Detection of caged and free-ranging Norway rats *Rattus norvegicus* by a rodent sniffing dog on Browns Island, Auckland, New Zealand

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SUMMARY

Campaigns to eradicate introduced rats (*Rattus* spp.) from small islands are very successful; however, reinvasions on rat-free islands continue to be a major concern. In New Zealand, rodent sniffing dogs are employed to detect suspected rat incursions. The ability to detect and catch a known free-ranging rat on a rat-free island has previously been proven only once and never been experimentally tested. This study tested the ability of a rodent sniffing dog to detect a free-ranging Norway rat *R. norvegicus* and four caged albino laboratory rats (*R. norvegicus*) on rodent-free Browns Island. A male Norway rat fitted with a GPS/VHF transmitter was released on the island as part of a trial to test the ability to detect its presence using caged 'lure' rats. A failure to detect any signal from the transmitter forced us to bring in a trained rodent sniffing dog to locate the rat. In a systematic search of the island, the dog found three of the four caged rats, and through air sniffing downwind it was able to track and catch the wild rat from a distance of approximately 170 m. This is one of the very few times that a rodent sniffing dog has been tested in a realistic scenario in which there was a confirmed free-ranging rat on an otherwise rodent-free island. The successful detection and capture indicates that trained sniffing dogs can contribute to the detection of rat incursions on island sanctuaries and assist in rat control.

BACKGROUND

Three rat species (*Rattus rattus, R. norvegicus* and *R. exulans*) are among the most common and destructive invasive mammalian species worldwide (Long 2003). Invasive rats have high fecundity, are highly adaptable, and have a broad diet spectrum (Atkinson & Towns 2005, Innes 2005a, Innes 2005b). They have been shown to be directly responsible for the decline and extinction of many native island species (Holdaway 1989, Vitousek *et al*. 1987). Nonetheless, the size and complexity of the ecosystem invaded often ameliorate the threat to indigenous species. In contrast, oceanic island ecosystems are small in size with relatively low numbers of species (Macarthur & Wilson 1967) and high rates of endemism (Primack 2010). The limited available habitat and isolation in which oceanic island biota have evolved, make these ecosystems sensitive to the introduction of highly competitive or predatory species. In the last 60 years or so, most invasive species eradication efforts have been concentrated on these small, isolated islands.

Eradication of rats from small islands (up to 11,300 ha) has proven very successful, with success rates of more then 90% being achieved (Howald *et al.* 2007, Towns & Broome 2003). Nonetheless, rats can re-invade either by swimming or as boat stowaways (Russell & Clout 2005, Russell *et al.* 2005, Russell *et al.* 2008b) and our abilities to quickly detect such re-incursions are limited (Russell *et al*. 2008a, Russell *et al*. 2005). In New Zealand, the issue of rodent reinvasions is a serious conservation management concern, as most rat-free islands are valuable native wildlife refuges. Most methods for detecting re-invasion by rats (and other rodents) are passive, and include food-based tracking and trapping devices (Russell *et al*. 2008a, Russell *et al*. 2008b). In addition, the New Zealand Department of Conservation (DOC) and several private operators use rodent sniffing dogs for active detection of invasive rats and mice. Rodents sniffing dogs in New Zealand are trained to detect both indirect (e.g. rodent trails, scats) and direct scents, although they are prey-motivated and are therefore more effective at detecting a live animal. New Zealand certified rodent sniffing dogs are considered very efficient (Gsell *et al*. 2010) and are used regularly and systematically to scan rodent free islands around the New Zealand mainland.

Examples of successful detection of reinvasions are scarce. A rodent sniffing dog found and killed a Norway rat on Motuihe Island (179 ha) in 2008. The rat had been detected in tracking tunnels, but attempts to trap it (over approximately two weeks) failed. The dog found and killed the rat within one and a half hours of arriving on Motuihe. The same dog indicated that ship rats *R. rattus* had invaded Motutapu Island (1,509 ha) in 2005, where conventional surveillance (bait stations and traps) had failed to detect their presence. The dog also located a rat corpse in another controlled releasing study in a known location on the much smaller (<10 ha) island of Motuhoropapa (Russell *et al*. 2008a).

All sniffing dogs under go a certification process managed by DOC. The length of training varies with each dog, but usually takes about 2 years. The dogs are tested regularly by DOC staff in order to maintain their certificated status. This study tested the ability of a certified border terrier-cross rodent sniffing dog (trained and handled by F. Buchanan) to detect four caged laboratory rats and one deliberately released (radio-collared) wild Norway rat *R. norvegicus.* This experiment was part of a trial studying male Norway rat behaviour and detection potential using the caged 'lure' rats, on a rat-free island.

ACTION

Study site: The study was conducted on Browns Island (Motukorea), a 60 ha island in the Hauraki Gulf, about 1 km off the mouth of the Tamaki River, Auckland, New Zealand (36º49'49.82"S, 174 º 53'40.47"E, Fig. 1). The nearest islands, Motuihe and Rangitoto, lie 3-4 km away and are rat-free. Browns Island vegetation comprises grasses with a few scattered trees with regenerating bush on some coastal margins. The island is a public recreation reserve and an important archeological site. Its nature conservation status is considered low, apart from the coastal margins that provide breeding habitat for a small population of endangered New Zealand dotterel *Charadrius obscurus*. Norway rats and house mice *Mus musculus* were eradicated from the island in 1995 (Veitch 2002).

Aims: The trial originally aimed to look at efficacy of Norway rat attraction to caged laboratory conspecifics (two males and two females) and to food-baited tracking tunnels (Fig. 2) using a wild male Norway rat fitted with a GPS unit and a VHF radio-transmitter. However, failure of the transmitter resulted in a decision to bring in the rodent sniffing dog to help locate the animal. In addition to the attempt to locate the wild rat, the opportunity was presented to test the dog's ability to locate the four caged rats. Since opportunities to test sniffing dogs in a real-life situation of rat incursion are rare, DOC supported this action.

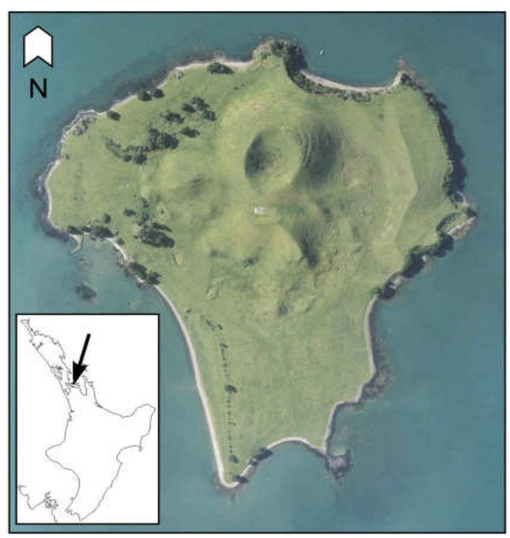

Figure 1. Aerial photograph of Browns Island showing its location off New Zealand's main North Island (inset). (Maps reproduced courtesy of the Department of Conservation).

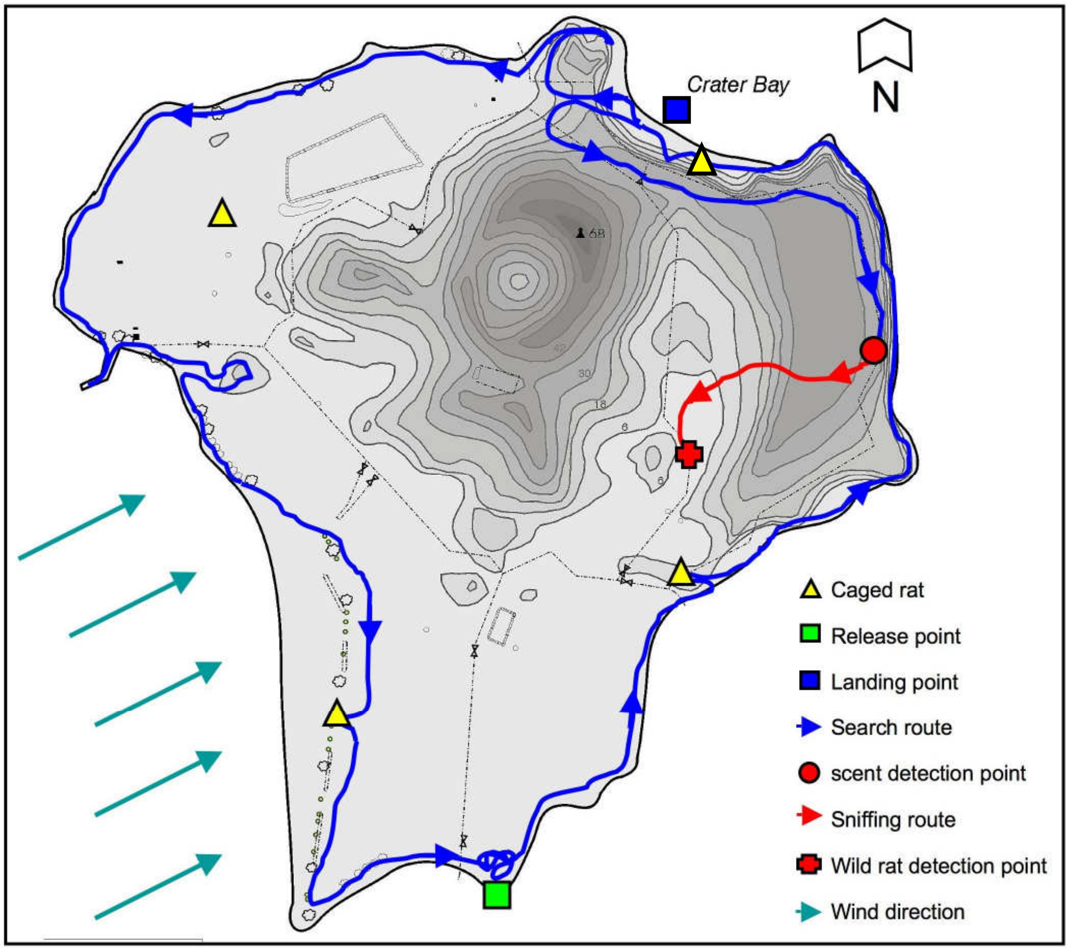

Figure 2. Map of Browns Island showing details of the dog search pattern: the search was conducted first counter clockwise along the coastline and then clockwise on an inner circle from which the dog detected the rat scent. (Map reproduced courtesy of the Department of Conservation).

Rat release and sniffer dog searching: Laboratory rats were housed in wooden cages (30 x 30 x 50 cm) placed inside A-shape coreflute (corrugated plastic) and wire mesh enclosures, and supplied with plentiful rodent food and water. The wild rat was released on the southern tip of the island (Fig. 2) at 15:00 h on 30 March 2011. The dog was brought onto the island at 10:00 h on 6 April, seven nights after the release. The weather was partly cloudy but mostly fine with southwesterly winds. There was no rain during the operation. The handler (FB) led the dog on a systematic search pattern (Fig. 2.) allowing it to hunt naturally but encouraging searches of areas believed to be potential rat habitat that the dog may have missed. The systematic search by the dog began with an entire coastline search (counter clockwise) and then moved inland (circling clockwise).

CONSEQUENCES

The dog successfully detected three of the four caged rats, always from downwind and from distances of between 10-20 m (Fig. 2). The fourth caged rat was not detected but the route the dog took was of considerable distance from it (around 100 m) and importantly with the closest point upwind. Upon arriving at the wild rat release point (at approximately 10:45 i.e. 45 min after arrival of the dog and handler on the island), the dog's behaviour indicated that it detected a scent (sniffing around the area for about 10 min) before continuing the search. At approximately 12:30, after starting the clockwise inner search, the dog detected a scent downwind and immediately followed it. The detection point (Fig. 2) was on the edge of the coastal cliff, approximately 25 m above sea level. The dog climbed (south) up the ridge to a height of approximately 36 m, before climbing down (southwest) towards the bottom of a gully, 6 m above sea level.

At the gully bottom, the dog walked about 20 m (west) and started to search with much excitement around a small area of thorn scrub and grass, running back and forth as if chasing something. After about 10 minutes, the search was concentrated around one spot. At this stage vegetation was cleared to try and reveal the source of the dog's interest. At 12:50 the dog went further into the vegetation, captured and killed the radio-tagged rat, before returning it to the dog handler. The altitude difference between the point at which the dog first showed signs of detecting the rat's scent and the point of capture was 16 m. The walking distance between the points of detection and capture was approximately 170 m. The point of capture was at least 600 m from the release point. Upon capture it was found that the rat had ripped off the transmitter antenna, hence the signal failure.

Discussion and conclusions: This study reports the first successful detection and capture of a deliberately released Norway rat on a rat-free island. While trained dogs are regularly employed by DOC to detect rat incursions on islands, this experiment provided the opportunity to test the effectiveness of rodent sniffing dogs in a real life situation. The long distance from which the dog detected the rat was significant. Gsell *et al*. (2010) found that two rodent sniffing dogs detected caged rats in a forested environment from average distances of 66 m and 50 m with maximum detection distances of 150 m and 110 m, respectively. The detection was, however, a combination of manipulated set rodent trails and air sniffing which were hard to distinguish between.

The results of the current study emphasize the necessity to consider wind direction when searching with a dog. Sniffing dogs have two basic modes of search, sniffing objects (i.e. ground, vegetation) and sniffing the air. Detecting scent trails is less affected by wind regime, but the dog needs to get relatively close to the trail to detect it (Gsell *et al*. 2010). In addition, environmental factors (Reed *et al*. 2011) and time since the trail was set (Gsell *et al*. 2010; Hepper & Wells 2005) also affect the strength of the scent and hence the ability of the dog to reliably detect it. However, a live animal produces scents constantly (Eisenberg & Kleiman 1972) and these scents will become airborne and travel with prevailing winds. In this present study, the dog detected the rat's odour from a distance of approximately 170 m; the scent carried by the wind was enough for the dog to locate the rat. We assume that if the dog were searching closer to the rat but upwind, it would have not found it; the dog detected three of the four caged rats from a distance ranging between 10-20 m, always from downwind. Since the distances of detection for the caged rats were the actual distance of the search route from the cages, it is not know if the dog could have detected them from a greater distance.

The rodent sniffing dog in the current study was extraordinarily effective at detecting the single male Norway rat that was lost (due to transmitter failure) on an otherwise rat-free island, locating it within 3 hours of searching. This demonstrates that the intensive training period of New Zealand's rodent sniffing dogs and their deployment as rodent detectors is worthwhile. The distance and accuracy of the rat detection support the view that sniffing dogs can contribute to conservation efforts on rat-free islands.

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REFERENCES

Atkinson I.A.E. & Towns D.R. (2005) Kiore. In: *The Handbook of New Zealand Mammals* (King, C.M. ed.). Oxford University Press, New York, pp. 159-174.

Eisenberg J.F. & Kleiman D.G. (1972) Olfactory communication in mammals. *Annual Review of Ecology and Systematics*, **3**, 1-32.

Gsell A., Innes J., de Monchy P. & Brunton D. (2010) The success of using trained dogs to locate sparse rodents in pest-free sanctuaries. *Wildlife Research*, **37**, 39-46.

Hepper P.G. & Wells D.L. (2005) How many footsteps do dogs need to determine the direction of an odour trail? *Chemical Senses*, **30**, 291-298.

Holdaway R.N. (1989) New Zealands pre-human avifauna and Its vulnerability. *New Zealand Journal of Ecology*, **12**, 11-25.

Howald G., Donlan C.J., Galvan J.P., Russell J.C., Parkes J., Samaniego A., Wang Y.W., Veitch D., Genovesi P., Pascal M., Saunders A. & Tershy B. (2007) Invasive rodent eradication on islands. *Conservation Biology*, **21**, 1258-1268.

Innes J.G. (2005a) Norway rat. In: *The Handbook of New Zealand Mammals* (King C.M. ed.). Oxford University Press, New York, pp. 174-187.

Innes J.G. (2005b) Ship rat. In: *The Handbook of New Zealand Mammals* (King C.M. ed.). Oxford University Press, New York, pp. 187-203.

Long J.L. (2003) *Introduced Mammals of the World*. CSIRO, Collingwood, Australia.

Macarthur R.H. & Wilson E.O. (1967) *The Theory of Island Biogeography*. Princeton University Press, Princeton, USA.

Primack R.B. (2010) *Essentials of Conservation Biology*. Sinauer, Sunderland, USA.

Reed S.E., Bidlack A.L., Hurt A. & Getz W.M. (2011) Detection distance and environmental factors in conservation detection dog surveys. *Journal of Wildlife Management*, **75**, 243-251.

Russell J.C., Beaven B.M., MacKay J.W.B., Towns D.R. & Clout M.N. (2008a) Testing island biosecurity systems for invasive rats. *Wildlife Research*, **35**, 215-221.

Russell J.C. & Clout M.N. (2005) Rodent incursions on New Zealand Islands. *Proceedings of the 13th Australian Vertebrate Pest Conference* (Parks, J., Statham, M. & Edwards, G. eds.). Landcare Research, Lincoln, New Zealand, 324-330.

Russell J.C., Towns D.R., Anderson S.H. & Clout M.N. (2005) Intercepting the first rat ashore. *Nature*, **437**, 1107-1107.

Russell J.C., Towns D.R. & Clout M.N. (2008b) Review of rat invasion biology: implications for islands biosecurity. *Science for Conservation 286*. Wellington, Department of Conservation, 1-53.

Towns D.R. & Broome K.G. (2003) From small Maria to massive Campbell: forty years of rat eradications from New Zealand islands. *New Zealand Journal of Zoology*, **30**, 377-398.

Vitousek P.M., Loope L.L. & Stone C.P. (1987) Introduced species in hawaii: biological effects and opportunities for ecological research. *Trends in Ecology & Evolution*, **2**, 224-227.