island, mainland, New Zealand

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# 1. Introduction

Islands are important foci for the conservation of biodiversity in New Zealand due to the high numbers of endemic species they support and the vulnerability of those species to pest species, particularly invasive mammalian predators (Medina et al. 2011; Doherty et al. 2016). Following the arrival of humans in New Zealand, there was an ongoing human-mediated and natural dispersal of invasive mammals to its islands, despite the ocean creating a natural invasion barrier (Russell et al. 2010; Lockwood et al. 2013). Consequently, considerable conservation management is focused on islands, which often involves pest eradication followed by biosecurity to maintain a pest-free status (Courchamp et al. 2003; Bassett et al. 2016).

The eradication of invasive mammals has focused predominantly on uninhabited islands and non-native mammalian pest species, particularly three invasive rat species: *Rattus rattus*, *R. norvegicus* and *R. exulans* (Russell & Broome 2016). Consequently, over the last three decades, the methods and technology for rat eradication have advanced to allow reasonably consistent successes to be achieved (Towns et al. 2013), resulting in efforts becoming focused on inhabited islands (Howald et al. 2007; Ogden & Gilbert 2008; Campbell et al. 2015). However, experience suggests that this progression to inhabited islands will bring new challenges to future eradications due to the added social influence and attitudes of people, particularly island residents (Howald et al. 2007; Ogden & Gilbert 2008; Towns et al. 2012; Glen et al. 2013). In particular, the eradication of rats by the aerial delivery of toxin, which is the only viable tool currently available for large islands, has been recently opposed both locally on Rakitu Island (Arid Island) (Neilson 2018) and internationally on Lord Howe Island (Cavanagh 2018).

Since attitudes are invisible, inferences must be drawn from combined indicators of values, beliefs, norms and motivations to gain insight into them (Heberlein 2012), with values relating to nature, self and others often being analysed to deduce environmental attitudes (Kellert 1993; Dietz et al. 1999, 2005; Stern et al. 1999; Schultz 2001) (see Table 1 for descriptions of these concepts). Environmental attitudes, also termed environmental concern (Dunlap & Jones 2001), are described as viewing the natural environment with ‘some degree of favour or disfavour’ (Milfont 2007 12). An emphasis is placed on understanding environmental attitudes because of the implied link with being able to determine behaviours, although this is a tenuous link at best (Gifford & Sussman 2012; Heberlein 2012). However, this also enables levels of support, or ‘pro-environmental’ attitudes (Gifford & Sussman 2012), to be identified, which is more applicable.

To date, research on attitudes towards pest management has predominantly stemmed from ethical concerns about the welfare of target species, the impact on non-target species and controversies regarding the use of environmental toxins (Cowan & Warburton 2011). Consequently, there has been a focus on attitudes towards particular pest management methods (Goldson et al. 2015) and pest species (Bremner & Park 2007) or both (Fraser 2006; Russell 2014). Thus, although there has been some research on the attitudes of various stakeholders towards pest management (Farnworth et al. 2014), including policymakers and scientists (Moon et al. 2015), there has been no specific focus on inhabited islands or a broader context.

The aim of this study was to determine the attitudes of inhabited island communities towards the environment and pest management, particularly rat eradication, and to investigate the relationship between these attitudes. We specifically sought to understand the site-dependency of these attitudes among islands with different biogeographies, social profiles and pest management histories, and to contrast these attitudes with an adjacent mainland population. The findings of this study will help gain an understanding of the underlying drivers of attitudes towards pest management, and how these differ among islands.

Table 1. Descriptions of the foundational attitude concepts that are mentioned throughout this report.

CONCEPT	DESCRIPTION
Attitude	An attitude results from an individual's 'balanced evaluation of something, be it a person, object, concept, event, action etc (i.e. the attitude object)' (Wood & Fabrigar 2012: para. 1) and is reliably stable and 'enduring' (Wood & Fabrigar 2012). An attitude is associated with three components: cognitive or thoughts about something, affective or feelings about something and conative or behavioural intentions about something (Gifford & Sussman 2012).
Value	An individual's values serve as guiding principles in their life, influencing their opinions and decisions (Ives & Kendal 2014). Although an attitude always has an object of focus, a value relates to no particular object (Heberlein 2012). Values are for the most part stable (Heberlein 2012; Steg & de Groot 2012) and help us to make decisions when we are in conflict (Dietz et al. 2005). Different values have different levels of importance, allowing them to be prioritised. An individual will then base their choice on this importance when faced with conflicting values. As a result, although people may share the same or very similar values, variation in the importance of these values will lead to individuals making different choices (Steg & de Groot 2012). Consequently, values are linked to a person's core identity (Hitlin 2003) and are associated with their motivations (Steg & De Groot 2012).
Belief	Beliefs are defined as convictions and are considered to be true (Dietz et al. 2005; Smoak 2007), i.e. if a person believes something, then it is true for them (Heberlein 2012). Unlike values, beliefs are tied to an object, becoming a cognitive component of attitudes (Heberlein 2012). Since beliefs need not be correct (Smoak 2007), they are not based on factual knowledge and can often be formed from experience (Heberlein 2012). Emotions, which are often termed an 'affective component', further distinguish knowledge from beliefs and, as such, from attitudes, forming a part of attitudes that is not influenced by reason (Heberlein 2012). Beliefs are extremely difficult to change and can remain unchanged despite opposing evidence (Smoak 2007). When a belief 'ties' to a value, it is termed an evaluative belief, resulting in one thing being considered better than another (Heberlein 2012).
Norm	Norms are expressed as behaviours and therefore can be seen. In the case of environmental attitudes, this relates to what an individual does rather than what they say (Heberlein 2012). Norms relate to how a person decides what to do based on what others are doing around them but may also be influenced by what the individual thinks is right or wrong (Xenitidou & Edmonds 2014). Norms are what a person ought to do (Dietz et al 2005). Social norms are established by society-sanctioning behaviours, either formally (e.g. a parking ticket) or informally with verbal or unspoken cues (e.g. standing in line) (Heberlein 2012). Personal norms reflect an individual's sense of obligation, and within an environmental context reflect social responsibility (Heberlein 2012).
Motivation	Motivations that are relevant to environmental attitudes are associated with three particular values that describe how an individual relates self with nature or their concern for nature, others and self: biospheric, altruistic and egoistic (Schultz 2001; Shultz & Kaiser 2012). Biospheric values are where an individual's concern is for nature and the environment overall, for nature's own sake (Steg & de Groot 2012), where 'concern' refers to the protection of the natural environment (Schultz & Kaiser 2012). Altruistic values relate to an individual's concern for others (Steg & de Groot 2012), and this awareness of consequences to others is associated with personal norms (Stern & Dietz 1994) and being socially responsible (Schultz & Kaiser 2012), where the term 'others' can range from family to community to humanity as a whole (Milfont 2007). Egoistic values are triggered by how an individual is affected personally (Stern & Dietz 1994) through self-interest and the avoidance of adverse consequences or the pursuit of benefits (Schultz & Kaiser 2012).

## 2. Methods

### 2.1 Study sites

The Hauraki Gulf Marine Park (HGMP), which lies on the east coast of the Auckland region, covers 1.2 million hectares of ocean and includes 30 major island groups (Bassett et al. 2016). Fourteen of the islands are classified as inhabited (based on Atkinson & Taylor (1991) while accounting for recent changes), some of which are free of certain invasive mammalian species that are encountered elsewhere in New Zealand (Bassett et al. 2016). However, while invasive mammals have been successfully eradicated from many of the smaller islands in the HGMP (Bassett et al. 2016), there has only been an ongoing dialogue regarding the eradication of mammals from larger, inhabited islands, with no implementation to date (Ogden & Gilbert 2008, 2011; Towns et al. 2012).

Four islands in the HGMP were the focus of this 2015 study: Rakino Island, Kawau Island, Great Barrier Island (Aotea Island) and Waiheke Island. At that time these islands had experienced different levels of pest management, with rats having been eradicated from Rakino, local pest management programmes having been undertaken and rat eradication having been discussed on Aotea, local pest management programmes having been undertaken on Kawau, and local pest management programmes having been undertaken on the more urbanised Waiheke<sup>1</sup>. The attitudes of the communities on these islands were compared with those of people living on the mainland in the adjacent Auckland region by way of a ‘control’, i.e. as a measure of the attitudes of people who are not living on an island, accepting that the North Island of New Zealand is a very large island where eradication of any invasive mammal is not currently feasible. The Auckland region, the borders of the HGMP and the locations of the four inhabited islands used in this study are shown in Fig. 1.

### 2.1.1 Rakino Island

Rakino is a small island (146 ha) that is located approximately 21 km from Auckland City (Fig. 1). The usually resident population count for Rakino is difficult to determine due to this island being combined with two other islands (Rangitoto and Motutapu) in the New Zealand Census. In 2013, all three islands combined had a population of 60 (Statistics New Zealand 2013a), with less robust information suggesting a permanent population of 16 on Rakino at the time of the study (Wikipedia 2015). Residents were predominantly working age and 60% were male. In terms of ethnic diversity, residents identified as predominantly European (89%), followed by Māori (11%), and Pacific and Asian peoples (6% each). The median income in 2013 was NZ\$30,600, which was mostly earned through wages (67%) (Statistics New Zealand 2013a).

This island lacks infrastructure, so its residents rely on tank water and septic tank waste management systems, with solid waste being shipped from the island bi-annually. Residents also have no access to an electricity supply. Minimal unsealed roads are in place, and there is a public wharf at Sandy Bay and ferry services operating to the island (Auckland Council 2001).

*Rattus norvegicus* was successfully eradicated from Rakino in 2002 through the distribution of brodifacoum in bait stations over the entire island (Bouzaid n.d.; Clout & Russell 2006), following an initial failed attempt in the 1990s (Clout & Russell 2006).

### 2.1.2 Kawau Island

Kawau (2058 ha) is located approximately 40 km north of Auckland City. In 2013, the usually resident population count was 78, over half of whom were working age and 60% of whom were male (Statistics New Zealand 2013b). In terms of ethnic diversity, the residents identified as predominantly European (95%), with small numbers of Māori (4%) and other ethnicities (4%). The median income was NZ\$23,500, which was predominantly earned through the pension (48%) and interest and dividends (43%) (Statistics New Zealand 2013b).

Most of the island is private land, with the New Zealand Department of Conservation (DOC) managing four areas that represent approximately 10% of the island (Shaw & Pierce 2002). The island lacks infrastructure, having all-terrain vehicle (ATV) tracks rather than roads (Shaw & Pierce 2002), water supplied by private tanks and effluent disposed of by private septic tank waste management systems. Transport links are provided by several ferry companies.

While deer have already been eradicated from Kawau (Auckland Regional Council 2007) and one species of wallaby (black-striped wallaby (*Macropus dorsalis*)) has not persisted (Shaw & Pierce 2002), the island’s ecology and native species are threatened by the ongoing presence of several invasive mammalian species, including possums (*Trichosurus vulpecula*), stoats (*Mustela erminea*), *R. rattus*, feral cats (*Felis catus*) and four wallaby species (dama wallaby (*Macropus*

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<sup>1</sup> Since this study, Waiheke has embarked on a Predator Free Waiheke campaign and Kawau and Aotea have become focal sites of the Auckland Council Regional Pest Management Plan.



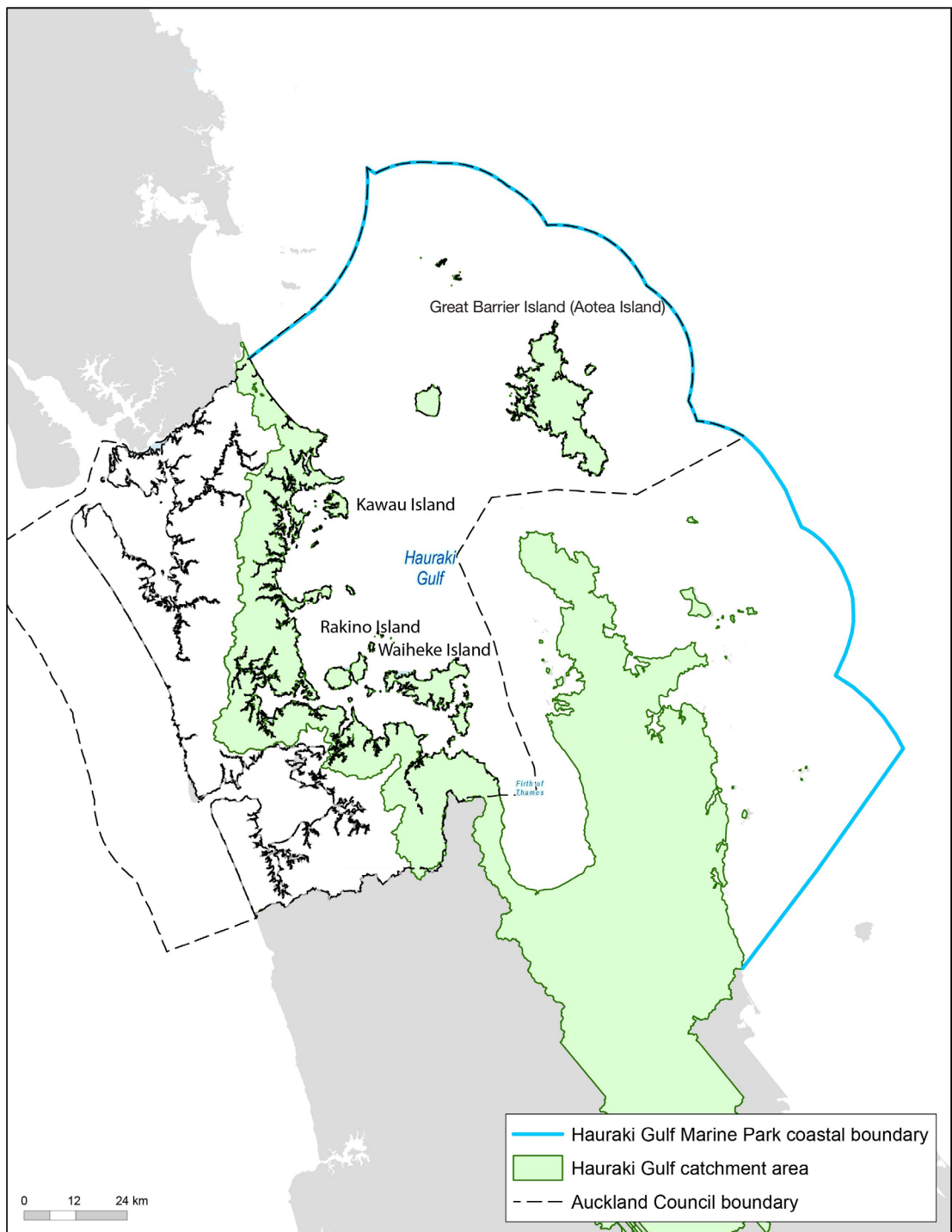


Figure 1. Map of the Auckland region showing the locations of the Hauraki Gulf Marine Park (both the wider overall boundary and the Auckland Council boundary) and the four study islands. Modified from [www.aucklandcouncil.govt.nz](http://www.aucklandcouncil.govt.nz).

*eugenii*), parma wallaby (*Macropus parma*), brush-tailed rock wallaby (*Petrogale penicillata penicillata*) and swamp wallaby (*Wallabia bicolor*) (Shaw & Pierce 2002). Conservation planning on Kawau has referred to wallaby and possum eradication, with rats being highlighted as a concern but no eradication programme having been outlined (Shaw & Pierce 2002)<sup>1</sup>.

### 2.1.3 Great Barrier Island (Aotea Island)

Aotea (27 400 ha) is located within the outer Hauraki Gulf, 100 km northeast of Auckland City (Ogden & Gilbert 2008). In 2013, the usually resident population count was 885, over 60% of whom were working age and 52% of whom were male (Statistics New Zealand 2013c). In terms

of ethnic diversity, the residents identified as predominantly European (91%), followed by Māori (18%), Pacific peoples (3%) and other ethnicities (3%). The median income was NZ\$19,000, which was mostly earned through wages (36%) and self-employment (31%) (Statistics New Zealand 2013c).

Over 60% of the island is administered by DOC (Clough 2011; Auckland Council 2013) with the remainder in private land ownership (Ogden & Gilbert 2008). The island lacks infrastructure, with no mains electricity supply and private tank systems being used for both water supply and septic waste management. Transport links are provided by one ferry company and several airlines that operate small-seater aircraft.

Aotea lacks many significant mammalian pests, with the eradication of feral goats (*Capra hircus*) already having been undertaken (Auckland Regional Council 2007; Bassett et al. 2016), leaving only *R. rattus*, *R. exulans*, mice (*Mus musculus*), feral cats, rabbits (*Oryctolagus cuniculus*) and pigs (*Sus scrofa*) (Ogden & Gilbert 2008; Bassett et al. 2016). Aotea is one of the largest remaining areas of New Zealand to be free from mustelids (weasels (*Mustela nivalis*), stoats and ferrets (*Mustela furo*)) and possums, making it a significant potential area for preserving native bird species (Lovegrove 2011). A rat eradication programme on Aotea has been suggested (Ogden & Gilbert 2008; Towns et al. 2012), and currently rats are intensively managed at Windy Hill and Glenfern Sanctuaries and around the summit of Hirakimata.

#### 2.1.4 Waiheke Island

Waiheke (9600 ha) is located approximately 17 km from Auckland City (Picard 2005). In 2013, the usually resident population count was 8238, ≥60% of whom were working age and 51% of whom were female (Statistics New Zealand 2013d). In terms of ethnic diversity, residents identified as predominantly European (90%), followed by Māori (11%), and Pacific and Asian peoples (3% each). The median income was NZ\$27,200, which was mostly earned through wages (47%) (Statistics New Zealand 2013d).

The main settlements are at the western end of the island (closest to Auckland City). Infrastructure includes a connection to the mainland electricity supply but private tank systems are being used for both water supply and effluent disposal (Auckland Council 2013). Both passenger and vehicle ferries run regular services to Auckland City, and there is an airport with infrequent air links (Auckland Council 2013).

Waiheke is free of many invasive mammalian species that are found on the mainland, including possums, weasels and deer. However, other species are present, including *R. rattus*, *R. norvegicus*, mice, stoats, feral cats and rabbits (Bassett et al. 2016). Unlike many other islands in the HGMP, at the time of this research no eradication programmes of any mammals had been undertaken on Waiheke (Auckland Regional Council 2007; Bassett et al. 2016), although rats and stoats were managed at sites around the island. However, funding has since been provided to plan a rat and stoat eradication project and undertake the latter (Auckland Council 2019).

## 2.2 Survey design

### 2.2.1 Environmental attitudes

A variety of concepts have been used in previous studies to measure people's environmental attitudes. The main concepts that were used in the present study are outlined below.

#### ***New Ecological (Environmental) Paradigm (NEP) Scale***

The survey of environmental attitudes was based on the NEP Scale. When it was first developed in 1978, this scale was called the New Environmental Paradigm Scale and consisted of a set of 12 statements (Dunlap & Van Liere 1978). However, the scale was revised in 2000 to include a set of 15 statements and was renamed the New Ecological Paradigm Scale (Dunlap et al. 2000).

These 15 statements were designed to measure peoples' relationships with nature and their use of natural resources and were neither environmental context nor place specific.

The revised NEP Scale (Dunlap et al. 2000) provides an established method for assessing general environmental attitudes against which further context-specific environmental attitudes can be compared. The NEP Scale was used as a unidimensional measure by calculating the mean score of respondents (Appendix 1, question 6). While the NEP Scale includes different sub-scale measurements within its design, these were not analysed in the present study.

### ***Membership in environmental organisations***

Since members of environmental organisations have been associated with more pro-environmental attitudes (Dunlap et al. 2000) and research has shown that New Zealanders are strong supporters of conservation groups (Russell et al. 2015), the level of membership in environmental organisations and the geographic location of those organisations was examined. This was measured by determining an individual's level of involvement with environmental organisations (Appendix 1, questions 7 and 8).

### ***Place attachment***

Pro-environmental behaviour has been shown to increase with connectedness to a place (Gosling & Williams 2010) or 'place attachment', which encompasses the meanings, attachment and satisfaction that develop a 'positive emotional bond ... between people and their environment' (Stedman 2003: 672). This question was adapted from that used by Stedman (2003), in which satisfaction was rated for different aspects of a place. For the purposes of this study, these aspects aimed to reflect the overall value (or bond) an island holds for an individual - for example, 'The remoteness and isolation' the island holds or 'The sense of community' it provides (Appendix 1, question 9). As many of the aspects were likely to resonate strongly with respondents, they were asked to tick only one descriptor of place rather than rate them, as requested by Stedman (2003). Since the length of time spent in a place has been suggested to influence place attachment (Larson et al. 2013), the length of time each respondent had owned a property on the island and spent on the island was also examined against place attachment.

### ***Environmental values***

Environmental values are associated with personal social norms but relate to how those personal norms are influenced by attitudes connected with nature (biospheric values), others (altruistic values) and self (egoistic values). For example, altruistic values consider how personal norms are influenced by an individual's responsibility to others and the consequences of their actions (Stern & Dietz 1994; Snelgar 2006; Milfont 2007), biospheric values consider the influence of nature on personal norms, and egoistic values consider the influence on self. These three types of values have been shown to be positively correlated with environmental attitudes. Therefore, a simplified set of three statements that aimed to reflect each of these was adapted from Schultz (2001), with respondents being asked to tick the single statement that best described their main concern for the environment (Appendix 1, questions 10-11).

### ***Attitudes towards conservation***

Since New Zealanders generally have favourable attitudes towards conservation and identify it as an important issue (Binnie 2013), its inclusion in this study provided the opportunity to determine whether attitudes towards conservation are associated with environmental and pest management attitudes (Appendix 1, questions 12 & 14).

### ***Attitudes towards science***

Attitudes towards science were also included due to the close association between scientific research and conservation, including invasive mammal management. These questions were derived from a nationwide survey of New Zealanders' attitudes towards science, which found that the population generally lacks trust in scientific claims and has gaps in its understanding of

science (Hipkins et al. 2002). Comparison of scientific attitudes against the wider New Zealand population and among the study sites provided insight into this strong aspect of invasive mammal management and also indicated whether science plays a role in influencing environmental attitudes. In consideration of the survey length, one statement was chosen from each of five sections in Hipkins et al. (2002): 1) interest in science and learning, 2) relationship between science and technology and the economy, 3) beliefs about science and knowledge building, 4) sociological aspects, and 5) understanding of science in the real world. The wording of statement four was amended slightly to better reflect the goals of this study (Appendix 1, question 19).

### **2.2.2 Pest management attitudes**

For the purposes of this study, we defined a pest management attitude as the psychological tendency to evaluate pest control with some degree of favour or disfavour. We assessed individuals' pest management attitudes by asking them questions relating to five key areas.

#### ***Pest Management Attitude (PMA) Scale***

Pest management attitudes were assessed using a set of ten statements, developed from an original set of 12 statements in Aley (2016), within a broad framework that was similar to the NEP Scale, with neither reference to nor focus on specific invasive mammalian species or management methods. An outline of the development of this scale, which was recently renamed the Pest Management Attitude (PMA) Scale (Aley et al. in press), can be found in Aley (2016). Like the NEP Scale, the PMA Scale was designed to give an overall attitude score. Reflecting the environmental attitude analysis (section 2.2.1), the PMA Scale formed a foundation against which specific pest management attitude measures were analysed (Appendix 1, question 13 excluding statements 2 and 9).

#### ***Attitudes towards the benefits of pest management***

The perceived benefits of pest management in contexts other than conservation (Fraser 2006) were measured to determine the level of knowledge about the wider benefits of pest management and whether this could provide future leverage for the planning of pest management projects (Appendix 1, question 15).

#### ***Concerns about rat management***

Taking the main result themes from Fraser (2006) and Kannemeyer (2013), concerns about rat management were measured through a set of statements that focused on the perceived impacts of pest management and/or the perceived risks associated with certain methods (Appendix 1, question 16).

#### ***Knowledge and experience of rat control***

Heberlein (2012) suggested that direct experience has the greatest influence on changing attitudes. Therefore, the association between an individual directly undertaking rat control on private or conservation land and the reasons why they may have chosen not to undertake any control were measured (Appendix 1, question 17). In addition, the level of awareness of rat control methods was measured, based on Wilkinson & Fitzgerald (2006), to measure the association between this and pest management attitudes (Appendix 1, question 18).

#### ***Support for rat control***

Individuals were asked directly whether they supported rat eradication on their particular inhabited island (Appendix 1, question 20) to obtain a real-time gauge of the respondents' appetite for any future proposed eradication programmes and to determine whether this was correlated with the PMA Scale score.

## 2.3 Data collection

Data were collected via an anonymous postal survey of property owners. A postal survey was chosen over a web-based survey because three of the study islands are not connected to a mains electricity supply and it is possible that not all property owners have access to the internet.

To ensure that we also reached property owners who were not permanently based at the physical property address on an island, particularly holiday home owners, addresses were derived from the Auckland Council rates (property tax) database and the property owner's postal address was used instead of the island property address where these differed. This focus on property owners rather than the resident census population upon which comparisons are usually drawn may have introduced bias but was chosen because any future eradications will likely require property owner consultation and permission for the application of eradication treatments on their property.

A separate property list was compiled for each of the four islands from the entire Auckland Council rates database ( $n = 535\,765$  properties), which included 196 properties for Rakino, 488 for Kawau, 1477 for Aotea and 6570 for Waiheke. Duplicate property owners within each island list were then removed, along with any government departments (e.g. DOC, Auckland Council, the New Zealand Police) and international postal addresses. The survey was distributed to all remaining property owners on the islands of Rakino ( $n = 152$ ), Kawau ( $n = 338$ ) and Aotea ( $n = 984$ ), but a random sub-sample of property owners was used on Waiheke that was equivalent to the combined total of eligible postal addresses for the three smaller islands ( $n = 1474$ ; 27% of eligible addresses).

A comparable 'control' sample of Auckland mainland residents who did not own property on a Hauraki Gulf island was obtained using stratified random sampling based on the postcodes of island property owners from the mainland Auckland region to reflect the socio-demographic characteristics of the island sample populations. An oversample was taken ( $n = 2018$ ) in anticipation of the rejection of some addresses through the same process that was used to identify duplicate or unsuitable addresses. In addition, addresses were considered unsuitable if they had the postcode '1142' ( $n = 263$ ), as this is the postcode for the Auckland Mail Centre, which is a sorting centre for private mail bags and some geographical areas (e.g. Kawau Island) and therefore does not represent a single geographical area. A final sample that equalled the combined total of the three smaller islands ( $n = 1474$ ) was then obtained.

The survey comprised three sections, with minor adjustments for the Auckland mainland property owners (see Appendix 1). Section one asked island property owners about their island property and Auckland mainland property owners about their visitation to the four Hauraki Gulf islands. Section two related to the respondents' environmental and pest management attitudes, with adjusted wording for Auckland mainland surveys from 'your island' to 'Hauraki Gulf islands'. Finally, section three captured demographic information for the respondents and their households, such as age, ethnicity, income, education and pet ownership.

The survey was piloted on a small group of people who were unrelated to the study. Surveys were then mailed to the selected households by an independent company on 24 August 2015, with completed surveys being accepted until 24 December 2015. To encourage participation, an incentive prize draw for a \$200 ferry voucher was included, eligibility for which required the surveys to be returned by 2 October 2015 (i.e. within 6 weeks). This resulted in 92% of the responses being received by this deadline.

## 2.4 Data analysis

Returned survey answers were analysed in SPSS (version 23). All single-option response questions were analysed for the percentage of missing data and patterns in these data. Respondents who had 100% of answers missing across all statements in the NEP and PMA

Scales were deleted and not used in any of the analyses ( $n = 5$ ). Less than 3% of data were missing and less than 2% were missing for most measures, with only two variables exceeding the recommended 5% missing data threshold (DiLalla & Dollinger 2006) – level of income (10.6% missing) and the main concern with methods of rat control (6.5% missing) – which were analysed as pairwise list deletions. Since the pattern of non-response was confirmed to be haphazard for all variables, series mean imputation was utilised for non-multiple response variables with a Likert Scale, enabling all SPSS analysis methods to be used. Data for the NEP and PMA Scales were analysed for skewness and zero-centred kurtosis to assess their normality (Curran et al. 1996). In addition, the distribution of data for each of the scales was assessed visually using a Q-Q plot.

Cronbach's alpha ( $\alpha$ ) was calculated to assess the association, or correlation, among a set of scale items and to verify the reliability of the complete scale (Furr & Bacharach 2008). Alpha values of  $>0.70$  are recommended (Nunnally & Bernstein 1994), although values of  $>0.60$  are considered good or adequate (Clark & Watson 1995). Corrected item-total correlations were also reviewed to analyse the homogeneity of the scale, with values of 0.15 to 0.50 being recommended (Clark & Watson 1995). Cross-tabulations for the frequency of responses for each geographical area were used to analyse multiple-response questions, Likert scale response data that were not designed to form a score, and yes/no and/or tick one option questions. Pearson's chi-square ( $\chi^2$ ) analysis was carried out to identify any statistically significant differences in frequency, using a significance level of  $P = 0.05$  and excluding any multiple-response questions, for which such an analysis is not applicable. Multiple-response questions were analysed by examining the percentage trends.

The influence of predictive demographic factors (sex, age, education and income) and the association between the number of years a respondent had owned and/or spent at the property and their place attachment were analysed using Pearson's chi-square, with examination of the percentages to identify trends. The predictive validities of age, income and education for the NEP and PMA Scales were analysed using Spearman's rank correlation, due to age, income and education being ordinal and ranked and the NEP/PMA Scale scores being continuous. By contrast, the effect of sex was analysed using an independent sample t-test. Respondent demographics were compared against the 2013 New Zealand census results for each of the study sites.

Analysis focused on comparing the response variables of the NEP or PMA Scales with potential explanatory variables. For each of these scales, a one-way analysis of variance (ANOVA) was first used to examine the effect of geographic area on environmental and pest management attitudes (i.e. the NEP and PMA Scale scores). Two-way ANOVAs followed by post-hoc Tukey's tests were then used to examine the effects of the other environmental and pest management variables outlined in sections 2.2.1 and 2.2.2 on environmental and pest management attitudes (i.e. the NEP and PMA Scale scores), while comparing across geographical areas.

## 3. Results

### 3.1 Demographic characteristics of respondents

A total of 1190 of the 4422 surveys mailed out (26%) were returned completed. All four islands had above average response rates (28–40%), while the Auckland mainland had the lowest response rate (20%). More males responded overall (males,  $n = 632$ ; females  $n = 545$ ;  $\chi^2 = 18.10$ ,  $df = 4$ ,  $P = 0.001$ ). The median ages of the survey respondents ranged from 59 (Auckland mainland) to 65 (Kawau), which is higher than for all areas in the 2013 census, reflecting trends in property ownership (the sampling object). In terms of ethnicity, New Zealand Europeans dominated for all study sites (83–93%), followed by Europeans (6–13%) and Māori (3–9%), with Pacific Islanders, Chinese, Indian and other ethnicities all being  $\leq 3\%$ , which is similar to the 2013 census. However, the Auckland mainland survey respondents had a higher proportion of New Zealand Europeans (83%) than the 2013 census results (59%), likely reflecting the stratified sampling for property owners of the Auckland mainland.

Educational qualifications departed from the 2013 census results for all study sites, with lower proportions of people with no qualification or a diploma and higher proportions with a Bachelor's Degree and above. Incomes for all study sites also differed from the census results, with a higher proportion of respondents having incomes  $> \$50,000$ . The type of property owned by respondents differed significantly among the islands ( $\chi^2 = 143.066$ ,  $df = 15$ ,  $P < 0.001$ ), with all except Waiheke having more holiday homeowners than permanent residents. This reflected the 2013 census results, where  $> 50\%$  of dwellings were unoccupied on all of the islands except Waiheke. The demographic results are outlined in Appendix 2.

### 3.2 New Ecological Paradigm (NEP) Scale

A Cronbach's alpha of 0.84 ( $n = 1190$ ) was calculated, indicating high internal consistency of the NEP Scale, and the corrected inter-item total correlations were above the lower threshold of 0.15 for all 15 statements, indicating strong reliability (Appendix 3). The NEP Scale score data were normally distributed, falling within the skewness and kurtosis thresholds, and this was further verified visually by the Q-Q plot.

Utilising the NEP scale as a unidimensional measure, there was an overall tendency for pro-environmental attitudes across all study sites, including the Auckland mainland (Appendix 4). However, there was a statistically significant difference among study sites ( $F = 6.889$ ,  $df = 4$ , 1185,  $P < 0.001$ ), with the post-hoc analysis identifying significant differences between respondents from the Auckland mainland and both Waiheke ( $P = 0.028$ ) and Aotea ( $P = 0.001$ ), and between respondents from Kawau and both Waiheke ( $P = 0.016$ ) and Aotea ( $P = 0.001$ ) (Fig. 2).

The NEP score was significantly but weakly negatively correlated with age ( $r = -0.115$ ,  $n = 1156$ ,  $P < 0.001$ ) and income ( $r = -0.123$ ,  $n = 1047$ ,  $P < 0.001$ ), and significantly but weakly positively correlated with education ( $r = 0.101$ ,  $n = 1172$ ,  $P = 0.001$ ). There was also a significant difference between the sexes ( $t = -7.279$ ,  $df = 1175$ ,  $P < 0.001$ ), with females having higher NEP scores than males.

#### 3.2.1 Conservation participation

Conservation participation varied significantly among the study sites ( $\chi^2 = 52.995$ ,  $df = 4$ ,  $P < 0.001$ ), with respondents from the islands of Rakino, Kawau, Aotea and Waiheke having higher levels of participation than those from the Auckland mainland (52%, 64%, 57%, 49% and 32%, respectively). Conservation participation was not significantly related to sex ( $\chi^2 = 0.001$ ,  $df = 1$ ,  $P = 0.975$ ), age ( $\chi^2 = 6.581$ ,  $df = 3$ ,  $P = 0.087$ ) or income ( $\chi^2 = 1.817$ ,  $df = 4$ ,  $P = 0.769$ ). However, it was significantly related to education ( $\chi^2 = 16.077$ ,  $df = 8$ ,  $P = 0.041$ ), with respondents with a Bachelor's Degree

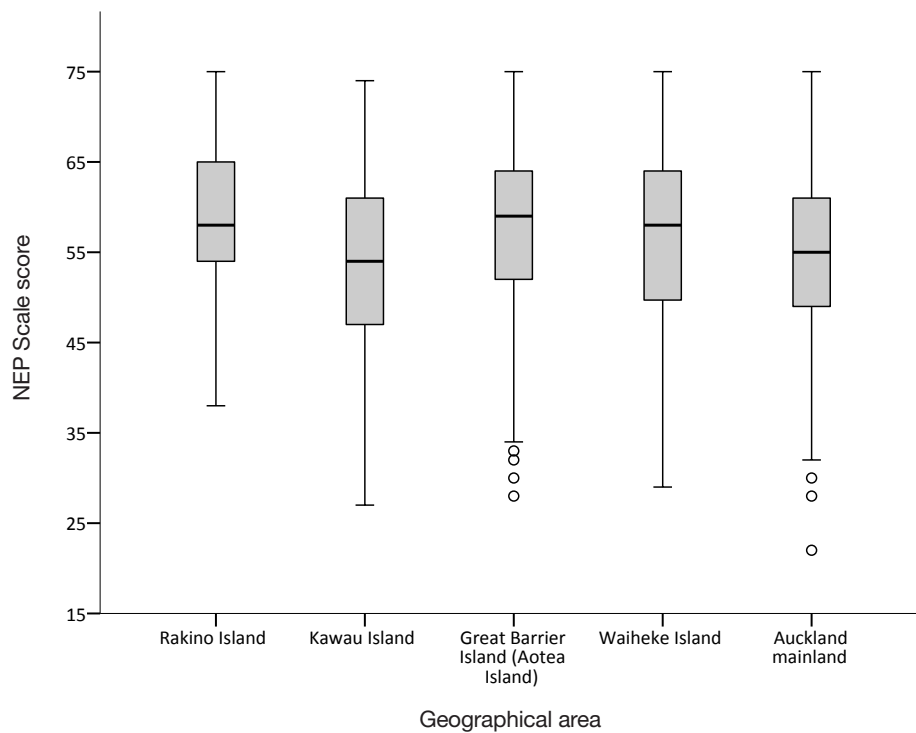


Figure 2. Median, first and third quartiles (25% and 75%), range, and outliers for the New Ecological Paradigm (NEP) Scale scores of respondents from different Hauraki Gulf island communities and the Auckland mainland. Scale scores ranged from 15 to 75, with higher scores indicating more pro-environmental attitudes ( $n = 1190$ ).

having the highest percentage of conservation participation (27%) followed by those who had completed secondary school (17%). By contrast, respondents with a Trade Certificate, Diploma, Postgraduate Diploma or Master's Degree had participation rates of between 10% and 15%, while those with no qualification, a Doctoral Degree or some 'other' qualification had < 5% participation. A total of 30% of respondents with altruistic values had participated in conservation within the last 12 months, compared with 16% of respondents with egoistic values. However, those with biospheric values participated the most at 54%. This trend was consistent across all study sites.

### 3.2.2 Environmental organisation membership

Membership in environmental organisations varied significantly among the five locations ( $X^2 = 51.120$ ,  $df = 4$ ,  $P < 0.001$ ), with Auckland mainland respondents having lower levels of membership (15%). However, non-membership was the norm (i.e. > 50%) for all locations. The NEP score was significantly related to membership in environmental organisations ( $F = 29.583$ ,  $df = 1, 1177$ ,  $P < 0.001$ ), with members of environmental organisations having higher scores (Fig. 3).

Environmental organisation membership was not significantly related to sex ( $X^2 = 1.531$ ,  $df = 1$ ,  $P = 0.216$ ), age ( $X^2 = 2.789$ ,  $df = 3$ ,  $P = 0.425$ ) or income ( $X^2 = 2.656$ ,  $df = 4$ ,  $P = 0.617$ ). However, it was significantly related to education ( $X^2 = 28.283$ ,  $df = 8$ ,  $P < 0.001$ ), with respondents with Bachelor's, Master's and Doctoral Degrees, and Postgraduate Diplomas having a higher probability of being members of environmental organisations and those with qualifications below a Bachelor's Degree being less likely to be members.

Survey respondents were able to indicate whether they were members of Hauraki Gulf island environmental organisations, national organisations or international organisations, ticking all that were applicable. This showed that Kawau and Aotea respondents were more involved with on-island environmental groups than national and international organisations, whereas respondents from Waiheke and the Auckland mainland were more involved with international environmental groups (Fig. 4). (Note: no environmental or conservation organisations formally exist on Rakino, so this island was excluded from the analysis.)



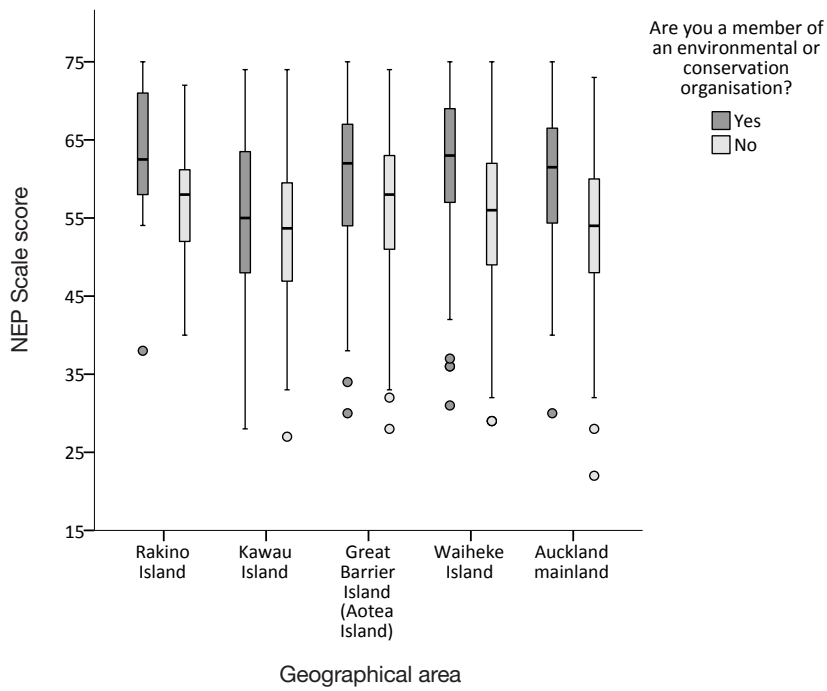


Figure 3. Median, first and third quartiles (25% and 75%), range, and outliers for the effect of membership to environmental organisations on the New Ecological Paradigm (NEP) Scale scores of respondents from four Hauraki Gulf island communities and the Auckland mainland. Scale scores ranged from 15 to 75, with higher scores indicating more pro-environmental attitudes ( $n = 1187$ ).

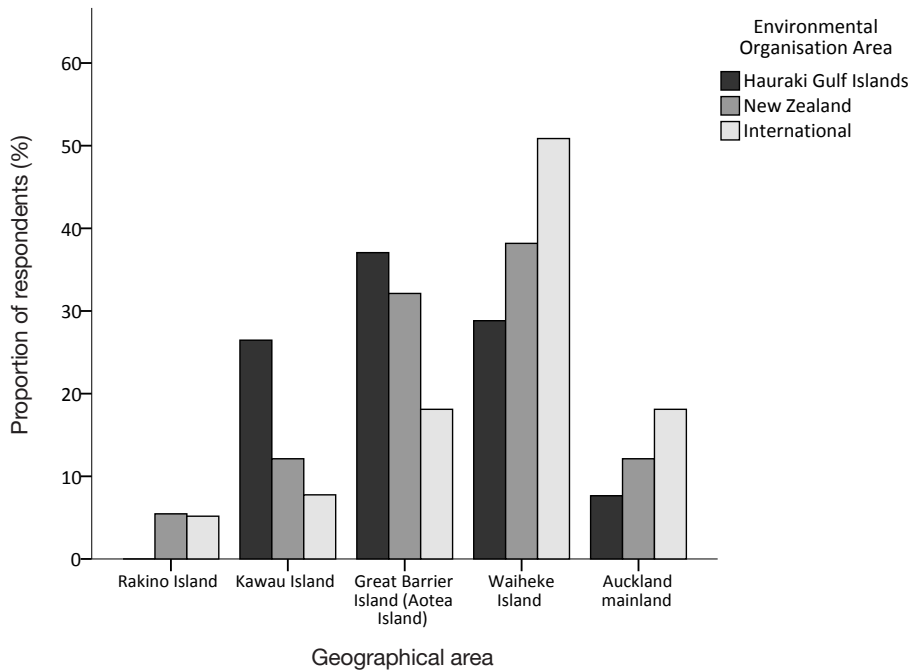


Figure 4. Proportion of respondents with memberships in Hauraki Gulf island, national and international environmental organisations on each of the four Hauraki Gulf islands and the Auckland mainland. Since multiple responses were allowed, the percentages for each geographic area may not total 100 ( $n = 451$ ).

### 3.2.3 Place attachment

Place attachment varied significantly ( $X^2 = 195.717$ ,  $df = 20$ ,  $P < 0.001$ ), with the value for 'landscape and environment' dominating across all locations, ranging from 37% for Waiheke to 68% for the Auckland mainland. There was a significant interaction effect between study site and place attachment on the NEP score ( $F = 1.810$ ,  $df = 17$ ,  $1146$ ,  $P = 0.023$ ), with respondents that valued the lifestyle having lower NEP scores, and respondents on Aotea and Waiheke only that valued business opportunities also having lower NEP scores). Rakino and Aotea had higher mean NEP scores associated with remoteness and isolation than other locations. Finally, a strong sense of community was associated with pro-environmental attitudes on Kawau, whereas no such relationship was observed on the Auckland mainland.

Place attachment was not significantly related to sex ( $X^2 = 4.727$ ,  $df = 5$ ,  $P = 0.450$ ), age ( $X^2 = 11.642$ ,  $df = 15$ ,  $P = 0.706$ ), education ( $X^2 = 53.968$ ,  $df = 40$ ,  $P = 0.069$ ), income ( $X^2 = 16.001$ ,  $df = 20$ ,  $P = 0.717$ ) or the length of time a respondent had owned an island property ( $X^2 = 28.939$ ,  $df = 25$ ,  $P = 0.266$ ). Place attachment was significantly positively related to the amount of time spent on the island, however ( $X^2 = 103.579$ ,  $df = 815$ ,  $P < 0.001$ ). While all subgroups (i.e. those that spent 0–3 months, 3–6 months, 6–9 months and 9–12 months on the island) tended to value the landscape and environment ( $\geq 30\%$ ), respondents who spent more time on the island over the course of a year (i.e. between 6 and 12 months) valued both the sense of community and lifestyle at least 7% more than those who spent less time on the island over a year (i.e. < 6 months).

### 3.2.4 Environmental values

There was no significant difference in environmental values among study sites ( $X^2 = 4.132$ ,  $df = 8$ ,  $P = 0.845$ ). The NEP score was significantly related to environmental values, however ( $F = 30.544$ ,  $df = 2$ ,  $1144$ ,  $P < 0.001$ ), with post-hoc analysis showing that there was a significant difference among all three values (biospheric, altruistic and egoistic;  $P < 0.01$ ). For all locations, higher NEP scores were associated with biospheric values, while lower NEP scores were associated with both altruistic and egoistic values (Fig. 5).

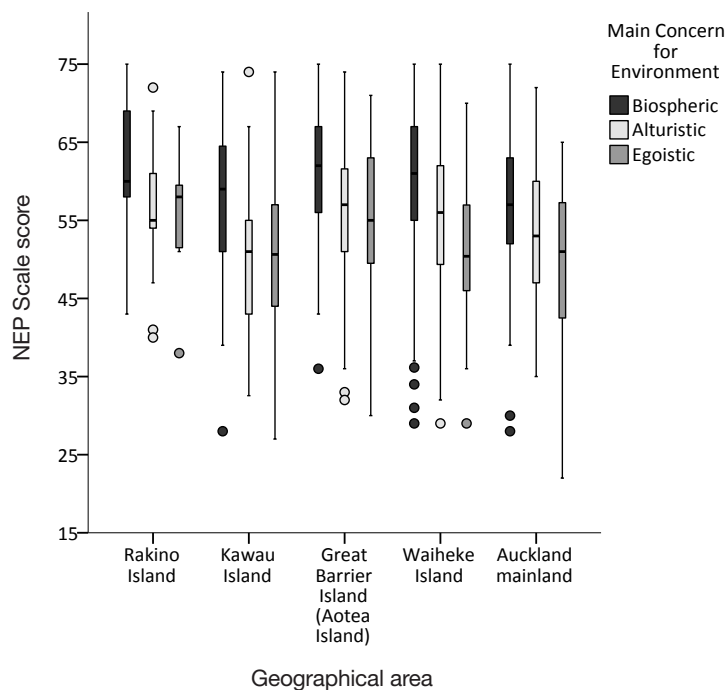


Figure 5. Median, first and third quartiles (25% and 75%), range, and outliers for the New Ecological Paradigm (NEP) Scale scores of respondents with different environmental values from the four Hauraki Gulf island communities and the Auckland mainland. Scale scores ranged from 15 to 75, with higher scores indicating more pro-environmental attitudes ( $n = 1159$ ).

Environmental values were not significantly related to age ( $X^2 = 11.707$ ,  $df = 6$ ,  $P = 0.069$ ), education ( $X^2 = 9.844$ ,  $df = 16$ ,  $P = 0.875$ ) or income ( $X^2 = 6.672$ ,  $df = 8$ ,  $P = 0.572$ ). They were, however, significantly related to sex ( $X^2 = 10.615$ ,  $df = 2$ ,  $P = 0.005$ ), with a greater proportion of females having biospheric values (54%) than males (45%) and a greater proportion of males having altruistic (35%) and egoistic (20%) values than females (31% and 15%, respectively). However, there was an overall trend for biospheric values to be more prominent than altruistic and egoistic values for both sexes.

### 3.2.5 Attitudes towards conservation

Overall, there appeared to be positive attitudes towards conservation in New Zealand across all locations (Appendix 5), with only two of the eight attitudes to conservation statements significantly differing among locations: statement 7 (I've got enough to worry about than care about conservation;  $X^2 = 50.753$ ,  $df = 20$ ,  $P < 0.001$ ) and statement 8 (I don't have the knowledge or skills to get involved with conservation;  $X^2 = 45.959$ ,  $df = 20$ ,  $P = 0.001$ ). Rakino respondents had a higher level of strong disagreement (80%) with statement 7 and general disagreement (78%) with statement 8 than respondents from other areas.

Responses to the conservation statements were not significantly related to age, education or income for more than 50% of the statements (Table 2). However, females had significantly different attitudes towards conservation than males for seven of the eight statements.

Table 2. Statistical significance of population demographic parameters on respondents' attitudes towards conservation.

STATEMENT ABOUT CONSERVATION	AGE ( <i>n</i> = 1156) <i>P</i>	INCOME ( <i>n</i> = 1047) <i>P</i>	EDUCATION ( <i>n</i> = 1172) <i>P</i>	SEX ( <i>n</i> = 1177) <i>P</i>
1. Protecting nature doesn't make any difference to me or my life.	0.001	0.810	0.001	0.009
2. Protection of NZ's native forests and species is important for us all.	0.888	0.409	0.303	0.001
3. Conservation is good for NZ's economy.	0.037	0.410	0.054	0.021
4. Having natural places to visit is very important to me.	0.077	0.312	0.451	0.011
5. Commercial development should not override conservation demands.	0.537	0.001	0.474	0.001
6. Protection of NZ's native forests and species is important for tourism.	0.279	0.668	0.007	0.021
7. I've got enough to worry about than care about conservation.	0.008	0.034	0.134	0.039
8. I don't have knowledge or skills to get involved in conservation.	0.011	0.167	0.018	0.599

### 3.2.6 Attitudes towards science

Overall, respondents had a positive attitude towards science across all geographical areas (Appendix 6). There was a high level of interest in science (>86% for strongly agree & mildly agree combined, statement 1) and a high level of agreement towards funding scientific research (>77% for strongly agree & mildly agree combined, statement 2). While the trend towards positive agreement in the belief in scientific benefits had lower percentages of strong agreement (<16%) and higher percentages of mild agreement (35-50%, statement 3), there was also higher trends for both neither agree nor disagree (13-28%) and mildly disagree (15-26%). For trust in science (statement 4), while strongly agree & mildly agree combined indicated positive attitudes, there was a notable trend towards higher levels of neither agree nor disagree (<30%). For the understanding of science (statement 5), there was a more even spread of attitudes across each level of agreement and disagreement for all geographical areas, including the highest level of strong disagreement for all the 5 statements (8-19%).

Attitudes towards the science statements were not related to age or income. However, respondents with any type of qualification were more likely to agree with engaging with science (statement 1:  $X^2 = 86.312$ ,  $df = 40$ ,  $P < 0.001$ ), investment in science (statement 2:  $X^2 = 62.418$ ,  $df = 40$ ,  $P = 0.013$ ) and trusting in science (statement 4:  $X^2 = 85.885$ ,  $df = 40$ ,  $P < 0.001$ ). In addition, males were significantly more likely to be engaged with science (statement 1:  $X^2 = 18.437$ ,  $df = 5$ ,  $P = 0.002$ ), believe in science (statement 3:  $X^2 = 16.027$ ,  $df = 5$ ,  $P = 0.007$ ) and understand science in the real world (statement 5:  $X^2 = 20.090$ ,  $df = 5$ ,  $P = 0.001$ ) than females.

### 3.2.7 Support for rat eradication

The level of support for rat eradication varied significantly among locations ( $X^2 = 39.295$ ,  $df = 12$ ,  $P < 0.001$ ) but overall there was a high level of support ( $\geq 67\%$ ). There were similar frequencies of ‘unsure’ and ‘no’ responses, and a higher frequency of ‘depends’ than ‘no’ and ‘unsure’ responses (Fig. 6). The NEP score was not significantly related to the level of support for rat eradication ( $F = 0.630$ ,  $df = 4$ ,  $1165$ ,  $P = 0.596$ ).

Support for rat eradication on Hauraki Gulf islands was not significantly related to age ( $X^2 = 15.510$ ,  $df = 9$ ,  $P = 0.078$ ) or education ( $X^2 = 23.857$ ,  $df = 24$ ,  $P = 0.470$ ). Furthermore, although it was significantly related to income ( $X^2 = 22.801$ ,  $df = 12$ ,  $P = 0.029$ ), the majority of respondents at all income levels were supportive. Support for rat eradication was significantly related to sex ( $X^2 = 10.607$ ,  $df = 3$ ,  $P = 0.014$ ), with males being more supportive than females (78% v. 70%).

## 3.3 Pest Management Attitude (PMA) Scale

The Cronbach’s alpha value for the PMA Scale was 0.711 ( $n = 1190$ ), indicating strong reliability, and the corrected inter-item correlations were above the accepted lower recommended threshold of 0.15 for all ten statements (Appendix 7). The PMA Scale scores were distributed normally, falling within the skewness and kurtosis thresholds, and this was further verified by a Q-Q plot.

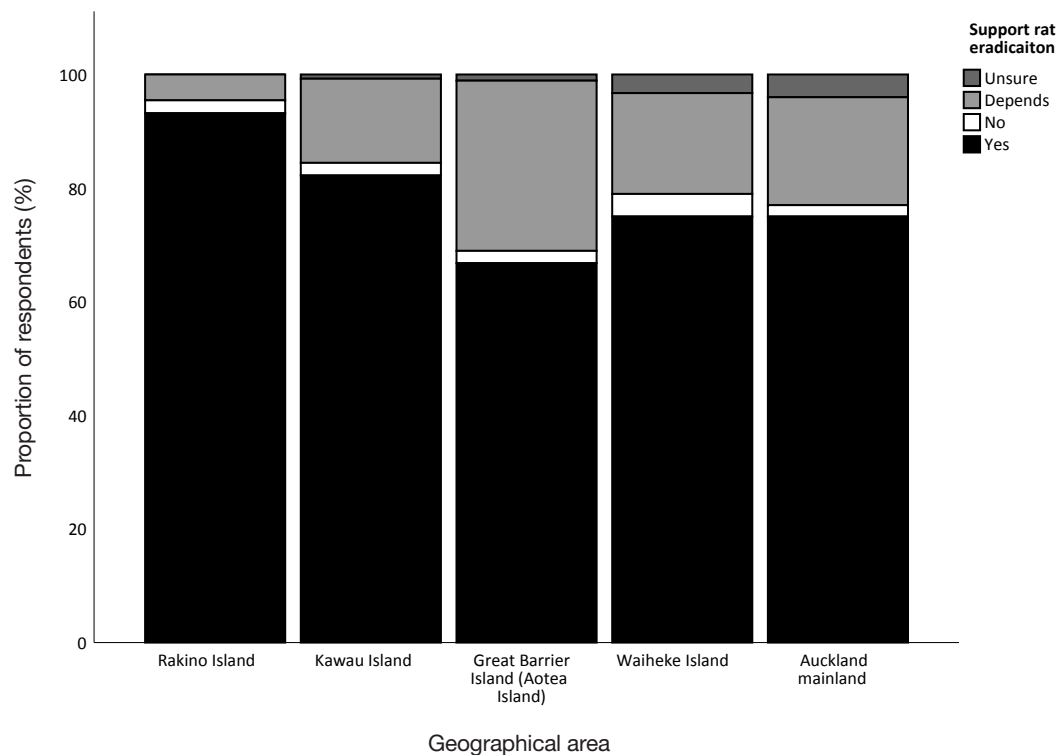


Figure 6. Proportion of respondents with different levels of support for rat eradication on Hauraki Gulf islands.

There was a tendency towards pro-pest management attitudes across all locations (Appendix 8). However, 'unsure' responses were given by  $\geq 20\%$  of respondents to seven of the ten statements, so the 'unsure' trends are also worth noting. There was a high percentage of 'unsure' responses to statement 6 (*Today's pest control methods are NOT proven to be effective*) across all locations ( $>40\%$ ), but there was a tendency for respondents with pro-pest management attitudes to agree. There was a general trend for disagreement with statement 2 (*Pest control is a losing battle*), but this statement had a high proportion of 'unsure' responses ( $>20\%$ ) for respondents from all islands except Rakino (13%) and a high proportion of mild agreement ( $>20\%$ ) across all locations. While respondents tended to agree with statement 3 (*The benefits of pest control outweigh the risks to native species*), there were more 'unsure' responses to this statement, particularly amongst Waiheke respondents (29%). Statement 10 (*Pest control has unknown side effects*) had a high proportion of respondents agreeing with it, as well as a high proportion of 'unsure' responses ( $>28\%$ ).

There was a statistically significant difference in the mean PMA score among locations ( $F = 2.482$ ,  $df = 4$ ,  $1185$ ,  $P = 0.042$ ). Post-hoc analysis identified a significant difference between respondents from the Auckland mainland and Kawau ( $P = 0.044$ ), with the latter having higher mean PMA scores. The PMA score was not significantly correlated with age ( $r = 0.002$ ,  $n = 1156$ ,  $P = 0.938$ ) but was weakly positively correlated with income ( $r = 0.093$ ,  $n = 1047$ ,  $P = 0.003$ ) and qualification ( $r = 0.068$ ,  $n = 1172$ ,  $P = 0.020$ ). There was also a significant difference in the PMA score between sexes ( $t = 3.419$ ,  $df = 1175$ ,  $P = 0.001$ ), with males having higher scores than females. There was a significant but weak positive correlation between the NEP and PMA scores ( $r = 0.089$ ,  $n = 1190$ ,  $P = 0.002$ ).

### 3.3.1 Pest control: benefits, concerns, knowledge and experience

Across all geographical areas, other than fir conservation respondents identified agricultural benefits (92%) as the greatest benefit of pest control, followed by threatened species translocations (83%) and tourism (81%) (Appendix 9). Economic and ecosystem services benefits were given equal weightings (74%), while human health and safety (69%) and financial (49%) benefits were ranked last. These trends were generally consistent across all study sites, with  $\leq 10\%$  differences overall. However, Rakino departed slightly from this trend, having higher percentages ( $\geq 7\%$ ) than other geographic areas for ecosystem services (87%) and threatened species translocations (91%).

The main concern around rat control varied significantly among locations ( $X^2 = 45.333$ ,  $df = 24$ ,  $P = 0.005$ ). However, the impact of poisons on non-target species consistently ranked the highest across all locations, ranging from 25% for Waiheke respondents to an equal high of 41% for Rakino and Kawau respondents. In addition,  $>20\%$  of respondents from Kawau, Waiheke and the Auckland mainland expressed concern about the effectiveness of techniques to kill target species, while 19% of Aotea respondents were concerned about the use of poison over other methods, which was higher than for other areas. A high proportion (19%) of respondents from Kawau and the Auckland mainland were concerned about the risk of poison to pets, livestock and people.

The concern about rat control was significantly related to the PMA score ( $F = 4.792$ ,  $df = 6$ ,  $1075$ ,  $P < 0.001$ ). Post-hoc analysis showed that concerns around the effectiveness to kill target species and the impacts of poison on non-target species were significantly related to the lack of public consultation ( $P = 0.001$  and  $P = 0.034$ , respectively), the risk of poison to pets ( $P < 0.001$  and  $P < 0.001$ , respectively) and the use of poison over other methods ( $P < 0.001$  and  $P < 0.001$ , respectively). Figure 7 illustrates the large variation in mean PMA scores that was observed across all locations for lack of public consultation, with the largest difference being seen between Rakino, where rat eradication has been successfully undertaken, and Aotea, where there has been ongoing contentious discourse surrounding pest eradication for several years.

Concerns about rat control were significantly related to age ( $X^2 = 32.720$ ,  $df = 18$ ,  $P = 0.018$ ), education ( $X^2 = 68.255$ ,  $df = 48$ ,  $P = 0.029$ ) and income ( $X^2 = 65.517$ ,  $df = 24$ ,  $P < 0.001$ ). However, the impact of poison on non-target species was of greatest concern across all ages, qualifications and income levels. There was also a significant difference between the sexes ( $X^2 = 36.918$ ,  $df = 6$ ,  $P < 0.001$ ), with males being more concerned about the effectiveness of techniques to kill the target species (27%) than females (16%), but all other concerns varying by  $<10\%$  between the sexes and both males and females being most concerned about the impact of poison on non-target species ( $>27\%$ ).

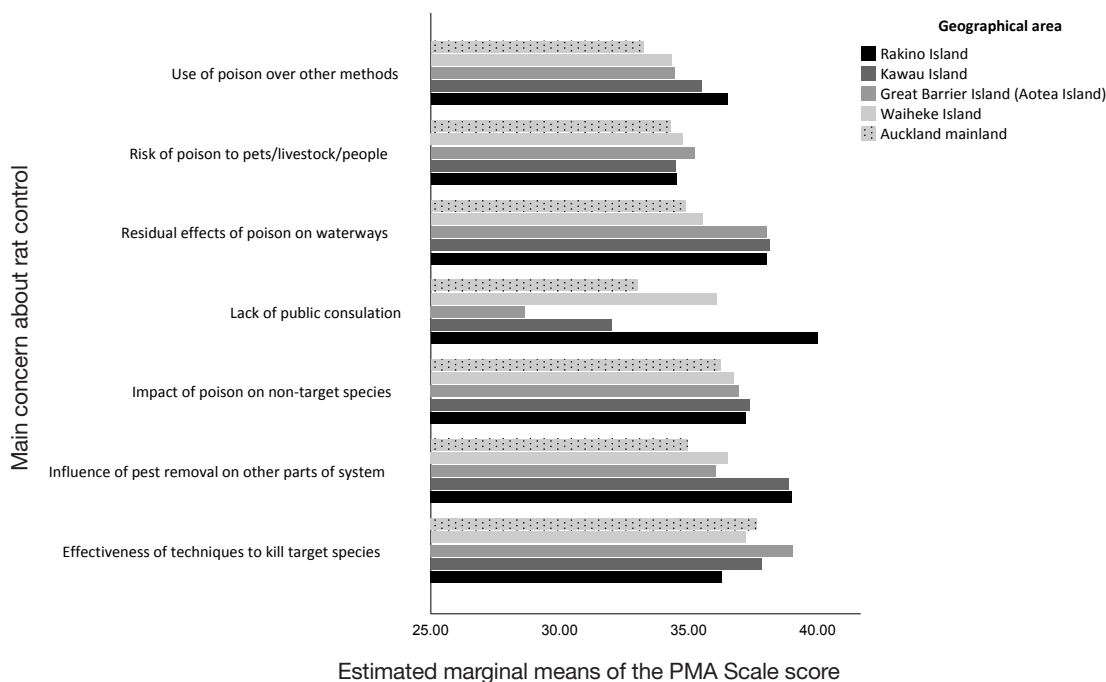


Figure 7. Differences in the main concern about rat control between respondents from four Hauraki Gulf island communities and the Auckland mainland. Pest Management Attitude (PMA) Scale scores ranged from 10 to 50, with higher scores indicating more pro-pest management attitudes ( $n = 1110$ ).

Respondents' personal experiences with rat control varied significantly among locations ( $\chi^2 = 50.071$ ,  $df = 4$ ,  $P < 0.001$ ). Kawau had the highest proportion of respondents who had undertaken rat control (87%), followed by Aotea (84%) and Waiheke (74%), while only 63% of Auckland mainland respondents and 59% of Rakino respondents had experience, which was expected for the latter since rats have now been eradicated from Rakino. The level of rat control experience was significantly related to the PMA score ( $F = 7.272$ ,  $df = 1$ ,  $1170$ ,  $P = 0.007$ ), with those who had undertaken rat control having higher PMA scores, particularly on Aotea, Waiheke and the Auckland mainland (Fig. 8).

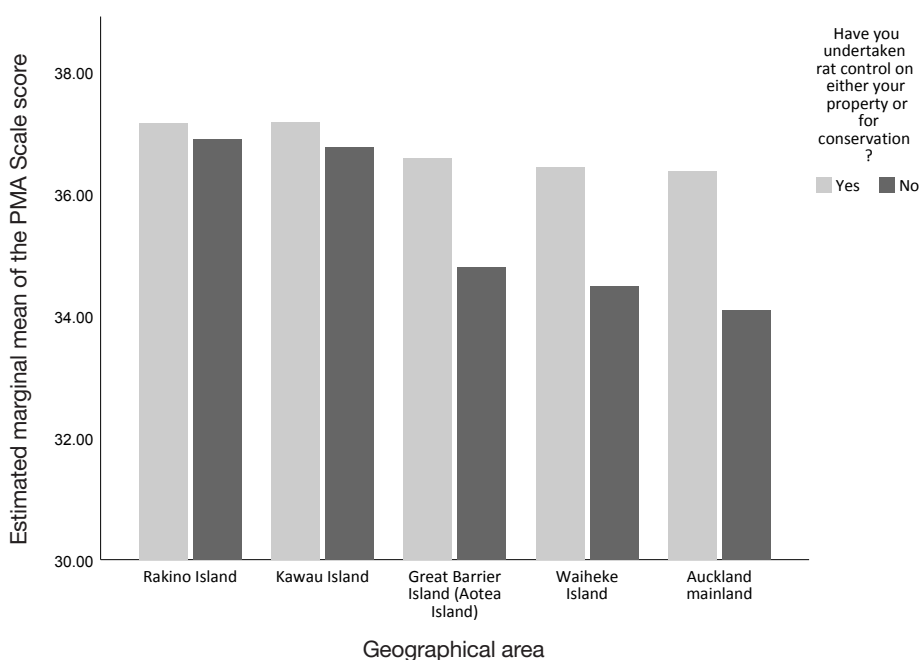


Figure 8. Differences in the level of rat control experience between respondents from four Hauraki Gulf island communities and the Auckland mainland. Pest Management Attitude (PMA) Scale scores ranged from 10 to 50, with higher scores indicating more pro-pest management attitudes ( $n = 1180$ ).

Rat control experience was significantly related to sex ( $X^2 = 12.372$ ,  $df = 1$ ,  $P < 0.001$ ) and age ( $X^2 = 26.901$ ,  $df = 3$ ,  $P < 0.001$ ), with males being more experienced than females (79% and 69%, respectively) and 41–80 year old respondents being more experienced than 21–40 year olds (>39% v. 4%). Income was also significantly related to rat control experience ( $X^2 = 11.417$ ,  $df = 4$ ,  $P = 0.022$ ). While all levels of income had more respondents that had done rat control (74%) than who had not (26%), those in the \$35,001 to \$70,000 had the highest level of undertaking rat control than all other income levels. Education had no significant effect on rat control experience ( $X^2 = 9.608$ ,  $df = 8$ ,  $P = 0.294$ ).

While over 78% of respondents stated that rats were not a problem on their property, some respondents from all locations except Rakino indicated that one of the reasons for not undertaking pest control was due to a dislike of poisons. This was particularly true for Aotea, where 14% of respondents indicated this compared with 6% for the other three island communities. Only Aotea and Waiheke had respondents who chose not to control rats using any method (6% and 7%, respectively).

The level of awareness of rat control methods varied significantly among locations ( $X^2 = 75.940$ ,  $df = 16$ ,  $P < 0.001$ ). Across all five locations, the highest proportion of respondents knew something about rat control methods, ranging from 33% to 40%. Over 20% of respondents from the four island communities reported having a good understanding of the technicalities, compared with only 11% of Auckland mainland respondents. None of the Rakino respondents knew ‘nothing’ about rat control methods.

The level of awareness about rat control methods was significantly related to age ( $X^2 = 46.492$ ,  $df = 12$ ,  $P < 0.001$ ) and income ( $X^2 = 32.865$ ,  $df = 16$ ,  $P = 0.008$ ). The majority of respondents of all ages and income levels knew ‘something’ about rat control methods (30–40% and >35%, respectively). A higher proportion (>23%) of those earning <\$70,000 had a good understanding of the technicalities, with those aged 21–40 being less experienced; more knew nothing (11%) about rat control and fewer had a good understanding (14%). Neither education ( $X^2 = 30.105$ ,  $df = 32$ ,  $P = 0.563$ ) nor sex ( $X^2 = 8.179$ ,  $df = 4$ ,  $P = 0.085$ ) were significantly related to knowledge of rat control methods.

The level of rat control experience was significantly related to the knowledge of rat control methods ( $X^2 = 268.150$ ,  $df = 4$ ,  $P < 0.001$ ), with respondents who had undertaken rat control having higher perceived levels of awareness.

### 3.3.2 Support for rat eradication

The level of support for rat eradication was significantly related to the PMA score ( $F = 22.190$ ,  $df = 3$ , 1165,  $P < 0.001$ ) but there was also a significant interaction between location and the level of support for rat eradication ( $F = 2.505$ ,  $df = 11$ , 1165,  $P = 0.004$ ). Post-hoc analysis identified a significant difference between ‘yes’ and all other response options (i.e. ‘no’, ‘unsure’ and ‘depends’) for the level of rat support ( $P < 0.001$ ), with ‘yes’ responses generally having higher mean PMA scores, as well as between ‘no’ and ‘depends’ ( $P = 0.004$ ) (Fig. 9).

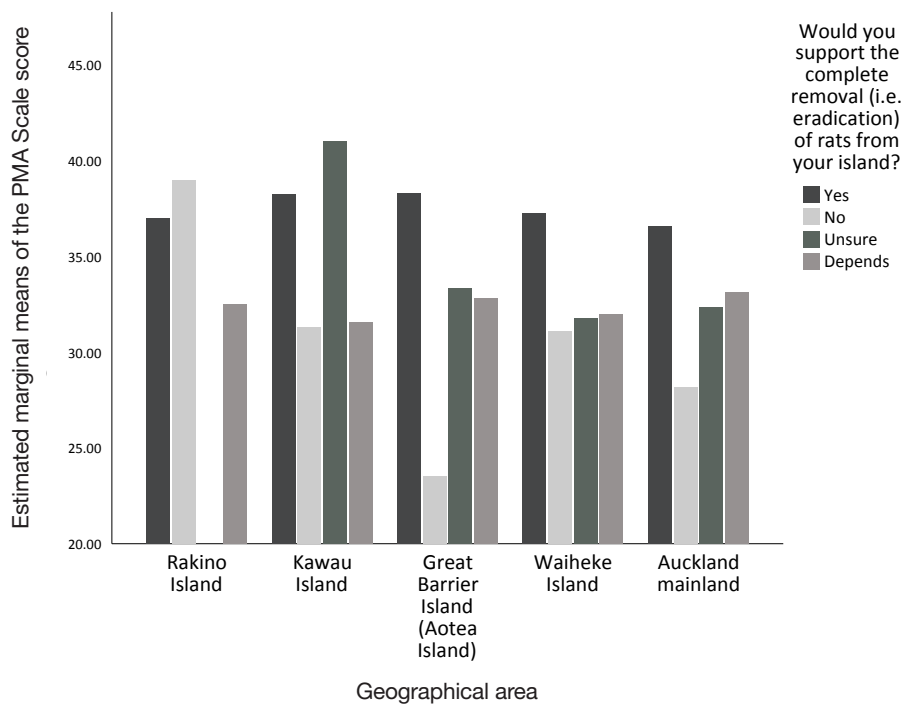


Figure 9. Differences in the level of support for rat eradication between respondents from four Hauraki Gulf island communities and the Auckland mainland. Pest Management Attitude (PMA) Scale scores ranged from 10 to 50, with higher scores indicating more pro-pest management attitudes ( $n = 1184$ ).

## 4. Discussion

In this study, we assessed the environmental and pest management attitudes of residents of four Hauraki Gulf islands and a comparable Auckland mainland sample to gain a better understanding of the factors that affect these and to gauge the level of support for future pest eradication programmes on inhabited islands. We found that the four Hauraki Gulf island communities held varying attitudes towards the environment and pest management, despite their close geographical proximity to each other, with direct experience, history of pest management discourse and values having clear effects.

At all five study sites, pro-environmental attitudes were strongly associated with biospheric environmental values and were also related to place attachment, through valuing the landscape and the environment. Those respondents who resided on an island for 6 months or more over the course of a year also indicated a stronger sense of community and lifestyle. Pro-environmental attitudes were also reinforced by strong environmental awareness through conservation involvement, with respondents from all four island communities engaging with their own island's environmental issues via on-island environmental organisations. This engagement was particularly strong for Kawau and Aotea, which have had historical pest management discourse. Conservation participation was greater for all locations than has previously been found for the wider New Zealand population (Binnie 2013), but respondents from Rakino, Aotea and Waiheke had greater participation than those from Kawau and the Auckland mainland. This may have been associated with the large number and variety of conservation organisations on these islands, particularly Aotea and Waiheke, which will provide a wider variety of opportunities for engagement.

Attitudes towards pest management were supportive (i.e. pro-pest management) across all locations and, in the case of Rakino, Aotea and Waiheke, also generally reflected environmental attitudes. Rakino respondents had the strongest pro-pest management attitudes among



the islands, inferring a stronger support for pest management, while Auckland mainland respondents had more moderate pest management attitudes. The environmental attitudes of Kawau respondents were closely aligned with those of Auckland mainland respondents, whereas their pest management attitudes were more aligned with Rakino, Aotea and Waiheke respondents, resulting in them being more supportive of pest management than Auckland mainland respondents. The majority of respondents supported rat eradication, and those who were uncertain and/or had dependent responses also outnumbered those who were opposed. The benefits of pest management were well acknowledged, with both personal experience with and knowledge about rat control methods being aligned with stronger pro-pest management attitudes. Across all locations, respondents were most concerned about the impact of poison on non-target species.

There was an overall trend for Rakino respondents to have stronger pro-environmental and pro-pest management attitudes than respondents from the other locations. While it is likely that the Rakino community already had positive attitudes in these areas, as indicated by their historical support when rat eradication was first proposed, this suggests that the benefits this community has experienced since the successful eradication of rats may have also had a reaffirming positive effect on attitudes. This was reinforced by the comments made by Rakino respondents, such as 'Rats were eradicated from Rakino about 8 years ago – best thing that ever happened. The bird life is now huge'. The observed increase in bird life on Rakino since the eradication of rats reflects the findings of other research that predator removal results in stable and increasing bird populations (Lavers et al. 2010) and was also reflected by Rakino respondents in the higher level of acknowledgement of the benefits of pest management to threatened species translocations and ecosystem services.

The level of geographical isolation or urbanisation appeared to have little effect on the attitudes of island communities towards pest eradication. The similarity of pest management attitudes among respondents from each of the islands compared with those from the Auckland mainland suggests that an increased influence or awareness of pest management may be associated with the greater discourse in these communities. This was particularly evident among respondents from Rakino, where rats have already been eradicated, than in the other island communities. Ogden & Gilbert (2011) previously showed that the Aotea community had divergent attitudes in terms of the future of pest management on the island; however, the attitudes of this community did not differ significantly from the other island communities in the present study.

The relationship between public consultation and pest management attitudes is likely to be associated with pest management discourse. Both Kawau and Aotea respondents tended to have more moderate pro-pest-management attitudes due to concern about a lack of public consultation, whereas Rakino and Waiheke respondents had stronger pro-pest-management attitudes. These islands differ greatly in their achieved and projected pest management outcomes, as well as their influence from and historical relationships with DOC, for which public consultation is an important remit. The Rakino community has experienced a positive rat eradication outcome, which was achieved in conjunction with DOC (Auckland Regional Council 2002), while the Waiheke community had yet to undertake any pest eradication programmes at the time of the study, with the island not having been identified as a priority area within DOC's Auckland Conservation Management Strategy (DOC 2014). Since the time of the study the island has become the target for the Predator Free Waiheke programme. By contrast, the Kawau community has experienced a lengthy programme to manage wallabies for the protection of flora from their effects, with a DOC progress report deadline of 2024 (DOC 2014). Furthermore, while the Aotea community has witnessed the successful eradication of goats from their island (Bassett et al. 2016), there has been only lengthy ongoing dialogue regarding the eradication of rats (Ogden & Gilbert 2008, 2011), with the only progress being rat management at some sites across the island. DOC manages over 60% of the land on Aotea and has identified the island as a priority area for conservation, including progression towards the eradication of rats (DOC

2014). However, there has been historical discord between the community and DOC regarding a past marine reserve proposal due to perceived injustices regarding a lack of public consultation surrounding this proposal (Rea 2008), and similar discord for the eradication of rats from nearby Rakitu Island in 2018 (Neilson 2018). The greater degree of concern for a lack of public consultation and consequent more moderate pro-pest management attitudes among Aotea respondents suggests that the role of DOC combined with historical discord may be having a negative effect on pest management attitudes.

It might be expected that pro-environmental attitudes would translate into pro-pest-management attitudes. However, it appears that some attributes have differing effects on the two, particularly place attachment, which was significantly related to environmental attitudes but not pest management attitudes. The importance placed on the landscape and environment in association with environmental attitudes did not extend to pest management attitudes, despite the known impact of rats on forest regeneration through the predation of seeds and seedlings (Howald et al. 2007). Two aspects may be influencing this. One possibility is that there is a general lack of awareness about the impact rats can have on the wider environment beyond the predation of birds, which is widely reported in the media (Morton 2013), resulting in a lack of association between the effects of rats and the health of the overall landscape and environment. It is also possible that the landscape and environment are more idealised values that are associated more with limited building and development for these island communities than with the ecosystem that forms them.

Additionally, although biospheric, altruistic and egoistic values were strongly associated with environmental attitudes, none of these were strongly associated with pest management attitudes. These results are perhaps not surprising considering that biospheric values reflect a concern about nature itself and therefore might not differentiate between native and pest species. This divergence between environmental and pest management attitudes suggests that there might be an associated component within environmental attitudes that translates into a biospheric concern for pest species, thus moderating attitudes towards pest management. This was reinforced by only a weak positive correlation being found between the NEP and PMA Scale scores.

Since values underpin attitudes (Heberlein 2012), the lack of a relationship between environmental and place attachment values and pest management attitudes was important and indicates that the priority that is placed on these values changes when considering pest management. Thus, although people may have similar or shared values, as the priority of those values varies, so too do people's choices (Steg & de Groot 2012). A variety of stakeholders are often involved in pest eradication (e.g. residents, scientists, governing bodies, businesses, property owners) (Omondiagbe et al. 2017), each of which will have an individual set of values and different priorities for each value. This diversity of values may cause disconnect among stakeholders through the disparity, or exclusion, of values within conservation decisions. This is of particular relevance for pest management, with Esteves et al. (2012) identifying how values around pest management risk perceptions differ between science and society. Therefore, avoiding the marginalisation of social values at the expense of scientific values, and vice versa, is a key social challenge for pest management on inhabited islands.

Although pro-pest management attitudes were evident in all of the communities surveyed, there were notable levels of uncertainty for many of the PMA Scale statements. When considering uncertainty, it is necessary to distinguish it from risk and to consider the notion of genuine uncertainty. Risk is a type of uncertainty (Knight 1921) that is associated with chance, probability and consequences (Ritchey 2011), and so has a measurable aspect to it and, as such, has no uncertainty (Knight 1921; Ritchey 2011). By contrast, genuine uncertainty is where 'outcomes cannot be ascribed probabilities ... often termed risk analysis ...' (Ritchey 2011). Added to this are the notions of unspecified uncertainty, where long-term scenarios cannot be known, and agonistic uncertainty, which stems from the classical Greek term 'agon', meaning struggle (e.g. mental) and refers to the reactions of stakeholders to one another, resulting in an element of unpredictability (Ritchey 2011).

All forms of uncertainty may play some role when considering pest eradication planning. Risk may be perceived and reflected as uncertainty by those who are cautious or sceptical about scientific evidence. However, for scientists, risk and genuine uncertainty are two distinct principles, which could be a cause for disparity among stakeholders. Unspecified uncertainty may result from the un-quantified long-term effects of some aspects of pest eradication, such as the unknown effects of any remaining pest species (e.g. feral cats) on the ecosystem. Agonistic uncertainty, through stakeholder influence, adds more uncertainty, and is of particular relevance to the communities of Kawau and Aotea, where there has been historical pest management discourse. Therefore, high levels of uncertainty may reflect risk, rather than genuine uncertainty, and the latter may include unspecified uncertainty as well as agonistic uncertainty, making it more unpredictable. Deciphering the predominant uncertainty focus of each community may prove important to future pest eradication dialogue.

When respondents were asked to indicate their level of support for rat eradication directly, all five communities had considerably higher levels of support than opposition. However, the 'depends' category formed the second largest group in all five communities surveyed. Furthermore, while a strong endorsement of conservation and acknowledgement of pest management benefits were evident among the communities, so too were concerns surrounding eradication methods, particularly the impact of poisons on non-target species. Additionally, while respondents from all four Hauraki Gulf island communities tended to have a stronger interest in science (a prominent aspect of pest eradication methods) than the national population, they were similarly inclined to have low levels of trust in scientific proof (Hipkins et al. 2002). Further research is recommended to understand what the respondents' support is dependent on and the underlying factors that influence levels of trust in science.

The factors outlined above indicate future challenges for the progression of pest eradication to inhabited islands, but also identify areas for future engagement and ways in which barriers to achieving pest eradication can be overcome. Areas of focus should include identifying the reasons that underly the dependency of support for rat eradication, combined with leveraging off many of the strengths that are already present, such as an interest in science and strong pro-environmental attitudes, alongside strong levels of engagement with conservation and environmental issues, and high levels of social cohesion and network structures. The growing complexity of the science associated with the development of many pest management methods (Campbell et al. 2015) suggests that cultivating these engagement opportunities will also help to lay the foundations for future dialogue with communities, with the aim of preventing misinformation from influencing attitudes towards pest management in the future. An opportunity also exists for Rakino residents to serve as pest eradication 'ambassadors' due to their positive experience, as the engagement of one island community with another will provide an alternative viewpoint to that of scientists and planners. However, evidence would suggest that focusing on environmental concern alone may not have a strong influence due to its weak relationship to strong pest management attitudes.

We also tested the effects of four demographic indicators that are generally associated with stronger pro-environmental attitudes: sex, age, income and education. Overall, each measure had inconsistent effects on attitudes towards the environment and pest management, with only sex having consistent trends, with notable differences between environmental and pest management attitudes. Females generally had more pro-environmental attitudes, identified more with biospheric values and had more pro-conservation attitudes, while males generally had more interest and a greater belief in and understanding of science. For pest management attitudes, males tended to be more supportive of rat eradication, held more pro-pest-management attitudes and had more experience of rat control methods than females, suggesting that the influence of direct experience on attitudes may affect the level of support for rat eradication. These findings indicate that demographic profiling is not as useful for determining environmental and pest management attitudes on these four inhabited islands as other factors, such as personal

experience. To determine whether this trend is applicable to inhabited islands in general, was a regional effect among these four closely located islands or was caused by island-related factors (often termed the 'island effect'), further research on other inhabited islands, both nationally and internationally, is necessary. This is especially important when considering the close proximity of these islands within the same region of the Hauraki Gulf, as research has indicated that the spatial distribution of inhabited islands, such as solitary islands or archipelagos, influences communities (Grydehøj & Hayward 2014). Additionally, further analysis of any community differences amongst these islands would highlight what, if anything, were true community effects associated with demographics.

There were clear advantages in using an attitude assessment scale that was designed specifically for pest management attitudes (i.e. the PMA Scale; Aley et al. in press) rather than a scale for general environmental attitudes (i.e. the NEP Scale), as highlighted by the fact that the level of support for rat eradication was not significantly associated with the NEP Scale score but was significantly associated with the PMA Scale score. By comparing environmental attitudes with attitudes towards pest management and focusing specifically on inhabited islands, we were able to identify important distinctions between the two. The four Hauraki Gulf island communities surveyed generally had positive attitudes towards both the environment and pest management. However, Aotea respondents had a notably weaker pro-pest management attitude, with a higher 'no' response rate than all other areas, which may be a challenge for future rat eradication proposals within this community. Furthermore, while pro-environmental attitudes may be correlated with pro-pest management attitudes, this relationship was not always evident, with the lack of any significant effect of values associated with place attachment and environmental concern on pest management attitudes further increasing this mismatch. Finally, it is possible that the long-term positive effect that pest eradication would have within an inhabited island community is the most important determinant of pest management attitudes, as seen in the Rakino community. However, this can only be tested once more inhabited islands have become pest free.

## 5. Acknowledgements

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# Appendix 1

## Hauraki Gulf island community survey

### Environmental attitudes and Hauraki Gulf islands: A survey of public opinions.

**Instructions:**

Please use a ballpoint pen to complete the questionnaire.

Mark your answers like this

If you make a mistake do this  then mark the correct answer like this

Or write answers clearly, where applicable

Where there are two or more owners/trustees registered to the property, choose any one registered owner over the age of 18 to fill out this form.

### About Your Island Property (If you own more than one property on the same island please fill out the survey based on what you consider to be the primary property)

---

1. Please tick the island that your property is located on.

- |   |   |
|---|---|
| <input type="checkbox"/> Great Barrier Island | <input type="checkbox"/> Kawau Island   |
| <input type="checkbox"/> Rakino Island        | <input type="checkbox"/> Waiheke Island |

2. Please choose from one of the below to describe the primary status of your island property.

- |  |   |
|--|---|
| <input type="checkbox"/> Permanent residence | <input type="checkbox"/> Holiday home               |
| <input type="checkbox"/> Vacant section      | <input type="checkbox"/> Investment/rental property |
| <input type="checkbox"/> Business            | <input type="checkbox"/> Other _____                |

3. How much time approximately would you spend on the island in total over a typical 12 month period? Please write the total number of months below.

\_\_\_\_\_

4. How long have you owned your island property? Please write the number of years below.

\_\_\_\_\_

5. Would you consider your property to be in a remote location of the island?

- Yes                       No

## Environmental Attitudes

6. Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, are UNSURE, MILDLY DISAGREE or STRONGLY DISAGREE with it.

DO YOU AGREE OR DISAGREE THAT:	STRONGLY AGREE	MILDLY AGREE	UNSURE	MILDLY DISAGREE	STRONGLY DISAGREE
1. We are approaching the limit of the number of people the earth can support					
2. Humans have the right to modify the natural environment to suit their needs					
3. When humans interfere with nature it often produces disastrous consequences					
4. Human ingenuity will ensure that we do NOT make the earth unliveable					
5. Humans are severely abusing the environment					
6. The earth has plenty of natural resources if we just learn how to develop them					
7. Plants and animals have as much right as humans to exist					
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations					
9. Despite our special abilities humans are still subject to the laws of nature					
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated					
11. The earth is like a spaceship with very limited room and resources					
12. Humans were meant to rule over the rest of nature					
13. The balance of nature is very delicate and easily upset					
14. Humans will eventually learn enough about how nature works to be able to control it					
15. If things continue on their present course, we will soon experience a major ecological catastrophe					

7. a) Are you a member of an environmental or conservation organisation?

- No                       Yes (if yes please answer 7b.)

b) and if yes, please indicate across which of the following regions. Please tick all that are applicable.

- Your island                       National                       International

8. Have you actively participated in conservation in the last 12 months. Active participation includes conservation events such as, but not limited to, tree planting projects, weed control, helping build tracks, or pest control.

- No                       Yes

9. Please tick one option below that best describes the MAIN value the island holds for you. Please tick only one.

Value	Tick one
The remoteness and isolation	
The sense of community	
The landscape and environment	
The lifestyle	
The sanctity it provides	
The opportunity it provides for business and employment	

10. Please tick one statement below that best describes your MAIN concern for the environment. Please tick only one.

Environment Concern	Tick one
I am concerned for the future existence of animals and plants	
I am concerned for the future impact on humanity	
I am concerned for the future ability to benefit from the environment	

11. When concerned about environment or conservation issues that could affect you and/or your island community have you ever carried out any of the following actions? Please tick all that are applicable.

Action you would take	Tick
Attend a public meeting	
Donate money to and/or join an environmental group	
Find out more about the issue	
Join a community group campaigning for the issue	
Nothing	
Sign a petition	
Vote for a candidate in an election, in part because he or she shared your views on the issue	
Write a letter to the local newspaper	
Write a letter or talk to your local Councillor or Member of Parliament (MP)	

12. Please rate your level of satisfaction with *'The quality of New Zealand's natural environment'*. 0=Completely Dissatisfied, 1 to 9=Somewhat Satisfied, 10=Completely satisfied. Circle one number.

Completely Dissatisfied	Somewhat Satisfied									Completely Satisfied
0	1	2	3	4	5	6	7	8	9	10

13. Listed below are statements about introduced pest species and their control. For each one, please indicate whether you **STONGLY AGREE**, **MILDLY AGREE**, are **UNSURE**, **MILDLY DISAGREE** or **STRONGLY DISAGREE** with it.

DO YOU AGREE OR DISAGREE THAT:	STRONGLY AGREE	MILDLY AGREE	UNSURE	MILDLY DISAGREE	STRONGLY DISAGREE
1. Pest species are a significant conservation problem					
2. Pest control is a losing battle					
3. The benefits of pest control outweigh the risks to native species					
4. Enough pest control is being done already					
5. Native species have greater rights than pest species					
6. Today's pest control methods are NOT proven to be effective					
7. Investment in pest control is beneficial for future generations					
8. Pest control is less important than other conservation issues					
9. Pest control is best done by experts					
10. Pest control has unknown side effects					
11. Humans are the fundamental cause of pest species					
12. Pest control interferes with nature					

14. Below are statements about conservation in New Zealand. For each one please indicate if you **STONGLY AGREE**, **MILDLY AGREE**, **NEITHER AGREE OR DISAGREE**, **MILDLY DISAGREE** or **STRONGLY DISAGREE** with it.

DO YOU AGREE OR DISAGREE THAT	STRONGLY AGREE	MILDLY AGREE	NEITHER AGREE OR DISAGREE	MILDLY DISAGREE	STRONGLY DISAGREE
1. Protecting nature doesn't make any difference to me or my life					
2. Protection of NZ's native forests and species is important for us all					
3. Conservation is good for NZ's economy					
4. Having natural places to visit is very important to me					
5. Commercial development should not override conservation demands					
6. Protection of NZ's native forests and species is important for tourism					
7. I've got enough to worry about than care about conservation					
8. I don't have the knowledge or skills to get involved in conservation					

15. As well as conservation do you consider any of the below sectors to additionally benefit from pest control (tick those that apply):

Sector	Tick
Agricultural	
Economic	
Ecosystem services	
Financial	
Human health & safety	
Threatened species translocations	
Tourism	

16. Below are some concerns people have about rat control. Although you may identify with more than one, please tick only one statement below that best describes your MAIN concern. Please tick only one.

Concern	Tick one
Effectiveness of techniques to kill target species	
Influence of pest removal on other parts of the ecosystem	
Impact of poison on non-target species	
Lack of public consultation	
Residual effects of poison in water ways	
Risk of poison to pets, livestock and people	
The use of poisons over other methods	

17. a) Have you ever undertaken rat control either on your property or for conservation?

- Yes (go to question 18)                       No (go to question 17b)

b) and if not, please indicate the reason why below

- I don't know how to control them  
 I choose not to control them  
 I don't like poisons  
 Rats are not a problem on my property

18. Which one of the following best describes the extent to which you are aware of rat control METHODS? Please tick only one.

Level of Awareness	Tick one
I have studied them and have a good <b>understanding</b> of the technicalities	
I have heard about them and could probably <b>explain</b> them to a friend	
I have heard of them and know <b>something</b> about them	
I have heard of them but know <b>little or nothing</b> about them	
I have <b>not</b> heard of them and know <b>nothing</b> about them	

19. Below are statements people have made about science. Please indicate if you **STRONGLY AGREE**, **MILDLY AGREE**, **NEITHER AGREE OR DISAGREE**, **MILDLY DISAGREE** or **STRONGLY DISAGREE** with it.

DO YOU AGREE OR DISAGREE THAT	STRONGLY AGREE	MILDLY AGREE	NEITHER AGREE OR DISAGREE	MILDLY DISAGREE	STRONGLY DISAGREE
1. I enjoy finding out about new ideas in science					
2. The government should fund scientific research, even if we can't be sure of the economic benefits					
3. If you are told something has been scientifically proven, you can have confidence in the results					
4. When scientists say they are uncertain about something, they are telling the truth					
5. An important part of science is persuading other scientists to agree with your theories					

20. Would you support the complete removal of rats permanently (i.e. eradicate) from your island? Please choose one of the following.

- Yes       No       Unsure       Depends on the details

21. Do you have any general comments regarding rat control on YOUR ISLAND?

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## About You / Your Household

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22. Are you?

- Male       Female

23. In what year were you born?

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24. Which ethnic group(s) do you belong to (tick as many as applicable)?

- New Zealand European       Māori  
 European       Pacific Islander  
 Chinese       Indian  
 Other – please specify \_\_\_\_\_

25. What is your highest formal education qualification (tick one)?

- No qualification  
 Secondary school qualification (NCEA Level 1 to 3 – including School Certificate, Sixth Form Certificate & University Entrance/Bursary)  
 Trade Certificate and/or Foundation Certificate  
 Diploma  
 Bachelor Degree or Bachelor Honours Degree  
 Postgraduate Certificate or Diploma  
 Masters Degree  
 Doctoral Degree  
 Other – please print \_\_\_\_\_

26. Which one of these best describes your main source of income over the last 12 months (tick one)?

- Wages, salary, commissions, bonuses, etc., paid by my employer
- Self-employment, or business I own and work in
- Interest, dividends, rent, other investments
- Government beneficiary (e.g. benefit, pension, superannuation, ACC, etc)
- Other sources of income, counting support payments from people who do not live in my household
- No source of income during that time

27. What is your total gross income range (before tax is deducted) (tick one)?

- |   |  |
|---|--|
| <input type="checkbox"/> zero                 | <input type="checkbox"/> \$1 - \$5,000         |
| <input type="checkbox"/> \$5,001 - \$10,000   | <input type="checkbox"/> \$10,001 - \$15,000   |
| <input type="checkbox"/> \$15,001 - \$20,000  | <input type="checkbox"/> \$20,001 - \$25,000   |
| <input type="checkbox"/> \$25,001 - \$30,000  | <input type="checkbox"/> \$30,001 - \$35,000   |
| <input type="checkbox"/> \$35,001 - \$40,000  | <input type="checkbox"/> \$40,001 - \$50,000   |
| <input type="checkbox"/> \$50,001 - \$60,000  | <input type="checkbox"/> \$60,001 - \$70,000   |
| <input type="checkbox"/> \$70,001 - \$100,000 | <input type="checkbox"/> \$100,001 - \$150,000 |
| <input type="checkbox"/> \$150,001 or more    |  |

28. Tick as many boxes as you need to show all the people who live in the same household as you.

- my legally married partner or legally registered civil union partner
- my de facto partner
- my mother and/or father
- my son(s) and/or daughter(s)
- my brother(s) and/or sister(s)
- my flatmate
- I live alone
- other (please specify) \_\_\_\_\_

29. Do you have any of the following pets?

- |                                       |                                  |
|---------------------------------------|----------------------------------|
| <input type="checkbox"/> cat(s)       | <input type="checkbox"/> bird(s) |
| <input type="checkbox"/> dog(s)       | <input type="checkbox"/> fish    |
| <input type="checkbox"/> other: _____ |                                  |

# Appendix 2

## Summary of the demographic results

Demographic characteristics of the respondents to the 2015 Hauraki Gulf island community survey. Values are percentages and have been separated by geographical area. *n* = the total number of respondents.

	RAKINO ISLAND (%)	KAWAU ISLAND (%)	GREAT BARRIER ISLAND (AOTEA ISLAND) (%)	WAIHEKE ISLAND (%)	AUCKLAND MAINLAND (%)
<b>Age</b>	<b><i>n</i> = 45</b>	<b><i>n</i> = 130</b>	<b><i>n</i> = 271</b>	<b><i>n</i> = 418</b>	<b><i>n</i> = 292</b>
21–40	2.2	3.1	3.7	4.5	11.0
41–60	48.9	33.1	46.5	38.5	44.2
61–80	48.9	56.2	46.5	54.1	40.4
> 81	–	7.6	3.3	2.9	4.4
<b>Sex</b>	<b><i>n</i> = 45</b>	<b><i>n</i> = 132</b>	<b><i>n</i> = 276</b>	<b><i>n</i> = 424</b>	<b><i>n</i> = 300</b>
Male	44.4	65.9	59.4	51.2	48.0
Female	55.6	34.1	40.6	48.8	52.0
<b>Ethnicity*</b>	<b><i>n</i> = 46</b>	<b><i>n</i> = 134</b>	<b><i>n</i> = 274</b>	<b><i>n</i> = 419</b>	<b><i>n</i> = 299</b>
New Zealand European	89.1	92.6	89.6	83.7	83.4
Māori	4.3	2.9	9.0	3.0	3.0
European	13.0	5.9	8.3	12.8	8.6
Pacific Islander	–	–	1.1	0.7	1.0
Chinese	–	–	–	0.5	3.3
Indian	–	–	0.4	–	1.3
Other	–	0.7	2.9	1.9	3.0
<b>Qualification</b>	<b><i>n</i> = 46</b>	<b><i>n</i> = 131</b>	<b><i>n</i> = 274</b>	<b><i>n</i> = 423</b>	<b><i>n</i> = 298</b>
No qualification	–	3.8	9.1	4.3	4.4
Secondary school	13.0	22.1	17.2	19.6	15.7
Trade/Foundation Certificate	15.2	9.2	15.0	9.0	11.7
Diploma	11.0	16.0	13.1	12.8	13.8
Bachelor's Degree	39.1	20.6	22.7	25.3	33.6
Postgraduate Diploma	13.0	10.7	8.0	9.0	11.1
Master's Degree	6.5	11.5	11.3	14.4	6.7
Doctoral Degree	2.2	5.3	2.9	4.7	2.0
Other	–	0.8	0.7	0.9	1.0
<b>Level of income</b>	<b><i>n</i> = 39</b>	<b><i>n</i> = 119</b>	<b><i>n</i> = 253</b>	<b><i>n</i> = 378</b>	<b><i>n</i> = 258</b>
\$0–\$35,000	17.9	10.9	33.2	21.4	19.0
\$35,001–\$70,000	23.1	28.6	30.8	30.4	25.2
\$70,001–\$100,000	30.8	16.8	14.2	17.0	15.5
\$100,001–\$150,000	15.4	18.5	12.3	15.1	20.9
\$150,001 and above	12.8	25.2	9.5	16.1	19.4
<b>Source of income</b>	<b><i>n</i> = 46</b>	<b><i>n</i> = 126</b>	<b><i>n</i> = 273</b>	<b><i>n</i> = 419</b>	<b><i>n</i> = 299</b>
Wages/salary/commission	37.0	23.8	28.2	29.4	34.1
Self-employed	32.6	42.1	34.4	30.7	28.8
Interest/investment	15.2	21.4	11.8	14.6	16.4
Government beneficiary	13.0	11.1	24.5	23.2	16.1
Other sources	2.2	1.6	0.7	0.7	0.3
No income	–	–	0.4	1.4	4.3

*Continued on next page*



	RAKINO ISLAND (%)	KAWAU ISLAND (%)	GREAT BARRIER ISLAND (AOTEA ISLAND) (%)	WAIHEKE ISLAND (%)	AUCKLAND MAINLAND (%)
<b>Household configuration*</b>	<b>n = 45</b>	<b>n = 131</b>	<b>n = 273</b>	<b>n = 419</b>	<b>n = 295</b>
Married/civil union partner	54.3	71.3	51.8	58.0	67.1
De facto partner	8.7	8.1	15.5	12.8	8.3
Mother/father	–	2.9	1.4	2.3	2.7
Sons(s)/daughter(s)	37.0	27.2	29.5	24.5	40.9
Brother(s)/sister(s)	–	1.5	1.1	0.5	2.0
Flatmate	6.5	1.5	1.8	2.8	3.3
Alone	26.1	9.6	23.4	20.3	13.6
Other	4.3	0.7	0.7	0.7	3.3
<b>Property type†</b>	<b>n = 45</b>	<b>n = 135</b>	<b>n = 277</b>	<b>n = 429</b>	
Permanent residence	11.1	13.3	39.7	58.5	
Holiday home	66.7	68.1	42.2	33.3	
Vacant section	22.2	14.8	11.9	3.3	
Investment property	–	0.8	2.9	3.0	
Business	–	2.2	1.1	1.7	
Other	–	0.8	2.2	0.2	

\* These questions allowed multiple responses so the columns may not total 100%.

† Excludes the Auckland mainland.

# Appendix 3

## Reliability and distribution of the New Ecological Paradigm (NEP) Scale scores

Corrected item-total correlations, mean, standard deviation (SD) and distribution (skewness and kurtosis) of the data collected for the New Ecological Paradigm (NEP) Scale statements included in the 2015 Hauraki Gulf island community survey. All statements were designed to have a maximum score of 5, with higher scores indicating more pro-environmental attitudes. Italic phrases in parentheses identify the dimension with which each statement is associated.  $n = 1190$ .

DO YOU AGREE OR DISAGREE THAT:	CORRECTED ITEM-TOTAL CORRELATIONS	MEAN	SD	SKEWNESS	KURTOSIS
1. We are approaching the limit of the number of people the earth can support ( <i>limits to growth</i> )	0.53	3.69	1.27	-0.62	-0.82
2. Humans have the right to modify the natural environment to suit their needs ( <i>anti-anthropocentrism</i> )	0.40	3.15	1.28	0.02	-1.39
3. When humans interfere with nature it often produces disastrous consequences ( <i>balance of nature</i> )	0.37	4.06	1.15	-1.25	0.61
4. Human ingenuity will ensure that we do NOT make the earth unliveable ( <i>anti-exemptionalism</i> )	0.55	2.99	1.23	0.16	-1.04
5. Humans are severely abusing the environment ( <i>eco-crisis</i> )	0.43	4.05	1.18	-1.30	0.68
6. The earth has plenty of natural resources if we just learn how to develop them ( <i>limits to growth</i> )	0.44	2.53	1.30	0.54	-0.91
7. Plants and animals have as much right as humans to exist. ( <i>anti-anthropocentrism</i> )	0.36	4.39	0.96	-1.78	2.56
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations ( <i>balance of nature</i> )	0.59	4.09	1.08	-1.03	0.01
9. Despite our special abilities humans are still subject to the laws of nature ( <i>anti-exemptionalism</i> )	0.27	4.56	0.68	-2.01	5.60
10. The so-called 'ecological crisis' facing humankind has been greatly exaggerated ( <i>eco-crisis</i> )	0.61	3.71	1.30	-0.54	-1.07
11. The earth is like a spaceship with very limited room and resources ( <i>limits to growth</i> )	0.53	3.55	1.27	-0.46	-1.03
12. Humans were meant to rule over the rest of nature ( <i>anti-anthropocentrism</i> )	0.47	3.96	1.24	-1.00	-0.18
13. The balance of nature is very delicate and easily upset ( <i>balance of nature</i> )	0.39	4.18	1.04	-1.40	1.25
14. Humans will eventually learn enough about how nature works to be able to control it ( <i>anti-exemptionalism</i> )	0.42	3.46	1.18	-0.26	-0.98
15. If things continue on their present course, we will soon experience a major ecological catastrophe ( <i>eco-crisis</i> )	0.62	3.83	1.22	-0.83	-0.38

# Appendix 4

## Percentage responses to the New Ecological Paradigm (NEP) Scale statements

Percentage responses (%) and the mean and standard deviation of the scores for the New Ecological Paradigm (NEP) Scale statements included in the 2015 Hauraki Gulf island community survey. Italic phrases in parentheses identify the dimension with which each statement is associated. All statements were designed to have a maximum score of 5, with higher scores indicating more pro-environmental attitudes.

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA (%)	MA (%)	U (%)	MD (%)	SD (%)	MEAN	STANDARD DEVIATION
1. We are approaching the limit of the number of people the earth can support ( <i>limits to growth</i> )	Rakino	37.0	23.8	19.6	17.4	2.2	3.76	1.20
	Kawau	27.2	31.6	13.2	19.9	8.1	3.50	1.30
	Aotea	34.2	36.4	8.6	15.8	5.0	3.79	1.21
	Waiheke	36.4	27.5	14.2	16.5	5.4	3.73	1.26
	Auckland	34.9	24.9	15.3	16.9	8.0	3.62	1.32
2. Humans have the right to modify the natural environment to suit their needs ( <i>anti-anthropocentrism</i> )	Rakino	4.3	43.6	4.3	30.4	17.4	3.13	1.28
	Kawau	5.1	47.1	7.4	27.2	13.2	2.97	1.22
	Aotea	7.9	33.1	7.2	28.8	23.0	3.26	1.34
	Waiheke	5.6	38.2	8.0	34.0	14.2	3.13	1.22
	Auckland	8.3	36.2	5.0	30.6	19.9	3.18	1.33
3. When humans interfere with nature it often has disastrous consequences ( <i>balance of nature</i> )	Rakino	47.8	34.8	2.2	6.5	8.7	4.07	1.25
	Kawau	40.4	35.3	8.1	12.5	3.7	3.96	1.15
	Aotea	46.4	33.1	5.0	9.7	5.8	4.05	1.19
	Waiheke	47.3	34.5	4.2	10.0	4.0	4.11	1.12
	Auckland	42.9	37.8	4.3	11.3	3.7	4.05	1.12
4. Human ingenuity will ensure that we do NOT make the earth unlivable ( <i>anti-exemptionalism</i> )	Rakino	10.9	17.4	23.8	28.3	19.6	3.28	1.28
	Kawau	14.7	37.5	17.6	18.4	11.8	2.75	1.25
	Aotea	5.8	28.7	23.4	24.1	18.0	3.20	1.20
	Waiheke	11.9	29.6	23.3	20.5	14.7	2.96	1.25
	Auckland	10.0	33.6	24.2	19.9	12.3	2.91	1.19
5. Humans are severely abusing the environment ( <i>eco-crisis</i> )	Rakino	52.2	37.0	2.2	4.3	4.3	4.28	1.02
	Kawau	39.0	36.8	6.6	11.8	5.8	3.91	1.21
	Aotea	54.0	30.9	2.9	6.8	5.4	4.21	1.13
	Waiheke	46.8	34.5	2.6	9.6	6.5	4.06	1.21
	Auckland	38.9	38.2	6.0	11.3	5.6	3.93	1.19
6. The earth has plenty of natural resources if we just learn how to develop them ( <i>limits to growth</i> )	Rakino	17.4	43.5	8.7	17.4	13.0	2.65	1.32
	Kawau	26.5	38.2	12.5	15.4	7.4	2.39	1.24
	Aotea	28.4	34.9	8.3	19.4	9.0	2.45	1.32
	Waiheke	20.0	36.9	12.6	18.4	12.1	2.65	1.31
	Auckland	24.9	37.2	12.7	16.6	8.6	2.47	1.26
7. Plants and animals have as much right as humans to exist ( <i>anti-anthropocentrism</i> )	Rakino	60.8	28.3	2.2	8.7	–	4.41	0.91
	Kawau	54.4	28.6	1.5	14.0	1.5	4.21	1.10
	Aotea	63.7	24.8	2.2	7.9	1.4	4.42	0.97
	Waiheke	63.8	27.3	2.8	4.7	1.4	4.48	0.87
	Auckland	55.5	31.9	3.0	7.3	2.3	4.31	1.00

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## Appendix 4 continued

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA (%)	MA (%)	U (%)	MD (%)	SD (%)	MEAN	STANDARD DEVIATION
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations ( <i>balance of nature</i> )	Rakino	2.2	6.5	6.5	23.9	60.9	4.35	1.02
	Kawau	1.5	16.9	14.0	28.6	39.0	3.87	1.15
	Aotea	0.7	8.3	8.3	24.8	57.9	4.31	0.98
	Waiheke	2.8	11.2	9.6	27.7	48.7	4.09	1.13
	Auckland	0.7	12.6	13.6	35.2	37.9	3.97	1.04
9. Despite our special abilities humans are still subject to the laws of nature ( <i>anti-exemptionalism</i> )	Rakino	65.2	28.3	2.2	4.3	–	4.53	0.75
	Kawau	59.5	36.0	2.9	0.8	0.8	4.53	0.66
	Aotea	68.3	23.8	5.0	2.2	0.7	4.57	0.75
	Waiheke	68.8	28.0	2.8	0.2	0.2	4.64	0.57
	Auckland	56.1	37.9	3.0	1.7	1.3	4.46	0.75
10. The so-called 'ecological crisis' facing humankind has been greatly exaggerated ( <i>eco-crisis</i> )	Rakino	6.5	10.9	6.5	19.6	56.5	4.09	1.30
	Kawau	6.6	20.6	19.8	28.7	24.3	3.43	1.24
	Aotea	5.4	17.6	11.5	23.1	42.4	3.79	1.30
	Waiheke	4.2	21.7	9.3	18.9	45.9	3.80	1.33
	Auckland	4.7	22.3	15.6	26.8	30.6	3.56	1.26
11. The earth is like a spaceship with very limited room and resources ( <i>limits to growth</i> )	Rakino	23.9	39.1	2.2	28.3	6.5	3.46	1.31
	Kawau	22.1	37.5	8.8	27.2	4.4	3.44	1.22
	Aotea	32.7	33.8	11.5	17.3	4.7	3.72	1.22
	Waiheke	31.2	31.2	11.2	20.0	6.4	3.60	1.28
	Auckland	23.3	32.2	12.0	25.2	7.3	3.38	1.28
12. Humans were meant to rule over the rest of nature. ( <i>Anti-anthropocentrism</i> )	Rakino	6.5	15.2	–	21.8	56.5	4.07	1.34
	Kawau	5.1	11.8	10.3	32.4	40.4	3.91	1.20
	Aotea	4.7	10.1	8.3	25.2	51.7	4.09	1.19
	Waiheke	4.4	11.9	11.0	23.5	49.2	4.01	1.22
	Auckland	8.0	14.3	8.6	30.9	38.2	3.77	1.31
13. The balance of nature is very delicate and easily upset ( <i>balance of nature</i> )	Rakino	58.6	37.0	2.2	2.2	–	4.53	0.65
	Kawau	41.9	37.5	5.9	11.8	2.9	4.04	1.10
	Aotea	57.2	30.5	3.7	7.2	1.4	4.35	0.95
	Waiheke	49.9	34.5	2.8	9.8	3.0	4.18	1.08
	Auckland	37.2	43.2	7.0	9.3	3.3	4.02	1.06
14. Humans will eventually learn enough about how nature works to be able to control it ( <i>anti-exemptionalism</i> )	Rakino	4.3	21.7	19.6	28.3	26.1	3.50	1.22
	Kawau	2.9	22.1	26.4	28.0	20.6	3.43	1.13
	Aotea	4.3	16.9	19.8	29.1	29.9	3.64	1.19
	Waiheke	5.1	21.9	23.5	26.6	22.9	3.41	1.20
	Auckland	4.3	21.6	25.5	30.0	18.6	3.37	1.14
15. If things continue on their present course, we will soon experience a major ecological catastrophe ( <i>eco-crisis</i> )	Rakino	54.3	26.1	8.8	4.3	6.5	4.17	1.18
	Kawau	25.0	28.6	19.1	22.9	4.4	3.47	1.21
	Aotea	39.9	36.0	11.2	8.6	4.3	3.98	1.12
	Waiheke	44.3	27.7	10.5	11.7	5.8	3.93	1.24
	Auckland	30.0	32.5	16.9	13.3	7.3	3.64	1.24

\* The five study sites were Rakino Island, Kawau Island, Great Barrier Island (Aotea Island), Waiheke Island and the Auckland mainland. SA = strongly agree, MA = mildly agree, U = unsure, MD = mildly disagree, SD = strongly disagree. Rows total 100% (n = 1190).

# Appendix 5

## Attitudes towards conservation responses

Attitudes towards conservation responses (%) and the mean and standard deviation of the scores in the 2015 survey of Hauraki Gulf island communities. The scale ranged from a minimum of 1 for strongly disagree to a maximum of 5 for strongly agree.

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA %	MA %	N %	MD %	SD %	MEAN	STANDARD DEVIATION
1. Protecting nature doesn't make any difference to me or my life	Rakino	–	–	2.2	15.2	82.6	1.18	0.44
	Kawau	2.2	3.7	4.4	27.2	62.5	1.56	0.91
	Aotea	2.5	6.1	4.7	18.4	68.3	1.56	1.01
	Waiheke	0.7	3.0	4.7	22.2	69.4	1.43	0.78
	Auckland	2.3	5.0	4.7	25.9	62.1	1.59	0.96
2. Protection of NZ's native forests and species is important for us all	Rakino	78.3	6.5	2.2	–	13.0	4.37	1.37
	Kawau	83.1	11.8	0.7	1.5	2.9	4.71	0.82
	Aotea	82.0	11.5	2.2	1.4	2.9	4.68	0.83
	Waiheke	79.0	13.1	0.5	1.4	6.0	4.57	1.03
	Auckland	77.7	15.6	1.0	0.7	5.0	4.60	0.95
3. Conservation is good for NZ's economy	Rakino	78.3	17.4	4.3	–	–	4.74	0.53
	Kawau	69.1	25.0	4.5	0.7	0.7	4.61	0.68
	Aotea	70.5	24.1	4.0	1.4	–	4.64	0.63
	Waiheke	75.4	20.3	3.3	0.5	0.5	4.69	0.60
	Auckland	70.4	24.6	4.0	0.3	0.7	4.64	0.64
4. Having natural places to visit is very important to me	Rakino	95.7	4.3	–	–	–	4.96	0.21
	Kawau	81.6	16.9	1.5	–	–	4.80	0.44
	Aotea	88.9	8.6	1.4	0.7	0.4	4.85	0.49
	Waiheke	87.6	11.7	0.5	–	0.2	4.86	0.39
	Auckland	82.0	15.7	1.3	0.7	0.3	4.78	0.53
5. Commercial development should not override conservation demands	Rakino	67.5	21.7	6.5	4.3	–	4.52	0.81
	Kawau	39.7	35.3	14.7	8.8	1.5	4.03	1.02
	Aotea	56.5	26.3	9.6	5.4	2.2	4.29	0.99
	Waiheke	56.9	27.5	9.1	5.1	1.4	4.34	0.94
	Auckland	48.5	30.9	10.0	8.3	2.3	4.15	1.05
6. Protection of NZ's native forests and species is important for tourism	Rakino	80.5	15.2	4.3	–	–	4.76	0.52
	Kawau	76.4	20.7	2.9	–	–	4.73	0.50
	Aotea	78.4	17.3	2.5	0.7	1.1	4.71	0.65
	Waiheke	79.3	16.7	2.6	0.9	0.5	4.73	0.60
	Auckland	75.1	20.9	1.3	1.7	1.0	4.67	0.68
7. I've got enough to worry about than care about conservation	Rakino	–	–	4.3	15.2	80.5	1.24	0.52
	Kawau	0.7	1.5	11.0	35.3	51.5	1.64	0.79
	Aotea	–	4.7	11.9	23.0	60.4	1.61	0.87
	Waiheke	0.7	4.2	9.1	29.2	56.8	1.62	0.87
	Auckland	0.7	7.6	10.0	35.9	45.8	1.81	0.94

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Appendix 5 continued

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA %	MA %	N %	MD %	SD %	MEAN	STANDARD DEVIATION
8. I don't have the knowledge or skills to get involved in conservation	Rakino	–	10.9	10.8	41.3	37.0	1.96	0.97
	Kawau	2.2	14.7	14.0	38.3	30.8	2.19	1.10
	Aotea	2.5	9.7	11.2	36.7	39.9	1.98	1.06
	Waiheke	2.8	14.5	16.5	35.0	31.2	2.23	1.12
	Auckland	3.3	21.6	21.3	30.5	23.3	2.51	1.16

\* The five study sites were Rakino Island, Kawau Island, Great Barrier Island (Aotea Island), Waiheke Island and the Auckland mainland.  
 SA = strongly agree, MA = mildly agree, N = neither agree nor disagree, MD = mildly disagree, SD = strongly disagree. Rows total 100% (n = 1190).

# Appendix 6

## Attitudes towards science responses

Attitudes towards science responses (%) and the mean and standard deviation of the scores in the 2015 survey of Hauraki Gulf island communities. *Italic phrases in parentheses after each statement indicate the area of scientific focus for each statement. The scale ranged from a minimum of 1 for strongly disagree to a maximum of 5 for strongly agree.*

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA %	MA %	N %	MD %	SD %	MEAN	STANDARD DEVIATION
1. I enjoy finding out about new ideas in science <i>(interest in science and learning)</i>	Rakino	47.8	43.5	6.5	2.2	–	4.40	0.70
	Kawau	60.3	31.6	6.6	1.5	–	4.51	0.69
	Aotea	59.0	29.5	7.6	3.5	0.4	4.43	0.81
	Waiheke	54.8	36.4	7.4	1.4	–	4.45	0.69
	Auckland	46.8	39.2	11.3	1.3	1.4	4.28	0.86
2. The Government should fund scientific research, even if we can't be sure of the economic benefits <i>(relationship between science &amp; technology, and the economy)</i>	Rakino	50.0	39.2	6.5	4.3	–	4.36	0.79
	Kawau	44.1	43.4	9.6	2.9	–	4.29	0.76
	Aotea	51.4	34.1	9.4	4.7	0.4	4.32	0.85
	Waiheke	53.1	32.0	9.3	3.7	1.9	4.31	0.92
	Auckland	38.5	38.2	12.0	8.0	3.3	4.03	1.04
3. If you are told something has been scientifically proven, you can have confidence in the results <i>(beliefs about science &amp; knowledge building)</i>	Rakino	8.7	34.8	28.2	26.1	2.2	3.24	1.01
	Kawau	11.0	50.0	15.5	19.1	4.4	3.44	1.06
	Aotea	16.2	46.0	13.7	17.3	6.8	3.48	1.15
	Waiheke	15.6	45.2	17.1	15.6	6.5	3.49	1.12
	Auckland	15.6	40.5	20.3	17.6	6.0	3.46	1.11
4. When scientists say they are uncertain about something, they are telling the truth <i>(sociological aspects of science attitudes)</i>	Rakino	32.6	30.4	30.5	6.5	–	3.93	0.93
	Kawau	25.0	40.4	30.2	2.9	1.5	3.85	0.88
	Aotea	29.1	41	20.6	6.8	2.5	3.88	0.99
	Waiheke	28.9	40.4	22.8	6.5	1.4	3.89	0.94
	Auckland	24.3	40.5	27.6	5.3	2.3	3.79	0.95
5. An important part of science is persuading other scientists to agree with your theories <i>(understanding of science in the real world)</i>	Rakino	17.4	23.9	26.1	19.6	13.0	3.13	1.29
	Kawau	10.3	19.1	31.6	19.9	19.1	2.82	1.24
	Aotea	9.7	30.2	25.6	16.9	17.6	2.97	1.25
	Waiheke	12.8	24.0	32.4	13.8	17.0	3.02	1.25
	Auckland	14.6	20.6	28.6	27.9	8.3	2.95	1.19

\* The five study sites were Rakino Island, Kawau Island, Great Barrier Island (Aotea Island), Waiheke Island and the Auckland mainland.

SA = strongly agree, MA = mildly agree, N = neither agree nor disagree, MD = mildly disagree, SD = strongly disagree. Rows total 100% (n = 1190).

# Appendix 7

## Reliability and distribution of the Pest Management Attitude (PMA) Scale scores

Corrected item-total correlations, means, standard deviations (SDs) and distribution (skewness and kurtosis) of the scores for the 12 Pest Management Attitude (PMA) Scale statements. All statements were designed to have a maximum score of 5, with higher scores indicating more pro-pest management attitudes.  $n = 1190$ .

DO YOU AGREE OR DISAGREE THAT:	CORRECTED ITEM-TOTAL CORRELATIONS	MEAN	SD	SKEWNESS	KURTOSIS
1. Pest species are a significant conservation problem	0.43	4.61	0.73	-2.45	7.06
2. Pest control is a losing battle	0.15	3.15	1.16	-0.14	-0.96
3. The benefits of pest control outweigh the risks to native species	0.38	3.46	1.17	-0.49	-0.56
4. Enough pest control is being done already	0.35	3.64	1.06	-0.39	-0.62
5. Native species have greater rights than pest species	0.33	4.37	1.01	-1.72	2.28
6. Today's pest control methods are NOT proven to be effective	0.36	3.10	1.01	-0.17	-0.36
7. Investment in pest control is beneficial for future generations	0.45	4.45	0.82	-1.93	4.57
8. Pest control is less important than other conservation issues	0.39	3.65	1.04	-0.56	-0.32
9. Pest control is best done by experts	-0.09	3.58	1.31	-0.51	-1.04
10. Pest control has unknown side effects	0.34	2.59	1.08	0.30	-0.58
11. Humans are the fundamental cause of pest species	0.06	4.23	1.09	-1.45	1.24
12. Pest control interferes with nature	0.37	3.06	1.22	0.49	-1.10



# Appendix 8

## Percentage responses to the Pest Management Attitude (PMA) Scale statements

Percentage responses (%) and the mean and standard deviation of the scores for the Pest Management Attitude (PMA) Scale statements included in the 2015 survey of Hauraki Gulf island communities. All statements were designed to have a maximum score of 5, with higher scores indicating more pro-pest management attitudes.

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA %	MA %	U %	MD %	SD %	MEAN	STANDARD DEVIATION
1. Pest species are a significant conservation problem	Rakino	80.4	17.4	–	2.2	–	4.76	0.56
	Kawau	79.4	15.4	0.7	3.8	0.7	4.69	0.73
	Aotea	71.6	23.4	1.4	2.2	1.4	4.61	0.75
	Waiheke	71.3	21.9	3.3	2.1	1.4	4.59	0.77
	Auckland	65.1	29.2	4.4	1.3	–	4.58	0.64
2. Pest control is a losing battle	Rakino	6.5	26.1	13.0	32.7	21.7	3.37	1.27
	Kawau	10.3	24.3	20.6	31.6	13.2	3.14	1.22
	Aotea	6.5	23.4	20.8	33.8	15.5	3.29	1.17
	Waiheke	7.0	26.1	23.5	31.5	11.9	3.15	1.14
	Auckland	9.6	26.0	26.6	30.2	7.6	3.00	1.12
3. The benefits of pest control outweigh the risks to native species	Rakino	15.2	37.0	23.9	17.4	6.5	3.37	1.14
	Kawau	28.7	36.0	19.1	8.8	7.4	3.71	1.19
	Aotea	22.3	26.6	20.9	19.8	10.4	3.31	1.30
	Waiheke	18.2	33.1	29.1	13.1	6.5	3.44	1.12
	Auckland	17.6	40.8	25.3	10.0	6.3	3.54	1.09
4. Enough pest control is being done already	Rakino	2.2	15.2	26.1	30.4	26.1	3.63	1.10
	Kawau	5.1	14.7	19.1	30.1	31.0	3.66	1.20
	Aotea	3.6	10.8	21.2	33.5	30.9	3.77	1.11
	Waiheke	1.4	13.3	25.6	34.8	24.9	3.68	1.03
	Auckland	2.0	13.3	37.5	31.3	15.9	3.46	0.98
5. Native species have greater rights than pest species	Rakino	63.0	28.3	6.5	2.2	–	4.52	0.72
	Kawau	67.6	19.9	3.7	6.6	2.2	4.45	0.99
	Aotea	64.0	23.5	6.1	3.2	3.2	4.42	0.97
	Waiheke	59.4	22.8	7.5	7.7	2.6	4.29	1.06
	Auckland	62.5	22.9	6.6	6.0	2.0	4.38	0.98
6. Today's pest control methods are NOT proven to be effective	Rakino	2.2	19.6	39.1	32.6	6.5	3.22	0.92
	Kawau	4.4	13.2	42.0	30.1	10.3	3.29	0.97
	Aotea	7.6	20.1	32.4	31.3	8.6	3.13	1.07
	Waiheke	7.9	21.0	40.1	24.0	7.0	3.01	1.02
	Auckland	6.6	16.6	44.5	27.0	5.3	3.08	0.95
7. Investment in pest control is beneficial for future generations	Rakino	63.0	30.4	6.6	–	–	4.57	0.62
	Kawau	59.6	33.1	4.4	–	2.9	4.47	0.83
	Aotea	62.2	29.2	5.4	1.4	1.8	4.49	0.81
	Waiheke	59.7	28.9	7.0	2.1	2.3	4.42	0.89
	Auckland	54.5	36.2	7.6	0.7	1.0	4.43	0.75

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Appendix 5 continued

DO YOU AGREE OR DISAGREE THAT:	STUDY SITE*	SA %	MA %	U %	MD %	SD %	MEAN	STANDARD DEVIATION
8. Pest control is less important than other conservation issues	Rakino	–	13.0	32.6	32.6	21.8	3.62	0.97
	Kawau	2.9	8.8	17.0	49.2	22.1	3.78	0.98
	Aotea	3.2	12.9	18.7	40.7	24.5	3.69	1.07
	Waiheke	3.0	12.4	23.5	40.8	20.3	3.63	1.03
	Auckland	2.7	15.0	22.6	40.2	19.5	3.59	1.05
9. Pest control is best done by experts	Rakino							
	Kawau							
	Aotea							
	Waiheke							
	Auckland							
10. Pest control has unknown side effects	Rakino	15.2	32.6	34.9	13.0	4.3	2.59	1.04
	Kawau	11.0	36.8	28.7	16.9	6.6	2.70	1.08
	Aotea	20.1	30.6	28.1	15.8	5.4	2.56	1.14
	Waiheke	17.5	31.0	30.3	16.8	4.4	2.59	1.09
	Auckland	16.3	32.2	33.9	14.0	3.6	2.56	1.03
11. Humans are the fundamental cause of pest species	Rakino							
	Kawau							
	Aotea							
	Waiheke							
	Auckland							
12. Pest control interferes with nature	Rakino	6.5	28.3	13.0	23.9	28.3	3.39	1.34
	Kawau	4.4	27.2	25.0	25.8	17.6	3.25	1.16
	Aotea	12.6	30.2	15.4	28.1	13.7	3.00	1.28
	Waiheke	9.1	27.3	23.3	26.1	14.2	3.09	1.21
	Auckland	9.0	35.9	19.3	24.5	11.3	2.93	1.19

\* The five study sites were Rakino Island, Kawau Island, Great Barrier Island (Aotea Island), Waiheke Island and the Auckland mainland.

SA = strongly agree, MA = mildly agree, U = unsure, MD = mildly disagree, SD = strongly disagree. Results are only presented for ten statements following the recommendation to remove two statements (see section 5). Rows total 100% ( $n = 1190$ ).

# Appendix 9

## Percentage responses<sup>1</sup> to the benefits of pest control statements

Counts (*n*) and percentage (%) responses for the benefits of pest control other than conservation, in the 2015 survey of Hauraki Gulf island communities.

BENEFITS	STATISTIC	STUDY SITE					TOTAL
		RAKINO ISLAND	KAWAU ISLAND	GREAT BARRIER ISLAND (AOTEA ISLAND)	WAIHEKE ISLAND	AUCKLAND MAINLAND	
		<i>n</i> = 46	<i>n</i> = 136	<i>n</i> = 278	<i>n</i> = 429	<i>n</i> = 301	<i>n</i> = 1163
Agricultural	<i>n</i>	41	129	252	379	274	1075
	%	89.1	96.3	93.3	90.7	92.9	92.4
Economic	<i>n</i>	37	106	211	293	209	856
	%	80.4	79.1	78.1	70.1	70.8	73.6
Ecosystem services	<i>n</i>	40	104	212	308	194	858
	%	87.0	77.6	78.5	73.7	65.8	73.8
Financial	<i>n</i>	22	71	137	210	127	567
	%	47.8	53.0	50.7	50.2	43.1	48.8
Human health & safety	<i>n</i>	32	91	183	301	195	802
	%	69.6	67.9	67.8	72.0	66.1	69.0
Threatened species translocations	<i>n</i>	42	112	228	349	235	966
	%	91.3	83.6	84.4	83.5	79.7	83.1
Tourism	<i>n</i>	41	114	227	342	219	943
	%	89.1	85.1	84.1	81.8	74.2	81.1

<sup>1</sup> These questions allowed multiple responses so the columns may not total 100%.