FORUM ARTICLE

Role of predator-proof fences in restoring New Zealand's biodiversity: a response to Scofield et al. (2011)

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Abstract: Scofield et al. (2011) recently questioned the goals and current achievements of New Zealand pest-fenced sanctuaries. Here we dispute some of their evidence, describe the conservation context and achievements of fenced sanctuaries, and show that pest-fenced projects have distinctive and important roles among the diverse approaches addressing biodiversity restoration in New Zealand. This arises primarily from their ability to achieve zero or near-zero residual abundance of nearly all mammal pests in mainland environments, and to capture public interest and involvement with exceptional advocacy and education opportunities that should benefit all conservation. The key sustainability challenge confronting fenced sanctuaries is little different from that facing other conservation initiatives, namely reducing threats over the long-term to enable indigenous species and ecosystem persistence. We concur with Scofield et al. (2011) that fenced sanctuaries need time and further research to evaluate costs and benefits compared with other approaches.

Keywords: conservation, pest-exclusion fences

Introduction

The focus on value for money is an increasingly important aspect of conservation management, given that resources for conservation are far exceeded by the potential needs that could be funded. Among these needs is mammalian pest control at a range of intensities and scales, critical to the recovery of many threatened native species on mainland New Zealand. We therefore appreciate the preliminary efforts of Scofield et al. (2011) to address the conservation value and costs of fenced and other sanctuaries. We agree that fenced sanctuaries can reasonably be seen as expensive, and support their call for 'consistent, timely and more complete information on fence benefits, costs and pitfalls to be disseminated and published'. However, we believe the strong cautionary views about pest-proof fences of Scofield et al. (2011) are premature and under-represent both the conservation and social benefits of these initiatives. In this paper, we critique their case against the proliferation of sanctuaries, and examine their claims in the light of national conservation goals, the vision and objectives of many sanctuaries, conservation achievements to date, and the complementary roles of sanctuaries in relation to other kinds of conservation management.

Critique of Scofield et al. (2011)

Improving ecosystem condition is a valid goal

Scofield et al. (2011) write 'that what is critically important here is the preservation of taxa that will become extinct without immediate intervention, not the somewhat illusory goal of the preservation of an exact copy of a prehuman functional ecosystem'. However, we suggest that preserving threatened species alone is an inadequate conservation goal, and that no sanctuary practitioners are actually trying to recreate prehuman ecosystems in any literal way.

Although data on historical reference states can be useful as inspiration and as general guides to restoration (Aronson et al. 1995), few modern conservation groups (and restoration scientists; Hobbs 2007; Hughes et al. 2011) believe that attempting to return biodiversity to an exact copy of a previous state is a credible restoration goal. This is because of uncertainties in defining what those previous states were, extinction of many species, decimation of some functional groups, extensive habitat modification, and new factors such as climate change and introduced pests. We therefore agree with Scofield et al. (2011) that 'A perfect re-creation of a prehuman ecosystem is impossible and New Zealand conservation has to accept that the crucial issue of the next few years is to maintain what we now have'. However, we suggest this latter statement is well understood by sanctuaries practitioners (see vision statements below) and that contributing to maintaining what we have is in fact exactly what fenced sanctuaries are achieving.

Key policy statements and legislation that drive national biodiversity protection do not require restoration of biodiversity to some prehuman state (Reserves Act 1977; National Parks Act 1980) but specifically include restoration of ecosystems as

a goal. The purpose of national parks was declared to preserve in perpetuity 'areas of New Zealand that contain scenery of such distinctive quality, *ecological systems*, or natural features so beautiful, unique, or scientifically important that their preservation is in the national interest' (National Parks Act 1980; our italics). Section 3b of the Reserves Act 1977 states that the general purpose of reserves is for 'Ensuring, as far as possible, the survival of all indigenous species of flora and fauna, both rare and commonplace, *in their natural communities and habitats, and the preservation of representative samples of all classes of natural ecosystems* and landscape, which in the aggregate originally gave New Zealand its own recognisable character' (our italics).

More recently, Goal Three of the New Zealand Biodiversity Strategy (NZBS; DOC & MfE 2000) is to 'Halt the decline in New Zealand's indigenous biodiversity', and requests that stakeholders 'Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state…'. A 'healthy functioning state' is then defined as 'a state in which an ecosystem can support all indigenous species occurring naturally within it'.

The Strategy holds that management of threatened species can be encouraged most directly in the context of an encompassing ecosystem and calls for managers to 'Increase planned recovery actions to cover priority threatened indigenous species and subspecies (including kiwi sanctuary zones) so that viable representative populations are maintained *in habitats and ecosystems important for biodiversity*' (NZBS, Objective 1.5, Action a; our italics). In fact separating species from ecosystems is seen by the strategy as problematic: 'A tendency to separate the management of species from their habitats is recognised as a problem that is starting to be addressed through a stronger ecosystem focus in management programmes' (NZBS, p. 36).

Conservation visions of fenced sanctuaries

The suggestion of Scofield et al. (2011) that fenced sanctuaries have the illusory goal of recreating the biodiversity configuration of some past time is not supported by vision statements from many sanctuary groups. This is evident from the selection below.

Glenfern (Great Barrier Island): '*To remove all mammalian pests and predators forever from Kotuku Peninsula and restore the habitat so that existing native species can thrive and lost species can be reintroduced to Great Barrier Island'* (Glenfern Sanctuary publicity leaflet, undated).

Tawharanui (Auckland): '*An open sanctuary where visitors can freely experience a representative range of natural communities that would originally have been present in the Tawharanui peninsula*' (Auckland Regional Council 2002. Tawharanui Open Sanctuary Operational Plan. Unpublished internal document).

Maungatautari (Waikato): '*To remove forever, introduced mammalian pests and predators from Maungatautari, and restore to the forest a healthy diversity of indigenous plants and animals not seen in our lifetime'*.

Rotokare (Taranaki): '*To restore Lake Rotokare Scenic Reserve biodiversity to its full potential'* (Campbell-Hunt et al. 2010).

Bushy Park (Wanganui): '*Paradise Restored: the preservation and enhancement of the forest by ridding it of all predators, together with the enhancement of native bird life and the introduction of rare and endangered species once found there'* (Campbell-Hunt et al. 2010).

Zealandia (Wellington): This lengthy vision statement starts with '*Imagine a secret valley only three kilometres from the central business district of Wellington. It is a large (250 ha) and spectacular valley, steep-sided with a rugged profile. It is clothed in vigorously regenerating native hardwood forest'*. The vision then describes a place with abundant native flora and fauna, including many threatened species, with many visitors including schoolchildren (Campbell-Hunt 2002).

We accept that some language (e.g. 'paradise restored') is evocative, but this is typical in vision statements of many organisations. In our experience, fenced sanctuary practitioners understand the limitations to restoration better than most, and none have the unrealistic goal of a return to a prehuman state.

Social goals are as important as ecological restoration

The findings of Scofield et al. (2011) regarding sanctuary objectives are based on a postal questionnaire survey sent to 15 of 18 fenced sanctuaries they had identified, with 12 responses being received. This investigation is limited in a number of ways. First, it is customary in the social sciences to report the survey instrument used so that its definitions and scales are open to review. For example, what definition was given to the potential benefit of 'Education and recreation' and was there a common understanding and interpretation of these terms between respondents and the researchers? Second, more information about the respondents is required. Were they general managers of the sanctuaries, or administration staff, or members of trust boards? What differences in perspective and insight might be expected from each group? Third, survey instruments provide respondents with a constrained range of responses to a limited number of questions, the whole being pre-selected by the researchers. This allows only a limited insight into the phenomenon of interest, a constraint that becomes more severe when the phenomenon (fenced sanctuaries) is new and has yet to settle into stable patterns.

Social research strategies better suited to the emergent nature of fenced sanctuaries are those used by Campbell-Hunt (2008), Campbell-Hunt et al. (2010), and Phipps (2011). Diane Campbell-Hunt undertook 45 semi-structured interviews with sanctuary trustees and staff, Māori representatives and associated government agency personnel in four fenced-sanctuary case studies – Karori (Wellington), Bushy Park (Wanganui), Rotokare (Taranaki) and Maungatautari (Waikato). She supplemented these data with analysis of additional documents (strategic plans, feasibility reports etc.) from case study groups (Campbell-Hunt et al. 2010).

Her results emphasised the large diversity of ecological and social goals that participants have for sanctuaries. Sanctuaries' direct contributions to biodiversity restoration are cited as important goals by many contributors to her study, as Scofield et al. (2011) also report, but these are outnumbered two-to-one by goals that will make an indirect contribution to other goals. These include increased involvement of local communities (also reported on by Roche & Rolley 2011); attracting additional funds for conservation from non-traditional sources; building the local community's capacity to contribute to conservation plus inspiration derived from direct contact with threatened species and ecosystems; provision of powerful advocacy and exemplars plus education and research on species and ecosystems, and evaluating a broader range of economic models for conservation.

Fenced sanctuary achievements

Scofield et al. (2011) base their assessment of biodiversity

achievements in sanctuaries on whether species translocated to a sanctuary had changed threat status according to the classification of Townsend et al. (2008). However, the New Zealand Threat Classification System used is a framework for assigning a conservation threat status to a taxon; it does not assess sites. It is extremely unlikely that any introduction of a vertebrate to any site – fenced, unfenced, or remote offshore island – could independently change the status of a taxon over the time that fenced sanctuaries have existed. Population changes used as primary criteria for designating threat status to a species are calculated over 10 years or three generations, whichever is longer (Townsend et al. 2008). Zealandia, the oldest fenced sanctuary in New Zealand, was established in 1999, but all other fenced sanctuaries larger than 60 ha were established from 2004 onwards, only 7 years ago (Burns et al. 2012).

Translocation to a single site is unlikely to change the status of a species on longer time scales unless (a) the taxon translocated is highly threatened and presently confined to one or two sites, (b) the site is big enough to support a very large population, and (c) substantial time has elapsed since initial translocation to allow the population to become large. In New Zealand, changes to threatened species status most frequently occur with the addition of multiple subpopulations (Townsend et al. 2008; R. Hitchmough, DOC, pers. comm.).

Unreported by Scofield et al. (2011), Miskelly et al. (2008) used the threat classification criteria of Townsend et al. (2008) to conclude that 19 bird taxa had *improved* status since the previous assessment in 2005, which they attributed to pest eradications on islands and to translocations to '*predator-free sites, or those with low predator densities due to sustained pest control'* (our italics). Four (brown teal *Anas aucklandica*, little spotted kiwi *Apteryx owenii*, South Island saddleback *Philesturnus carunculatus*, North Island saddleback *P. rufusater*) of the 19 species with improved status have been successfully translocated to fenced sanctuaries (Burns et al. 2012), and it is reasonable to suggest that these new populations contributed to the improved taxon threat status accorded by Miskelly et al. (2008). In this context the sanctuaries formed an important part of a broader translocation scenario.

Scofield et al. (2011) consider that sanctuaries fail the sustainability test because the fence requires long-term maintenance and vigilance. In their view 'a population is deemed to be self-sustaining if it is considered probable that succeeding generations will persist without human interference (Dudley 2005). It could readily be argued that, as fences require maintenance in perpetuity, no population within a fence will ever fit the criterion of self-sustaining used by Dudley (2005)'. The use of Dudley's definitions is inappropriate because he considers 'a self-sustaining population' to be one 'that survives at, or increases beyond, what is assessed to be a viable stable level in a natural state in the wild in Britain' (Dudley 2005). While appropriate in England, this definition is misplaced in New Zealand where introduced pest mammals pervade and dominate the faunal composition of ecosystems. Arguably, self-sustainability will be impossible for some sensitive taxa on the New Zealand mainland where a 'natural' state ended with human arrival in the 13th century, and also tenuous at best on all New Zealand islands, by Dudley's definition, because human vigilance will always be required to sustain their pest-free status.

The requirement for continued human support for pest-vulnerable taxa in New Zealand is a profound and irrefutable characteristic of restoration here for the foreseeable future. Pest mammals frequently reinvade islands (e.g. King 2005; Clout & Russell 2006; Elliott et al. 2010) as well as mainland sites. Clout and Russell (2006) list 28 reinvasions by four mammal pests to New Zealand islands. Even very remote islands may be reinvaded by pests from visiting or wrecked vessels, or as a deliberate act of eco-vandalism, and so also require endless human vigilance.

Do fences work?

We agree with Scofield et al. (2011) that '... predators quickly exploit new breaches in fences (e.g. fallen trees, damaged fences) and many studies examining the effectiveness of predator fences report the need for ongoing removal of predators from within fenced enclosures (i.e. Numata 1996; Reynolds & Tapper 1996)'. We could not obtain a copy of Numata (1996; an unpublished student report, Zoology Department, University of Otago), but note that the fences described by Reynolds and Tapper (1996) are old overseas types and not those currently in use in New Zealand.

The predator-proof fences being erected in New Zealand are based on extensive experimental research (Day & MacGibbon 2007) and are combined with extraordinarily successful multi-species eradication programmes that lead the world in terms of numbers of vertebrate species eradicated (Speedy et al. 2007; Innes & Saunders 2011). While eradication and exclusion of mice (*Mus musculus*) frequently fails, the emerging track record of exclusion fences with other pest species is excellent. We are aware of no possum (*Trichosurus vulpecula*), goat (*Capra hircus*), deer (*Cervus* spp.), ferret (*Mustela furo*), Norway rat (*Rattus norvegicus*), hedgehog (*Erinaceus europaeus*), rabbit (*Oryctolagus cuniculus*), hare (*Lepus europaeus*), sheep (*Ovis aries*) or cattle (*Bos taurus*) reinvasion of any ring-fenced sanctuary to date, other than when they were deliberately let in; stoats (*Mustela erminea*) and weasels (*M. nivalis*) are very rare reinvaders, while ship rats (*Rattus rattus*) are more common, but still infrequent (Connolly et al. 2009). Reinvasion is predictably more frequent at peninsula-fenced sanctuaries where reinvaders can walk or swim around fence ends, although a key issue requiring research is whether the pests are detected and removed before significantly harming resident biodiversity. Fenced sanctuaries are pest-resistant rather than pest-proof, but it is already clear that they not only target many more pest species than unfenced mainland islands, but also achieve significantly lower residual abundances (frequently zero) of all of them except mice. Whether this attainment of fewer pests is worth the extra cost is a valid question also requiring ongoing study.

Scofield et al. (2011) note the lack of published evidence showing that fenced sanctuaries in New Zealand increase breeding success of native birds, increase survival of native birds, or definitely exclude all predators. However, this assessment is premature because most sanctuaries were established after 2004, too recent to achieve, monitor and publish bird translocation successes at population level. The role of fenced sanctuaries (primarily Zealandia, Karori, Wellington) in returning vulnerable taxa such as tuatara (*Sphenodon punctatus*), little spotted kiwi, North and South Island saddlebacks, hihi (*Notiomystis cincta*), Cook Strait giant weta (*Deinacrida rugosa*) and Hamilton's frog (*Leiopelma hamiltoni*) to the mainland for the first time in a century is well known, although published quantitative assessments of the outcomes are only now emerging (Ewen et al. 2011). The origins, status and biodiversity outcomes of fenced sanctuaries are now reviewed in Burns et al. (2012).

Sixty-three translocations of 40 species have been made to the 24 pest-exclusion-fenced sites in the last 10 years. Over the same time period, 82 translocations were made to pest-free offshore islands, suggesting that pest-exclusion-fenced areas are now playing a similar role to islands in securing the future of threatened species (Burns et al. 2012).

Ecosystem outcomes consequent to the extremely low residual abundance of most mammal pests, except mice, in fenced sanctuaries are beginning to emerge. In Zealandia (Karori Sanctuary, Wellington), seedling density has increased markedly and possum-vulnerable species such as kohekohe (*Dysoxylum spectabile*), māhoe (*Melicytus ramiflorus*), patē (*Schefflera digitata*) and kanono (*Coprosma grandifolia*) have increased strongly in importance since mammal eradication (Blick et al. 2008). Monitoring at Maungatautari, the largest and most expensive sanctuary, has shown doubling of mean five-minute bird counts of tūī (*Prosthemadera novaeseelandiae*) and bellbird (*Anthornis melanura*) compared with non-treatment sites, as well as significantly higher flower pollination and fruit dispersal of tree fuchsia (*Fuchsia excorticata*, J. Iles, Canterbury University, pers. comm.). Also, adult tree weta (*Hemideina thoracica*) have increased 12-fold since mammal eradication and other weta have increased 52-fold (Watts et al. 2011). At this early stage these observations are inevitably incomplete in terms of fully describing ecosystem changes attributable to mammal removal, and it will be many years before they can be validly compared with similar measures in other kinds of protected areas (e.g. islands and unfenced mainland sites).

Advantages of fenced sanctuaries

Scofield et al. (2011) argue that marine islands are superior because they have lower probability of reinvasion of pests and are less expensive to maintain compared with mainland reserves; we agree. They acknowledge that islands protect different environments to the mainland (as assessed in Meurk & Blaschke (1990)). In fact 75% of the 100 environments (Level II) classified by LENZ (Land Environments of New Zealand) do not occur in areas larger than 100 ha on islands at all (Leathwick et al. 2003; C. Briggs, Landcare Research, pers. comm.). Offshore islands therefore represent different environmental conditions from those found on the mainland and both need consideration to achieve representative reserve networks.

We propose that there are four additional reasons why we are seeing greatly expanding mainland restoration compared with on islands.

First, we are rapidly exhausting our supply of offshore islands suitable for pest eradication and restoration. The number of islands that are nature reserves, large enough to be worthwhile, distant enough from the mainland that reinvasion is unlikely, and that have not already been subject to pest mammal eradication is now few (Bellingham et al. 2010; D.R. Towns, DOC, pers. comm.). Bellingham et al. (2010) comment that for island restoration 'the next two decades could productively become a period of consolidation'. Therefore, the search for new opportunities to increase the area of zero or near-zero pest-free estate in New Zealand must increasingly look to the mainland. Scofield et al. (2011) cite a 'large rat-free island in Golden Bay from which [the Crown] had paid the owners to eradicate the rats' that they suggest should have been a priority for Crown purchase. However, there are no large islands in Golden Bay, but they may be referring to 69-ha Puangiangi that occurs east of D'Urville Island, from where rats were eradicated by the Department of Conservation in 1999, using money from the South Pacific Conservation and Development fund that had been obtained by Victoria University of Wellington. Purchase was considered by the Department of Conservation but the island was under no immediate threats and was already subject to covenants and therefore considered secure (P. Gaze, DOC, pers. comm.).

Second, biodiversity restoration, especially in lowland areas, can no longer be separated from its major social drivers. Most people live in urban centres on the mainland, and communities are increasingly taking up restoration projects at sites that have local significance for them. Nearly all mainland sanctuaries are community- rather than agency-led (Campbell-Hunt et al. 2010).

Third, there is clearly a better chance of taxa establishing or supplementing populations in surrounding landscapes from mainland than from remote island sanctuaries, as whiteheads (*Mohoua albicilla*) and North Island tomtits (*Petroica macrocephala toitoi*) have done in wider Wellington after their release at the fenced Zealandia sanctuary (Miskelly et al. 2005). The abundance of tūī in private gardens within 10 km of Maungatautari sanctuary (Waikato) has more than doubled since all pest mammals except mice were eradicated inside the 3400-ha sanctuary in 2006 (N. Fitzgerald & J. Innes unpubl. data).

Finally, fenced sanctuaries arose directly from problems experienced with maintaining low pest densities in unfenced sanctuaries established in the late 1990s, and these problems all remain today. In unfenced 'mainland islands', predator control often failed to prevent damage by surviving or reinvading pests; some pest species such as mice and hedgehogs were mostly not targeted at all; there was concern about ongoing use of toxins and traps, including toxin residues in non-target wildlife; and there were well-known interactions between pest species that meant that key species (stoats, possums and ship rats in particular) required simultaneous control (Burns et al. 2012). There are many pest-sensitive endemic species that have been driven off the mainland by mammal predation during the last century that apparently require near-zero pest levels for population reestablishment. Translocations of some, such as North Island saddlebacks and hihi, have failed in unfenced sanctuaries, at least partly because of their vulnerability to even limited predation.

Conservation context for fenced sanctuaries in New Zealand

The diverse requirements for species and ecosystem restoration across all New Zealand environments, and the increasingly diverse individual, community and agency approaches to biodiversity protection, mean that no single approach will ever be adequate by itself. Our answer to 'Are predator-proof fences the answer to New Zealand's terrestrial faunal biodiversity crisis?' posed by Scofield et al. (2011) is 'not by themselves'. In our view they are, however, a critical component of New Zealand's modern conservation strategy, transferring an effective approach used in recent decades of creating predator-free offshore islands to the mainland.

We see the roles of fenced sanctuaries as:

1. Experimental projects restoring mainland ecosystems through achieving zero or near-zero density of a broad range of mammal pests, as key conservation policy and legislation has demanded since the 1970s. Such bold attempts are overdue, given known ongoing national biodiversity declines (e.g. Innes et al. 2010).

2. Providing critical scientific opportunities to improve pest eradication technologies and strategies; to explore New Zealand ecosystem structure free of the constraints of top-down control by pest mammals, and to discover rare, residual indigenous biodiversity elements in fragmented habitats.
3. Community initiatives to return pest-sensitive, iconic, endemic species to accessible sites on the mainland for the first time in a century, to create places of inspiration and biodiversity benchmarks for other conservation ventures that do not involve fences. For some of these indigenous species, fenced sites are essential on the mainland, but these sanctuaries also show what is possible in areas under different types of pest control.
4. Partnerships involving new types of funding including direct revenue generation and sponsorships for conservation outside of traditional government-funded schemes. Importantly, they have injected substantial sums of new non-governmental money into conservation from communities, businesses, regional and city councils and others.
5. Providing unprecedented educational and advocacy opportunities to large numbers of people, often from urban environments. For example, Zealandia sanctuary in Wellington had 89 000 visitors in the year prior to June 2011, and has had at least 50 000 schoolchildren on a guided educational experience since its opening in 2000 (N. McIntosh-Ward, Karori Sanctuary Trust, pers. comm.).
6. Providing opportunities to reframe conservation success. Sanctuary projects do not occur in isolation, but in a broader social and cultural context. As such, sanctuaries provide opportunities for people, including those driving conservation efforts, to learn from one another about different reasons why they perceive restoration as important. This may require a conceptual shift for some, to one that is inclusive of a range of knowledge types and values (Robertson et al. 2000; Kelsey 2003). In the absence of such a two-way conversation, conservation progress is likely to be stifled; not by a lack of ecological or technical understanding about how to proceed, but by the conflict that will inevitably arise (Woolley & McGinnis 2000).

In our view, conservation of threatened species alone, as emphasised by Scofield et al. 2011, while important, is an inadequate response to our conservation plight, policies and legislation, and the separation of species from their habitat, community or ecosystem is in practice impossible, especially for plants and invertebrates.

We agree with Scofield et al. (2011) that time is now required to properly evaluate the ecological outcomes of fenced sanctuaries, and whether these in turn are regarded by stakeholders as worth the cost. However, we dispute the claim that 'the rate of growth in predator-proof fence building is out of proportion to its benefits' when some benefits are already obvious, and many others are as yet unevaluated and therefore little understood. Most fenced sanctuaries are small (79% less than 240 ha; Fig. 1) and the rate of construction is declining with most new sites aiming to protect small seabird colonies (J. McLennan, Pestproof Fences Ltd & T. Day, Xcluder Pestproof Fencing Company, pers. comms). The only planned new large sites we are aware of are the ring-fenced 715-ha Brook Sanctuary at Nelson (D. Butler, Trust chair, pers. comm.) and the peninsular 500-ha Shakespear Open Sanctuary (http://www.sossi.org.nz/; accessed 26 July 2011). Most multi-species pest control sites are not fenced. Only 14 of the 62 projects defined as sanctuaries by the website sanctuariesnz.org are fenced, protecting 19% of the 55 577 ha included in the sanctuary definition (http://www.sanctuariesnz.org/projects.asp; accessed 2 August 2011). Among fenced sanctuaries, 3400-ha Maungatautari is uniquely large and, now that it is built, deserves support and time to properly evaluate its benefits.

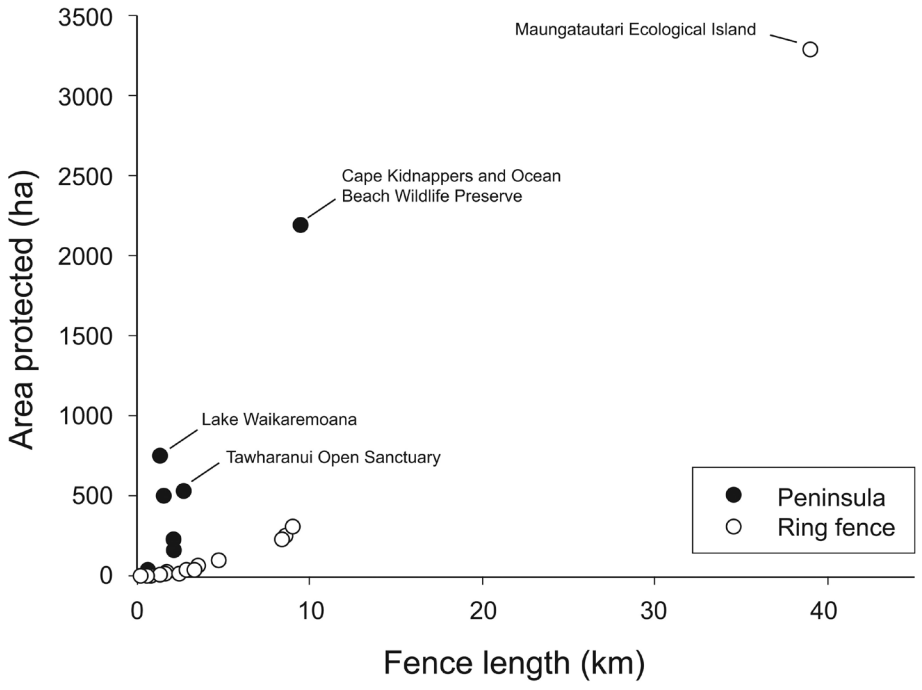

Figure 1. Fence length versus area protected for fenced sanctuaries in New Zealand. Data from Burns et al. (2012). The Lake Waikaremoana fence was built to limit kiwi juvenile dispersal rather than to exclude pests.

In contrast to Scofield et al. (2011) we support the development of the fenced sanctuaries on the New Zealand mainland as an important component of ecosystem restoration and species protection in areas most heavily impacted by human and pest activities. As community-supported, accessible sites for education and ecotourism, fenced sanctuaries are creating a network of relatively small areas where 'halting the decline' and experiencing the dawn chorus is inspiring a new generation of conservation advocacy.

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