

RODENT INCURSIONS ON NEW ZEALAND ISLANDS

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INTRODUCTION

New Zealand has been colonised by the four most wide-spread and invasive rodent species in the world (Atkinson 1985). In chronological order; the kiore (*Rattus exulans*, c1200AD), the Norway rat (*R. norvegicus*, c1790), the mouse (*Mus musculus*, 1824) and the ship rat (*R. rattus*, c1860) all arrived and rapidly spread across the country, often displacing the former rodent species (Taylor 1978). From the mainland they have dispersed by transport (mostly accidental) and swimming to many of New Zealand's 300 offshore islands >5ha (Russell and Clout 2004).

Since 1964 New Zealand conservation practitioners have gradually increased the size of islands from which it has been possible to eliminate rodent species (Towns and Broome 2003). This increase has been particularly marked since the 1980s, with the advent of new technologies at that time (Clout and Russell in press). The trends in eradication of introduced mammals, in particular rodents, from New Zealand offshore islands have been documented elsewhere (Veitch and Bell 1990; Clout and Russell in press). Clout and Russell (in press) also draw attention to the increasing number of rodent reinvasions, once islands have had their incumbent rodent species removed

Less well documented are the instances where a single or small number of rodents have been detected arriving at an island, but have not subsequently gone on to colonise the entire island. These 'incursions' highlight the constant threats and pathways of reinvasion by which rodent free islands, including those from which rodents have been eradicated, are at risk.

DEFINITIONS AND DATA PRESENTATION

For the purposes of this paper we define an incursion as an instance where a rodent species is believed to have arrived on an island, but where a self-sustaining island-wide population (necessitating island-wide eradication) has not established. By comparison an invasion is what follows an incursion, where a rodent species colonises across an entire island. We collated all available information on incursions from a range of sources, including publications, file reports and personal accounts. All data on incursions are summarised in Table 1 (Appendix 1). The format is based on the original database of incursions, compiled by Fitzgerald and Veitch (1992), which was in turn generated from Roberts (1991). The table is organized by islands and gives the name of the island concerned, its rodent status at the time of the potential invasion, the suspected invader, the date and circumstances of the incursion, and key references.

RESULTS

Rodent incursions

Incursions by rodents are listed for 27 New Zealand offshore and outlying islands. On six islands more than one incursion has been recorded. In total 42 rodent incursions have been recorded. Fourteen of these are of mice, sixteen are of Norway rats and three of ship rats. The remaining nine are of an unknown rat species, although almost certainly one of the previous two. Kiore have relatively poor swimming abilities (Atkinson 1986). Three of the mouse

incursions were locally established populations restricted to the area of landing, not having established across the entire island. This has also been recorded on Barrow Island (Burbidge and Morris 2002) and Ile Surprise overseas (Courchamp 2004), and is attributable to incumbent rat populations (Taylor 1978).

Recent incursions have occurred through a combination of natural swimming, and accidental transport by fishing vessels, private boats and scientific expeditions.

Roberts (1991, Table 2) also provides a list of nine islands from which there is parasitological evidence of rodent incursion.

Swimming distance

In many cases it can only be speculated as to whether incursions were from swimming or accidental transport of rodents. Recent advances in population genetic methods may allow the sources of invading rodents to be reliably identified (Abdelkrim *et al.* in press), but this requires a thorough genetic cataloging of local rodent populations.

However some statements about the swimming distances of the various rodent species can be made. It appears that mice do not swim as a method of dispersing to islands. All recorded mouse incursions have been via transport of stores and equipment (Taylor 1978).

No incursions of kiore are recorded here, and only one kiore invasion has ever been documented (McCallum 1986). The distribution of kiore in New Zealand is now much reduced, limiting their opportunities to invade new islands compared to the other rat species. Even when the opportunity exists their swimming abilities seem limited (Whitaker 1974; Atkinson 1986).

All ship rat incursions appear to be from accidental transport and then by swimming only when very close to shore, given the distance offshore of the islands where incursions of this species have been recorded. However, the recent reinvasions of ship rats onto Motutapere (Chappell 2004) and Tawhitinui (Ward 2005) both involved crossings of approximately 500m in calm waters. Both invasions were presumably by swimming, and they extend the distance which this species has been suspected of swimming.

By far the majority of known rat incursions are by Norway rats. The Norway rat is evidently the most likely rodent invader of offshore islands given its inclination towards swimming (Russell *et al.* unpubl.), although ship rats may pose a greater overall threat to native biodiversity (Towns *et al.* in press). From the distribution and recorded reinvasions of Norway rats it appears that they can cross up to 1km of water comfortably, and up to 2km of open water more rarely when conditions are suitable (mudflats, intermediate rocky islets, tidal flow, etc). The Noises Islands, 2.2km offshore, have possibly been reinvaded up to six times from neighbouring Rakino, after apparently successful eradications (Moors 1985; Clout and Russell in press).

DISCUSSION

The number of recorded incursions of rats and mice onto New Zealand's offshore islands demonstrates that constant vigilance is needed to prevent rodents establishing on rodent free islands, including those recently cleared of these invasive mammals. Even despite this reinvasion can still occur such as on Moturemu and Motutapere where full-sale reinvasion took place, and on Moturoa and Rotoroa where established grids catch multiple rats annually, well

above normal incursions rates, suggesting re-established populations that are instead maintained at low densities.

Quarantine measures must be invoked at all of the potential points of departure, during transport, and on the islands themselves. Incursions have been detected during all three of these stages (though only the latter are documented here). On islands biosecurity procedures (e.g. Jansen 1989) should include the unpacking of stores in secure areas, and permanently maintained rodent detection systems, with the availability of invasion response kits should an incursion be detected or suspected (Roberts 2003). Complacency in application of any of these measures can lead to new rodent invasions.

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Table 1 Records of rodents reaching New Zealand islands but not establishing populations. Rodent status is at the time of the potential invasion. The authors would be grateful to be made aware of any omissions or errors in this compilation.

Island	Distance Offshore	Rodent Status	Potential Invader	Date	Circumstances	Reference
Big South Cape (Stewart)	1.5km	Rodent free	<i>R. rattus</i>	1955	One female with active corpora lutea trapped near beach, no further sign till 1963	Bell 1978
Campbell (Subantarctic)	600km	<i>R. norvegicus</i> <i>R. norvegicus</i>	<i>Mus</i> <i>Mus</i>	<1931 1978	Present at homestead and government depots Observed on south-east harbour beach but could not be caught	Waite 1909; Taylor 1978 Dilks and Dunn 1978
Codfish (Stewart)	3.1km	<i>R. exulans</i> <i>R. exulans</i>	<i>R. norvegicus</i> <i>R. rattus</i>	1984 1994	One male caught in possum trap Dead male found on high-tide line, probably drowned swimming from moored fishing boat	McSweeney 1984; Bell 1989 A. Roberts pers. comm.
Kapiti (Wellington)	5.2km	<i>R. exulans</i> and <i>R. norvegicus</i> Rodent free Rodent free	<i>Mus</i> <i>Mus</i> <i>Rattus</i> spp. <i>R. norvegicus</i>	? 1970 1998 1998	Landed on occasions, failed to establish Mummified specimen found in whare Missing bait from station, trapping undertaken, no further sign Corpse found by black-back gull colony	Taylor 1978 L. Rodda pers. comm. C. Giddy pers. comm. C. Giddy pers. comm.
Koi (Hauraki Gulf)	250m	Rodent free	<i>R. norvegicus</i>	1997	Green faeces found, ate old Talon and presumably died	Lee 1999
Korapuki (Coromandel)	5.8km	Rodent free	<i>R. rattus</i>	1988	Virgin female 'Virginia' trapped after 1986 kiore eradication follow-up	Dilks and Towns 2002; Towns and Broome 2003
Little Barrier (Hauraki Gulf)	21.5km	<i>R. exulans</i>	<i>Mus</i>	1950s	One brought ashore in stores and killed	Watson 1961
Mana (Wellington)	2.5km	<i>Mus</i> <i>Mus</i> <i>Mus</i> <i>Mus</i> Rodent free	<i>R. norvegicus</i> <i>Rattus</i> spp. <i>R. norvegicus</i> <i>Rattus</i> spp. <i>Mus</i>	1974/75 1976-78 1978 1981 1992	One brought ashore in bales of hay and killed Jumped overboard, reached shore and killed Partly eaten carcass on shore Dead rat found in high tide drift line, about 300m south of jetty One female from packed stores killed on boat before reaching island	M. Meads pers. comm. Veitch and Bell 1990 Efford et al. 1988 M. Meads pers. comm. T. Hook pers. comm.
Mangere (Chathams)	850km	Rodent free	<i>Mus</i>	1970s	Adult female and nest of young in equipment brought ashore by dinghy	Bell 1978, 1989
Maud (Marlborough)	850m	Rodent free	<i>Mus</i>	2000	Green faeces found in equipment in lodge, trapping undertaken, no further sign	Ward 2000
Matakohe (Whangarei)	550m	<i>Mus</i>	<i>Rattus</i> spp.	1999-2000	Four rats detected and killed on grid	Ritchie 2000

Mokoia (Rotorua)	2.1km	<i>R. norvegicus</i> <i>Mus</i>	<i>Mus</i> <i>R. norvegicus</i>	<1966 1995	Extremely low numbers and confined to the vicinity of the huts Observed around hut, poison laid, body of very large virgin female found in hole on beach	Beveridge and Daniel 1966; I. Castro pers. comm.
		Rodent free	<i>R. norvegicus</i>	2003	Corpse found, possibly flown over by harrier	I. Castro pers. comm.
Motuhoropapa (Hauraki Gulf)	2.2km	Rodent free	<i>R. norvegicus</i>	1987	Carcass of young female found in old trap, sign on two islets	Moors 1987
Moturemu (Kaipara)	2.5km	Rodent free	<i>R. norvegicus</i>	1999	Sign reported by T. Wilson. Poison and traps laid, no further sign till 2002	Russell and Abdelkrim unpubl.
Moturoa (Bay of Islands)	375m	Rodent free	<i>Rattus</i> spp.	1996	Reinvade from mainland annually, grid present	Asquith 2004
Ohinau (Coromandel)	4.5km	<i>R. exulans</i>	<i>Mus</i>	2000-5	Low numbers present around north-west bay campsite	R. Chappell pers.comm.
Otata (Hauraki Gulf)	2.3km	Rodent free	<i>R. norvegicus</i>	2005	Escaped from controlled release on neighbouring Motuhoropapa, sign reported by owners, rat caught	Russell et al. unpubl.
Pitt (Chathams)	850km	<i>Mus</i>	<i>Rattus</i> spp.	1996/7	Swam from moored fishing vessel	Dilks and Towns 2002
Poutama (Stewart)	275m	Rodent free	<i>Rattus</i> spp.	1984	Rat sign reported by muttonbirders and seen by A. Cox, poison laid, no further sign	Bell 1989; Veitch and Bell 1990
Rangatira (Chathams)	850km	Rodent free	<i>Mus</i>	1998	Possible mouse sighting	Dilks and Towns 2002
Raoul (Kermadecs)	900km	<i>R. exulans</i> and <i>R. norvegicus</i>	<i>Mus</i>	1972	One pregnant female carried ashore in stores and killed	Taylor 1978; Veitch and Bell 1990
Snares (Subantarctic)	105km	Rodent free	<i>Rattus</i> spp.	1950s	Rat jumped from boat onto island during landing of scientific party	Roorda 1981
Stewart	27km	All 3 rat spp.	<i>Mus</i>	?	Landed in stores on several occasions	Taylor 1975
Takangaroa (Hauraki Gulf)	1.8km	Rodent free	<i>R. norvegicus</i>	1987	Sign reported by owners and seen by G. Taylor, poison laid, no further sign	Taylor 1989; Veitch and Bell 1990
Tawhitinui (Marlborough)	475m	Rodent free	<i>Rattus</i> spp.	1986- 2000	Old sign found in 'rat hotel', trapping undertaken, no further sign	Dilks and Towns 2002; Ward 2005

Tiritiri Matangi (Hauraki Gulf)	3.4km	<i>R. exulans</i>	<i>Mus</i>	1986	Brought ashore in stores and killed	Roberts 1991
Ulva (Stewart)	800m	Rodent free	<i>R. norvegicus</i>	1997	One rat killed by trapping	Dilks and Towns 2002
		Rodent free	<i>R. norvegicus</i>	1999	One rat swam ashore from a moored yacht, killed by trapping	Dilks and Towns 2002
		Rodent free	<i>R. norvegicus</i>	2001	Mummified rat found in trap	B. Beaven pers. comm.
		Rodent free	<i>R. norvegicus</i>	2002	Two rats killed by trapping	Russell 2002
		Rodent free	<i>R. norvegicus</i>	2003	Found drowned on Boulder Beach	B. Beaven pers. comm.

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